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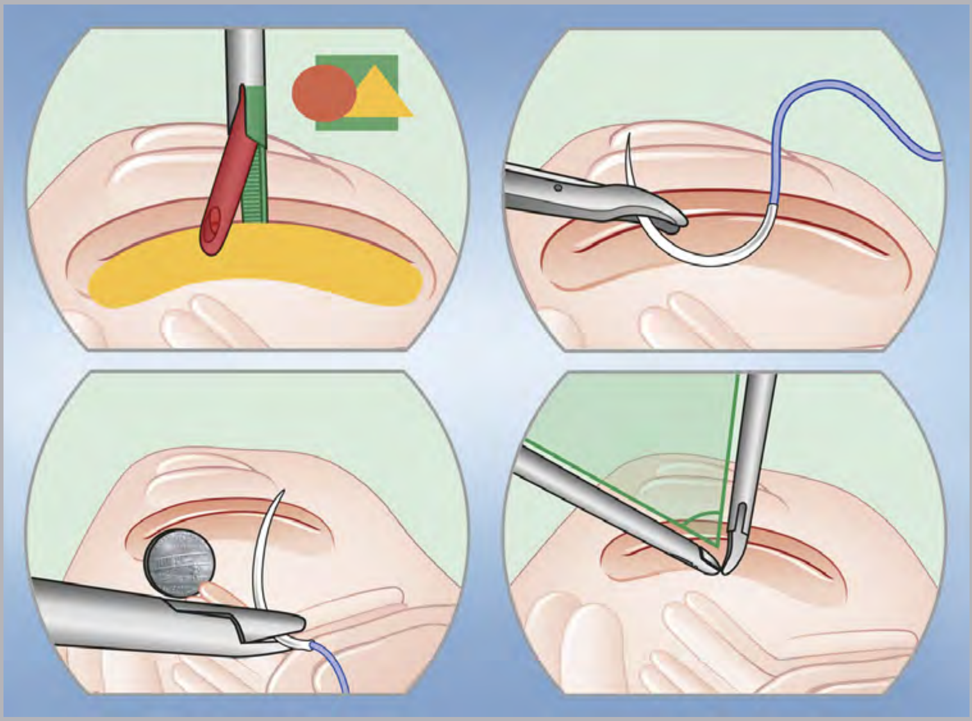
FUNDAMENTALS OF GEOMETRIC LAPAROSCOPY AND SUTURING



Joseph L. HUDGENS
Resad P. PASIC

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FUNDAMENTALS OF GEOMETRIC LAPAROSCOPY AND SUTURING

JOSEPH L. HUDGENS[1]
RESAD P. PASIC[2]

[1] | M.D., Assistant Professor – Department of Obstetrics and Gynecology, Director of Minimally Invasive Surgery at Wiser Women's Hospital, University of Mississippi Medical Center, Jackson, MS, USA

[2] | M.D., Professor of OB/GYN, Fellowship Director in Minimally Invasive Gynecology – Department of OB/GYN and Women's Health University of Louisville School of Medicine, Louisville, KY, USA

Illustrations by:
Katja Dalkowski, MD
Hauptstraße 64
91054 Erlangen, Germany
Email: kdalkowski@online.de

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Joseph L. Hudgens and Resad P. Pasic

Correspondence addresses of the authors:

Joseph (Jay) Hudgens, M.D.
Wiser Hospital for Women & Infants
2500 N. State St., Jackson, MS 39216, USA
Email: jhudgens@umc.edu

Resad P. Pasic, M.D., Ph.D.
Department of Obstetrics, Gynecology and Women's Health
University of Louisville School of Medicine
Ambulatory Care Building
550 South Jackson Street, 3rd Floor
Louisville, KY 40202, USA
Email: paya@louisville.edu
www.gynlaparoscopy.com

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Contributing and Assisting Authors

Joseph (Jay) Hudgens
M.D., Assistant Professor
Department of Obstetrics and Gynecology,
Director of Minimally Invasive Surgery at Wiser
Women's Hospital, University of Mississippi
Medical Center, Jackson, MS, USA

Resad Pasic
M.D., Ph.D., Professor of OB/GYN, Fellowship
Director in Minimally Invasive Gynecology –
Department of OB/GYN and Women's Health
University of Louisville School of Medicine,
Louisville, KY, USA

Thomas Lang
M.D., Department of OB/GYN and Women's
Health, University of Louisville School of Medicine,
Louisville, KY, USA

Linda-Dalal Shiber
M.D., Department of OB/GYN and Women's
Health, University of Louisville School of Medicine,
Louisville, KY, USA

Preface

The goal of this book is to describe how efficient laparoscopic suturing is performed by the systematic manipulation of geometry, and to serve as a guide to the laparoscopic surgeon who wishes to become proficient at suturing. Geometry by definition is the study of relationships. This concept provides the basis for our scientific explanation of efficient laparoscopic suturing. Experienced laparoscopic gynecologists debate the best technique for laparoscopic suturing which usually revolves around port placement. The development of this book is an attempt to clarify why these experts are equally successful regardless of their port placement. Their efficiency does not result from the placement of their ports but rather is founded on their ability to systematically manipulate the relationships between their instruments, needle, and anatomy which lead to their surgical proficiency. *Geometrically Efficient Laparoscopic Suturing* is a system that uses geometry to explain simple mechanical principles. The goal is to teach proper mechanics and use these mechanics to learn feel rather than using feel to learn mechanics. Once the surgeon learns the feel of these mechanics, then efficient suturing can be reproduced.

The manuscript of this monograph was compiled incorporating efficient learning principles. The authors have adopted well-established concepts developed in areas of education, skill acquisition models, and interpretation of visual graphics. It is commonplace in the realm of learning theory that a student's comprehension is diminished when faced with more than four ideas at one time[3]. The technique of breaking complex task into manageable parts and presenting additional information as components of those parts is known as the *Whole-Part-Whole Method*[2].

Laparoscopic suturing is a complex task that is evident by the prolonged learning curve. The struggle of learning this skill exists somewhat due to the simplicity in which it is taught. By following innate capacity that exists in the student, the instructor may give an oversimplified explanation of the task. This impedes the student from fully grasping the mechanics of the task and reaching their full potential. This is by no fault of the instructor who learned from repetitive and prolonged practice. The instructor has learned to subconsciously combine key individual elements into larger wholes. This in itself may not be apparent to the instructor which perpetuates the struggle in the learning process for both the student and instructor. A recent study showed that experienced laparoscopic surgeons had less movement of the right instrument than beginners[1]. This efficiency, in our opinions, results from the systematic manipulation of the needle and tissue that is learned through practice and experience and the importance of using the left hand in this process. Our goal is to present the concepts needed for efficient laparoscopic suturing explained by geometry and presented in a manner that is consistent with these educational principles.

We have broken down suturing into three phases; which are *setting the needle, tissue re-approximation, and knot tying*. The most important factor in laparoscopic suturing is the ability to set the needle perpendicular to the shaft of the needle driver. Until the student possesses this skill, the system of *Geometrically Efficient Laparoscopic Suturing* cannot be fully utilized. Many students underestimate its importance and focus undue time on the ability to tie an intracorporeal knot. The ability to tie a knot is useless without the ability to place the needle and suture in the proper location. The skills that enable the user to place the suture in the proper location is a direct reflection of the ability to control the needle and the anatomy. The ability to control the needle results from the needle being set perpendicular to the shaft of the needle driver. Control of the anatomy comes from the receiver (left hand). For the student to reach their full potential, they must first grasp, accept, and apply these concepts.

The first two chapters of this book will focus on the scientific explanation how to learn to manipulate a three-dimensional world on a two-dimensional screen and the equipment needed. Chapters 4–9 will provide a systematic approach that is based on the geometric and mechanical principles discussed from various port placements. Finally, chapters 10–14 will explain how to apply these concepts in the clinical setting.

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1 Laparoscopic and Geometric Principles – Understanding Visualization, Angles, and Planes

1.1 Obstacles to Laparoscopic Suturing and Surgery

There are three main obstacles that affect the initial learning curve when performing laparoscopy and laparoscopic suturing which are:

- Visualization
- Lack of depth perception
- Fixed range of laparoscopic ports

The rest of this chapter will define these obstacles in relation to geometry and explain how these obstacles can be overcome.

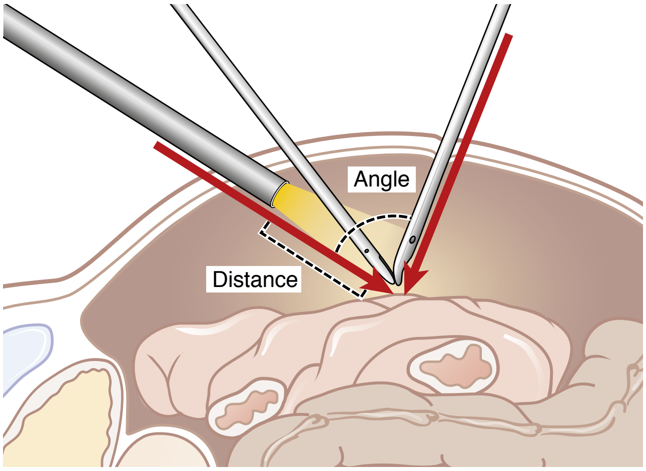


Fig. 1.2a Schematic diagram explaining the terms *visual distance* and *visual angle*.

1.2 Visualization and Understanding Visual Angle

Visualization by definition is to make something visible or the ability to form a mental picture. In laparoscopy, it is the visual field created by the laparoscope. In art, this is referred to as perspective. Visualization can also be implied as the ability to form a mental image of the task that the surgeon would like to accomplish. Improved visualization of the target anatomy and instruments allows for more efficient surgery to be performed. There are two major factors that affect visualization which are *visual distance* and *visual angle* (Fig. 1.2a).

As the distance between the camera tip and a fixed object is altered, the visualization of the object is affected because of the change of the visual angle. If the distance between laparoscope and object is large, the surgeon has a good panoramic view but loses good depth sensation (Fig. 1.2b). The visual angle is the angle that is created between the line of sight and the instrument or anatomy. When the distance between the laparoscope and the object is small, depth sensation is improved, but the global view is lost (Fig. 1.2c). As the camera is moved closer, the visual angle is

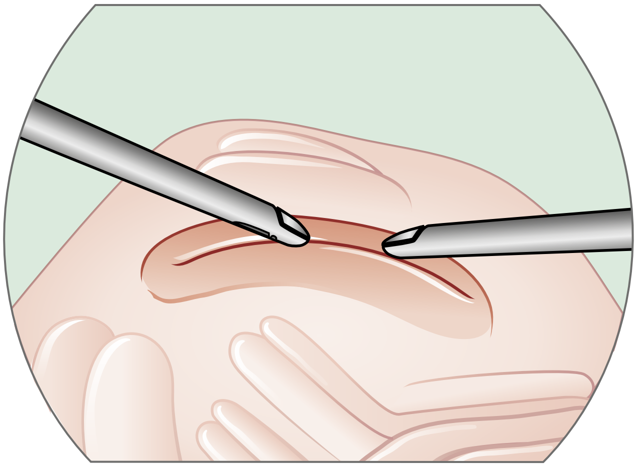


Fig. 1.2b Panoramic view.

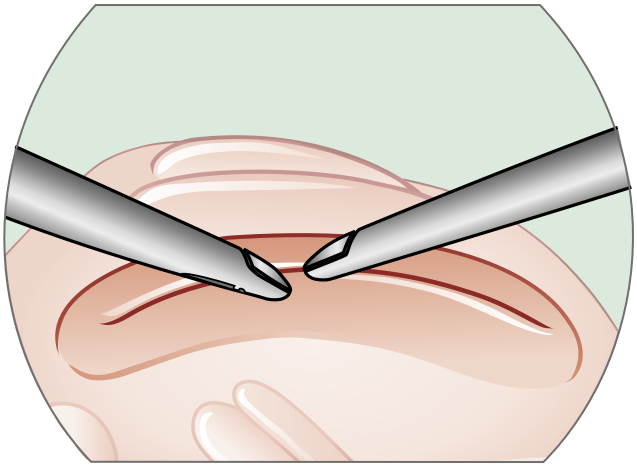


Fig. 1.2c Magnified visual angle.

increased and depth perception is improved. As the visual distance is increased, the visual angle is decreased. This improves the panoramic view of the surgical field, but at the same time decreases depth perception.

Visual angle is the most important factor, that affects the ability to perceive depth

When using a 0°-scope, the line of sight corresponds to the shaft of the scope (Fig. 1.2d). When using an angled scope, the line of sight is angled away from the shaft of the scope opposite the light source (Fig. 1.2e]). The visual angle is the most important factor affecting the ability to perceive depth, which has been shown by multiple studies in the areas of vision and perceptional psychology. One study from Brazil[1] (*Matsushima EH et al.*, 2005) showed that as the visual angle decreases from 90 degrees to 10 degrees, the ability to accurately predict distances progressively decreases. Examples of visual angles with laparoscopic instruments are shown in Fig. 1.2f. A 45°-visual angle is optimal when perceiving depth in two or more dimensions. When the visual angle is greater than 90 degrees, then the surgeon begins to work towards the camera and is performing *'backwards laparoscopy'* which can be quite challenging.

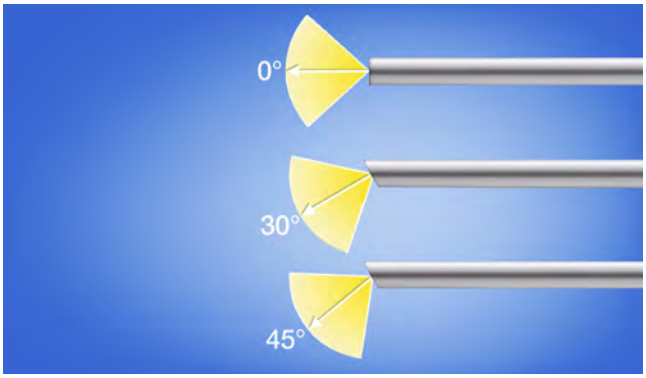


Fig. 1.2d Schematic diagram showing the various angles of view of a standard rod-lens laparoscope.

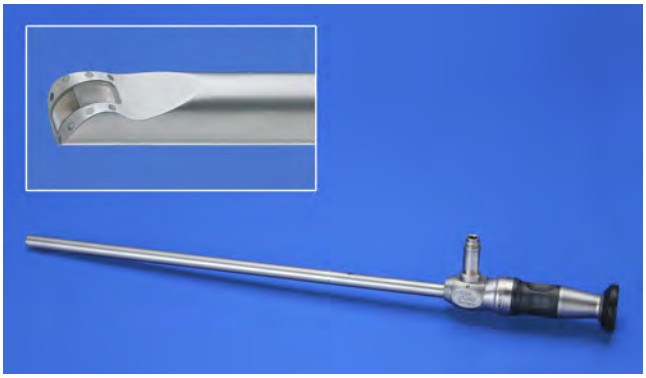


Fig. 1.2e The ENDOCAMELEON® (KARL STORZ Tuttlingen, Germany) allows the user to select the desired angle of view by use of an adjusting knob, obviating the need for switching between multiple scopes with different, but fixed angles of view.

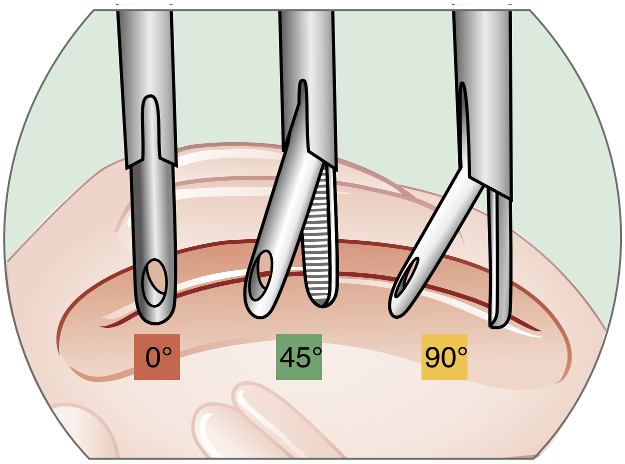


Fig. 1.2f Examples of visual angles with laparoscopic instruments.

A **45-degree visual angle** is the optimal angle for perceiving depth in two or more dimensions or between two or more objects.

1.3 Depth Perception and the Use of Monocular Cues

Depth perception is the ability to perceive spatial relationships and distances between objects in three dimensions. Depth perception comes from both binocular and monocular cues. In laparoscopy, the surgeon is looking at a flat screen and depth perception is more difficult. The surgeon must rely on monocular cues to calculate depth. The two categories of cues that lead to depth perception in laparoscopy are motion cues and size cues.

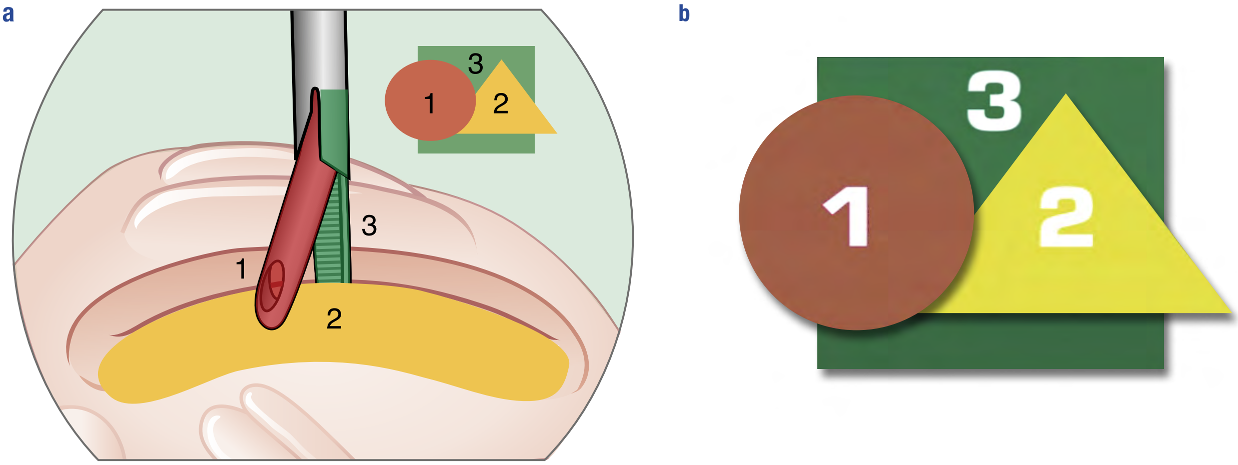
Motion Cues
- Object-kinetic depth perception
- Observer-motion parallax
- Occlusion

Size Cues
- Perspective (visual angle)
- Relative size
- Familiar size

Experienced laparoscopic surgeons have learned to subconsciously interpret these cues and develop a reconstructed three-demensional view of the operative field. Each cue is defined in relation to their role in depth perception and is outlined below.

- *Kinetic Depth Perception* is determined by dynamically changing an object's position to help determine depth. As objects are moved closer, they become larger and as objects are moved farther away, they appear smaller. This movement allows the observer to calculate velocity in relation to the rate of size change to determine depth.
- *Motion Parallax* occurs when the observer changes their perspective in relation to a stationary object. When the direction and velocity of this change in perspective is known, it allows absolute depth to be calculated. In laparoscopy, this occurs when a surgeon uses an angled scope to alter the line of sight or visual angle. This changes the surgeon's perspective and allows the depth of tissue planes and structures to be identified. Motion parallax can aid or hinder a surgeon during laparoscopic suturing.
- *Occlusion occurs* when one object blocks another and allows the surgeon to rank objects in depth (Figs. 1.3a, b). Occlusion is the most important visual cue in laparoscopy.

a b



Figs. 1.3a, b Schematic drawings illustrating the perception of depth by occlusion.

Occlusion is the most important visual cue in laparoscopy.

Perspective is the property of parallel lines converging at infinity and allows us to reconstruct the relative distance of two parts of an object. This is most relevant when dealing with the principle of visualization from the previous section. Perspective is a most important factor and can be defined as the optimal visual angle that enables accurate perception of depth.

Familiar Size is the size of an object that can be recalled from previous experience (size of needle) and allows information about depth to be inferred. If the size of two objects is known from experience, then a relative depth can be inferred by the change in their size relative to one another. This concept is crucial in determining the plane of the needle when setting the needle. By knowing the distance that exist between the tip and the swedge of the needle, the experienced surgeon can accurately determine the angle of the needle from the relative distance between the needle tip and swedge of the needle that appears on the screen (Fig. 1.3c).

Relative Size is a cue that provides information about the relative depth of two objects because the observer knows that they are of the same size or because their difference in size is known. Comparing the relative size of two different instruments allows relative depth to be observed (Fig. 1.3d).

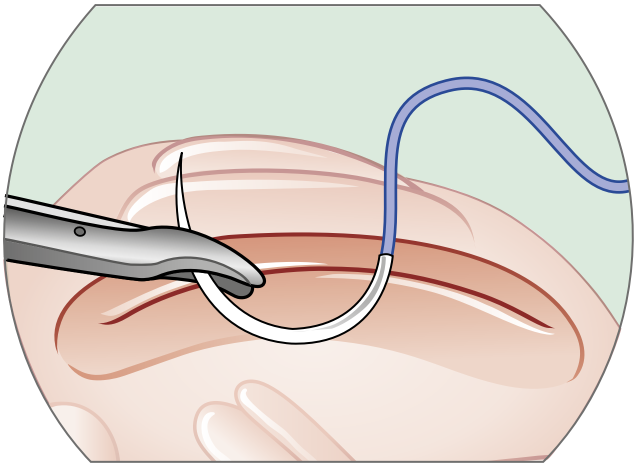


Fig. 1.3c Schematic drawing demonstrating the *familiar-size cue,* in this case, the distance between swedge and tip of needle.

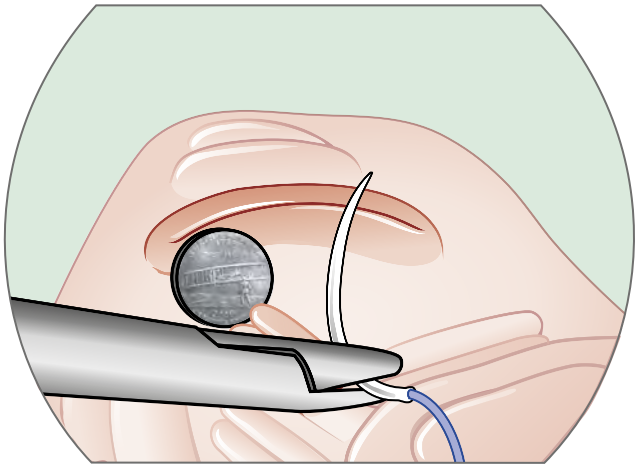


Fig. 1.3d Depth perception by use of the relative-size cue.

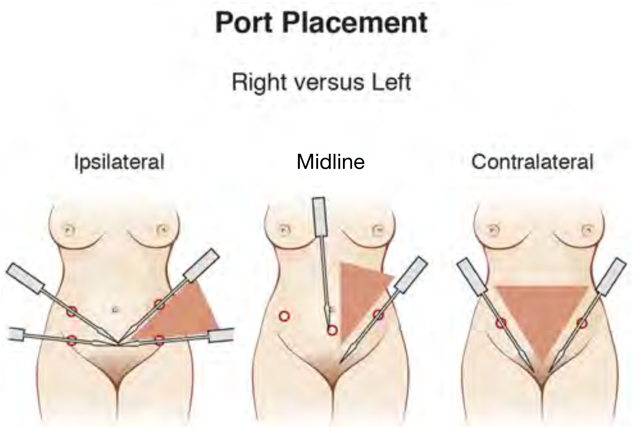


Fig. 1.4a Imaginary planes resulting from different port configurations.

1.4 Planes Determined by Port Placement

Ports are placed to gain abdomino-pelvic access. The resulting unrestricted movement of that instrument results in the range of that port. A port's range is mostly determined by its relation to fixed anatomic structures (like the bony pelvis). When two ports are placed and instruments are inserted, a plane is created. This plane can be altered by simultaneous movement of the ports. These imaginary planes can be visualized if you imagine a sheet of paper, shaped like a triangle, extending from the shaft of each instrument (Fig. 1.4a). If a third port is placed, then planes can be created by each pair of trocars. The trocar configuration determines possible operative planes that can be established. The effects of different port configurations are discussed in chapter 3, Port Configuration and Triangulation.

When two ports are placed, a plane is created by the instruments in the ports.

1.5 Understanding Angles, Planes, and Efficiency

As previously stated, one of the obstacles to overcome with laparoscopy is the fixed range associated with port placement. By definition, parallel lines do not intersect and perpendicular lines transect at 90 degree angles. When an object is perpendicular to the instrument tip, then the odds of grasping the object is increased (Figs. 1.5a,b). The further the instrument deviates from a perpendicular relationship the chance the object will be grasped is decreased. Objects approached at angles closer to parallel are more likely to be missed.

We have learned from previous sections that depth perception is improved when looking at objects from visual angles of next to 90° (perpendicular) and depth perception decreases as you approach visual angles closer to 0° (parallel). Therefore, the optimal angle for depth perception in two opposing planes is 45°. The goal for efficient laparoscopy is to create the best visual angle while arranging the instruments and anatomy in parallel and perpendicular planes to perform the desired task. This relationship of the camera, instruments, and anatomy is referred to as *triangulation* and is further described in *Section 3.1.*

When an instrument tip and object are perpendicular, it can be grasped. When there is a parallel relationship, the object will be missed.

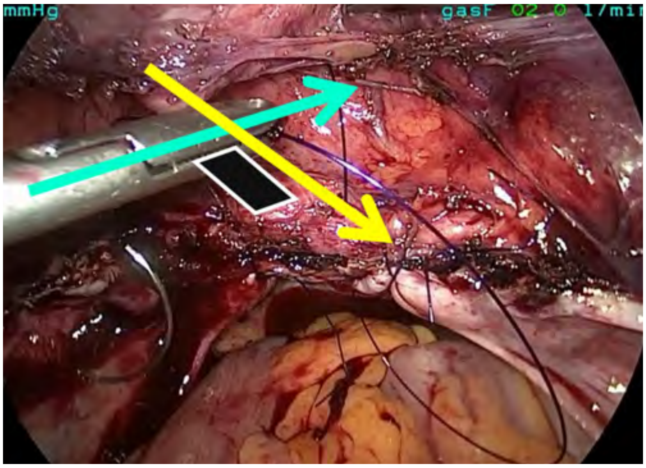


Fig. 1.5a The suture is grasped at a perpendicular angle with the left hand.

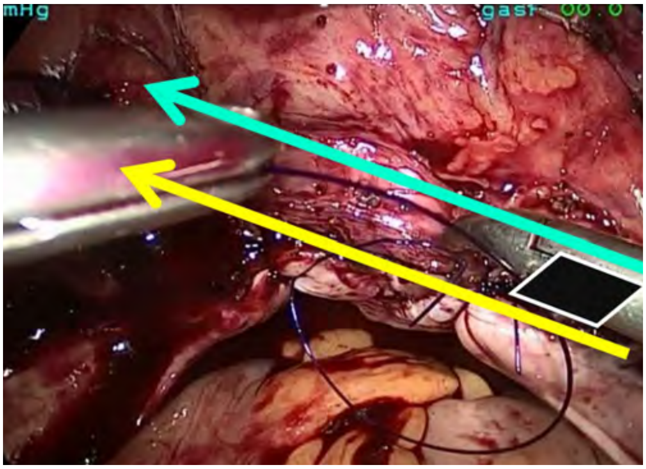


Fig. 1.5b The loop formed by the suture is parallel to the throwing (right) hand.

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2 Equipment

2.1 Video Imaging System and Laparoscope

The video imaging system and laparoscope are two of the most important pieces of equipment in laparoscopic surgery because they are your only visual link between the surgeon and the operative field. The newer generation of high definition (HD) cameras has dramatically improved the visualization of the operative field. An ideal scope is one that provides a clear image, provides excellent tissue contrast, minimizes glare, and allows a panoramic view. Laparoscopes traditionally come in 5-mm and 10-mm sizes and an angle of 0 °, 30°, or 45° (Figs. 2.1a, b). The ability to capture high-resolution images and video clips is important not only to communicate your findings to the patient, but to also allows the surgeon to assess critical portions of the procedure.

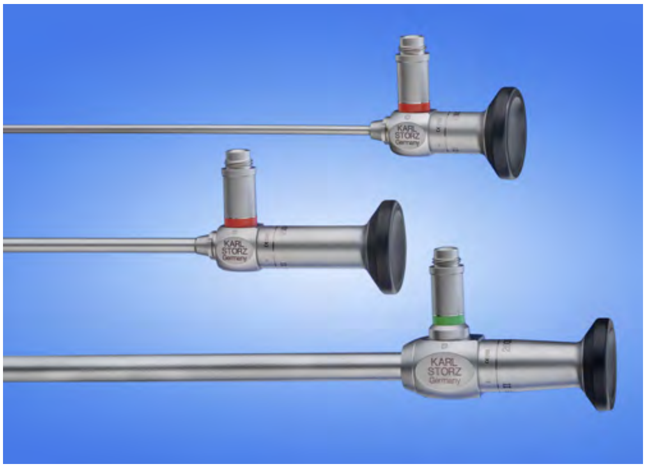

Fig. 2.1a Laparoscopes of various sizes and angles of view.

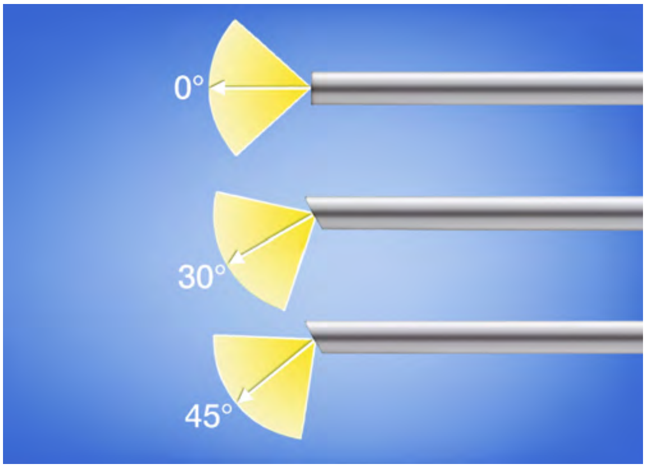

Fig. 2.1b Schematic diagram of the most common angles of view, 0°, 30° and 45°.

Fig. 2.1c MAGE1 SPIES™ FULL HD Camera System (IMAGE1 CONNECT™ and IMAGE1 H3-LINK™ for rigid endoscopy) with visualization tools. Three-chip FULL HD SPIES™ camera head (insert image) (KARL STORZ Tuttlingen, Germany).

Fig. 2.1d FULL HD 16:9 widescreen video monitor (KARL STORZ Tuttlingen, Germany).

2.2 Ports

For laparoscopic surgery and suturing to be performed ports must be placed. The configuration of these ports determines the plane in which suturing will be performed and will be discussed in Chapter 3, *Port Configuration and Triangulation*. The minimum number of ports necessary is two, however, a third port is often used by the first assistant. The size of port must correspond to the size of the needle being introduced or the needle must be back loaded. An ideal port is one that does not slip in and out of the abdominal wall, allows stabilization and unencumbered movement of an inserted instrument and maintains pneumoperitoneum.

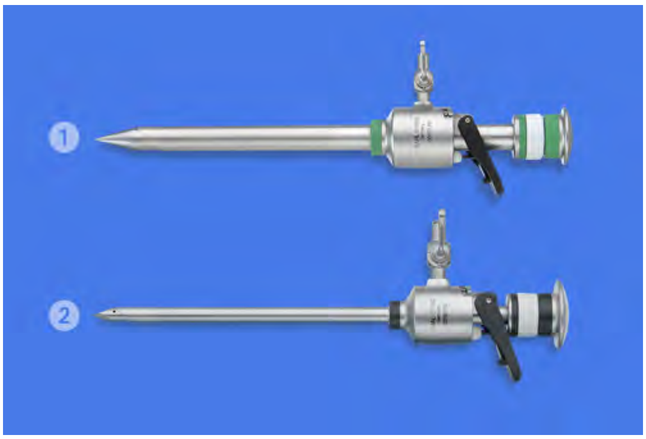

Fig. 2.2a Reusable sharp trocars with conical (**1**) and pyramidal (**2**) tips.

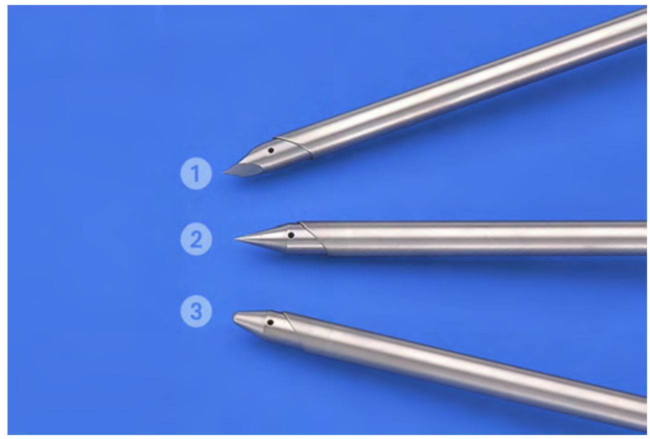

Fig. 2.2b Close-up views of the tip section of the most commonly used laparoscopic trocars, sharp pyramidal tip (**1**), sharp conical tip (**2**), and blunt conical tip (**3**).

2.3 Needle Drivers

A quality needle driver is the most important piece of equipment for performing laparoscopic suturing. Needle drivers are available in a variety of styles including curved and straight models (Fig. 2.3a). The jaw strength is an import factor in the instrument's performance and reliability to prevent the needle from slipping or rotating. A straight needle driver tip can be used from both sides and for both forehand and backhand suturing. A curved tip allows for a better visual angle as previously described and aids in intracorporeal knot tying. Curved left needle drivers are used from the patient's right side and curved right needle drivers from the patient's left side (Fig. 2.3b). The ergonomics of the ratchet and release mechanism is also a key feature of a needle driver. The surgeon should have the ability to easily

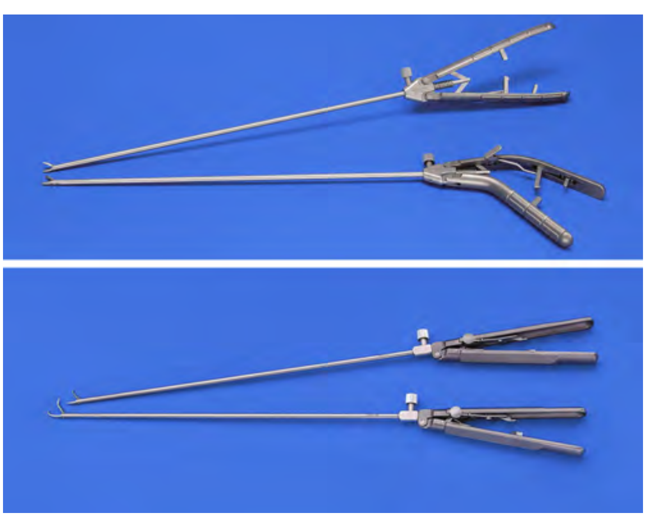

Fig. 2.3a Needle holders with straight and curved handles.

Fig. 2.3b Close-up views showing the jaws of the most commonly used laparoscopic needle holders, curved left (**1**), curved right (**2**), and straight (**3**).

lock and release the needle and suture to help avoid straining and fatigue in the small muscles in the hand required for laparoscopic suturing. An ideal laparoscopic needle driver should have the following characteristics:

- Grasp the needle without slipping
- Grasp the suture without damage
- An ergonomic handle and release

2.4 Receivers and Assisting Instruments

The assistant tissue grasping instrument is just as important as the needle driver during laparoscopic suturing. Some surgeons use a second needle driver which has an advantage in intracorporeal knot tying or when suturing with both hands. However, needle drivers in general are not good tissue graspers. To fully utilize geometrically efficient suturing, the receiver must be able to manipulate the tissue. The ideal assistant grasper should be able to control the needle, suture, and most importantly, the tissue.

An ideal assistant grasper should have the ability to grasp and hold tissue without causing trauma. The grasper should also be able to hold onto the needle and suture without slippage to effectively aid in suturing and knot tying.

The ability to ratchet the instrument helps avoid surgeon fatigue with repetitive suturing. The ability to disable the ratchet is desired by some surgeons and can be useful in certain situations. The instrument used by the first assistant is also important. The first assistant is often assigned with the task of orienting the tissue in the proper plane for the surgeon. A small toothed grasper is often helpful in these situations Examples of various types of assisting instruments are shown in Figs. 2.4a, b.

The ideal assistant grasper should be able to control the needle, suture, and most importantly, the tissue.

Fig. 2.4a Close-up view of the KOH Assistant Needle Holder, straight jaws with distal hole (**1**), and the KOH Macro Needle Holder, straight jaws (**2**).

Fig. 2.4b Close-up view of the MANHES Grasping Forceps available with Cobra jaws (**1**) and Tiger jaws (**2**).

2.5 Suture Material

The selection criteria that a surgeon uses for open procedures should be followed for laparoscopic procedures. One characteristic that is more influential in laparoscopy is the memory of the suture especially when tying intracorporeal knots. Monofilament suture has more memory and can aid in forming the loop when tying intracorporeal knots. This concept can be a source of frustration if not understood. The length of the suture is another important consideration. The recommended lengths of suture for different applications are outlined in the panel on the right.

The introduction of barbed suture has alleviated the need to tie knots in certain instances, but the basic principles for laparoscopic suturing still apply.

Intracorporeal
- Interrupted = 10–12 cm
- Figure-of-eight = 15 cm
- Running = 30 cm

Extracorporeal
- Length of suture = 36 inch

2.6 Knot Pushers

A knot pusher is used to tie extracorporeal knots. They come in two standard varieties and which are open and closed (Fig. 2.6). Open knot pushers are easier to load, but require the surgeon to maintain the proper tension on the suture to avoid slippage. Closed knot pushers require the suture to be threaded through the opening. Extracorporeal knot tying will be discussed further in Chapter 5.

Fig. 2.6 Close-up view of the two varieties of knot pushers that come with closed (**1**) and open (**2**) tips.

2.7 Laparoscopic Scissors

Scissors are required to cut the suture. They come in several types including curved, straight, and hook scissors (Figs. 2.7a–c). Hook scissors can be employed so that the curved dissection scissors are not overused.

Fig. 2.7a Close-up view of METZENBAUM curved scissors.

Fig. 2.7b Close-up view of straight scissors.

Fig. 2.7c Close-up view of hook scissors.

3 Port Configuration and Triangulation

3.1 Triangulation

Triangulation in laparoscopy refers to the relationship between two instruments and the camera in relation to the target anatomy. Triangulation has three main components which are: 1) *angle between instruments*, 2) *plane between instruments*, and 3) *visual angle*. When two ports are placed, they create a plane and angle of triangulation. The angle between these two instruments creates the *angle of triangulation* (Fig. 3.1a). This angle varies depending on the distance between the ports on the abdominal wall and the distance the instruments are inserted. The instruments also create a *plane of triangulation* (Fig. 3.1b) which is the plane created between these two instruments. The perspective of the plane of triangulation depends on the position of the camera relative to the plane.

Ideal visualization occurs when the camera is placed in the middle and above the plane of triangulation. Studies on visual perception have shown that once the visual angle is reduced to less than 30 degrees, the ability to judge depth is reduced. In gynecology, the camera is mostly at the umbilicus. For this ideal triangulation to occur, the surgeon must operate from contralateral ports which requires reaching over the patient. The following sections will highlight the advantages and disadvantages of the three most commonly used port configurations and the resulting components of triangulation.

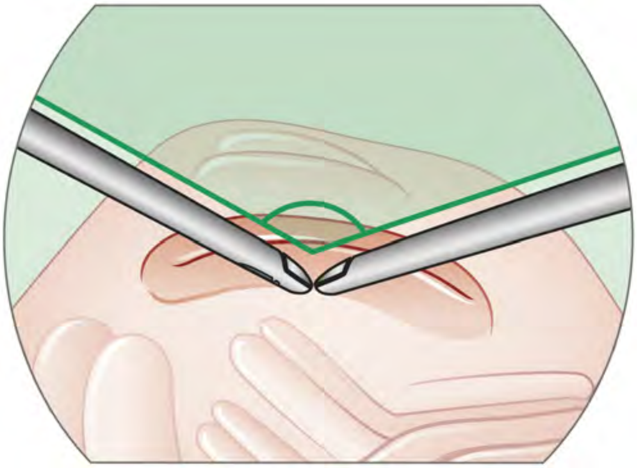

Fig. 3.1a Angle and plane of triangulation for a contralateral, midline and ipsilateral right port placement.

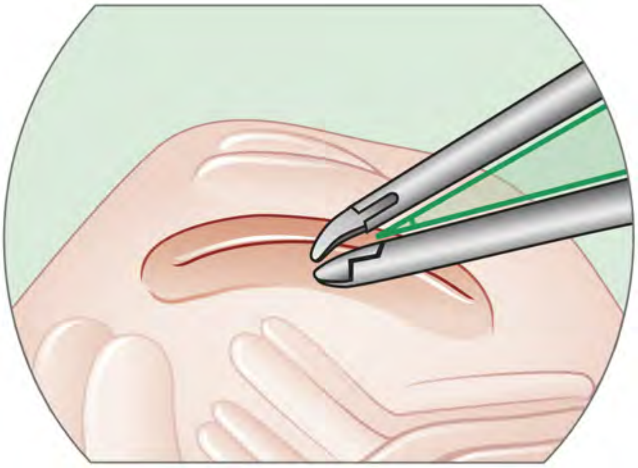

Fig. 3.1b Angle and plane of triangulation for an ipsilateral right port placement.

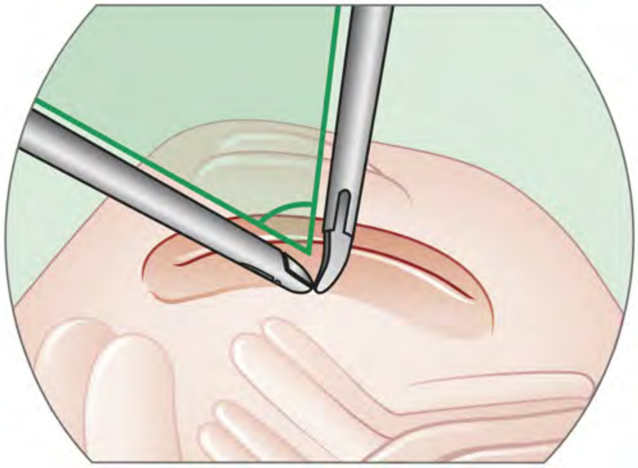

Fig. 3.1c Angle and plane of triangulation for a midline port placement.

3.2 Contralateral Port Placement

A contralateral configuration occurs when ports are placed on either side of the abdomen. The ports may be placed from just above the iliac crest or lateral to the umbilicus. Both the distance lateral and caudal from the umbilicus determines the plane and angle of triangulation. The major advantages to this configuration is ideal triangulation and visualization which may improve intracorporeal knot tying.

A disadvantage of a contralateral port placement is the loss of a third port. This limits the ability of an assistant to aid in using traction counter-traction which may be required for more complex cases. The other major disadvantage is poor ergonomics. Because the surgeon must reach across the table, this can lead to significant stress and fatigue on the shoulders when operating for extended periods of time. The use of a stool to elevate the surgeon above the patient improves ergonomics. The table can also be tilted towards the surgeon.

Fig. 3.2a Contralateral port placement, external view.

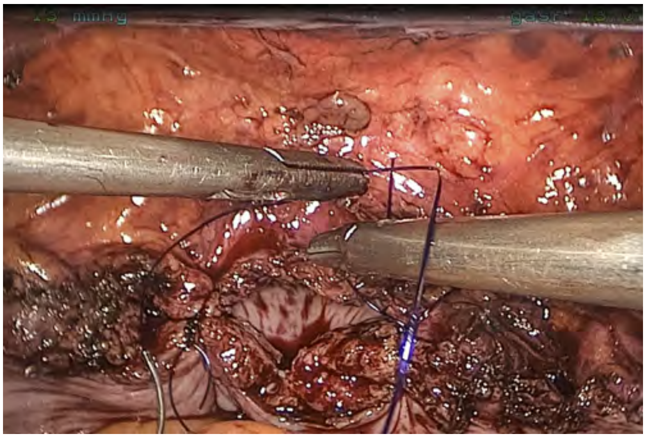

Fig. 3.2b Contralateral port placement, internal view.

Fig. 3.2c Contralateral port placement, poor ergonomics.

3.3 Ipsilateral Port Placement

Ipsilateral port placement occurs when lateral ports are established on the same side of the patient. This configuration is often accompanied by a third port for the assistant on the opposite side .The two ports can be placed on either the right or left and is a matter of surgeon choice. The major advantage of this configuration is ergonomics. This configuration allows for a more relaxed position for the surgeon and therefore is ideal for longer procedures and those requiring repetitive suturing.

The disadvantage to this configuration are the loss of a midline port, which decreases the range for vertical triangulation. Another disadvantage is the loss of the ability to switch the role of surgeon and first assist without switching sides of the table. This is most applicable in the academic setting. This can be alleviated by placing a forth port on the assistant's side which gives even more versatility without compromising ergonomics.

Fig. 3.3a Ipsilateral right port placement, external view.

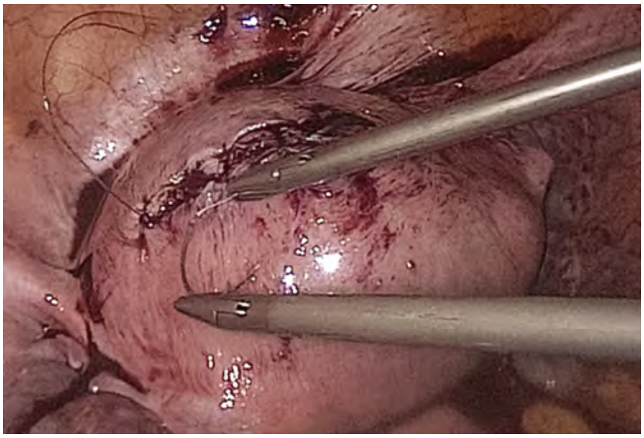

Fig. 3.3b Ipsilateral right port placement, internal view.

Fig. 3.3c Ipsilateral left port placement, external view.

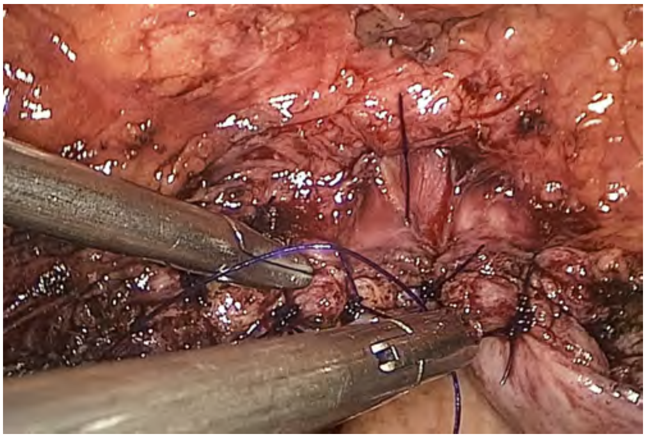

Fig. 3.3d Ipsilateral left port placement, internal view.

3.4 Midline Port Placement

A midline port configuration occurs when lateral ports are placed in conjunction with a midline suprapubic port (Figs. 3.4a,b). The lateral ports may be placed either just above the iliac crest or even with the umbilicus. Advantages of this port configuration include the ability for the role of surgeon to be switched from the left and right without having to move around the table. This configuration also allows for vertical triangulation and medial traction which can be useful in certain instances like enlarged uteri, urogynecologic procedures, or in the case of midline endometriosis.

A major disadvantage of this configuration is the fact that few instruments are designed to be held through a midline port. This may lead to poor ergonomics for the surgeon (Fig. 3.4e). This is overcome by grasping the instrument upside down. It is important to learn to manipulate these instruments with the small muscles in the hand and not the larger muscles of the arm. This facilitates fine manipulation that is needed for dissection, suturing and intracoporeal knot tying.

When a midline port placement is used, the surgeon is usually standing on the left with the first assistant on the right. The relationship of the midline port in relation to the lateral port depends on whether the surgeon is placing their right or left hand through the midline port. When the surgeon places their right hand through the midline port, the lateral port must be at the same level or lower than the midline port. If the surgeon places their left hand through the midline port, then the port should be lower and the lateral ports are placed more cephalic. Understanding this relationship is important for proper ergonomics. The following figures give examples of these various port placements, hand positions, and ergonomics.

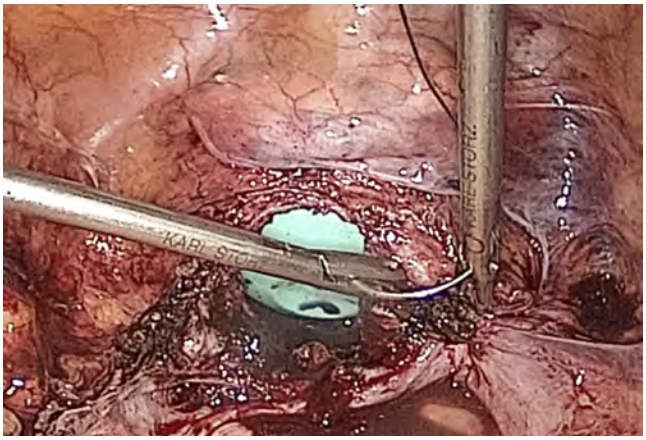

Fig. 3.4a Midline port placement, internal view.

Fig. 3.4b Midline port placement, right hand, external view.

Fig. 3.4c Midline port placement, left hand, external view.

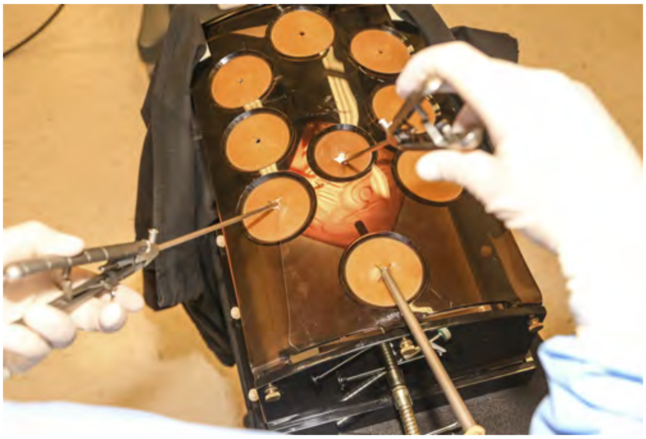

Fig. 3.4d Proper ergonomics right handed midline port suturing.

Fig. 3.4e Poor ergonomics for right handed midline port suturing.

Fig. 3.4 f Proper ergonomics for left handed midline port suturing.

Fig. 3.4 g Poor ergonomics for left handed midline port suturing.

4 Systematic Method

4.1 Introduction: Rationale for Systematic Approach

Laparoscopic suturing is a complex task which takes patience and hours of practice to become proficient. A systematic approach is important for learning, reproducibility, and efficiency. The general theme of skill acquisition models is to teach the fundamentals and rules that apply to all skill levels. With experience, the learner finds these rules are conditional based on the situation. It has been shown that complex tasks are best learned by applying the *Whole-Part-Whole Method*. The basic principles for laparoscopic suturing, like geometry, visual angle, and triangulation, have already been discussed.

The goal of this chapter is to present a systematic approach to suturing that can be applied to a variety of situations and applications. This system relies less on a particular port configuration and more on a generalized approach that can be modified based on an individual surgeon's skill, needs, and experience. We have divided laparoscopic suturing into three steps: 1) setting the needle, 2) tissue re-approximation, and 3) knot tying. Each step is then subdivided into three, as shown in the tables below. By breaking down the process in this manner, this allows a systematic progression while passing through the learning curve.

In each section, we will present what we have found our keys for efficiency. We will also present common mistakes that lead to compounded errors and decreased efficiency.

Table 4.a

1.	**Set the Needle**
2.	**Reapproximate Tissue**
3.	**Tie the Knot**

Table 4.b

1.	**Set the Needle** ■ Align needle ■ Right needle ■ Confirm needle
2.	**Reapproximate Tissue** ■ Place Tissue Parallel ■ Axial Rotation ■ Reset Needle
3.	**Tie the Knot** ■ Prepare Loop ■ Throw Knot ■ Secure Knot

Understanding the relationships between the instruments, needle, suture, and tissue is crucial to reproduce efficient laparoscopic suturing. There are three key axes that are critical in understanding these geometric relationships which are:

- The rotational axis between the needle and the driver
- The angle between the upright needle and the shaft of the driver.
- The axis between the needle plane and the tissue.

4.2 Setting of the Needle

Setting the needle perpendicular to the shaft of the needle driver is the first and most important step towards efficient laparoscopic suturing. Until this step is mastered, more information only yields more frustration and confusion. More time is lost and motion wasted on setting the needle than in any other step. If a surgeon-in-training takes the time to learn and master this step, we have found that progression through learning suturing is greatly accelerated. There are times where setting of the needle at an angle greater than 90 degrees may be more advantageous and require less tissue manipulation. However, as the angle is increased to more than 90 degrees, stability is lost and improper torque on the needle during rotation may cause it to slip in the tissue. The needle should never be set at an acute angle that is less than 90 degrees.

Setting the needle **perpendicular** to the shaft of the needle driver is the most crucial step in efficient laparoscopic suturing.

The needle is divided into three sections: the tip half of the needle, the swedge half of the needle, and the suture. We have also assigned a point on each section designated A-B-C where Point A is on the suture 3 cm from the swedge, point B is 1/3 of the way from the tip, and point C is 1/3 from the swedge (Figs. 4.2a, b). To avoid unnecessary steps, we recommend that the swedge half of the needle is only grasped by the driving hand (right hand) and the tip half of the needle is only grasped by the receiving hand (left hand).

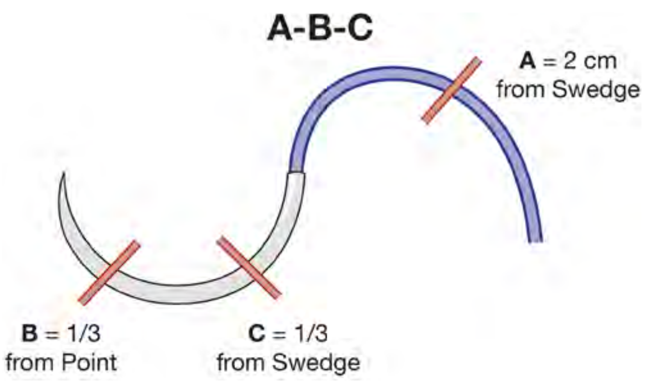

Fig. 4.2a Anatomy of the needle.

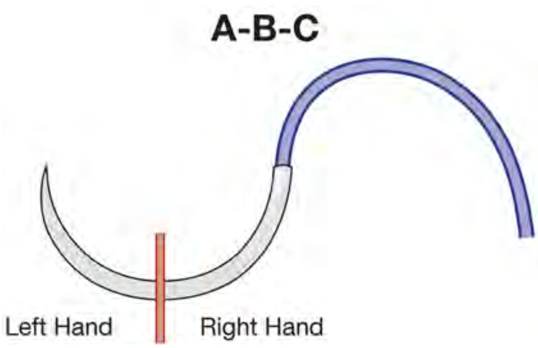

Fig. 4.2b The front of the needle should only be grasped by the left hand and the back of the needle should only be grasped by the right hand.

4.2.1 Introduction of the Needle

Needle introduction is the first step in the suturing process. There are three basic ways that a needle can be introduced which are:

- Direct trocar entry
- Back loading
- Through the abdominal wall.

Understanding different entry techniques and how they relate to the initiation of setting the needle is an important concept to improve operative efficiency.

Direct trocar entry is the most common form of entry used. The ability to pass the needle directly through the trocar is related to two factors: the size of the needle and the diameter of the trocar. Another important consideration is the type of valve used in the trocar and how this affects the ability to safely introduce and remove the needle from the abdominal cavity. Fig 4.2c lists the different trocar sizes commonly used and specifies the needles that can be passed through them. The orientation of the needle at the time of introduction is a major factor in efficiency. The suture should be grasped outside the abdomen so that the needle lies in the same plane that will be needed for suturing. This will allow for an easy transfer of the needle between the receiver and driver. When the needle is introduced in an orientation that is not the same as the orientation needed to begin suturing, unnecessary steps have to be taken to reorient the needle.

Set the needle outside the body in the same orientation that you want inside the body.

5 mm = Keith Needle
8 mm = SH-1 Needle
10 mm = CT-1 and CT-2 Needles
12 mm = CT Needle

Fig. 4.2c Various trocar sizes commonly used and needles that can be passed through them.

Back loading is another entry option that is commonly used. This technique can be broken down into four steps; See *Section 5.4*.

- Remove the trocar and pass the driver through the trocar
- Grasp the tail and pull it through the trocar.
- Grasp the suture 2–3 inches from the swedge of the needle
- Reinsert the driver through port site and slide the trocar back into place.

A benefit to this method is that you can pass a larger needle (CT-1) through a 5-mm port site. This can have a cosmetic benefit and allows a suture to be placed through any trocar site. One drawback of this technique is that it may be difficult to reinsert the driver through the port site. This may lead to a decrease in efficiency and port site trauma. Complications arising from this technique include subcutaneous insufflation and port site hematomas. There have also been some case reports of bowel herniation through trocar sites where back loading of the needle had occurred.

Placing the needle **directly through the abdominal wall** is another option (Fig. 4.2d). This is commonly done when straight needles are used as traction sutures. CT-1 needles can be passed directly through the abdomen if patients have thin abdominal walls. These needles can be retrieved back through the skin or back loaded out through a trocar site.

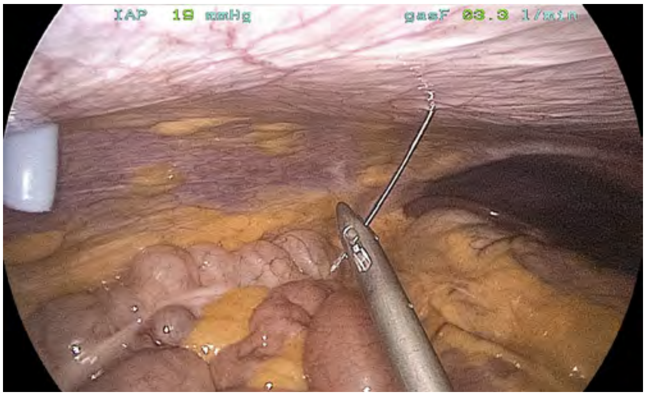

Fig. 4.2d Straight needle passed directly through the anterior abdominal wall.

Setting the needle s divided into three parts that correspond to the points **A-B-C**. The last step is critical in confirming the needle is set in perpendicular. If this process is rigidly followed, then setting the needle becomes reproducible. When a mistake occurs, the surgeon can reverse the process and correctly set the needle. This helps to minimize compounded mistakes which plague beginners.

- **A** – pass to receiver
- **B** – right the needle
- **C** – confirm with rotation

A – Drag: We recommend the driver starts at position ‘A’. The surgeon then passes the needle to the receiver which grasps the needle at point ‘B’ (Fig. 4.2e). A dragging motion can be beneficial in performing this maneuver. The receiver is not locked at point ‘B’ which allows the needle to be positioned into the correct plane in the next step.

B – Right: The Needle is righted by the driver manipulating the suture at point ‘A’ (Fig. 4.2f). The suture is moved in a push-and-pull manner until the needle lies in a plane that is perpendicular to the needle driver. Rotating the receiver can also slightly change the orientation of the needle into the correct plane. Once the needle is at the ‘right’ angle, the driver is released from point ‘A’.

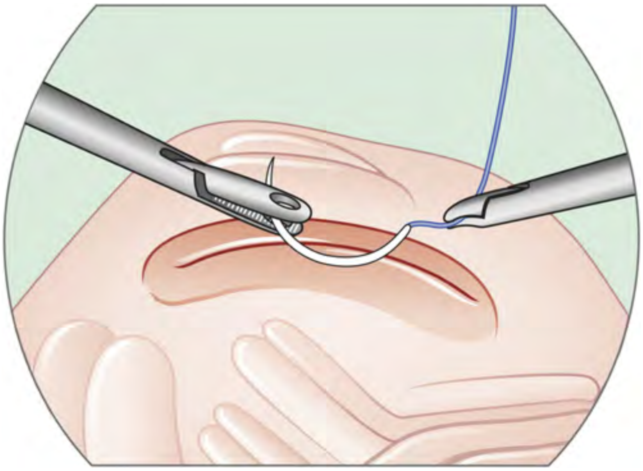

Fig. 4.2e The needle is passed to the receiver by grasping point ‘B’.

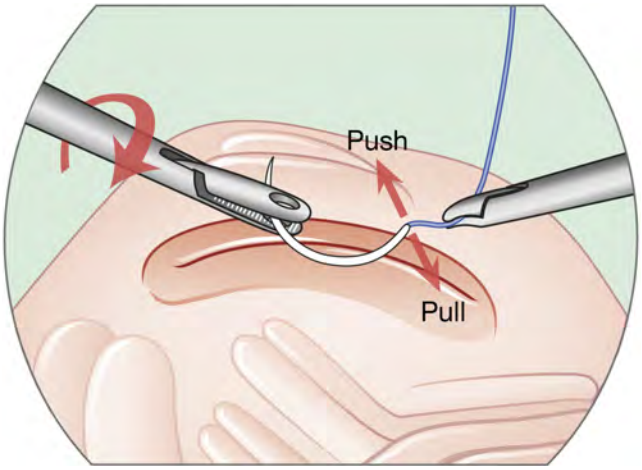

Fig. 4.2f The needle is “righted” by using a push-pull-up motion, and rotation of the assistant instrument.

C – Confirm: The needle is now grasped by the driver at point 'C' (Fig. 4.2g). The flat edge of the fixed side of the driver is rotated so that its position corresponds the curvature of the needle. This step is critical so that the plane of the needle is not altered during this step. The receiver releases point 'B' and an axial rotation of the driver confirms the position of the needle. If the angle of the needle is not appropriate for suturing, then the process is repeated in reverse order, with the receiver placed at point 'B' and then the driver at point 'A'. The angle of the needle is then readjusted and the driver reset at point 'C'.

- Grasp objects as close to 90° as possible.
- Use a 45° visual angle and the occlusion principle for increased accuracy.
- Don't let gravity win. Always have one instrument on the suture or needle and manipulate it to a favorable position in preparation for the next step.

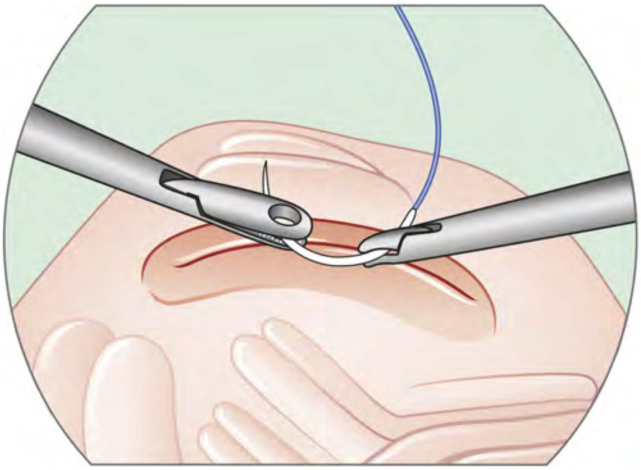

Fig. 4.2g The needle is grasped at point 'C' with the flat edge of the needle driver aligned with the curvature of the needle.

4.2.2 Advanced Setting of the Needle: A–C Method

Many experienced laparoscopist have learned to set the needle without following these steps. The needle may be introduced with the suture grasped at point 'A' with the receiver (left hand). The driver then grasps the needle at point 'C'. The receiver moves the suture to change the axis of the needle into the suturing position. Although this can save a step theoretically, many beginners have difficulty getting the needle in the proper axis and – if this is left undone – run the risk of wasting motion and even more time to reset the needle later in the suturing process where their errors are compounded.

- Stabilize the needle against tissue when grasping the needle at point 'C'.
- Small movements make a big difference in needle position.

Fig. 4.2h The A–C Method.

4.3 Suturing

Suturing for the purpose of this section will refer to the passing of the needle through the tissue for re-approximation. We have divided this step into three parts:

- Tissue positioning parallel to the shaft of the needle driver (Fig. 4.3a).
- Driving of needle with axial rotation of the needle driver (Fig. 4.3b).
- Rotating needle out of tissue and resetting needle (Fig. 4.3e).

By following this simple and repetitive algorithm, efficient tissue approximation can occur in a reproducible manner. The tissue is grasped with the receiver and positioned parallel to the shaft of the needle driver. This allows the needle to be passed through the tissue with an axial rotation of the needle driver. The assistant may aid in this step.

By changing the plane of the tissue in relation to the camera, the visual angle is changed to give the surgeon better depth perception and a better idea of where the needle should be placed.

The needle driver is rotated around its longitudinal axis to pass the needle through the tissue. Ideally both the rotational axis and the upright axis of the needle are perpendicular to the shaft. With the tissue placed in the proper orientation, this allows for optimal passage of the needle. The angle of the needle to the shaft may be increased to 120° to account for anatomic variation but care must be taken not to apply undue force along the vector of the shaft because otherwise twisting of the needle is more likely to occur.

After the needle is passed through the tissue, it is grasped by the receiver, rotated out of the tissue and reset with the driver. If the needle is rotated out of the tissue and the plane of the needle is not perpendicular to the driver, the suture is grasped at point 'A', the angle of the needle is adjusted and the needle is reset with the driver.

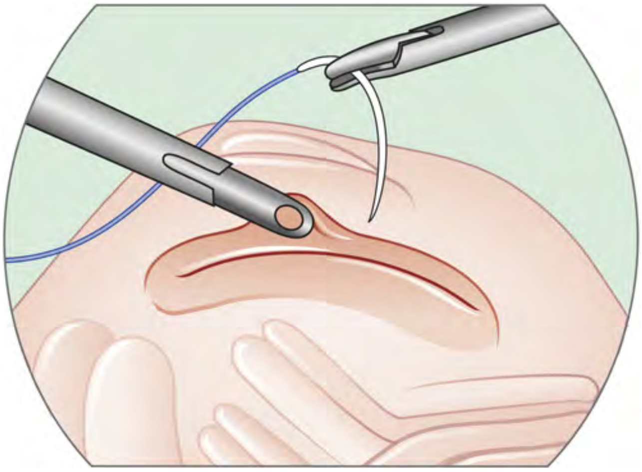

Fig. 4.3a The tissue is placed parallel to the needle driver.

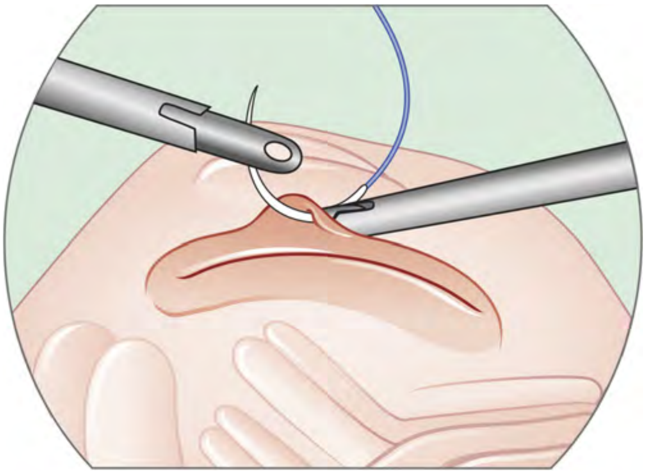

Fig. 4.3b Needle passed perpendicularly through tissue and grasped at point 'B'.

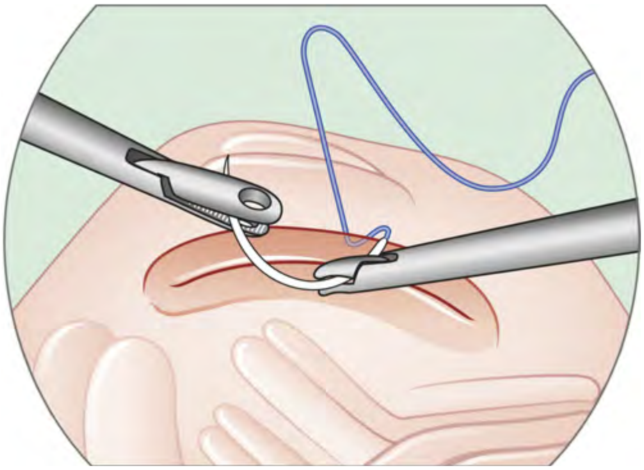

Fig. 4.3c The needle is reset at the level of the tissue.

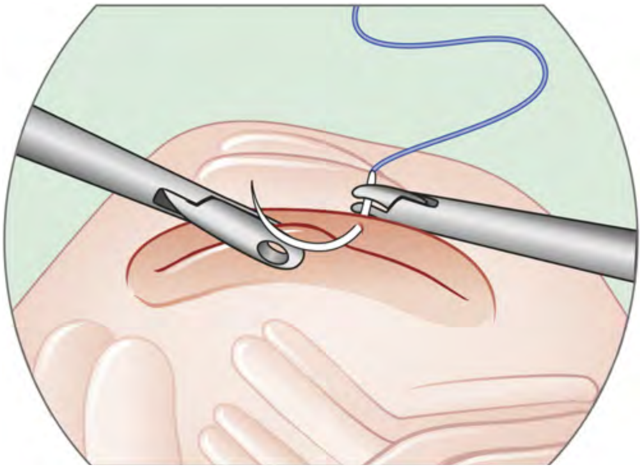

Fig. 4.3d Needle passed through other side of tissue.

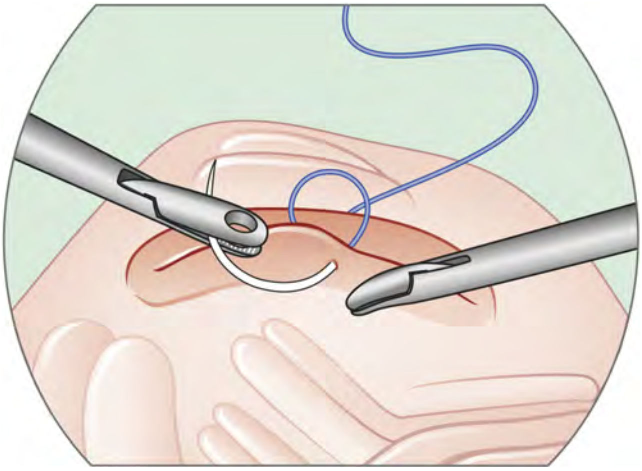

Fig. 4.3e The needle is rotated out of the tissue.

The needle should be rotated so that it lies perpendicular to the receiver. Ideally, the needle should be grasped at point 'B' (Fig. 4.3b). If the needle is under rotated, then the tip of the needle will be parallel to the receiver which makes grasping and rotating the needle out of the tissue difficult.

Basic Suture Types
- Interrupted
- Figure-of-eight
- Continuous

To re-approximate tissue, an interrupted, figure-of-eight, or continuous suturing may be performed. If an interrupted suture is being performed, then the knot is ready to be tied once it is passed through the tissue. If a figure-of-eight suture is being performed, then the needle is reset, the suture pulled through to allow a second passage of the needle through the tissue. The needle is pulled toward the abdominal wall and an 'X' is created by the two strands of the suture. The suture is then grasped by the assistant instrument at the 'X' and the suture is moved to place the tissue in the correct plane for the second pass of the needle.

If continuous suturing is being performed, then the needle is reset and the suture pulled through the tissue so that the next throw can be made. An efficient way to pull the suture through is with a pulley technique (Fig. 4.3f). This can avoid a lot of unnecessary grasping of the suture. Once the suture is reset, it is moved toward the anterior abdominal wall. The receiver then advances the suture using a pulley technique. The assistant then grasps the suture at the level of the tissue. This process is repeated until the knot is ready to be thrown.

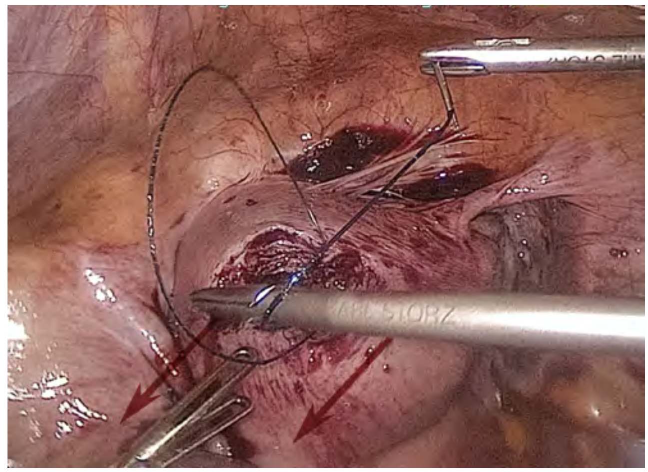

Fig. 4.3f A pulley technique is used for continuous suturing by moving the needle toward the abdominal wall and the receiver pulls the suture through the tissue.

4.4 Knot Tying

Once the needle has been passed through the tissue it is time for the knot to be tied. Knot tying may be done by extracorporeal knots or intracorporeal knots. The goal is to secure the suture in a fashion that is both hemostatic and that re-approximates the tissue. Extracorporeal knot tying meets the majority of suturing needs for most gynecologists. For this reason, intracorporeal knot tying is infrequently used, but can be mastered if the surgeon is committed to practicing. For simplicity and continuity, we have divided the knot tying process into three parts.

Knot Tying
- Prepare Knot
- Throw Knot
- Secure Knot

For each part of the process, we will highlight the key concepts and illustrate the most common errors that surgeons make, leading to decreased efficiency, increased time and frustration. Extracorporeal knot tying will be discussed in *Chapter 5.*

4.5 Intracorporeal Knot Tying

Intracorporeal knot tying is a complex process that requires hours of practice and patience to become proficient. This process can be difficult to learn in the operating room. For this reason considerable time must be spent practicing in a lab which can be a major deterrent to practicing physicians. The purpose of this chapter is to present a simplified process for learning intracorporeal knot tying. This process relies less on a certain port placement but rather on a process that can be applied to any technique and modified based on a surgeon's skills, experience and needs. We will discuss needle-assisted knot tying as well as expert knots in detail. Like in extracorporeal knot tying, we have organized the process into three parts: *Prepare, Throw and Secure Knot.*

We will identify key elements for efficient knot tying as well as describe the most common errors encountered by surgeons-in-training, leading to waste of time and loss of efficiency. The most important factor for efficient intracorporeal knot tying is the knot (loop) preparation phase.

The most important factor for efficient intracorporeal knot tying is knot (loop) preparation.

To reach an adequate level of proficiency in intra-corporeal knot tying, one must be committed to learning and studying this step. The surgeon should memorize the process outlined below and should understand common mistakes made by most surgeons-in-training. By doing this, the trainee will be able to identify mistakes themselves and reverse the process to complete the desired task.

The three critical elements for loop preparation are a short tail, aligning the suture parallel with the throwing instrument, and placing the loop over the knot by moving the loop hand over and across the suture line.

Three Keys for Successful Loop Formation
- Short tail
- Parallel suture to throwing hand
- Loop positioned over the knot

4.5.1 Prepare Knot

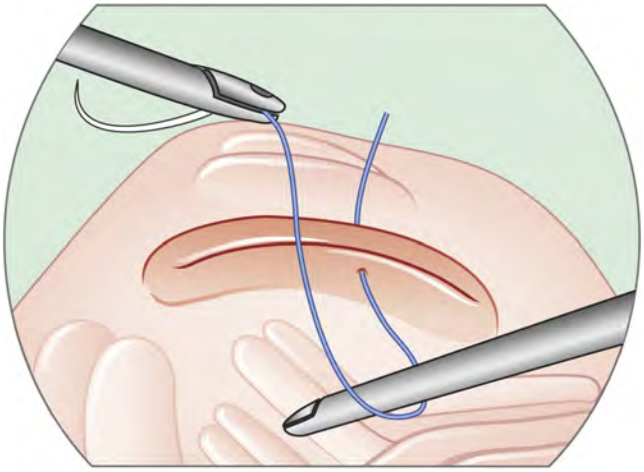

Fig. 4.5a A short tail is formed.

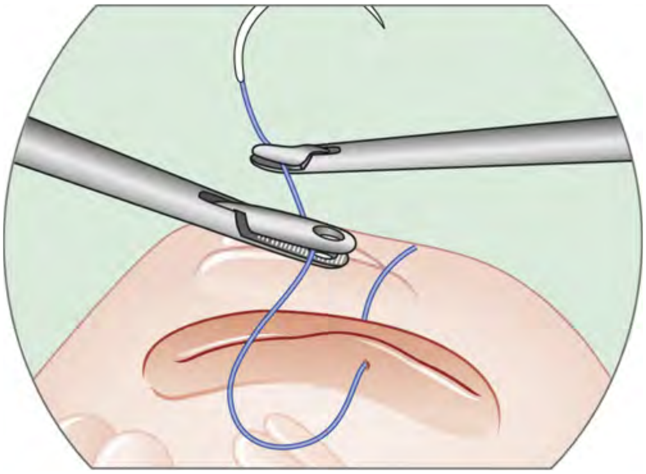

Fig. 4.5b The suture is grasped with the loop hand at 90 degrees. This creates a parallel relationship of the suture with the throwing hand.

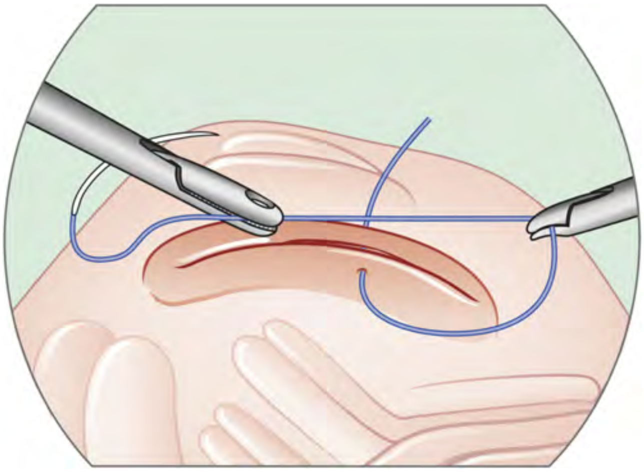

Fig. 4.5c The loop is moved over the tissue where the knot will be secured.

4.5.2 Throw Knot

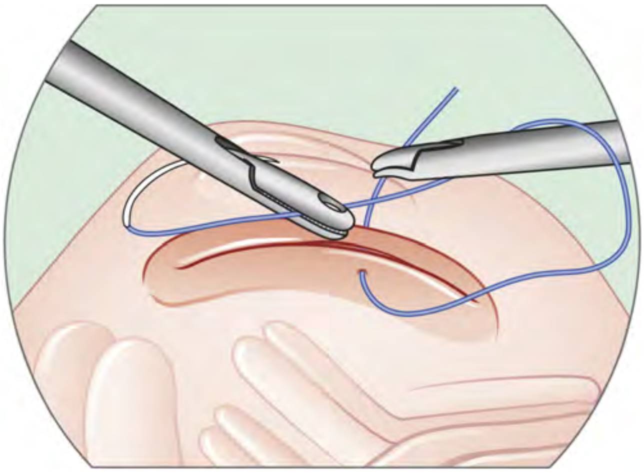

Fig. 4.5d A clockwise throw is made.

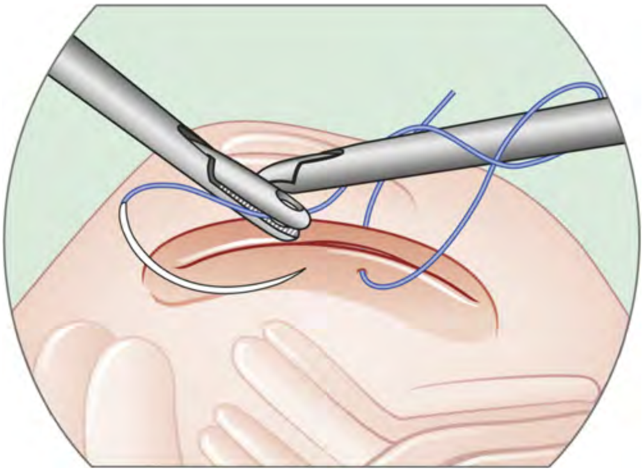

Fig. 4.5e A second clockwise throw is made. It is important to maintain the proper supination of the loop hand.

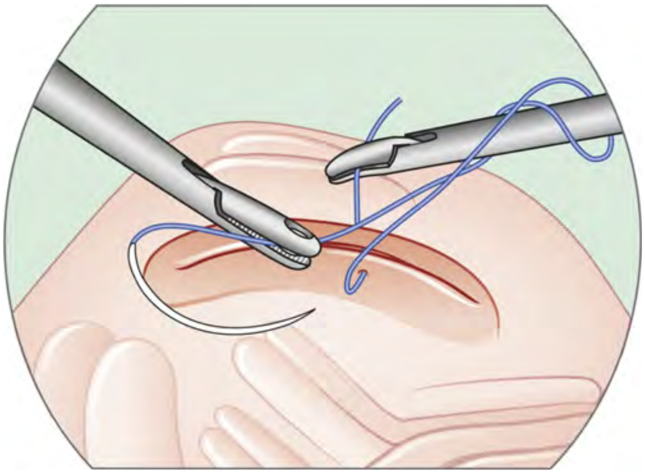

Fig. 4.5f The short tail is grasped.

4.5.3 Secure Knot

The last part of intracorporeal knot tying is to secure the knot (Figs. 4.5g,h). Once the knot is thrown, the suture is grasped on the distal 1/3 of the short tail. Before the knot can be tightened, the loop around the driver must be reduced. The assisting hand is moved laterally away from the throwing hand and suture line (Fig. 6.1e). Once the loop has been reduced, the throwing hand is moved just across the suture line and held in place to avoid a long tail. The assistant hand is then moved to the opposite side of the suture line and the knot is now secured. The suture may need to be released with the assisting hand and grasped closer to the knot to secure it at this point to avoid a needle-stick injury.

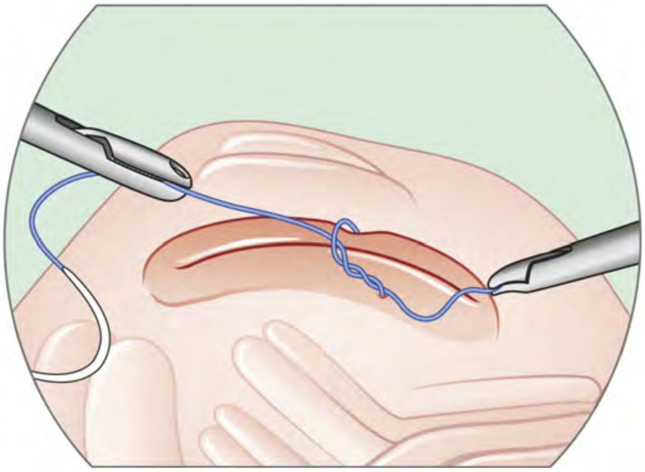

Fig. 4.5g The knot is secured by moving the loop hand away from the knot.

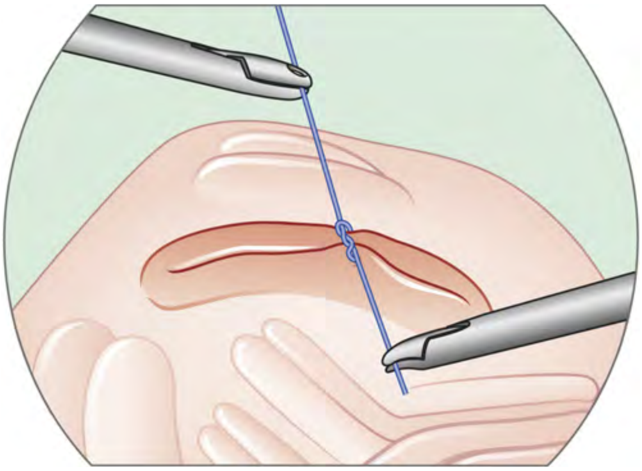

Fig. 4.5h The tail and loop are then crossed over the suture line.

4.5.4 Repeat

Once the first knot is secured, the three-part process of *Prepare, Throw and Secure* is repeated in alternating directions until an adequate number of throws is obtained. The suture is then cut and the needle removed or used to tie another suture (Figs. 6.1f, g).

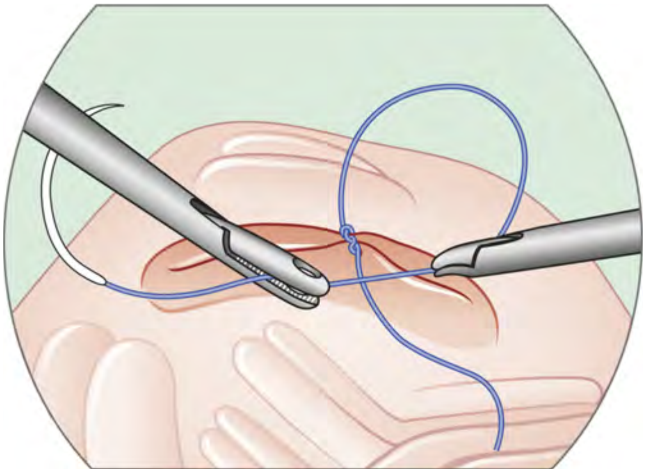

Fig. 4.5i The loop is reformed.

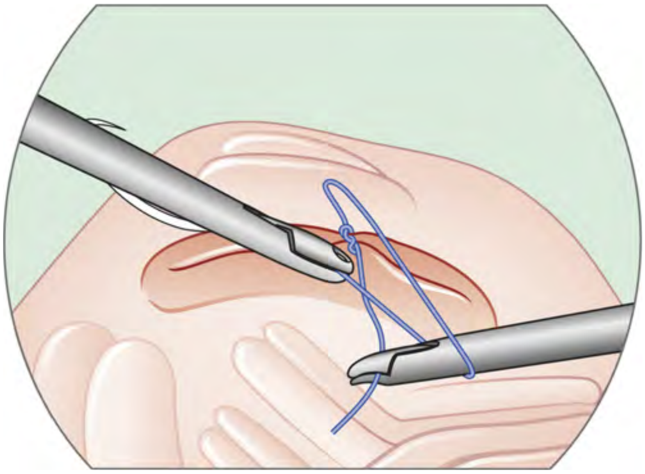

Fig. 4.5j The short tail is grasped.

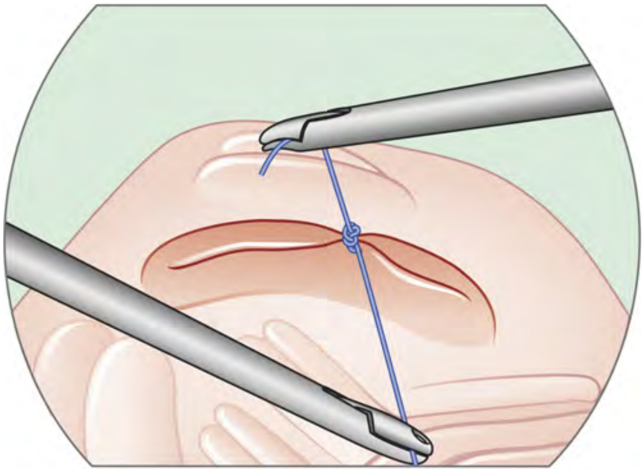

Fig. 4.5k The knot is secured by moving the loop away then over the suture line.

4.6 Common Mistakes With Intracorporeal Knot Tying

The three most common mistakes identified as a cause of inefficiency are the formation of a long tail, a departing suture (not parallel), and *lift* or *drifting*. If any one of these mistakes are made, intracorporeal knot tying becomes unnecessarily difficult. Expert knot tying can magnify these mistakes which is why vigilant attention to these details must be paid.

Three Most Common Mistakes
- Long Tail
- Loop not parallel
- Lift and Drift

A *long tail* has two results. First, the loop is shortened, which will make throwing the knot more difficult. Second, if the knot is thrown and the long tail is grasped, a bow tie is likely to result (Fig. 4.6d). These two consequences can lead to a considerable waste of time and motion. If the suture is grasped on the proximal half on the short tail, a bow tie is likely to result and can best be avoided by grasping the distal third of the short tail. If the throwing hand that grasps the short tail moves too far away from the suture line, then, while tightening the knot, a long tail is created for the second throw. If this happens, then the loop for the next throw is shortened and efficiency is lost.

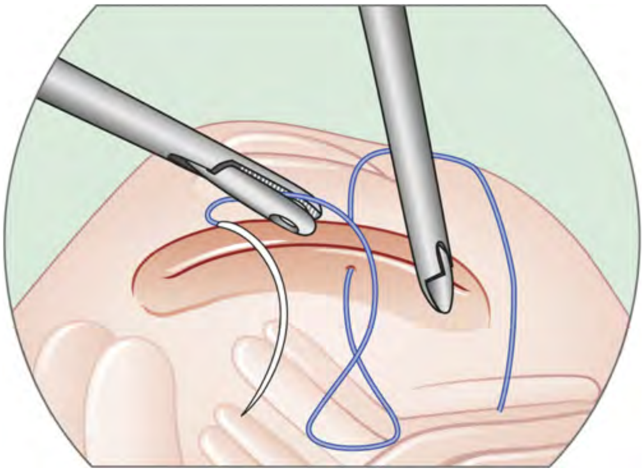

Fig. 4.6a A long tail is formed with the initial loop.

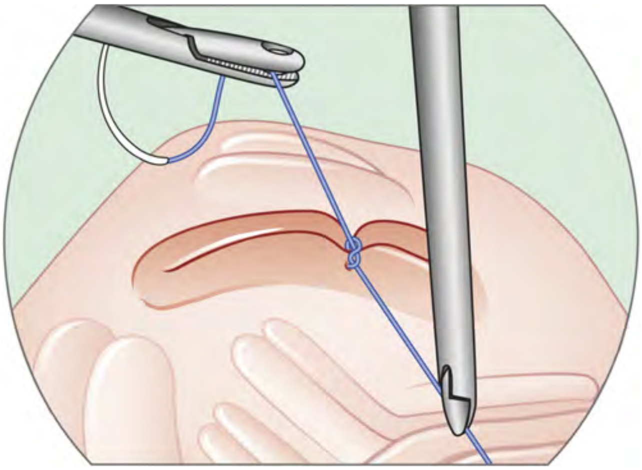

Fig. 4.6b A long tail is made by pulling the tail too far after the first knot is thrown.

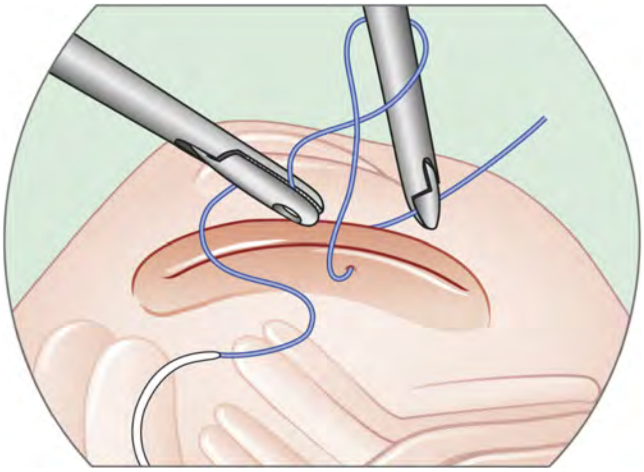

Fig. 4.6c The tail is incorrectly grasped on the inner half of the tail.

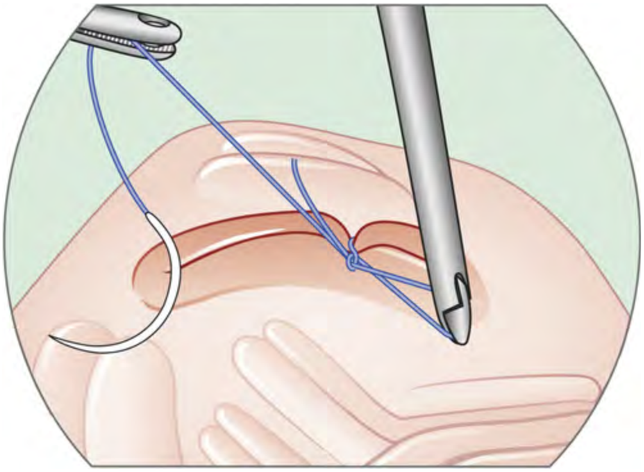

Fig. 4.6d A bow tie results when the inner half is incorrectly grasped.

When the **loop is not parallel** and the suture goes away from the throwing hand (driver), it becomes very difficult to throw intracorporeal knots (Fig. 4.6f). This results from not establishing a perpendicular relationship with the hand holding the loop, a maneuver that is aimed at creating a parallel relationship between the loop and the throwing hand. The more the suture angle departs from this relationship the more difficult throwing the knot becomes.

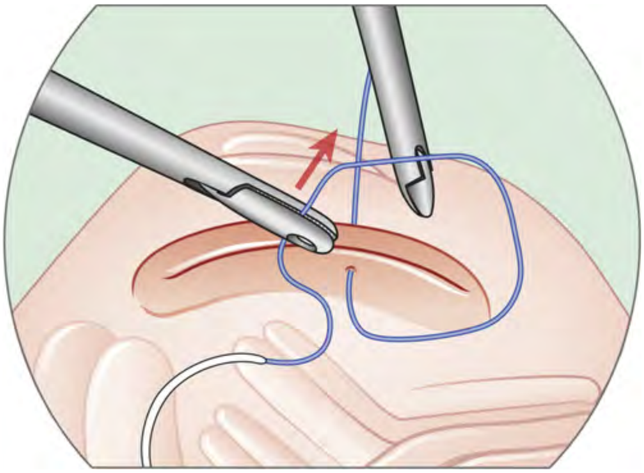

Fig. 4.6e The correct orientation of the loop. The suture is grasped perpendicular with the loop hand and the resulting suture is parallel to the throwing hand.

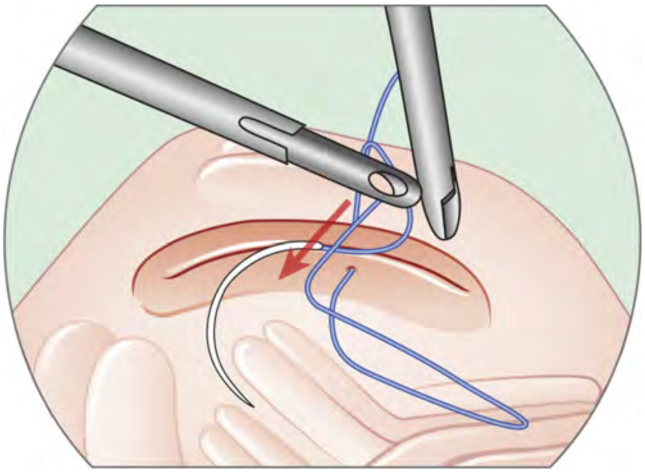

Fig. 4.6f The suture is not in the correct orientation with the loop hand and the resulting suture is angled away from the throwing hand. The result is that knot throwing becomes extremely difficult.

Another common error is *lift and drift* (Figs. 4.6g,h). In an attempt to improve visualization, the surgeon often lifts the knot towards the camera and away from the suture line. This straightens the loop which makes it more difficult to form the knot. Drift occurs when the surgeon moves too far laterally from the suture line. This also straightens the loop and has the same consequence as above. When this error occurs, the surgeon will often blame their struggles on the placement of the camera. As the surgical assistant centers the view, drift often continues which further straightens the loop and compounds the error. To avoid this, the surgical assistant should keep the camera's field of view centered over the suture line and the surgeon should move their instruments over the knot and the loop will be formed (Fig. 4.6i).

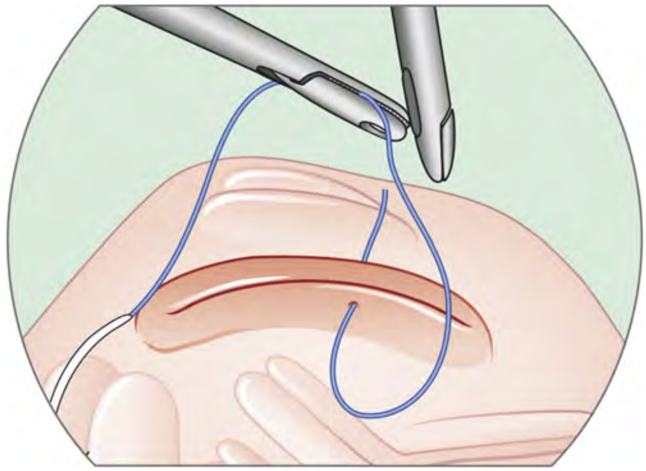

Fig. 4.6g Lifting the loop towards the camera caused the loop to be straightened.

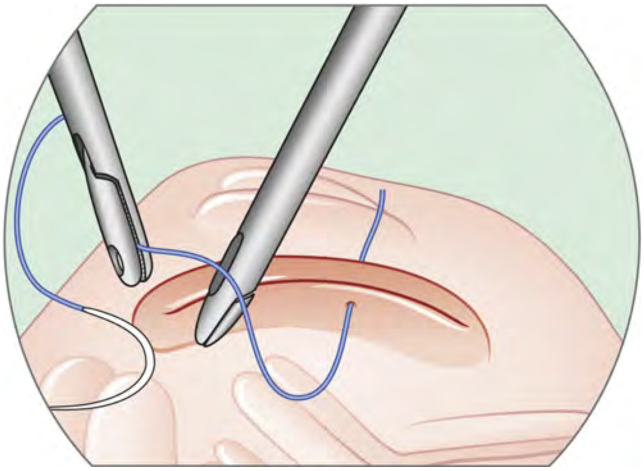

Fig. 4.6h Drifting the loop away from the center of the knot causes the loop to straighten and the knot is difficult to throw.

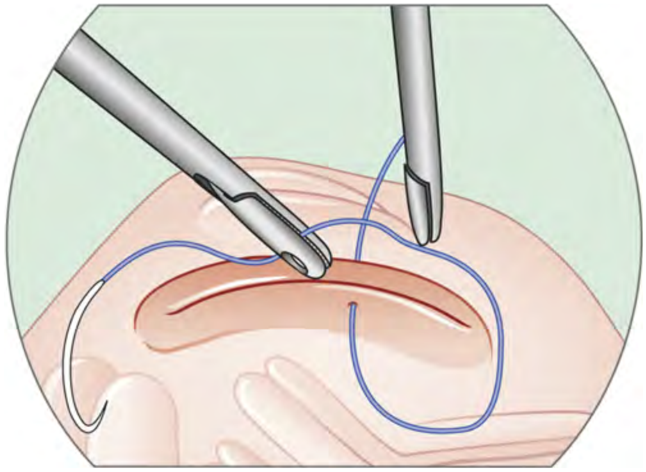

Fig. 4.6i The correct orientation of the loop with the loop over the knot and close to the tissue.

4.7 Cinch Knot

A cinch knot allows a laparoscopic surgeon the ability to re-approximate tissue that is under tension. The surgeon is not always able to maintain tension on the suture while tying the knot. The use of monofilament suture and the amount of tissue can also cause tension to be lost. For these reasons, a cinch knot is a very valuable tool for the laparoscopic surgeon. A cinch knot is a square "air" knot that is converted to a sliding knot. The knot is advanced to the tissue and the knot is locked back into place. The basic steps of this knot will be outlined below.

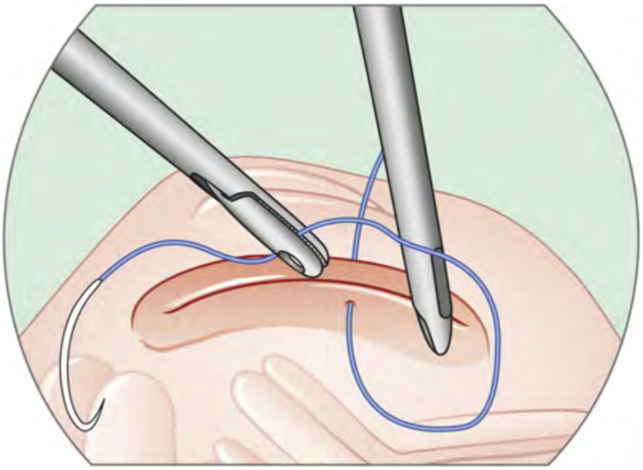

Fig. 4.7a The first loop is formed by creating a parallel relationship.

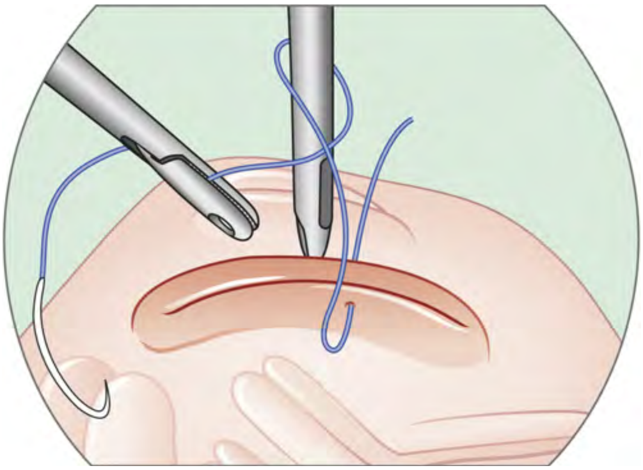

Fig. 4.7b The first knot is thrown in a clockwise direction.

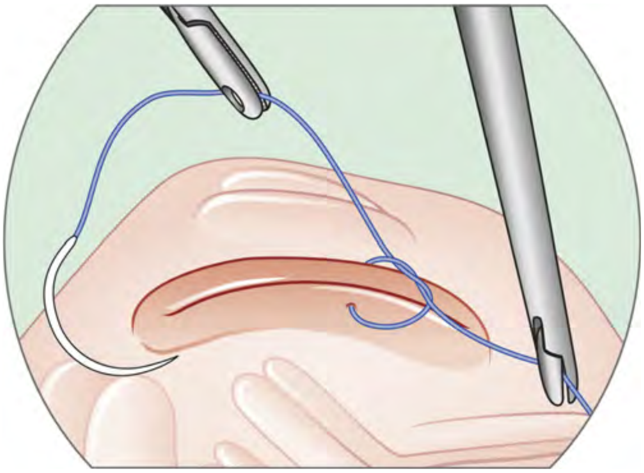

Fig. 4.7c The knot is secured with but left loose. It is important at this point to leave an adequate tail.

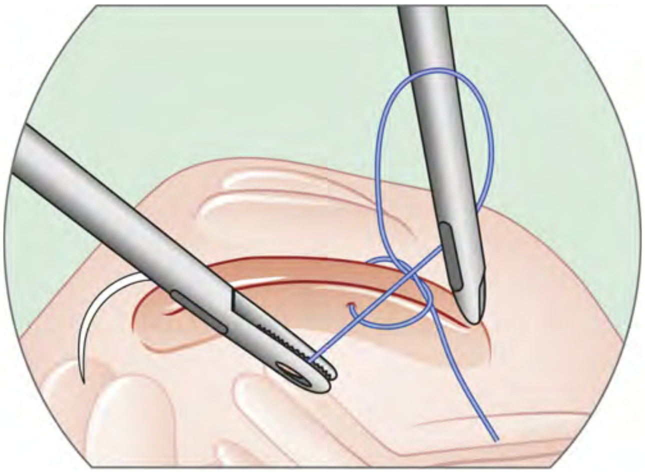

Fig. 4.7d The second loop is formed.

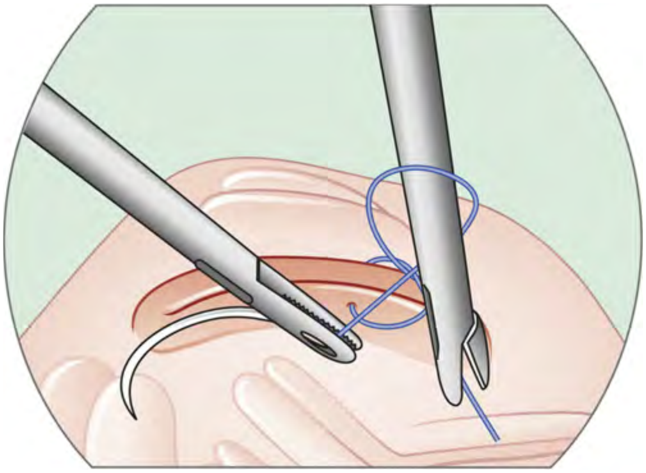

Fig. 4.7e The second throw is made in a counter-clockwise direction.

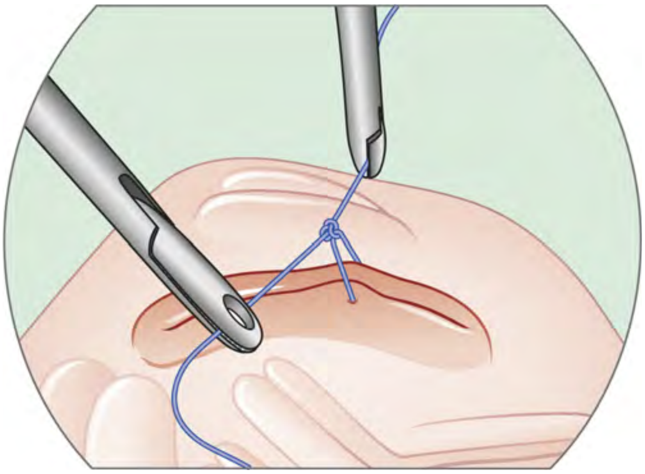

Fig. 4.7f The second knot is secured and laid flat to form and air knot. Notice the direction of the left hand caudally and toward the left shoulder. This allows for the suture to lie in the proper orientation.

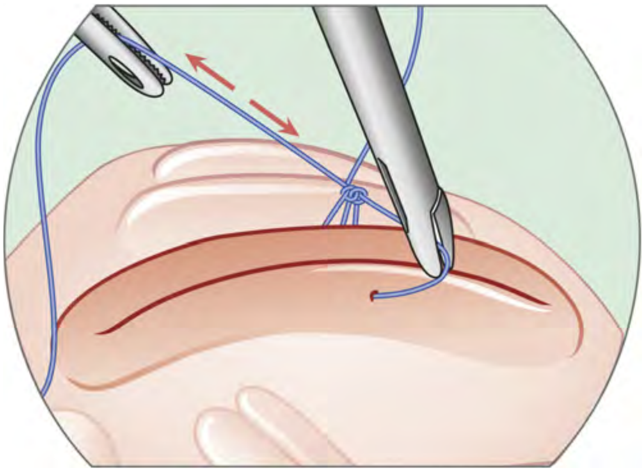

Fig. 4.7g The suture is grasped below the knot where the needle last exited the tissue. The right and left hands are then pulled in opposite directions. You will feel the knot 'snap' which tells you the knot has been converted to a sliding knot.

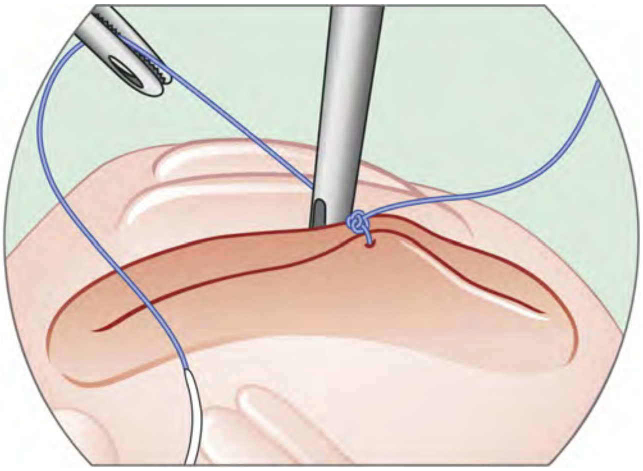

Fig. 4.7h The knot is then pushed down to the tissue with the needle driver.

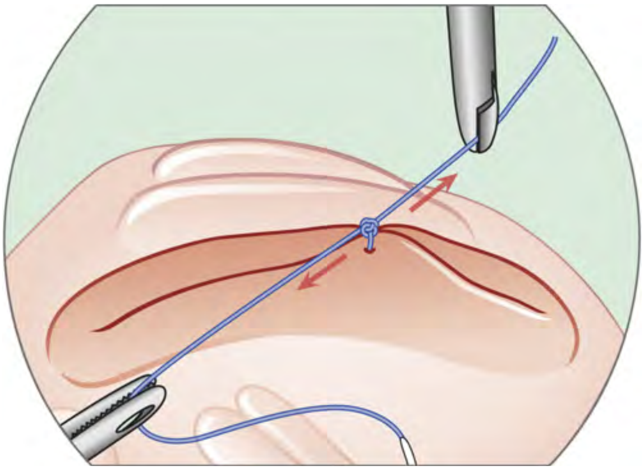

Fig. 4.7i The short tail is grasped and pulled to convert the knot back to a flat knot.

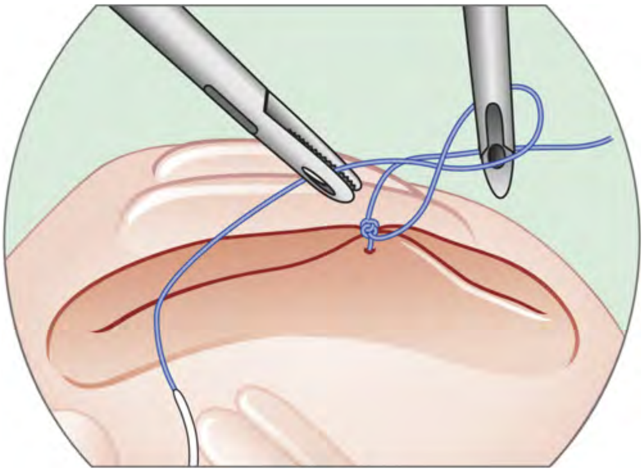

Fig. 4.7j A third loop is formed and a clockwise throw is made.

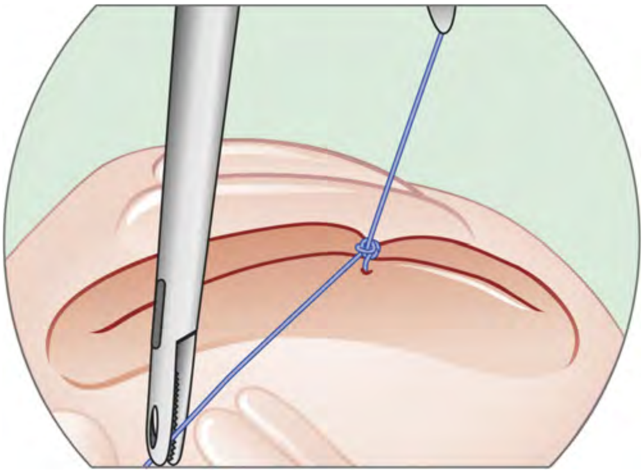

Fig. 4.7k The third knot is secured. The process is repeated until 4–6 throws are made.

4.8 Continuous Suturing

Continuous suturing in laparoscopy can present specific challenges. Proficient continuous suturing is dependent on good suture management skills. It is also important to understand the types of running closures that can be accomplished. Key factors to consider are how to start and end the closure, the type of suture, as well as the length of the defect and suture. Although continuous suturing can be accomplished from any port placement, we have found that an ipsilateral port placement has improved ergonomics and that it is more reproducible. The types of running closures are outlined below.

Types of Running Closures

- Double-layer suture tying to initial tail.
- Single-layer continuous tying to loop at the end.
- Single-layer continuous tying to stay suture at the end.
- Single-layer continuous with barbed suture

Clinical examples of running closures will be addressed in *Chapters 10, 12, and 13.*

5 Extracorporeal Knot Tying

5.1 Introduction

Extracorporeal knot tying is the simplest way to tie laparoscopic knots. The knots may be simple interrupted sutures or 'figure-of-eight' sutures. Knots may be secured with a closed knot pusher or an open knot pusher. As previously described, we have organized the process of tying knots into three parts and these can be applied to learning extracorporeal knot tying as well.

Extracorporeal Knot Tying
- Prepare Knot
- Throw Knot
- Secure Knot

5.2 Closed Knot Pusher

5.2.1 Prepare Knot

The suture must be passed through the knot pusher and tagged with a Webster needle holder or hemostat. We recommend the second surgical assistant to pass the free end of the suture through the closed knot pusher while the surgeon is setting the needle and re-approximating the tissue. This step can reduce the time between removing the needle and throwing the knot. The needle is then removed through the trocar and cut from the suture and the surgeon is ready to start throwing the knots. The surgeon may decide to thread the needle himself which requires the removal of the needle to be the first step.

Prepare Knot
- Thread Suture (Fig. 5.2a)
- Clamp Suture (Fig. 5.2b)
- Remove Needle (Fig. 5.2c)

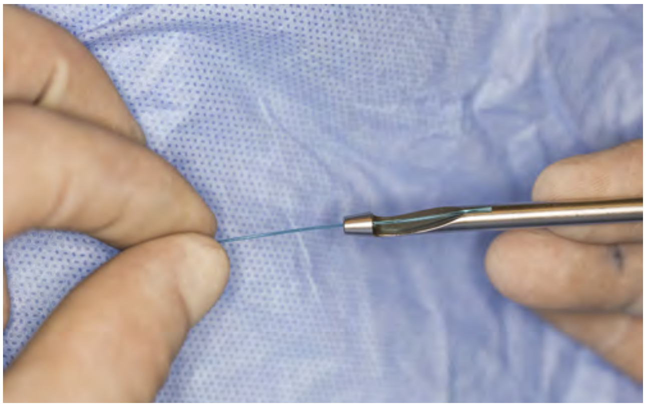

Fig. 5.2a Threading of the suture.

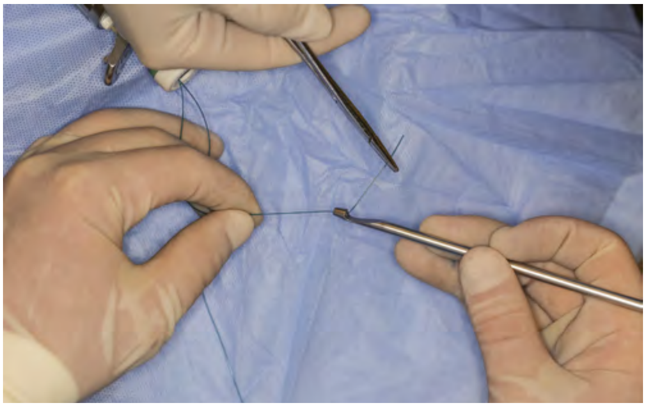

Fig. 5.2b Clamping of the suture.

Fig. 5.2c Removing the needle.

5.2.2 Throw Knot

A one-handed or two-handed knot is then thrown. It is important that the second throw be made in the same direction as the first one, so that a granny knot is formed and the knots will slide down to re-approximate the tissue.

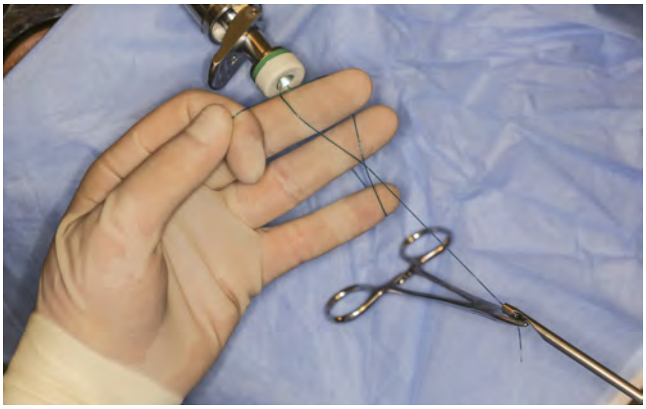

Fig. 5.2d One-handed knot.

5.2.3 Secure Knot

The knot is then secured by advancing the knot pusher through the trocar and past the tissue. The tagged end of the suture is allowed to hang freely until the knot pusher is past the tissue. Tension is then placed on both the free hanging tagged end of the suture and the threaded end of the suture while pushing past the knot. The knot is secured once a proper amount of tension is placed on both strands of the suture.

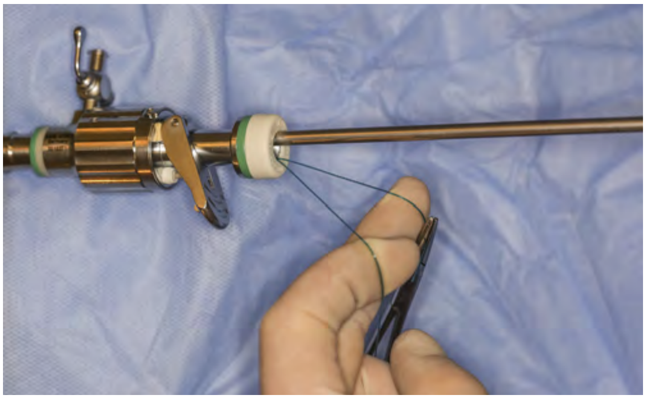

Fig. 5.2e Free hanging clamp.

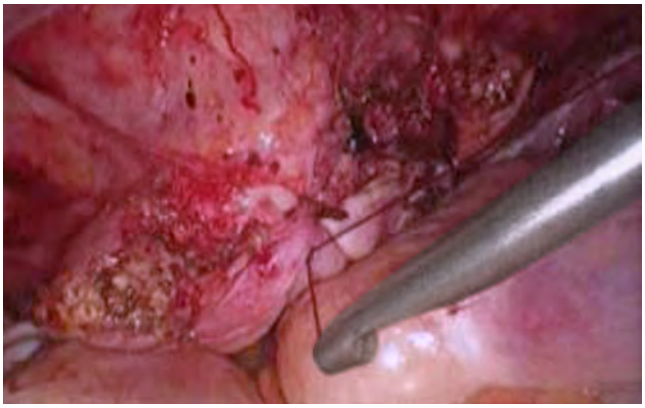

Fig. 5.2f Tension placed by pushing past the knot.

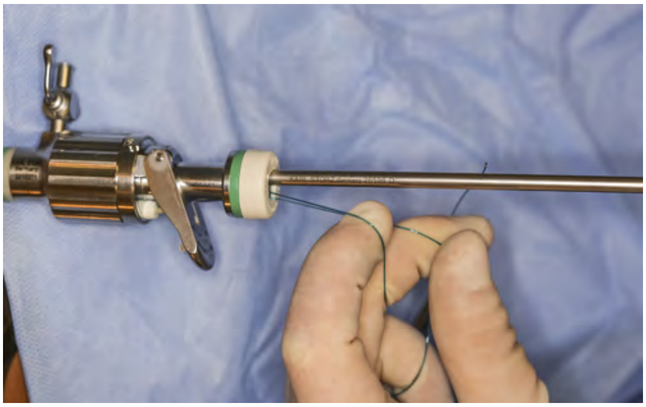

Fig. 5.2g Proper tension placed on both sutures.

5.2.4 Repeat

A second knot is thrown in the same direction. This creates a granny knot which allows the knot to be slipped down as it is secured in the way described above. For this reason, a monofilament suture, such as monocryl or PDS, is commonly used although vicryl can also be used. After the knot is secured, a third knot is thrown in the opposite direction to lock the granny knot in place. A total of six throws is recommended for monofilament suture while four knots is adequate for braided suture such as vicryl. The suture is then cut by the assistant.

5.3 Open Knot Pusher

Open knot pushers do not need to be threaded. Once the knot is thrown, the knot pusher is put into position. The knot pusher is advanced in a similar manner as a closed knot pusher. Maintaining the correct tension on the knot pusher and suture is critical to prevent the open knot pusher from slipping off the suture. Once the knot is secured, the knot pusher is removed, a second throw is completed, and the knot pusher replaced on the suture above the knot. If the open-ended knot pusher slips off the suture while trying to secure the knot, the surgeon can replace the knot pusher by adjusting the tension on one of the strands and using a rolling motion to hook the knot pusher back onto the suture.

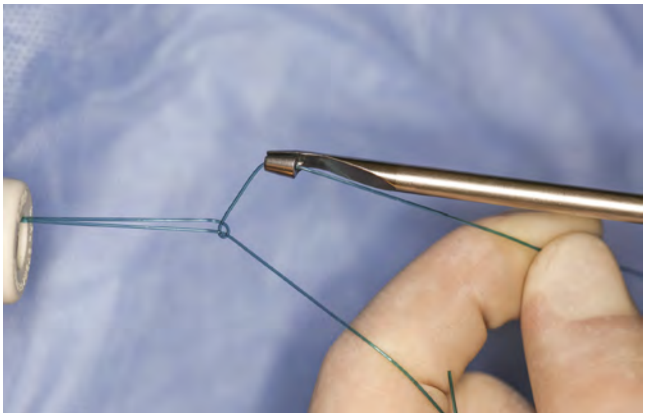

Fig. 5.3a Open knot pusher placed on suture.

5.4 Back-loaded Suture

If needle is being passed through a 5 mm port, the suture will need to be back-loaded. To back-load the suture, the port is removed from the patient's abdomen and the needle driver is inserted through the trocar. The free end of the suture is then grasped with the needle driver and is pulled through the trocar The needle driver is then passed back through the trocar and the suture is grasped 2–3 cm from the swedge of the needle.

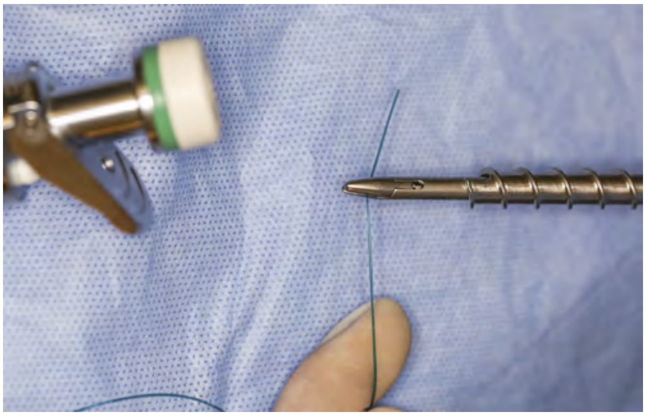

Fig. 5.4a Driver passed through trocar outside abdomen.

Fig. 5.4b Free end of suture pulled through trocar.

Fig. 5.4c Suture grasped near swedge.

The needle driver is then guided back through the abdominal wall at the same angle that the trocar was initially placed. The trocar is then reinserted into the abdomen using the needle driver as a guide. The tissue is then reapproximated, the needle is cut from the suture and the needle is anchored in the anterior abdominal wall.

The cut end of the suture is removed and the knot is secured with a knot pusher. After the suture is cut, the needle is retrieved by grasping the suture adjacent to the swedge. The needle, the needle driver, and the trocar are all removed and the back-loading process is repeated.

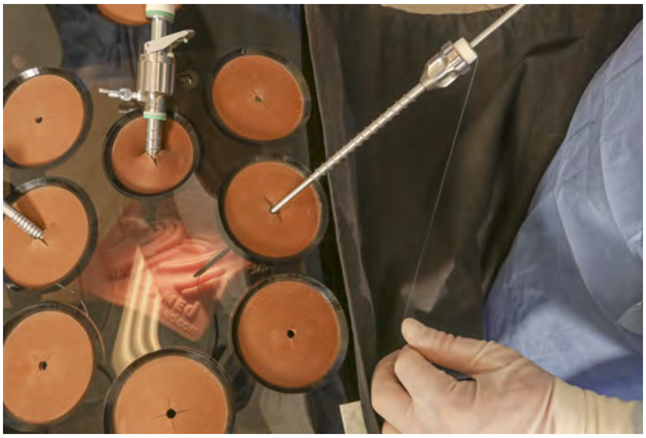

Fig. 5.4d Needle driver passed through abdominal wall.

Fig. 5.4e Trocar reinserted into abdomen.

6 Contralateral Suturing

6.1 With the Needle (Smiley) Knot Tying Technique

6.1.1 Setting the Needle

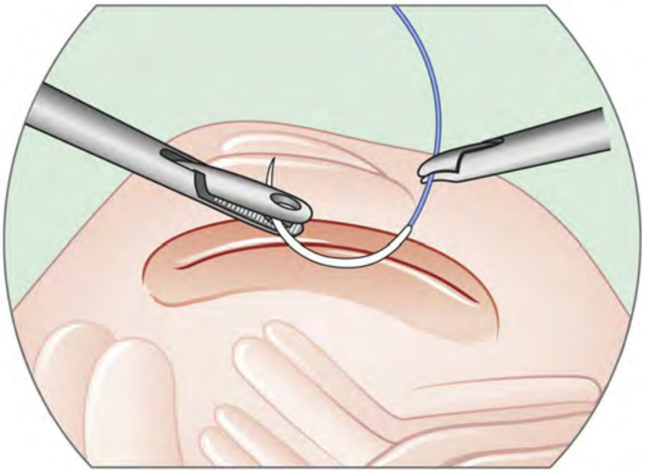

Fig. 6.1a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

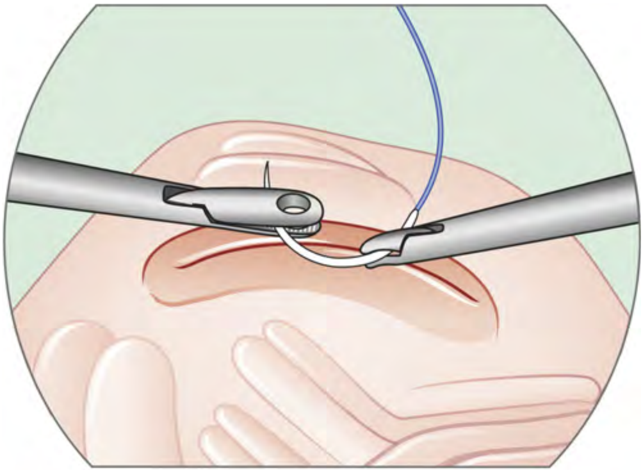

Fig. 6.1b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver, grasping the needle at point 'C'. The assisting instrument is used to stabilize the needle through this process.

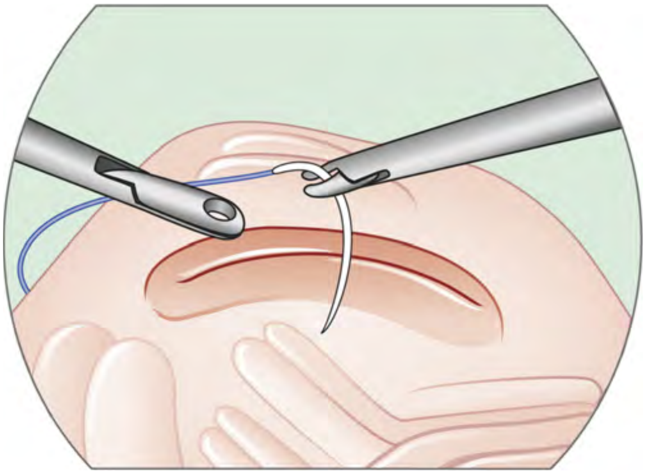

Fig. 6.1c A perpendicular relationship between the needle and the needle driver is confirmed.

6.1.2 Tissue Re-approximation

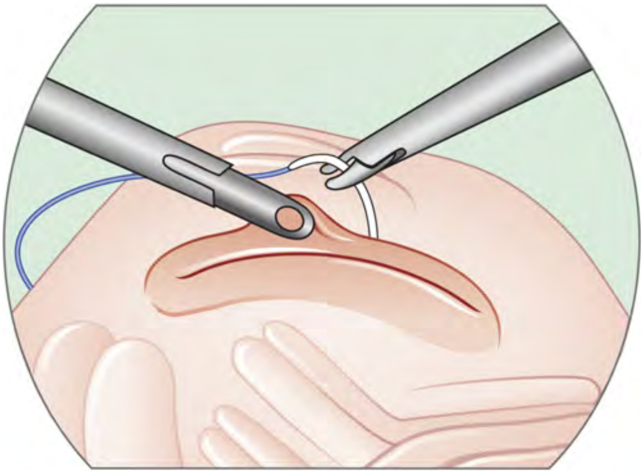

Fig. 6.1d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

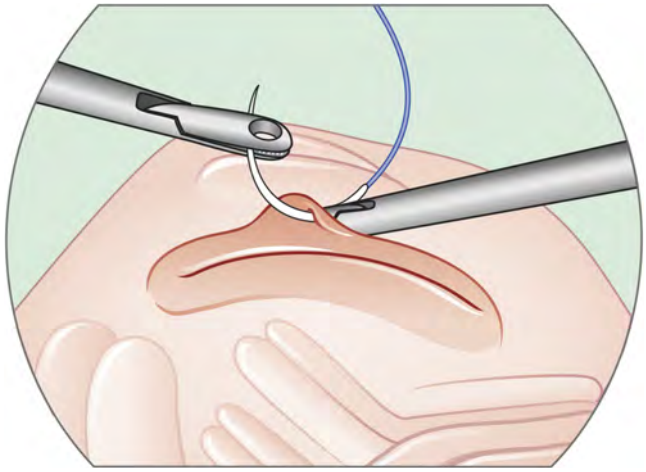

Fig. 6.1e The needle is passed through the tissue by an axial rotation of the needle driver and picked up by the assisting instrument. The assisting instrument grasps the needle at point 'B'.

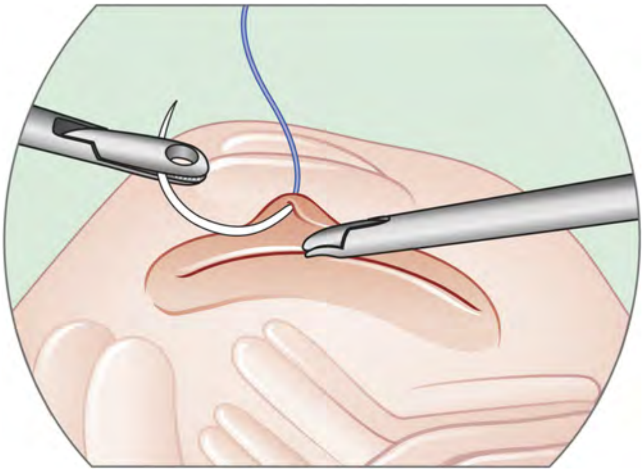

Fig. 6.1f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

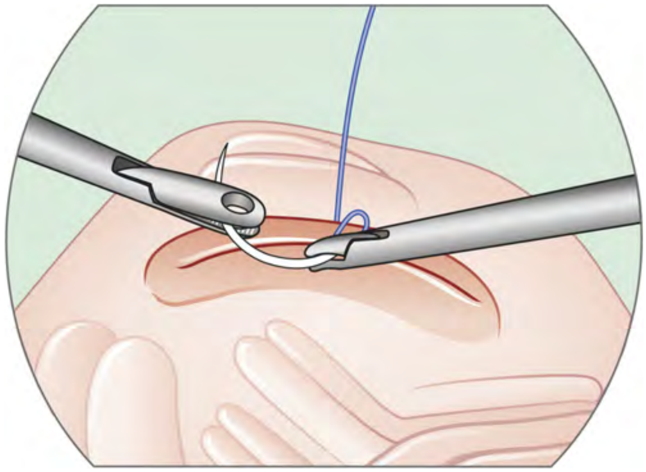

Fig. 6.1g The needle is reset at the level of the tissue by re-grasping at point 'C'.

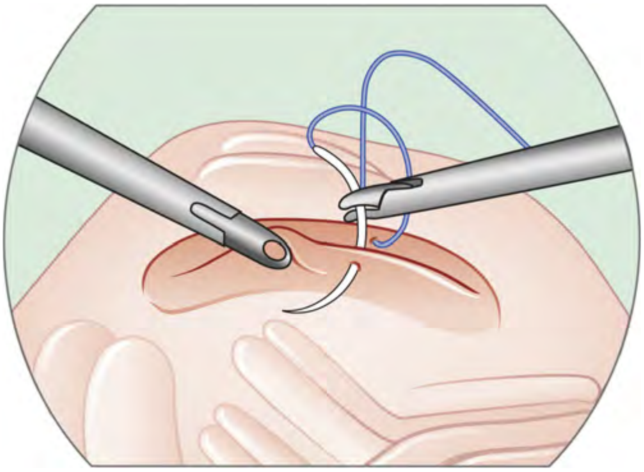

Fig. 6.1h The assisting instrument is used to grasp and 'align' this opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver, which finally passes the needle through the tissue by making an axial rotation.

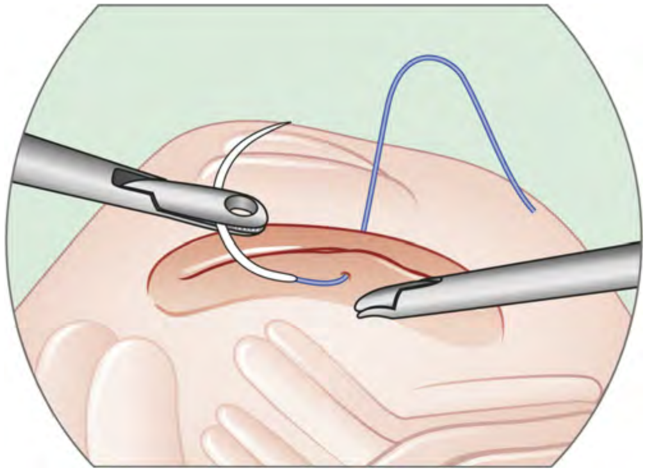

Fig. 6.1i The assisting instrument is used to grasp the needle in the middle and the needle is transferred. This allows for the best stability when throwing knots with the assistance of the needle.

6.1.3 Knot Tying

Loop Preparation

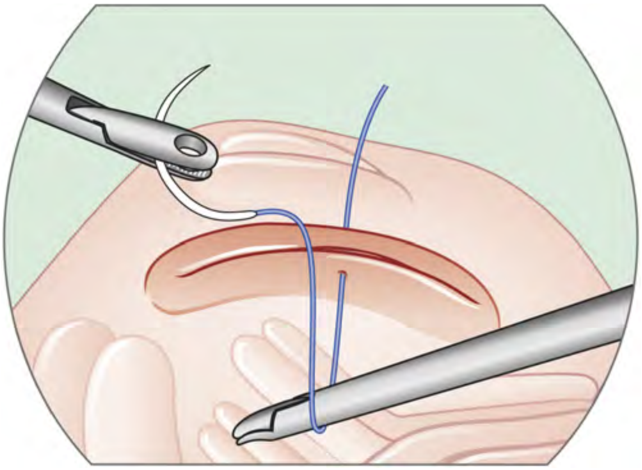

Fig. 6.1j The suture is pulled through the tissue until a short tail is formed. A pulley technique may be useful at this time.

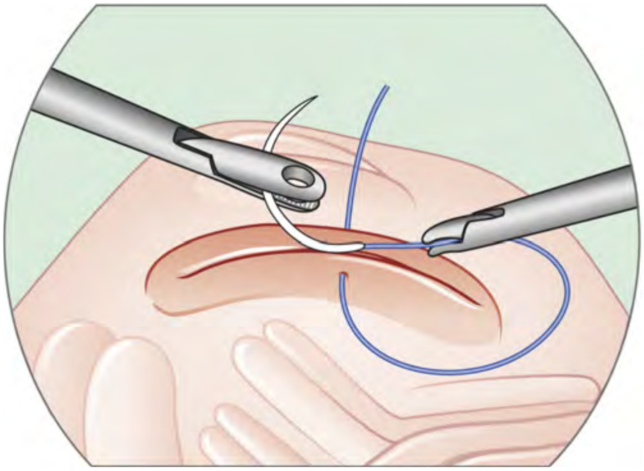

Fig. 6.1k The needle driver grasps the suture at point 'A' and the swedge of the needle is manipulated until the swedge forms a parallel relationship with the needle driver. Rotating the assisting instrument will also change the orientation of the swedge in relation to the needle driver.

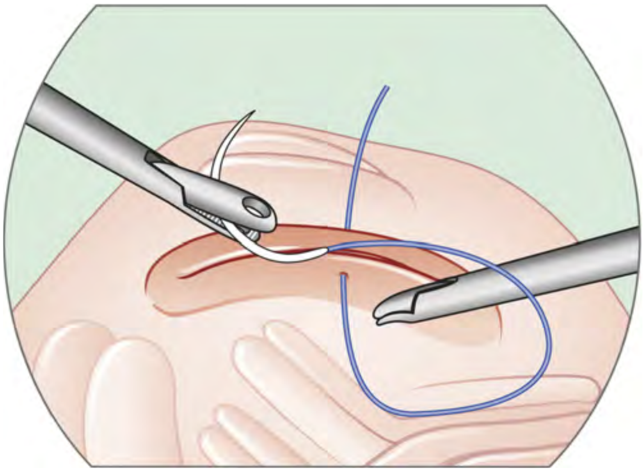

Fig. 6.1 l The loop is formed by bringing the swedge of the needle over the tissue where the knot is to be secured.

Throwing the Knot

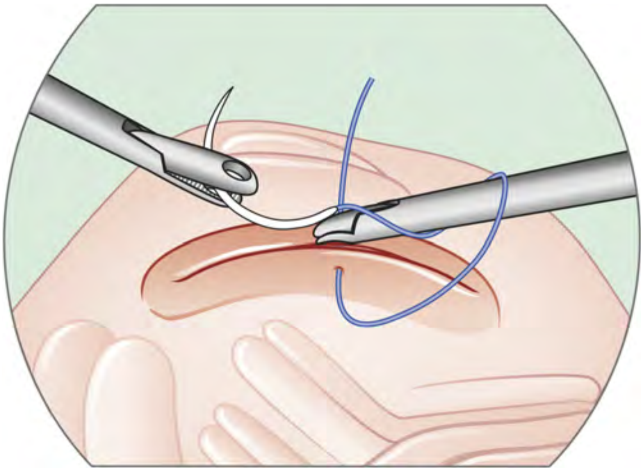

Fig. 6.1m A clockwise throw is made by wrapping the needle driver around the swedge of the needle or by wrapping the swedge around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the tip of the needle driver close to the swedge of the needle at the level of the tissue. If the swedge of the needle is not in a parallel relationship with the needle driver, this step is made unnecessarily difficult.

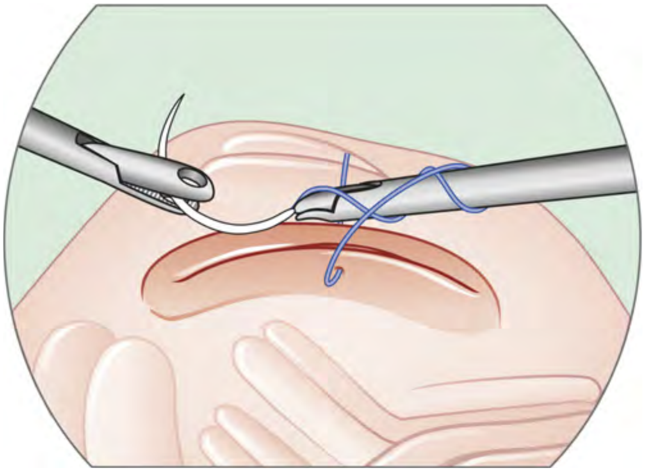

Fig. 6.1n A second throw is made if a *surgeon's knot* is preferred. Using the assistance of the needle makes the second throw much easier than performing knot tying without the needle.

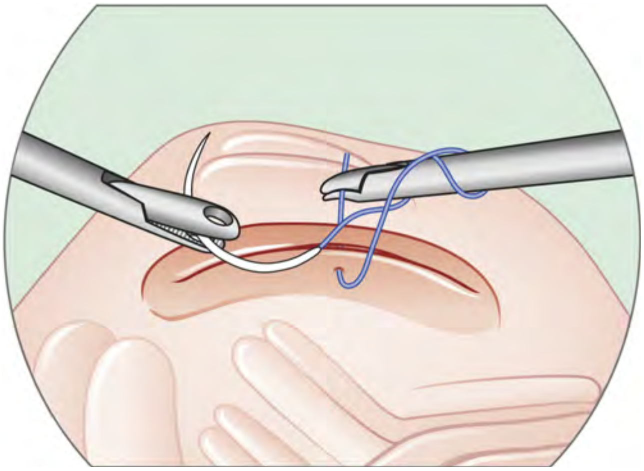

Fig. 6.1o The short tail is then grasped. It is important to grasp the outer third of the tail to avoid a *bow tie knot*.

Securing the Knot

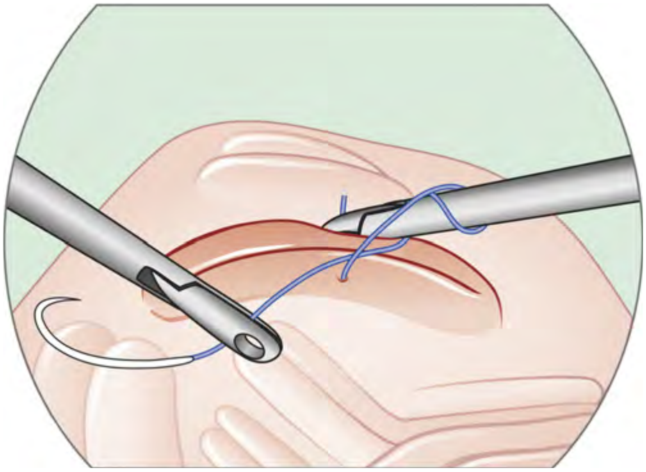

Fig. 6.1p The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'. This allows the knot to be secured without any concern for causing inadvertent needle stick injuries.

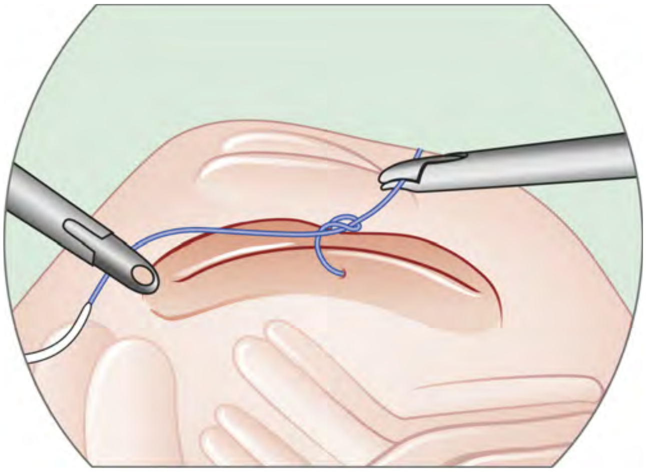

Fig. 6.1q The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

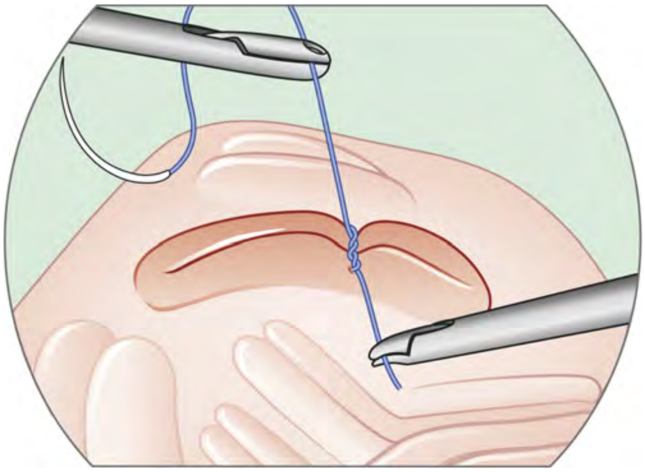

Fig. 6.1r The needle driver then moves the tail to the opposite side of the tissue and the assisting instruments holding the loop is now moved opposite the tail to secure the knot. It is import to keep the tail at the level of the tissue and to avoid pulling with the instrument holding the tail to avoid the formation of a long tail. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

Second Throw

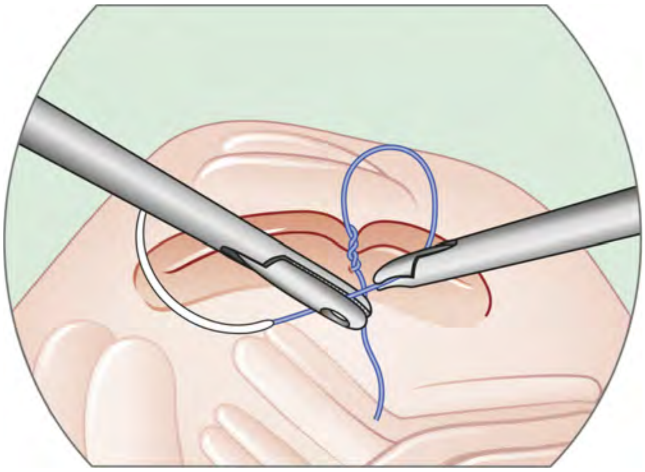

Fig. 6.1s The needle driver (right hand) now grasps the suture next to the assisting instrument at point 'A'.

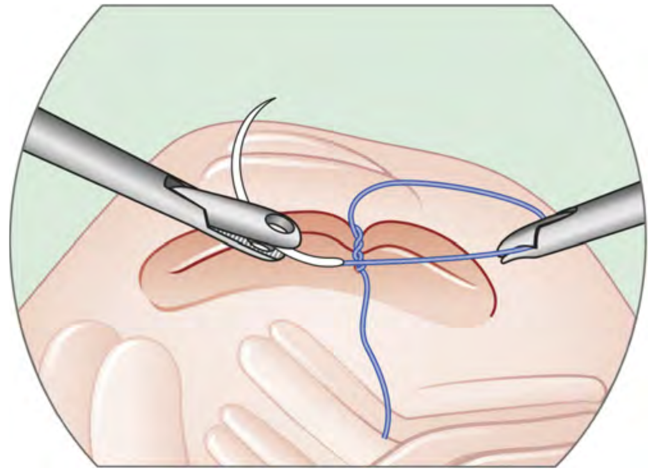

Fig. 6.1 t The assisting instrument releases the suture and grasps the needle in the middle. The needle driver manipulates the suture until the swedge of the needle lies in a parallel relationship with the needle driver and the assisting instrument moves the swedge of the needle over the first knot at the level of the tissue.

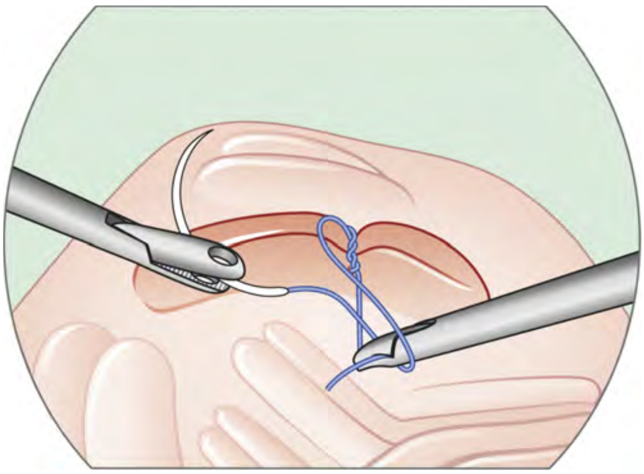

Fig. 6.1u A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

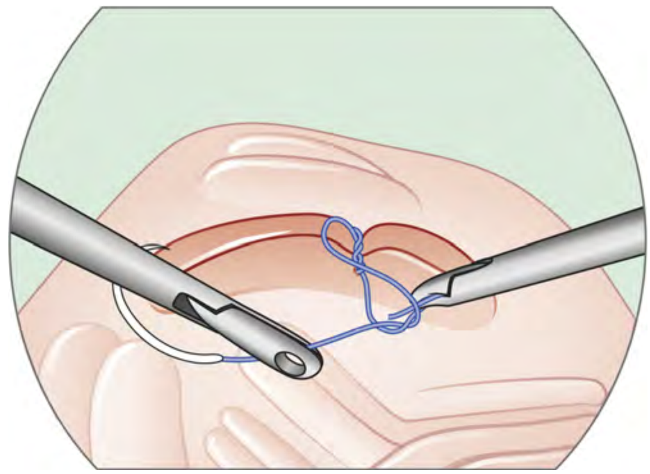

Fig. 6.1v The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'.

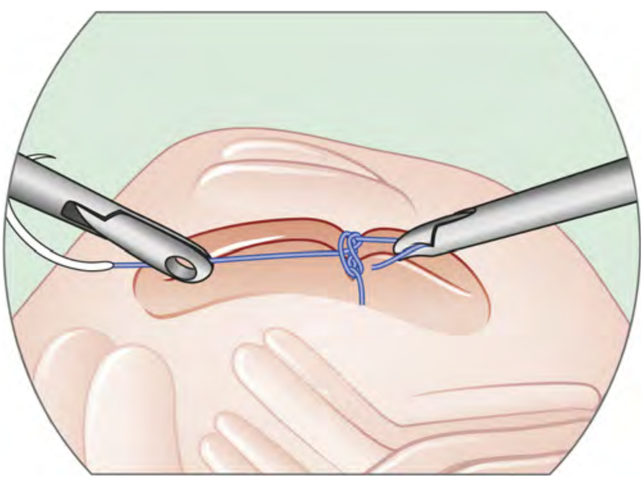

Fig. 6.1w The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

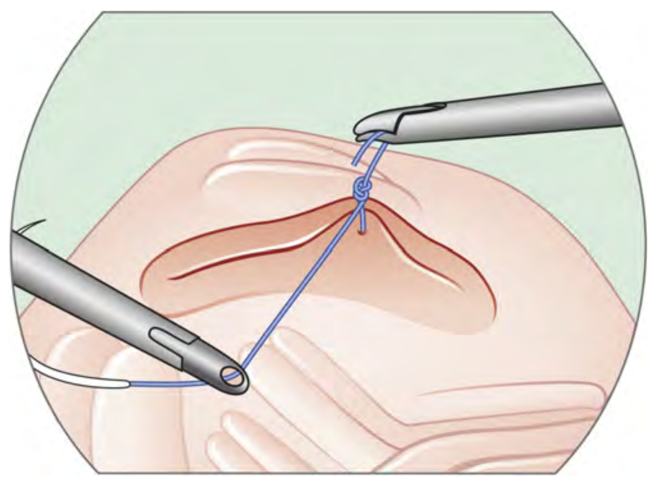

Fig. 6.1x The needle driver moves the tail to the opposite side of the tissue and the assisting instrument pulls the loop opposite of the tail to secure the square knot. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

6.2 Without the Needle (Expert) Knot Tying Technique

6.2.1 Setting the Needle

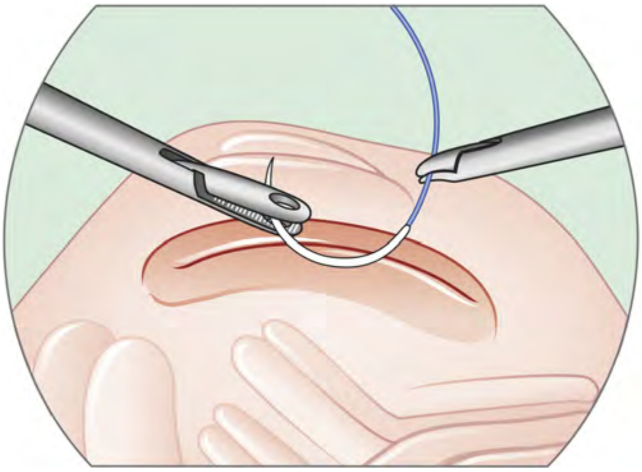

Fig. 6.2a The needle is introduced with the needle driver at point ‘A’ and grasped with the assisting instrument (left hand) at point ‘B’.

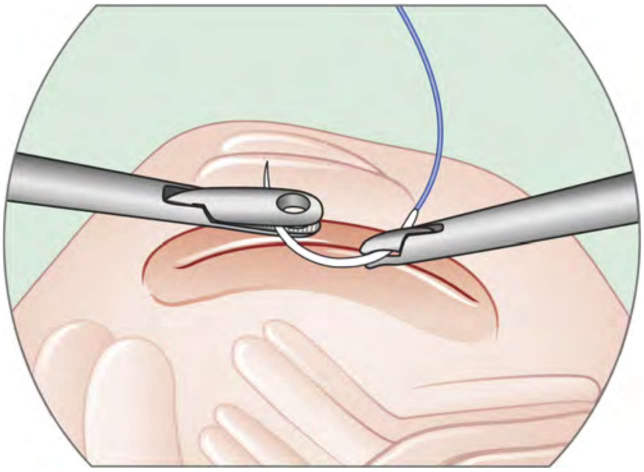

Fig. 6.2b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver finally grasping the needle at point ‘C’. The assisting instrument is used to stabilize the needle through this process.

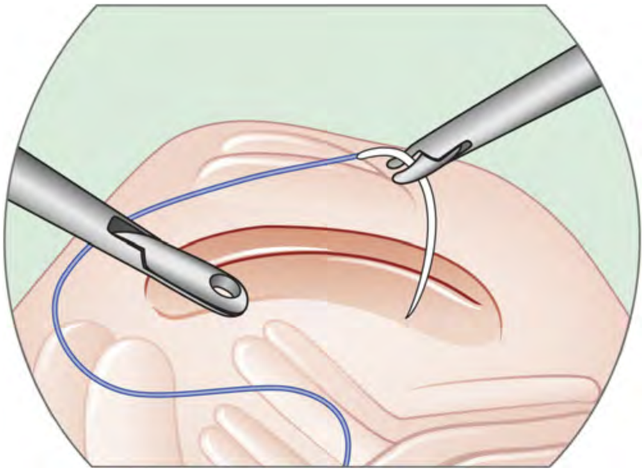

Fig. 6.2c A perpendicular relationship between the needle and the needle driver is confirmed.

6.2.2 Tissue Re-approximation

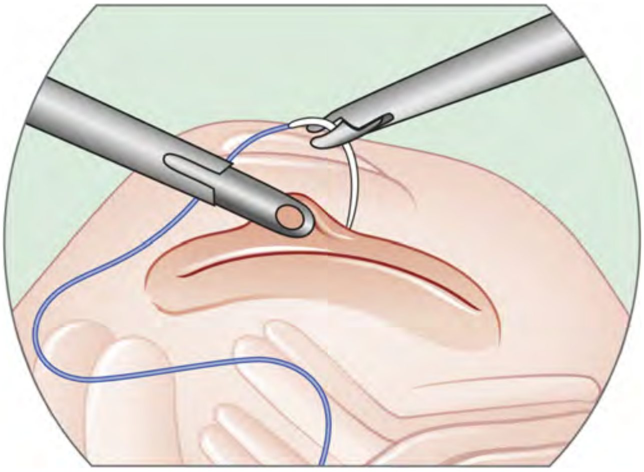

Fig. 6.2d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular plane or a 90 degree angle.

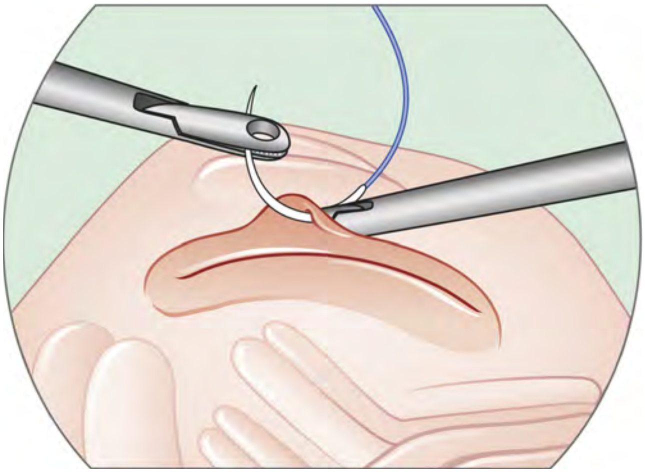

Fig. 6.2e By axial rotation of the needle holder, the needle is passed through the tissue and is picked up by the assisting instrument, grasping the needle at point 'B'.

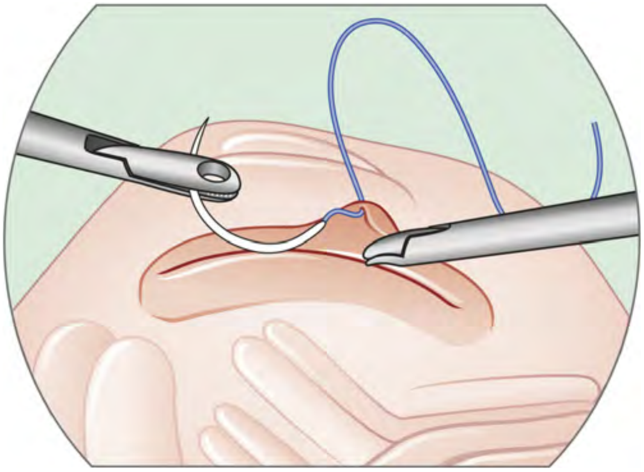

Fig. 6.2f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

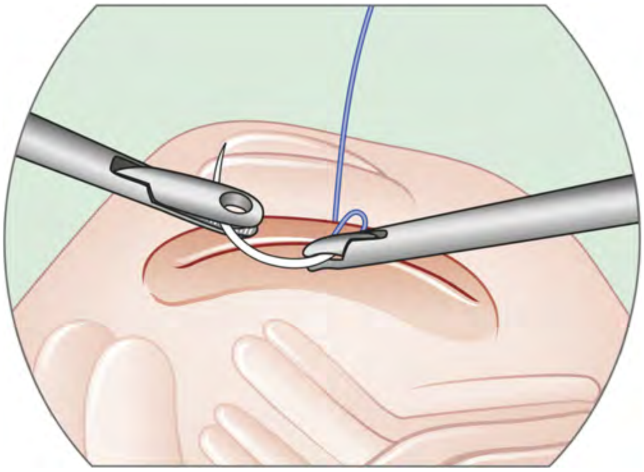

Fig. 6.2g The needle is reset at the level of the tissue by re-grasping at point 'C'.

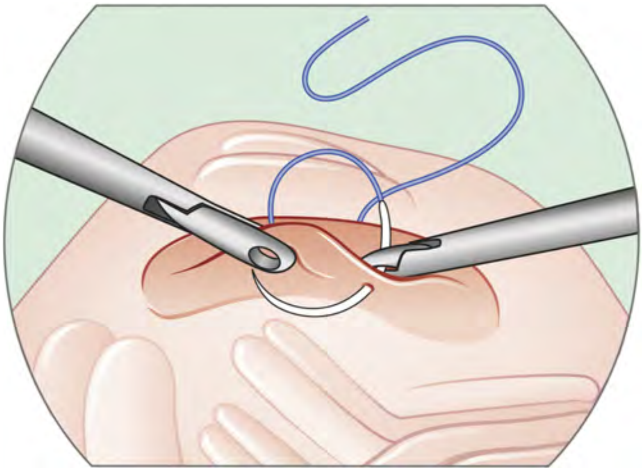

Fig. 6.2h The assisting instrument is used to grasp and 'align' the opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver which passes the needle through the tissue by making an axial rotation.

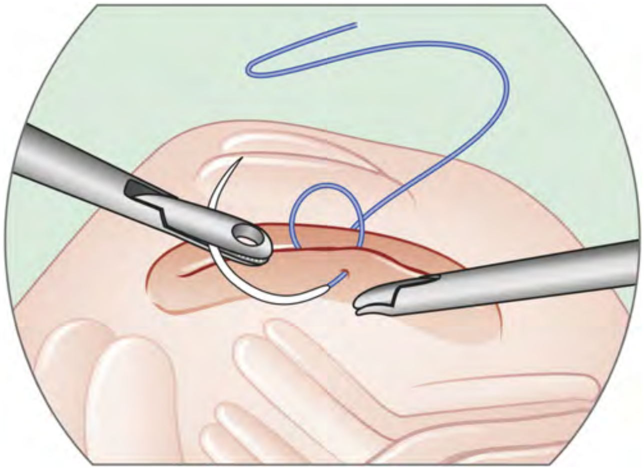

Fig. 6.2i The assisting instrument is used to grasp the needle at point 'B' and the needle is transferred.

6.2.3 Knot Tying

Loop Preparation

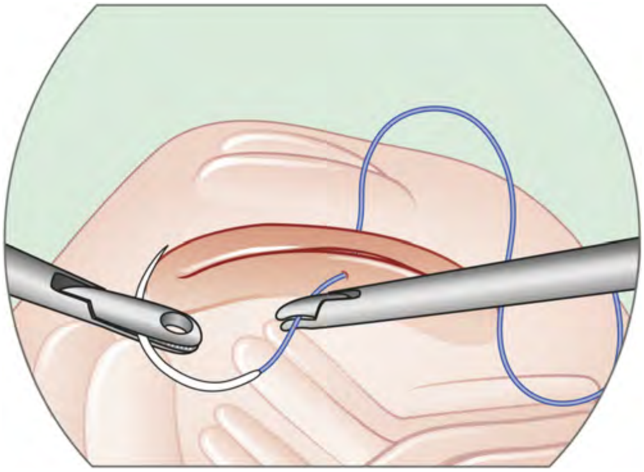

Fig. 6.2j The suture is grasped by the needle driver at point 'A'. It is important that the needle be positioned with the assisting hand so that the needle driver can grasp perpendicular to the suture.

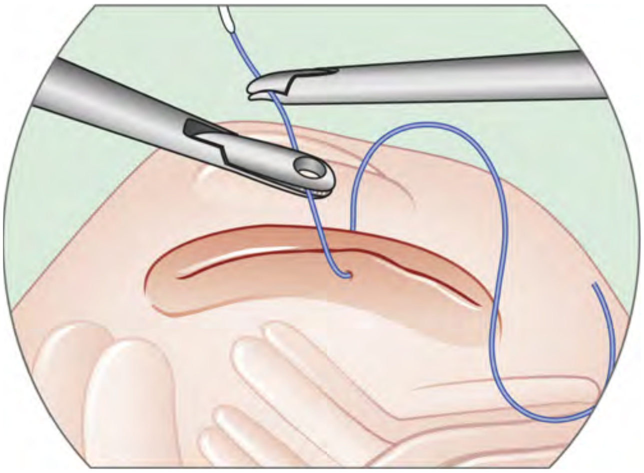

Fig. 6.2k The suture is passed from the needle driver to the assisting instrument at point 'A' so that the assisting instrument grasps the suture at a 90 degree angle (perpendicular).

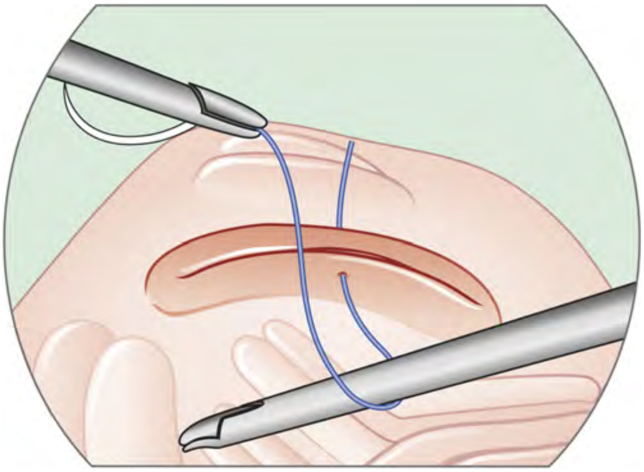

Fig. 6.2 l The suture is pulled through the tissue by moving the assisting instrument in a cephalic direction until a short tail is made. The needle driver then grasps the suture that leaves enough length to form a loop of adequate size.

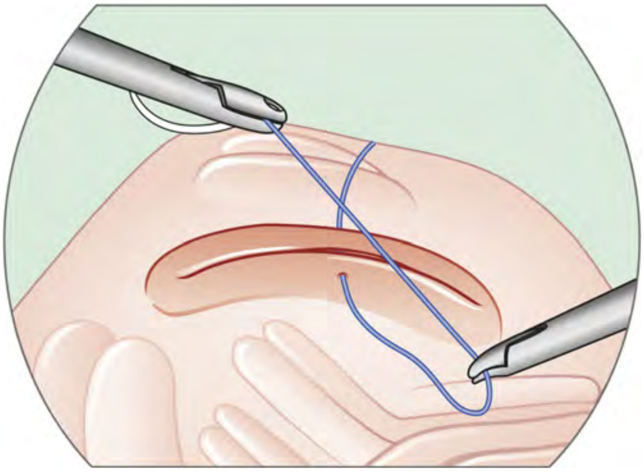

Fig. 6.2m The assisting instrument then grasps the suture at a perpendicular angle once an adequate loop has been formed. This process of transferring the suture is referred to as 'walking the line'.

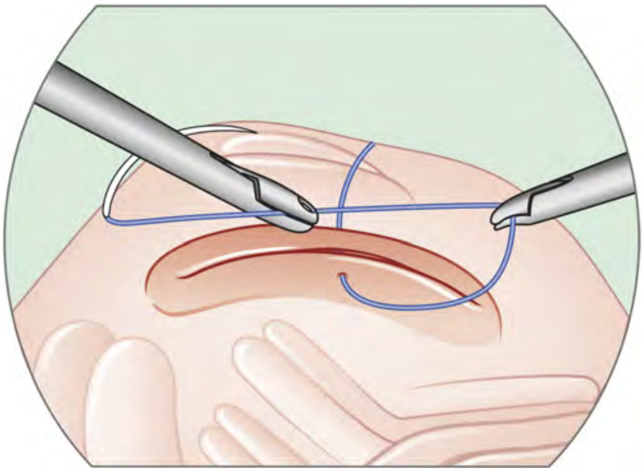

Fig. 6.2n The loop is formed by bringing the assisting instrument over the tissue where the knot is to be secured. The needle driver can be used at this time to grasp the suture at the mid-portion of the loop. This can aid in adjusting the orientation of the loop. Placing the left hand at the level of the tissue helps avoid 'lift and drift' which is a common mistake that is made when tying intracorporeal knots.

Throwing the Knot

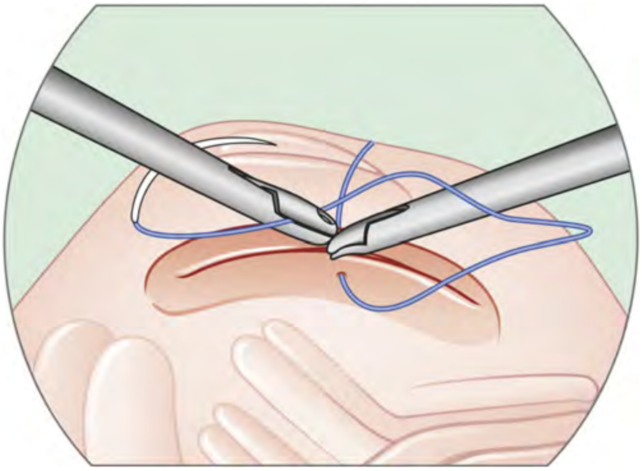

Fig. 6.2o The assisting instrument is 'supinated' (rotated) so that the suture exiting the assisting instrument is 'aligned' with the needle driver. The suture exiting the loop should lie in an oblique orientation between the horizontal and vertical axes. This allows the knot to be thrown and the loop to be maintained.

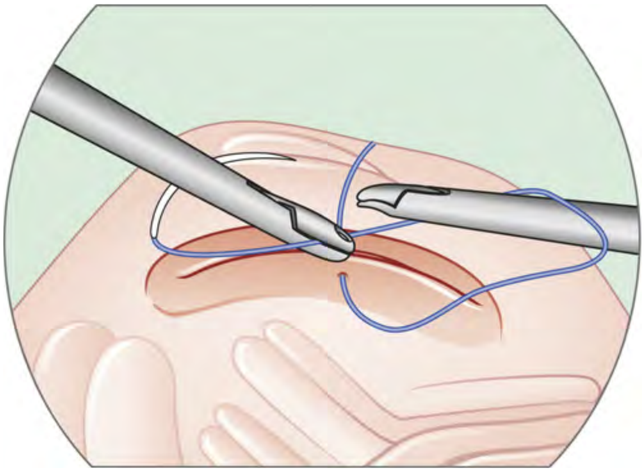

Fig. 6.2p A clockwise throw is made by wrapping the needle driver around the loop or by wrapping the loop around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the two instrument tips close to each other at the level of the tissue. If the hand holding the loop is pronated too much, it can make this step more difficult.

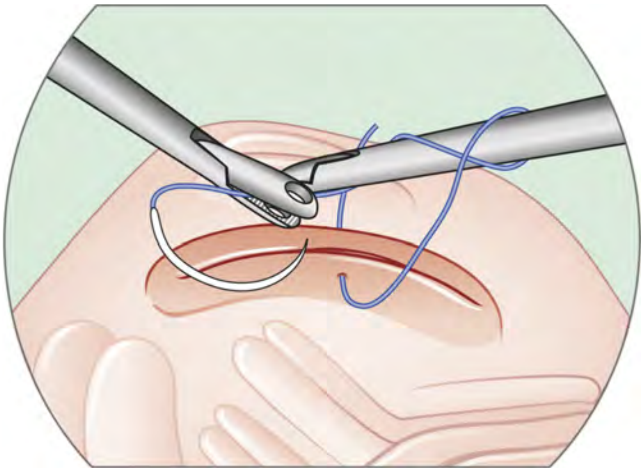

Fig. 6.2q A second throw is made if a *surgeon's knot* is preferred. This may be a difficult task without a monofilament suture.

Securing the Knot

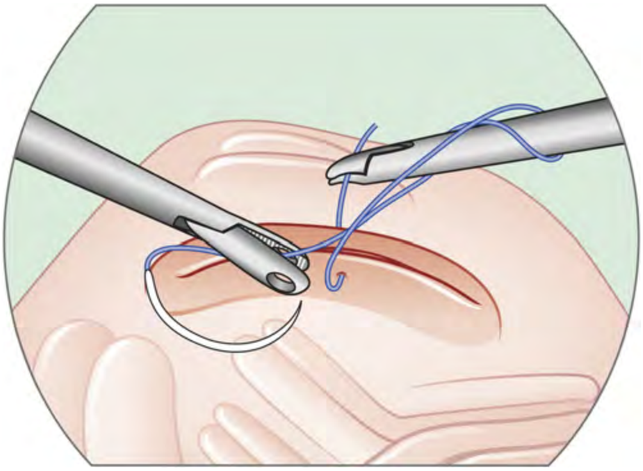

Fig. 6.2r The short tail is grasped. It is important to grasp the outer third of the tail to avoid a *bow tie knot*.

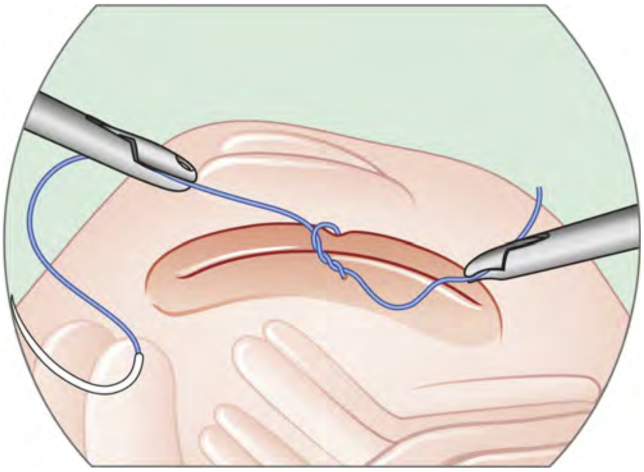

Fig. 6.2s The assisting instrument holding the loop is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

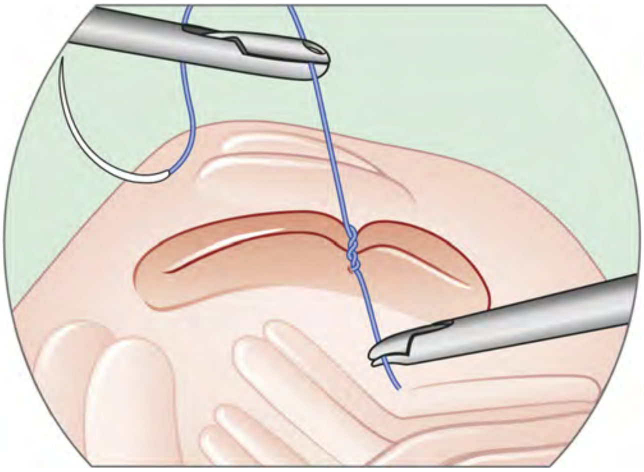

Fig. 6.2t The needle driver then moves the tail to the opposite side of the tissue while the assisting instrument holding the loop is moved in the opposite direction to secure the knot. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lays flat. It is important to keep the tail at the level of the tissue and to avoid pulling. If the needle driver pulls the suture too far, a long tail will result.

Second Throw

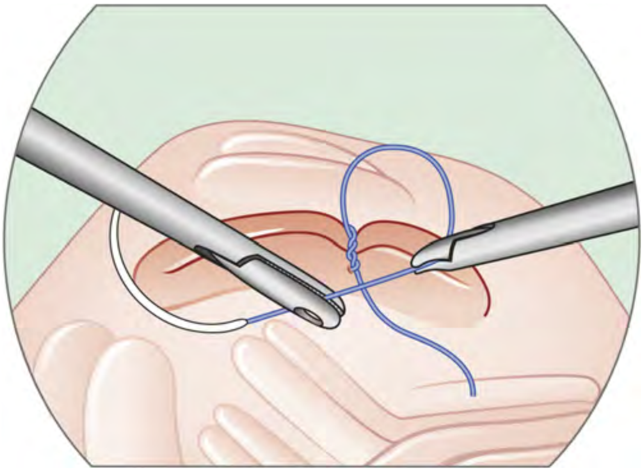

Fig. 6.2u The loop is formed by moving the assisting instrument over the first knot at the level of the tissue. This is the proper moment to adjust the length of the loop by 'walking' the suture as described earlier.

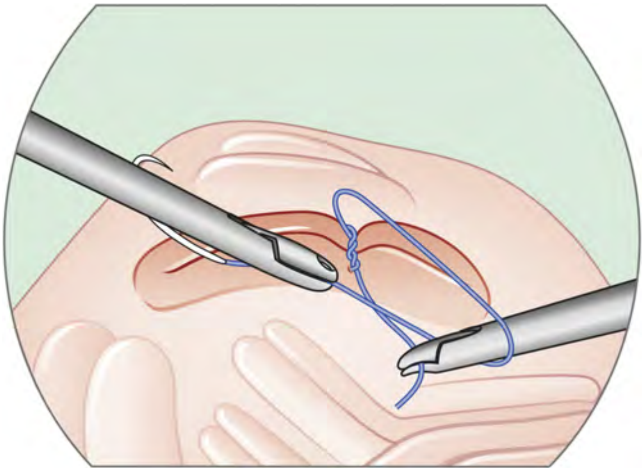

Fig. 6.2v A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

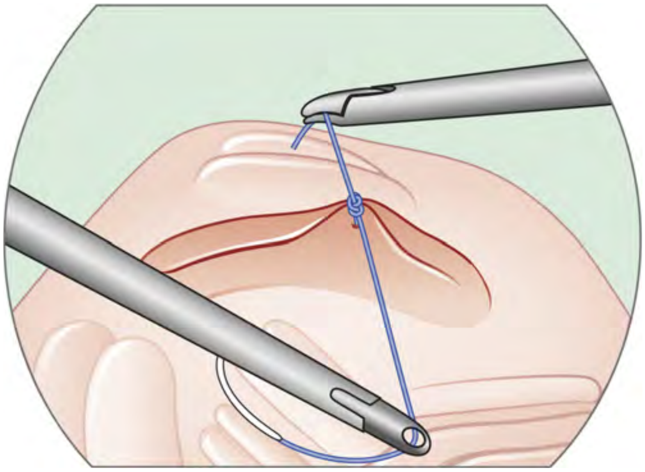

Fig. 6.2w The assisting instrument moves the loop away from the knot. The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured.

7 Midline Port Placement

7.1 With the Needle (Smiley) Knot Tying Technique

7.1.1 Setting the Needle

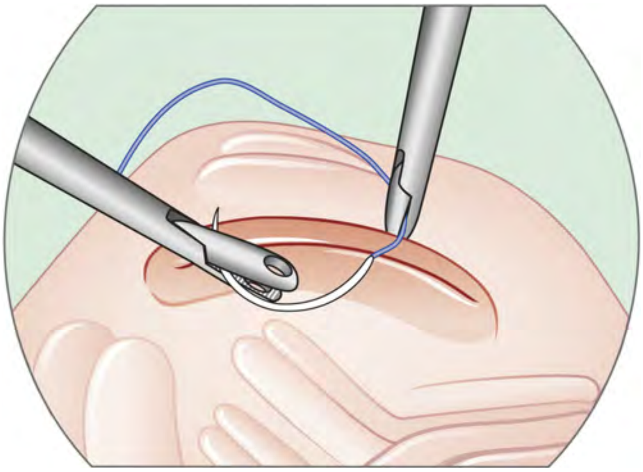

Fig. 7.1a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

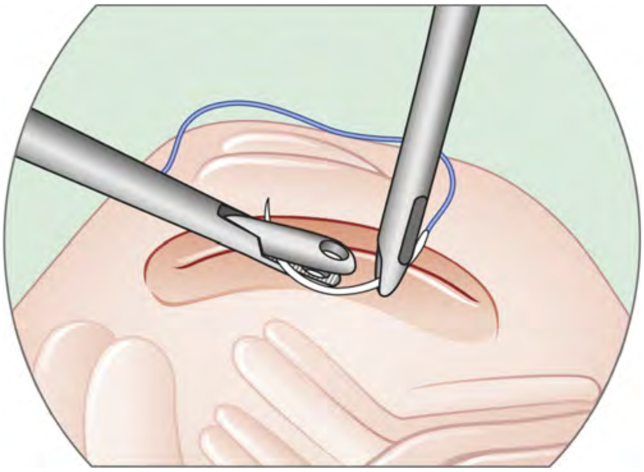

Fig. 7.1b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver and the needle is grasped at point 'C' by the needle driver. The assisting instrument is used to stabilize the needle through this process.

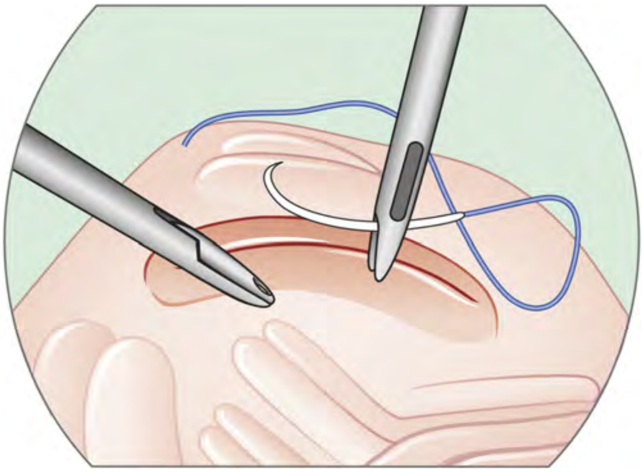

Fig. 7.1c A perpendicular relationship between the needle and the needle driver is confirmed.

7.1.2 Tissue Re-approximation

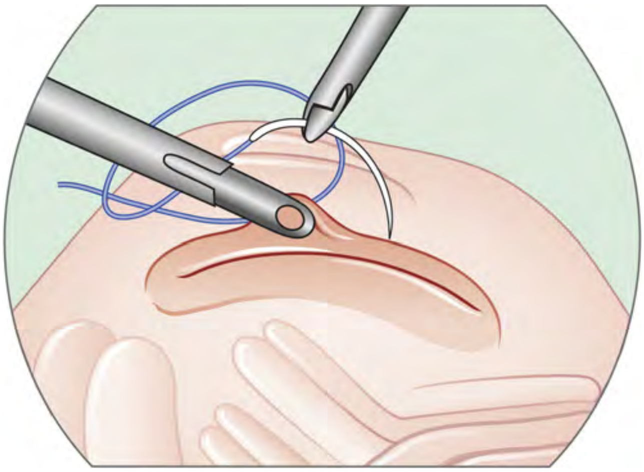

Fig. 7.1d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

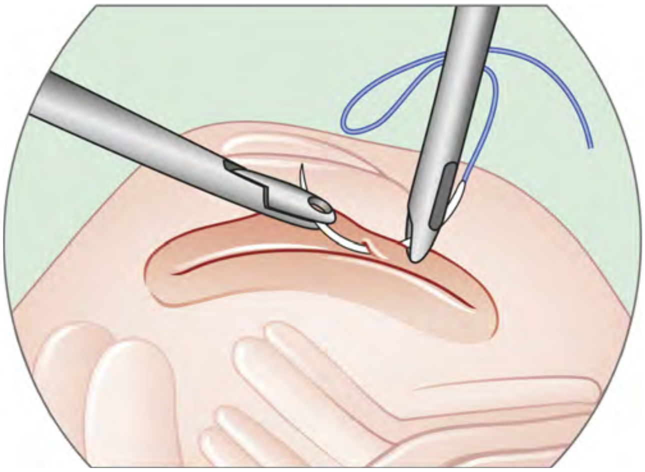

Fig. 7.1e By axial rotation of the needle holder, the needle is passed through the tissue and picked up by the assisting instrument grasping the needle at point 'B'.

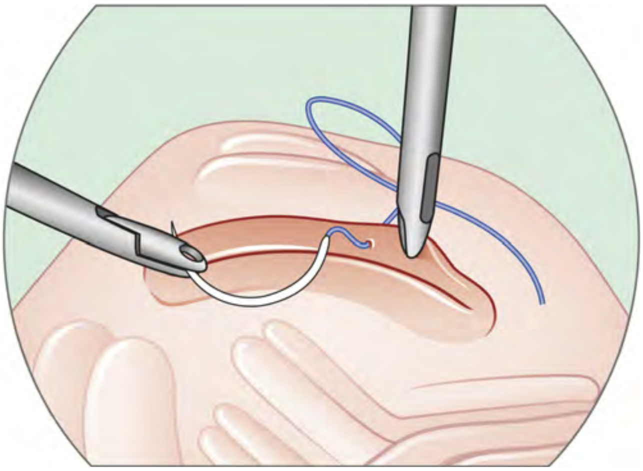

Fig. 7.1f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

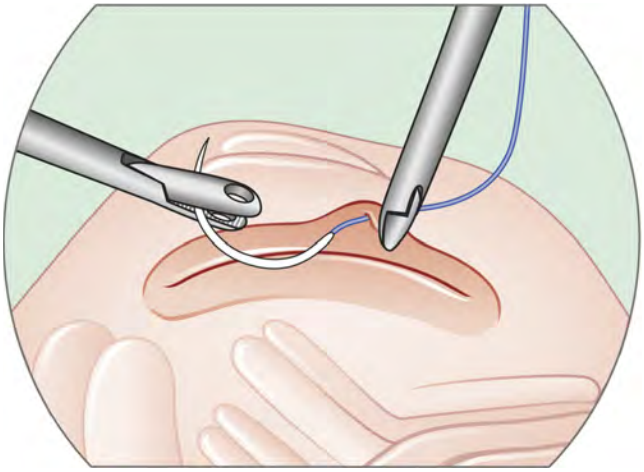

Fig. 7.1g The needle is reset at the level of the tissue by re-grasping at point 'C'.

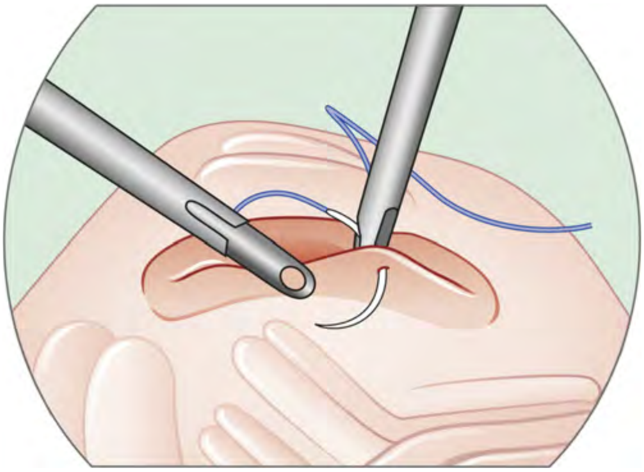

Fig. 7.1h The assisting instrument is used to grasp and 'align' the opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by axial rotation of the needle driver.

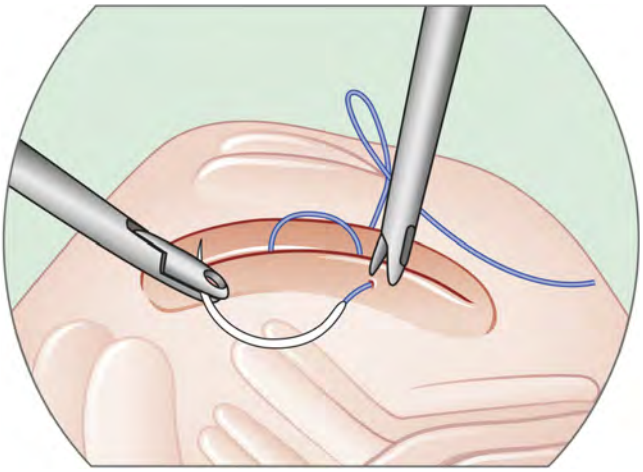

Fig. 7.1i The assisting instrument is used to grasp the needle in the middle and the needle is transferred. This allows for the best stability when throwing knots with the assistance of the needle.

7.1.3 Knot Tying

Loop Preparation

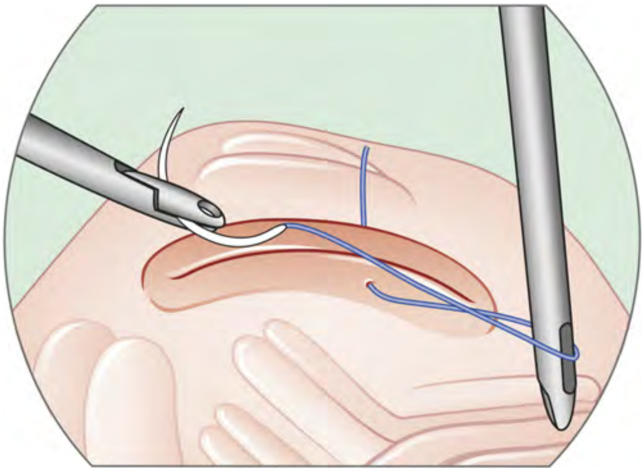

Fig. 7.1j The suture is pulled through the tissue until a short tail is formed. A pulley technique may be useful at this time.

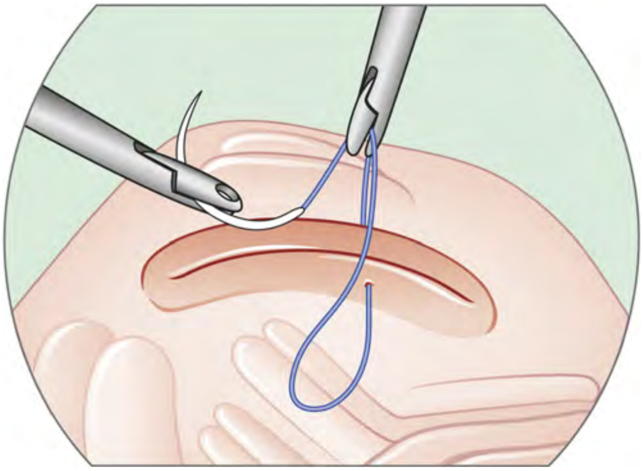

Fig. 7.1k The needle driver grasps the suture at point 'A' and swedge of the needle is manipulated until the swedge forms a parallel relationship with the needle driver. Rotating the assisting instrument will also change the orientation of the swedge in relation to the needle driver.

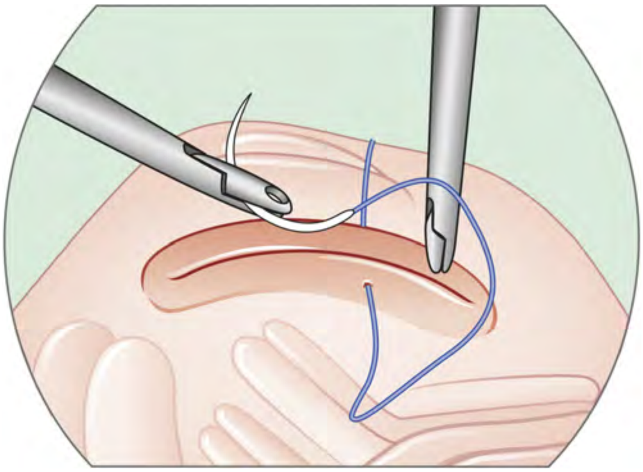

Fig. 7.1 l The loop is formed by bringing the swedge of the needle over the tissue where the knot is to be secured.

Throwing the Knot

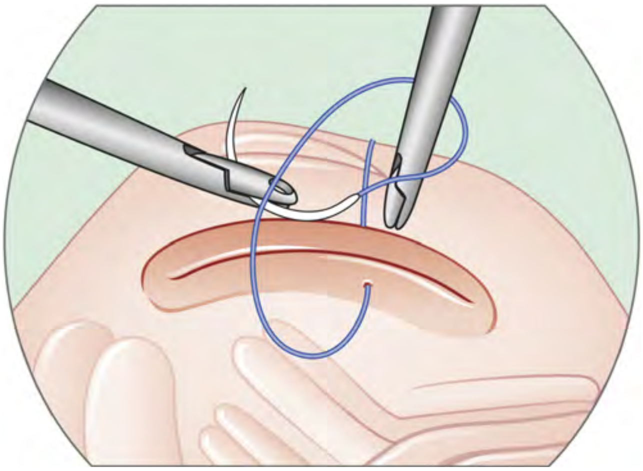

Fig. 7.1 m A clockwise throw is made by wrapping the needle driver around the swedge of the needle or by wrapping the swedge around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the tip of the needle driver close to the swedge of the needle at the level of the tissue. If the swedge of the needle is not in a parallel relationship with the needle driver, this step is made unnecessarily difficult.

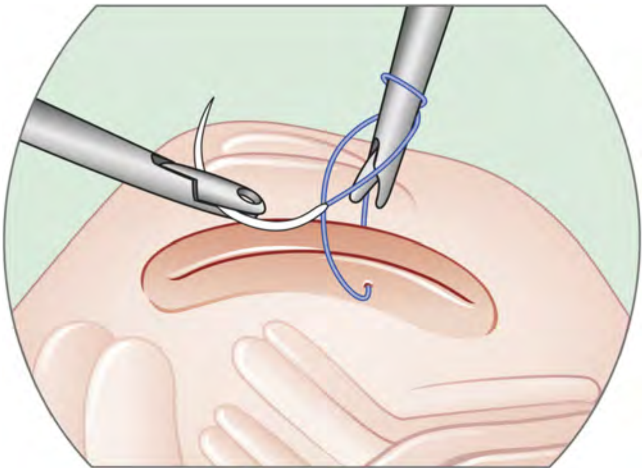

Fig. 7.1n A second throw is made if a *surgeon's knot* is preferred. Using the assistance of the needle makes the second throw much easier than performing knot tying without the needle.

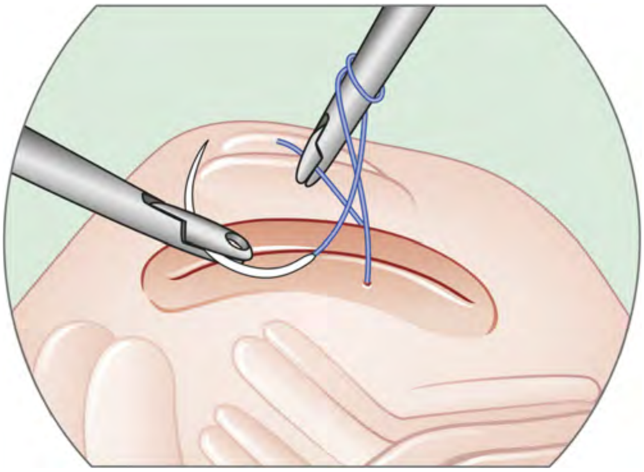

Fig. 7.1o The short tail is then grasped. It is important to grasp the outer third of the tail to avoid a *bow tie knot*.

Securing the Knot

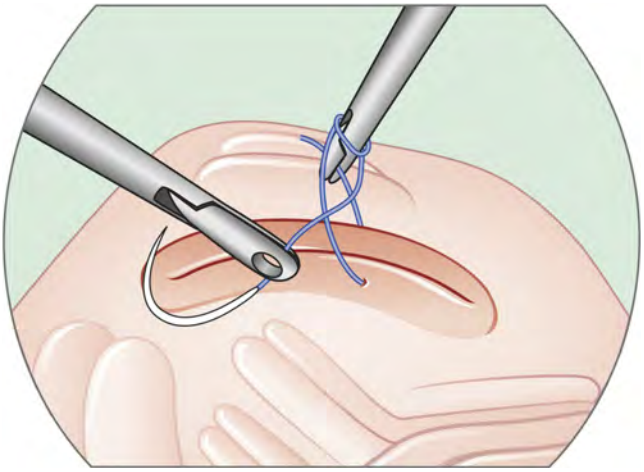

Fig. 7.1p The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'. This allows the knot to be secured without any concern for causing inadvertent needle stick injuries.

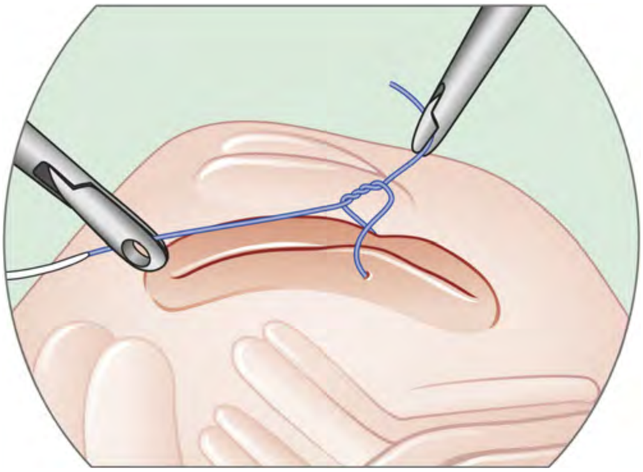

Fig. 7.1q The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

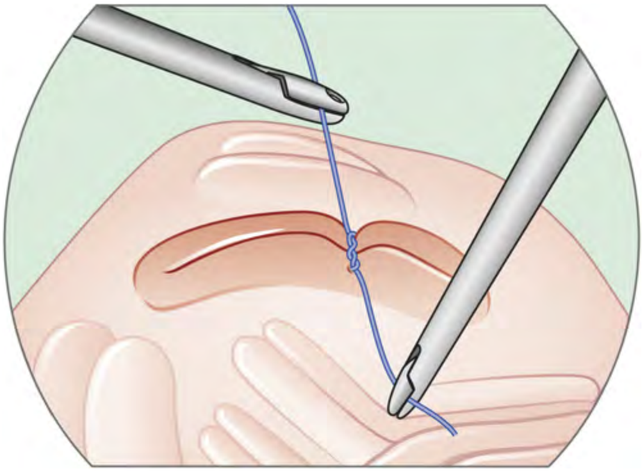

Fig. 7.1r The needle driver then moves the tail to the opposite side of the tissue and the assisting instrument holding the loop is now moved opposite the tail to secure the knot. It is important to keep the tail at the level of the tissue and to avoid pulling with the instrument holding the tail to avoid the formation of a long tail. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

Second Throw

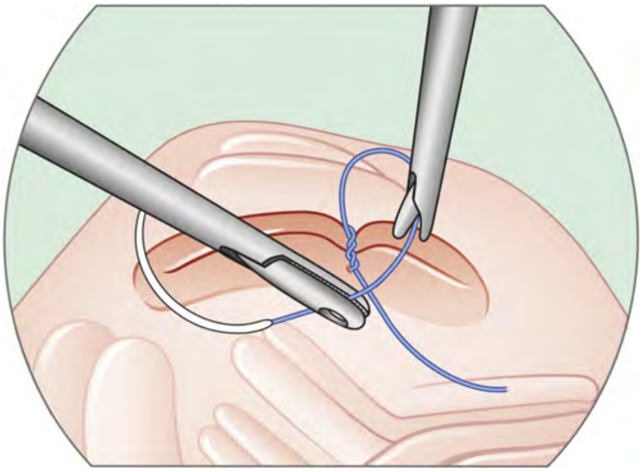

Fig. 7.1s The needle driver (right hand) now grasps the suture next to the assisting instrument at point ‘A’.

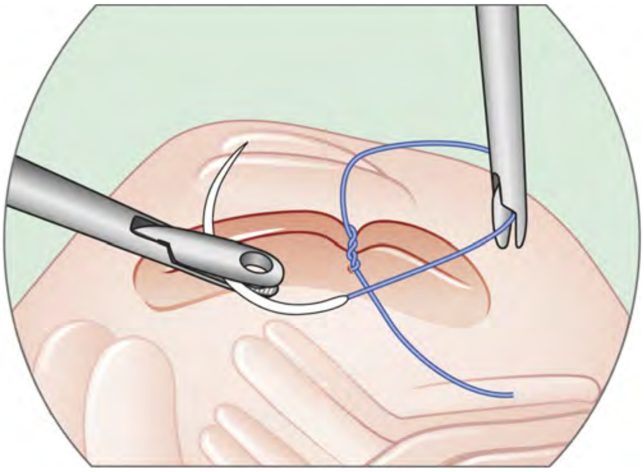

Fig. 7.1 t The assisting instrument releases the suture and grasps the needle in the middle. The needle driver manipulates the suture until the swedge of the needle assumes a parallel relationship with the needle driver and the assisting instrument moves the swedge of the needle over the first knot at the level of the tissue.

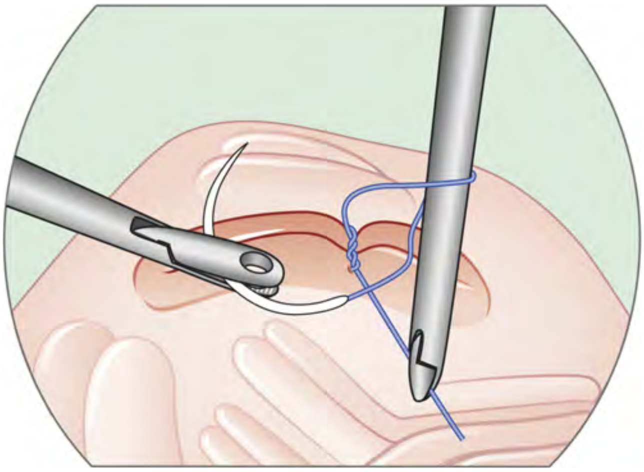

Fig. 7.1u A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

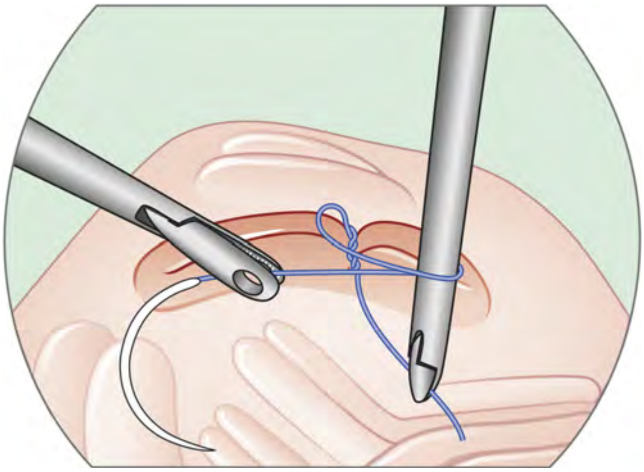

Fig. 7.1v The assisting instrument (left hand) releases the needle and grasps the suture at point ‘A’.

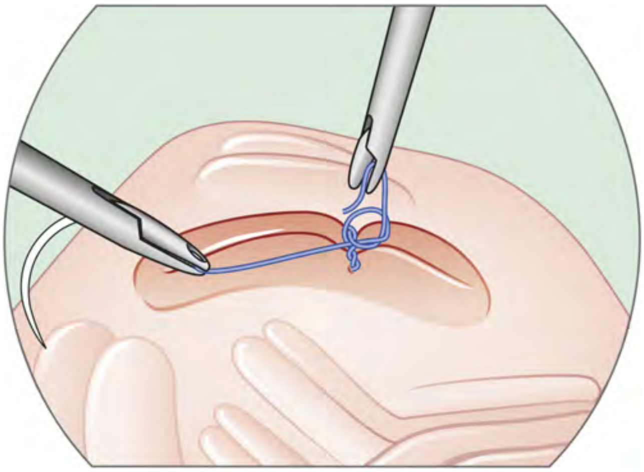

Fig. 7.1w The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

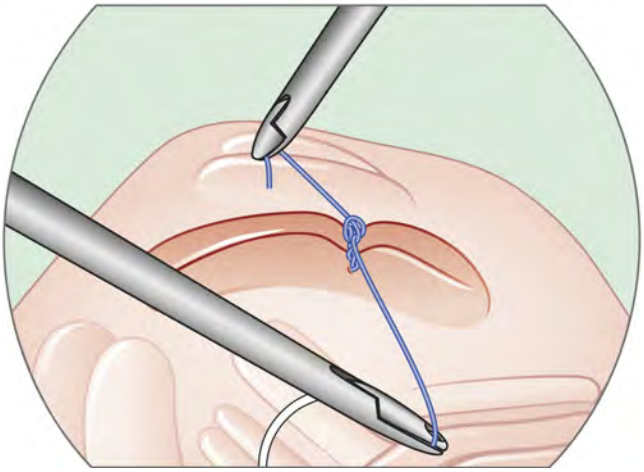

Fig. 7.1x The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

7.2 Without the Needle (Expert) Knot Tying Technique

7.2.1 Setting the Needle

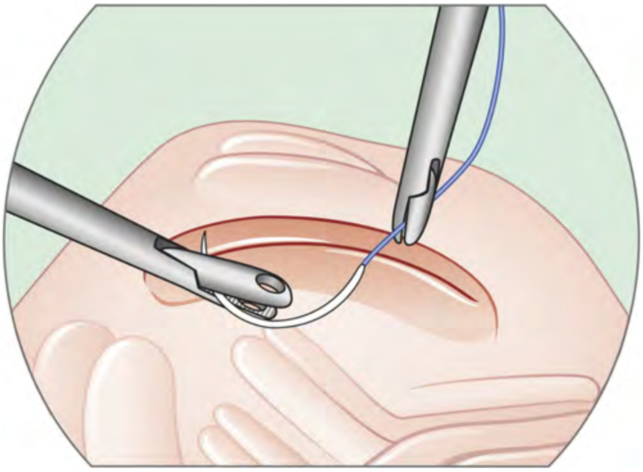

Fig. 7.2a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

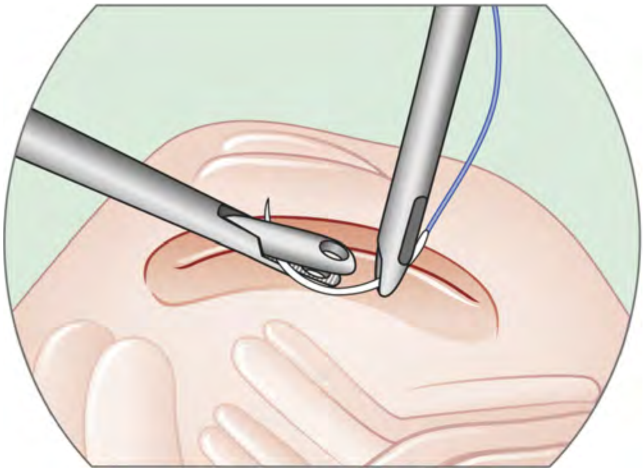

Fig. 7.2b The needle driver (right hand) is used to manipuate the needle so that it lies in a perpendicular plane to the needle driver and the needle is grasped at point 'C' by the needle driver. The assisting instrument is used to stabilize the needle through this process.

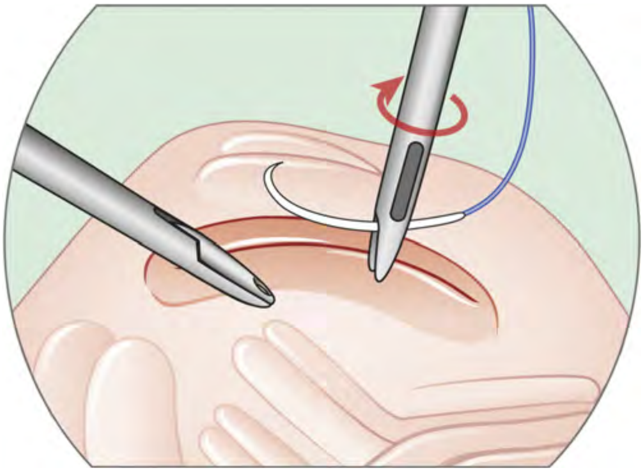

Fig. 7.2c A perpendicular relationship between the needle and the needle driver is confirmed.

7.2.2 Tissue Re-approximation

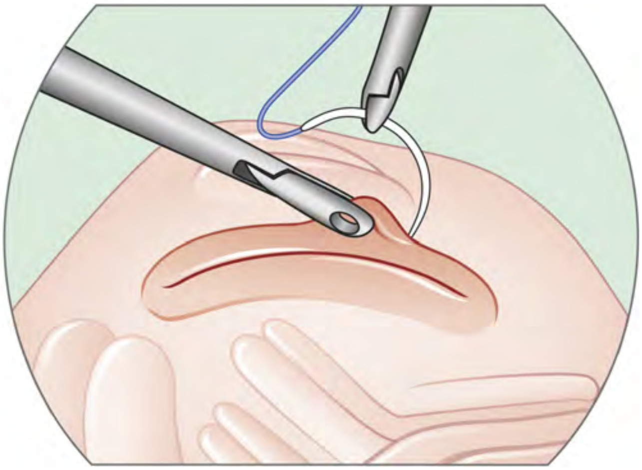

Fig. 7.2d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle (see insert picture of the hand rotation).

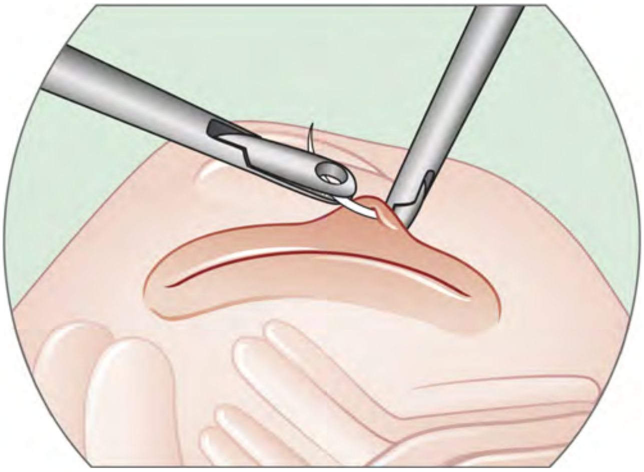

Fig. 7.2e The needle is passed through the tissue by axial rotation of the needle driver and is picked up by the assisting instrument. The assisting instrument grasps the needle at point 'B'.

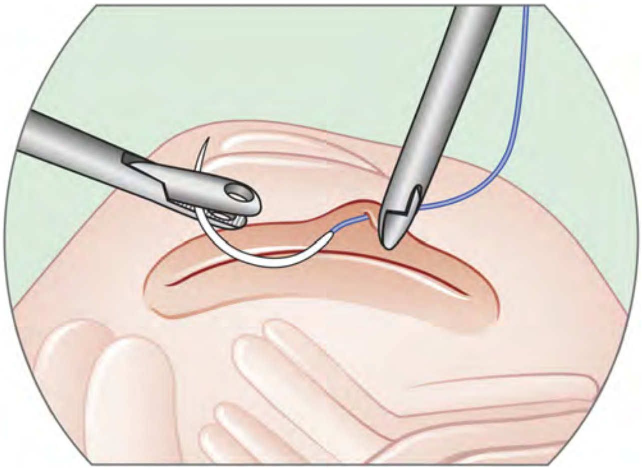

Fig. 7.2f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

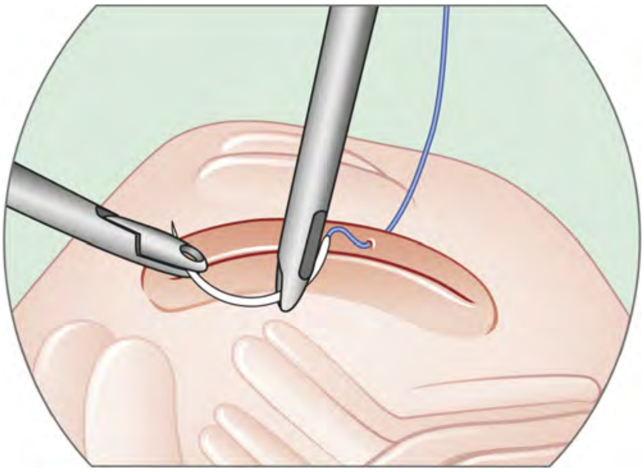

Fig. 7.2 g The needle is reset at the level of the tissue by re-grasping at point 'C'.

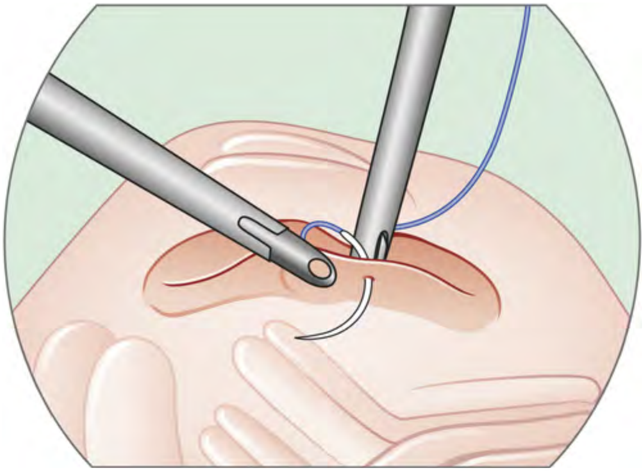

Fig. 7.2h The assisting instrument is used to grasp and 'align' the opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by axial rotation of the needle driver.

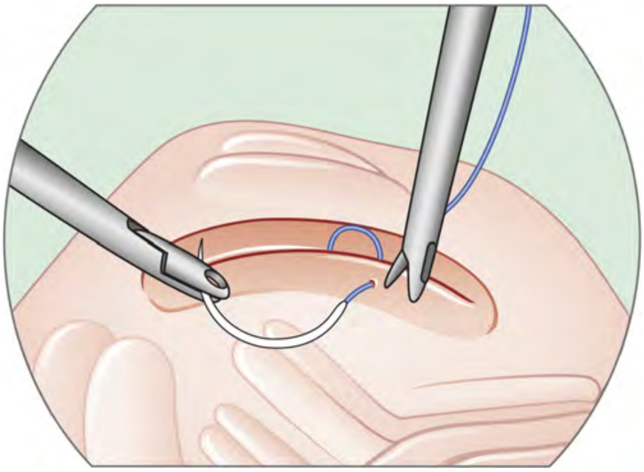

Fig. 7.2i The assisting instrument is used to grasp the needle at point 'B' and the needle is transferred.

7.2.3 Knot Tying

Loop Preparation

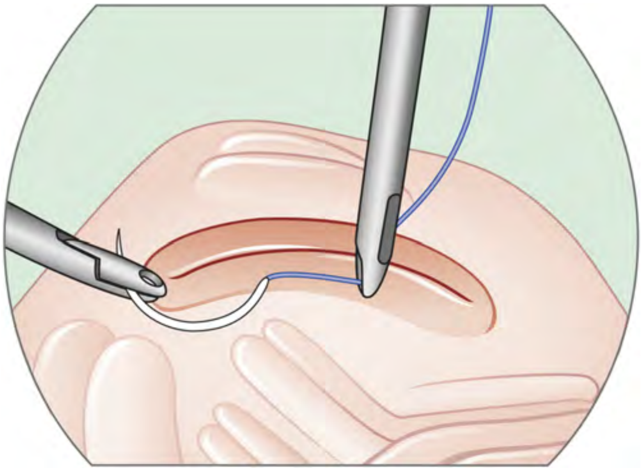

Fig. 7.2j The suture is grasped by the needle driver at point 'A'. It is important that the needle be positioned with the assisting hand so that the needle driver can grasp perpendicular to the suture.

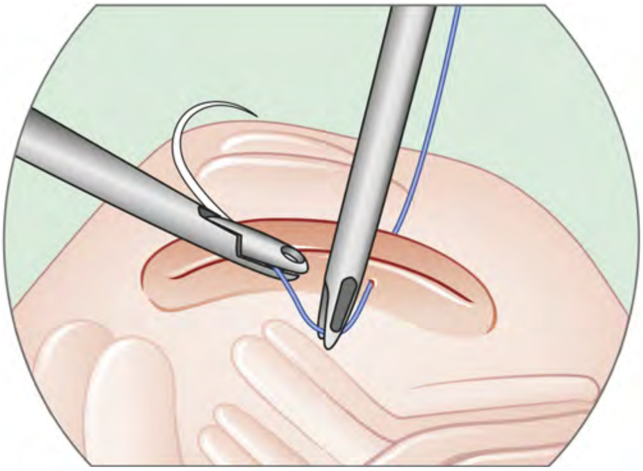

Fig. 7.2k The suture is passed from the needle driver to the assisting instrument at point 'A' so that the assisting instrument grasps the suture at a 90 degree angle (perpendicular).

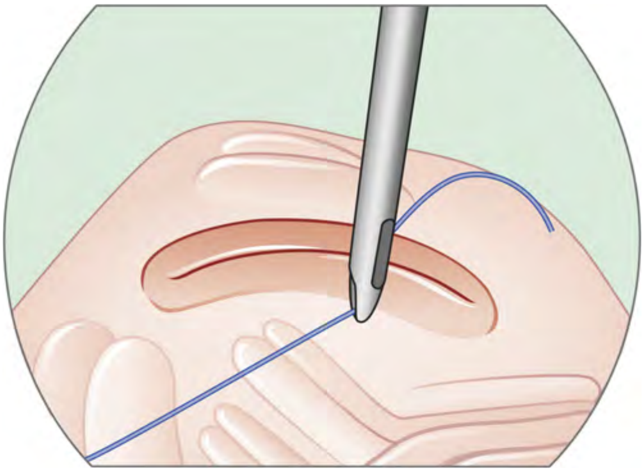

Fig. 7.2 l The suture is pulled through the tissue by moving the assisting instrument in a cephalic direction until a short tail is made. The needle driver then grasps the suture that leaves enough length to form a loop of adequate size.

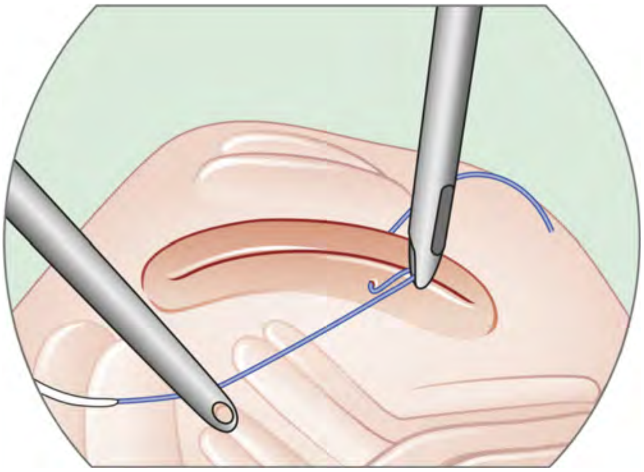

Fig. 7.2 m The assisting instrument then grasps the suture at a perpendicular angle, once an adequate loop has been formed. This process of transferring the suture is referred to as "walking the line".

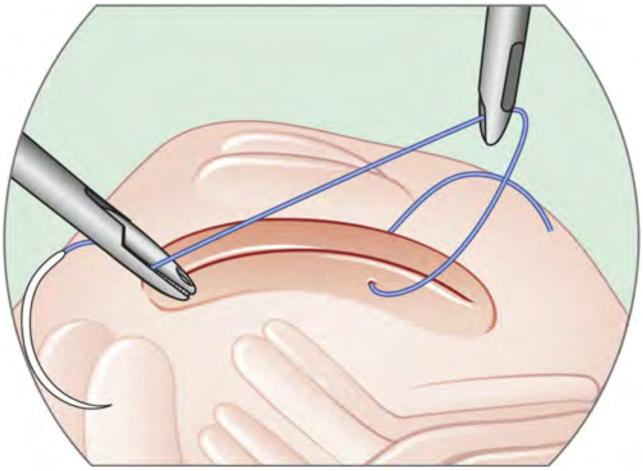

Fig. 7.2n The needle driver can be used at this time to grasp the suture at the mid-portion of the loop. This can aid in adjusting the orientation of the loop.

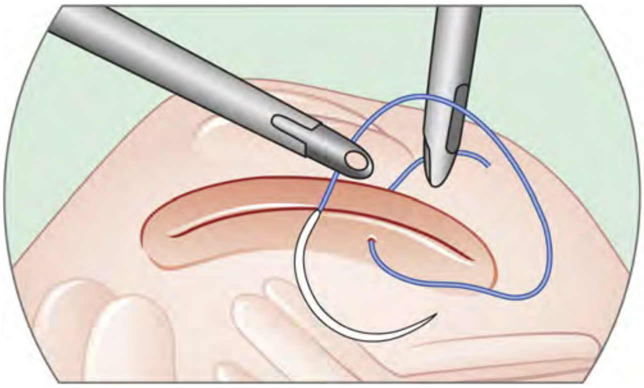

Fig. 7.2o The loop is formed by bringing the assisting instrument over the tissue where the knot is to be secured. The assisting instrument is 'supinated' (rotated) so that the suture exiting the assisting instrument is 'aligned' with the needle driver. The suture exiting the loop should lie in an oblique orientation between the horizontal and vertical axes. Placing the left hand at the level of the tissue helps avoid 'lift and drift' which is a common mistake that is made when tying intracorporeal knots.

Throwing the Knot

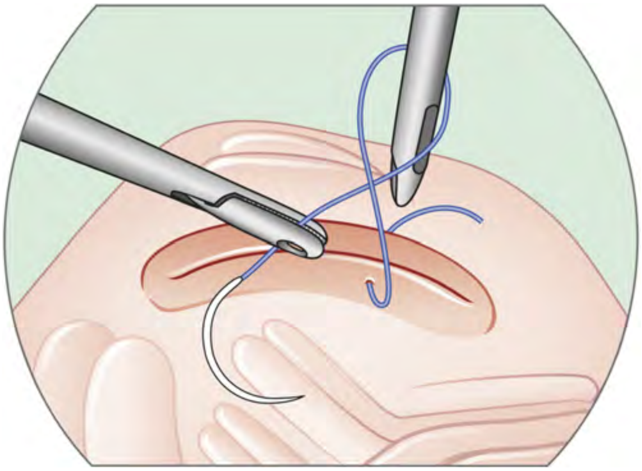

Fig. 7.2p A clockwise throw is made by wrapping the needle driver around the loop or by wrapping the loop around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the two instrument tips close to each other at the level of the tissue. If the hand holding the loop is pronated too much, it can make this step more difficult.

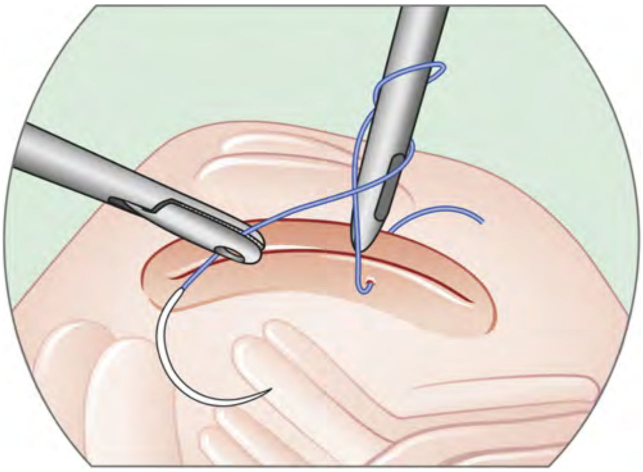

Fig. 7.2q A second throw is made if a *surgeon's knot* is preferred. This may be a difficult task without a monofilament suture.

Securing the Knot

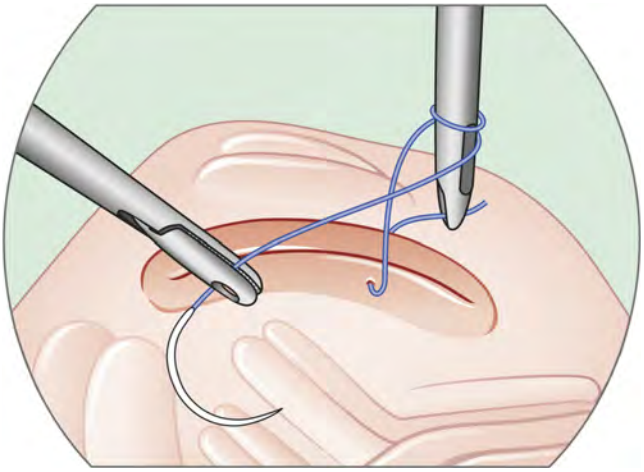

Fig. 7.2r The short tail is grasped. It is important to grasp the outer third of the tail to avoid a *bow tie knot*.

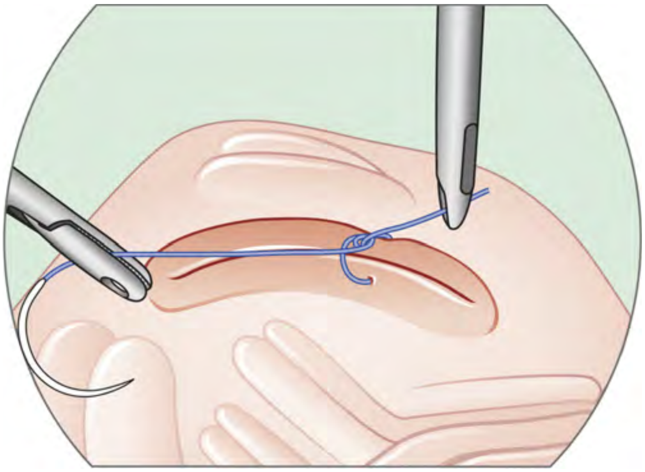

Fig. 7.2s The assisting instrument holding the loop is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

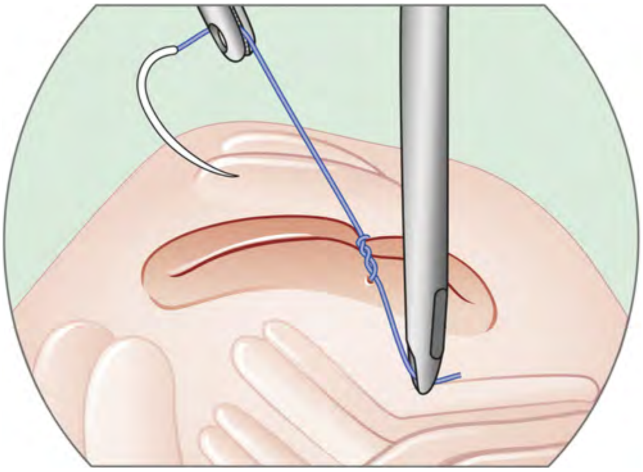

Fig. 7.2 t The needle driver then moves the tail to the opposite side of the tissue while the assisting instrument holding the loop is moved in the opposite direction to secure the knot. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lays flat. It is important to keep the tail at the level of the tissue and to avoid pulling. If the needle driver pulls the suture too far, a long tail will result.

Second Throw

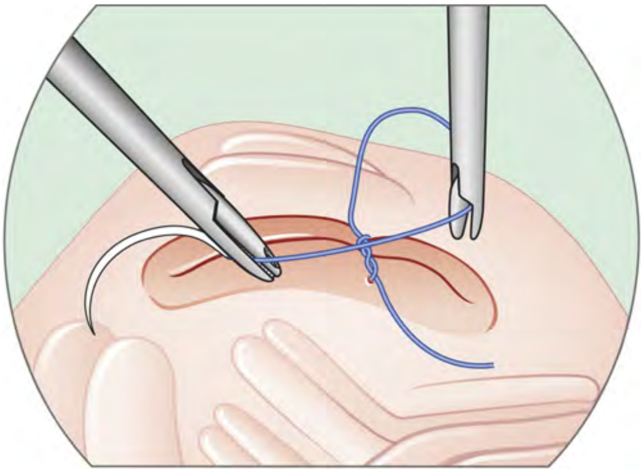

Fig. 7.2u The loop is formed by moving the assisting instrument over the first knot at the level of the tissue. This is the proper moment to adjust the length of the loop by ‘walking’ the suture as described earlier.

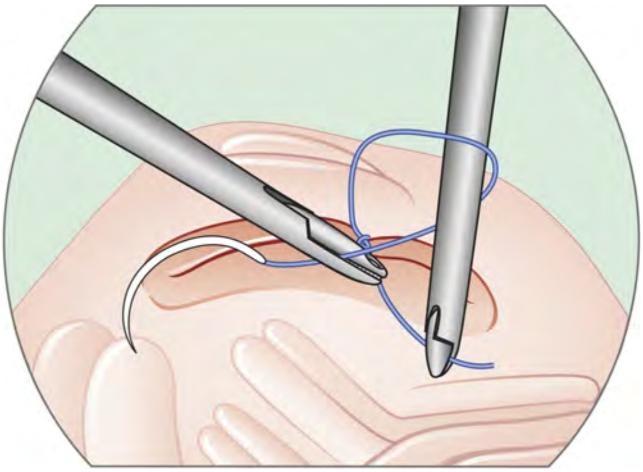

Fig. 7.2v A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

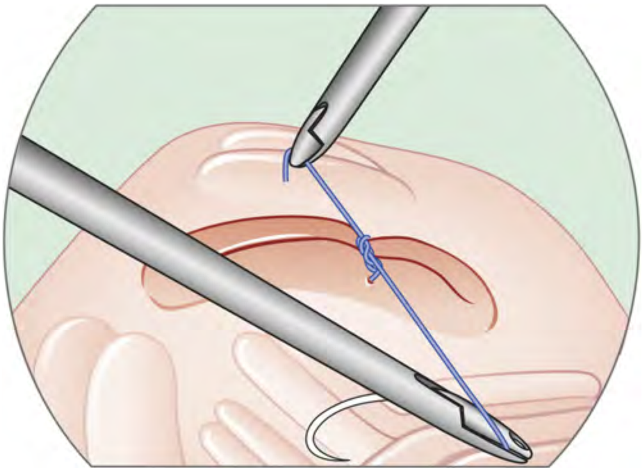

Fig. 7.2w The assisting instrument moves the loop away from the knot. The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured.

8 Ipsilateral Right Port Placement

8.1 With the Needle (Smiley) Knot Tying Technique

8.1.1 Setting the Needle

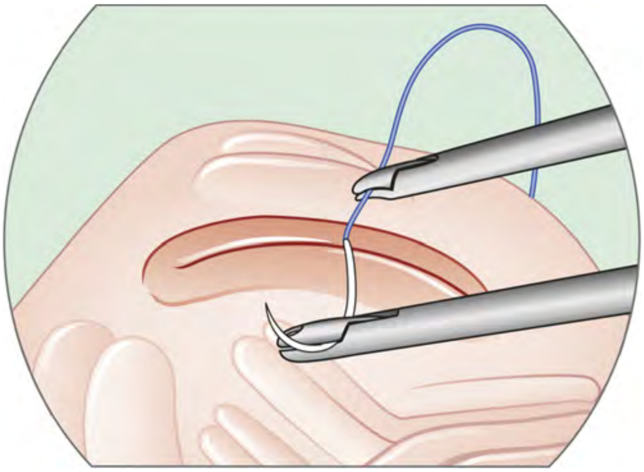

Fig. 8.1a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

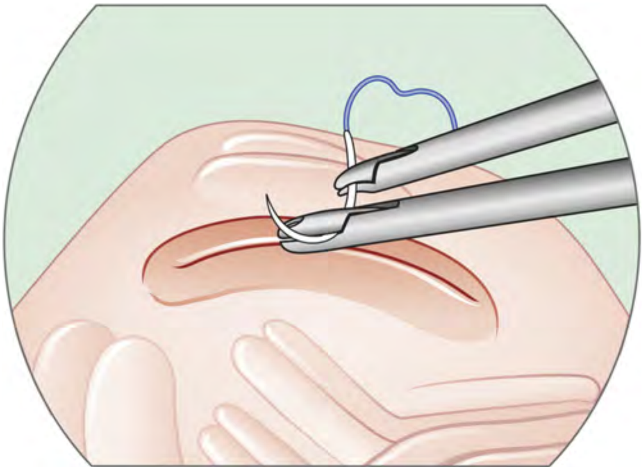

Fig. 8.1b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver grasping the needle at point 'C'. The assisting instrument is used to stabilize the needle through this process.

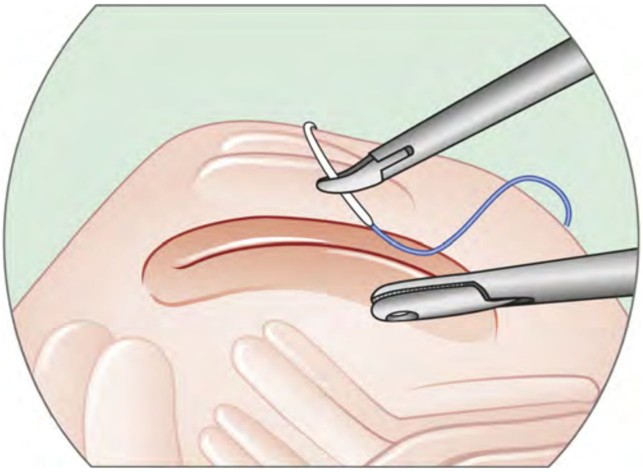

Fig. 8.1c A perpendicular relationship between the needle and the needle driver is confirmed.

8.1.2 Tissue Re-approximation

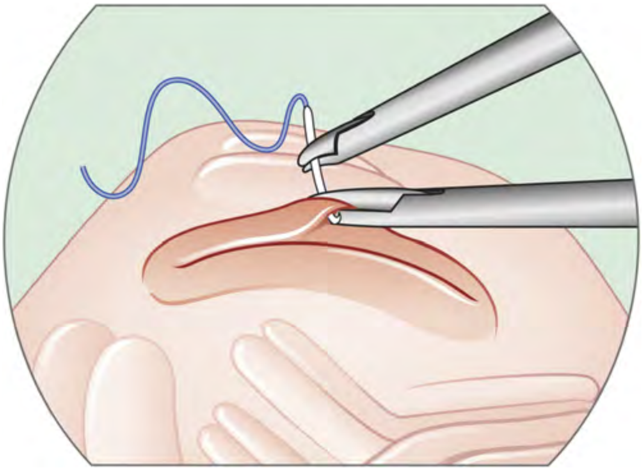

Fig. 8.1d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

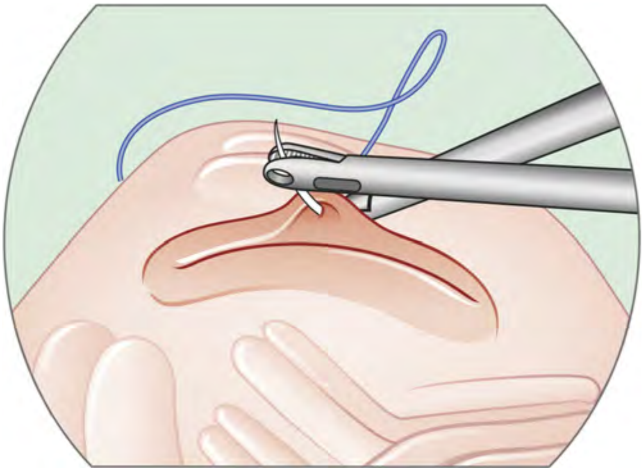

Fig. 8.1e By axial rotation of the needle driver, the needle is passed through the tissue and passed to the assisting instrument, grasping the needle at point 'B'.

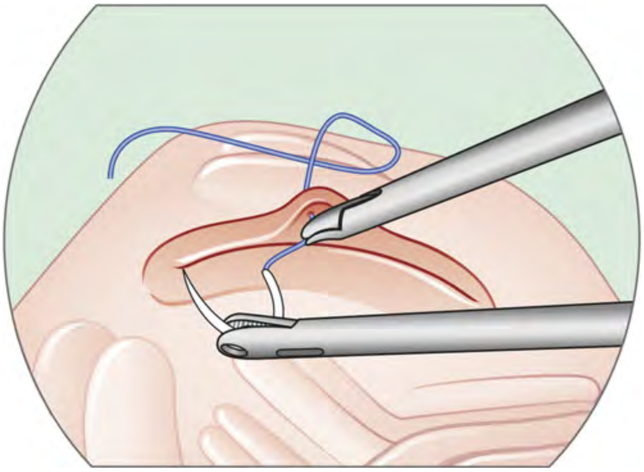

Fig. 8.1f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

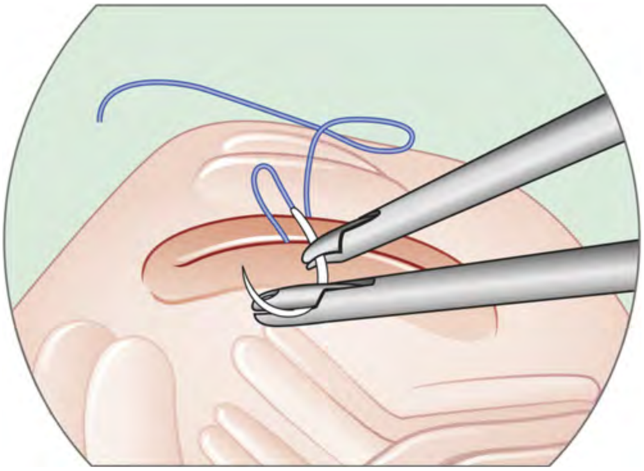

Fig. 8.1g The needle is reset at the level of the tissue by re-grasping at point 'C'.

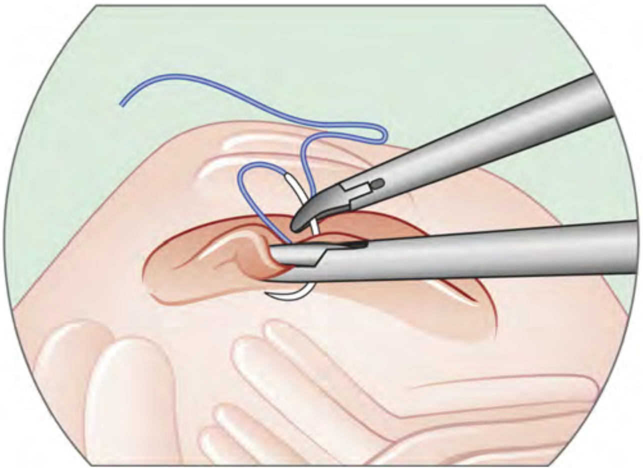

Fig. 8.1h The assisting instrument is used to grasp and 'align' this opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by an axial rotation of the needle driver.

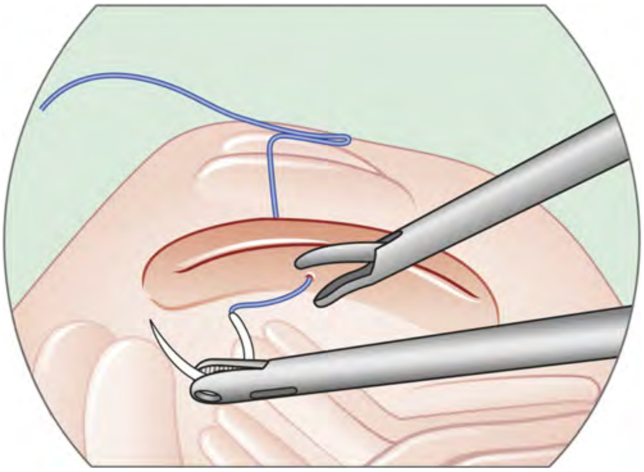

Fig. 8.1i The assisting instrument is used to grasp the needle in the middle and the needle is transferred. This allows for the best stability when throwing knots with the assistance of the needle.

8.1.3 Knot Tying

Loop Preparation

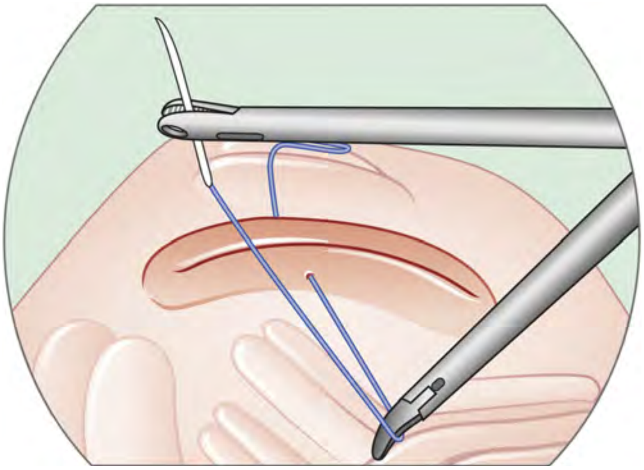

Fig. 8.1j The suture is pulled through the tissue until a short tail is formed. A pulley technique may be useful at this time.

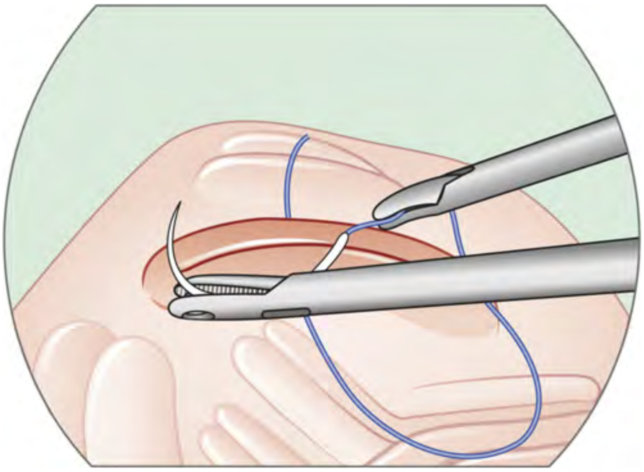

Fig. 8.1k The needle driver grasps the suture at point 'A' and the swedge of the needle is manipulated until it forms a parallel relationship with the needle driver. Rotating the assisting instrument will also change the orientation of the swedge in relation to the needle driver.

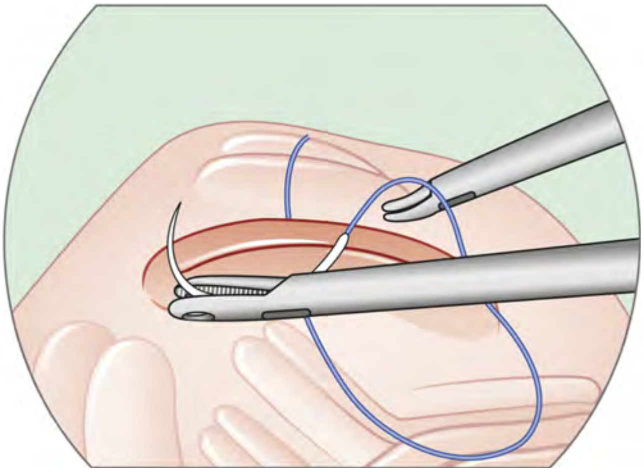

Fig. 8.1 l The loop is formed by bringing the swedge of the needle over the tissue where the knot is to be secured.

Throwing the Knot

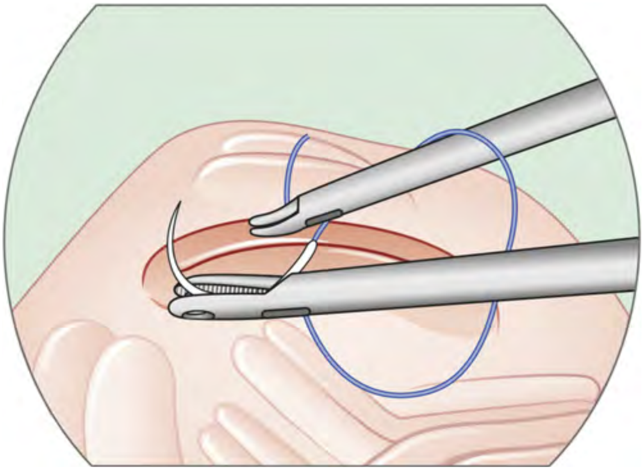

Fig. 8.1 m A clockwise throw is made by wrapping the needle driver around the swedge of the needle or by wrapping the swedge around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the tip of the needle driver close to the swedge of the needle at the level of the tissue. If the swedge of the needle is not in a parallel relationship with the needle driver, this step is made unnecessarily difficult.

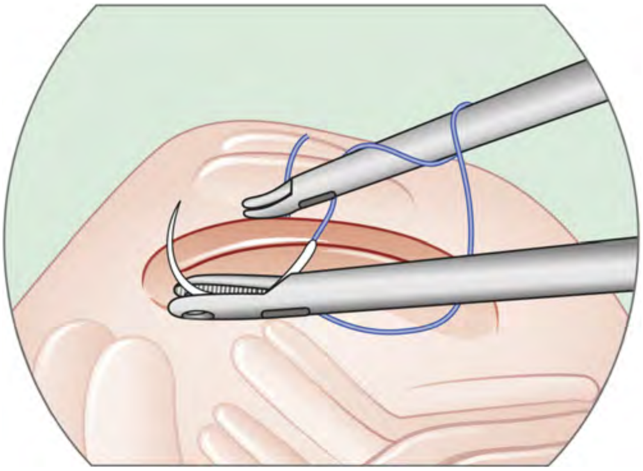

Fig. 8.1n A second throw is made if a *surgeon's knot* is preferred. Using the assistance of the needle makes the second throw much easier than performing knot tying without the needle.

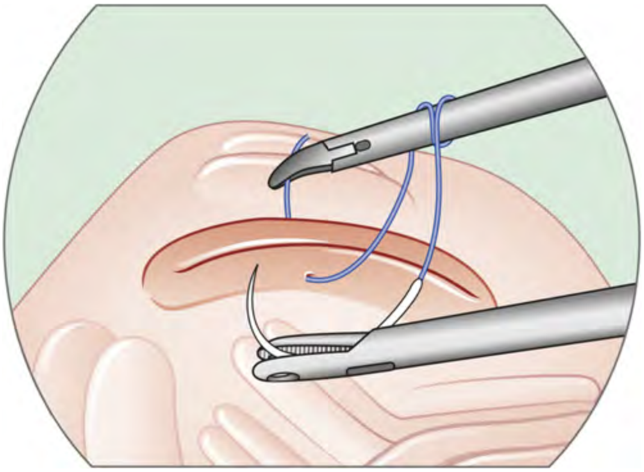

Fig. 8.1o The short tail is then grasped. It is important to grasp the outer third of the tail to avoid formation of a *bow tie knot*.

Securing the Knot

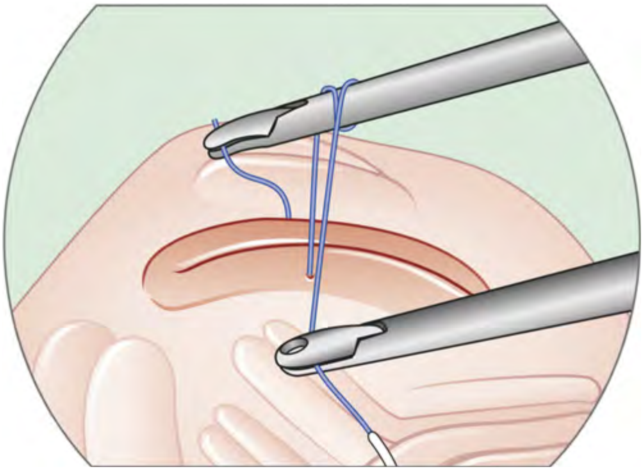

Fig. 8.1p The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'. This allows the knot to be secured without any concern for causing inadvertent needle stick injuries.

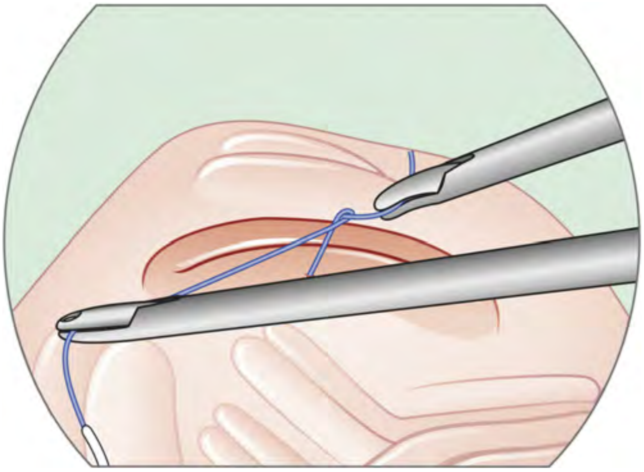

Fig. 8.1q The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

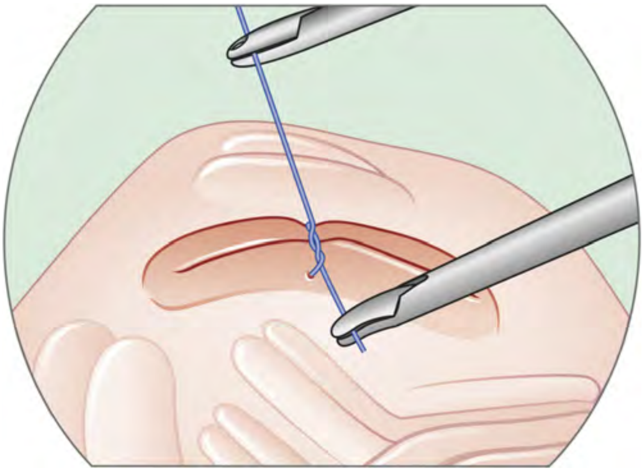

Fig. 8.1r The needle driver then moves the tail to the opposite side of the tissue and the assisting instrument holding the loop is now moved opposite the tail to secure the knot. It is important to keep the tail at the level of the tissue and to avoid pulling with the instrument holding the tail to avoid the formation of a long tail. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

Second Throw

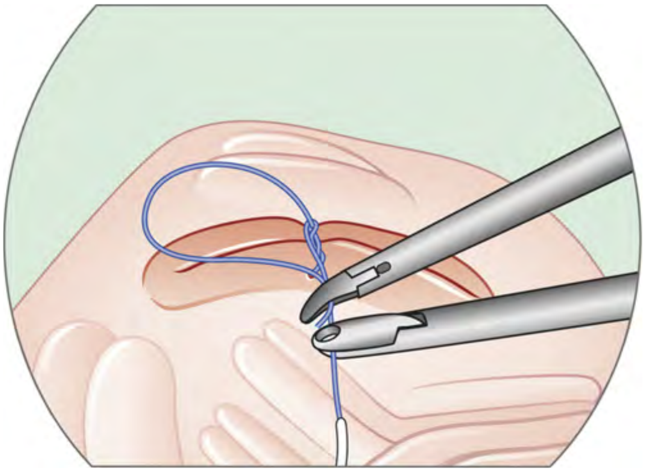

Fig. 8.1s The needle driver (right hand) now grasps the suture next to the assisting instrument a point 'A'.

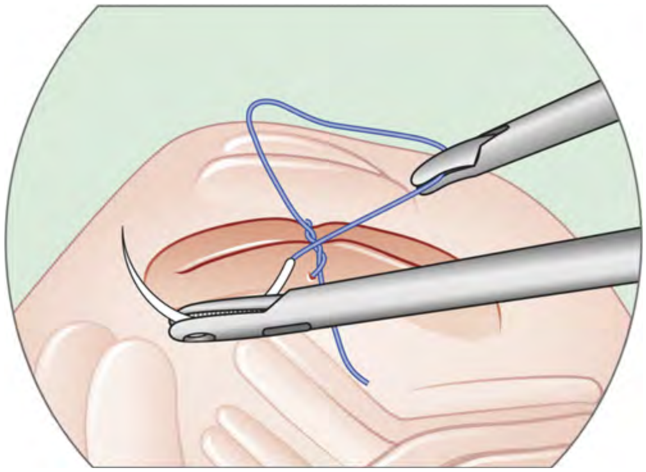

Fig. 8.1 t The assisting instrument releases the suture and grasps the needle in the middle. The needle driver manipulates the suture until the swedge of the needle assumes a parallel relationship with the needle driver and the assisting instrument moves the swedge of the needle over the first knot at the level of the tissue.

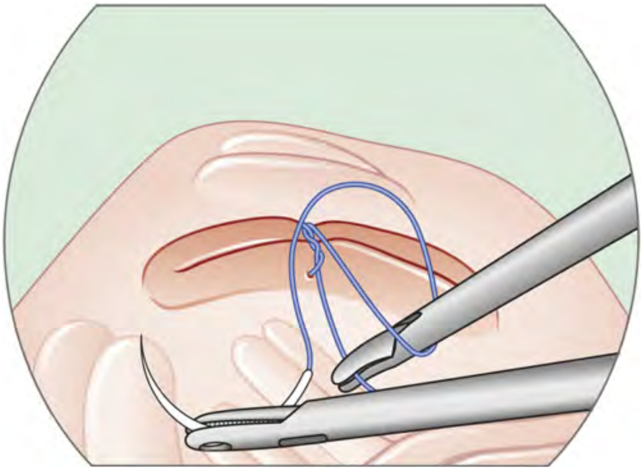

Fig. 8.1u A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

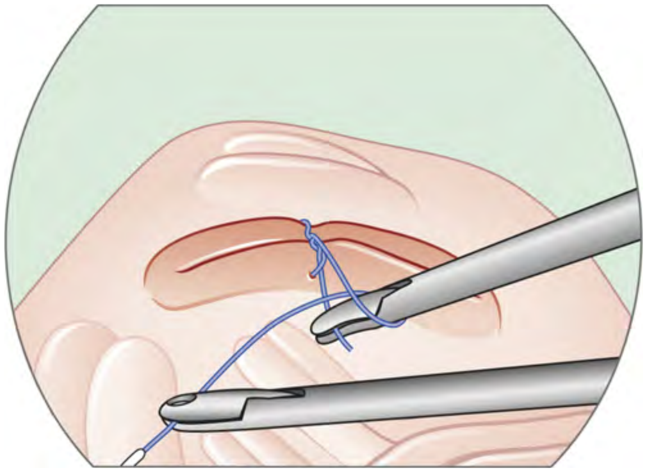

Fig. 8.1v The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'.

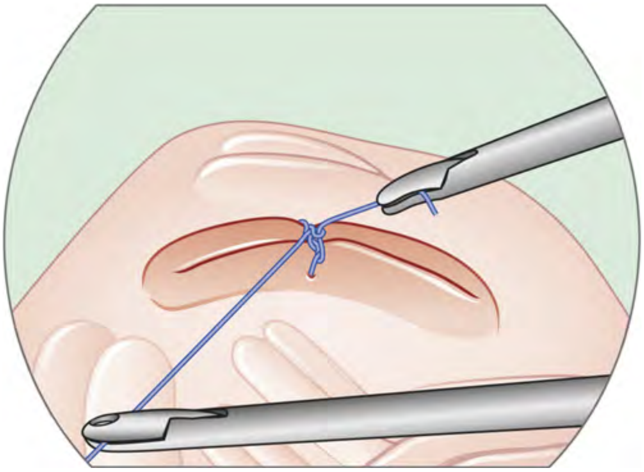

Fig. 8.1w The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

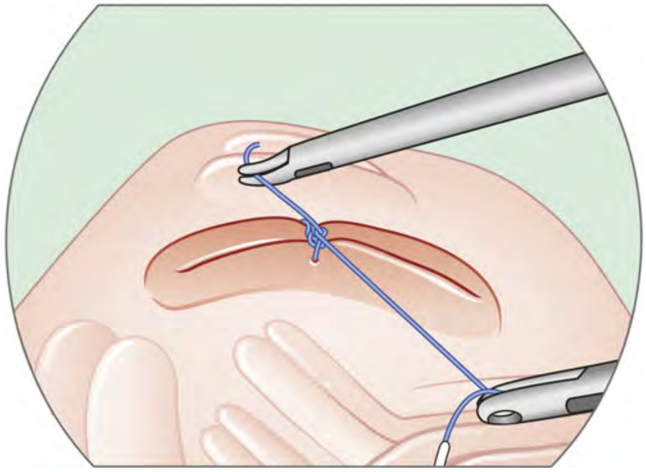

Fig. 8.1x The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

8.2 Without the Needle (Expert) Knot Tying Technique

8.2.1 Setting the Needle

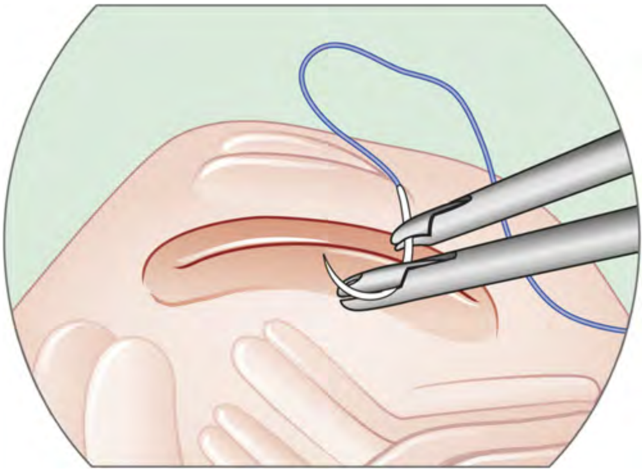

Fig. 8.2a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

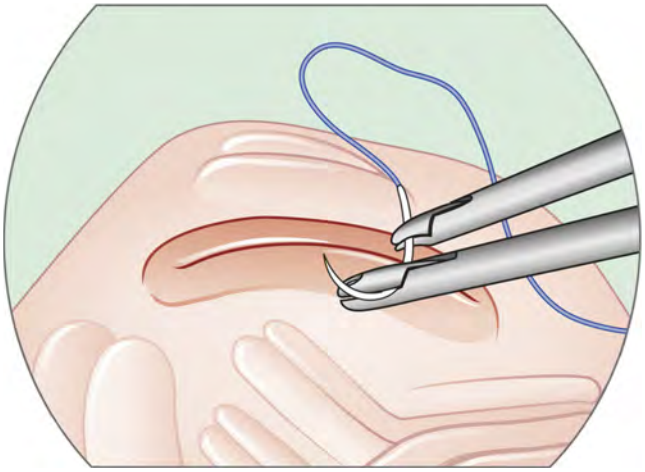

Fig. 8.2b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver grasping the needle at point 'C'. The assisting instrument is used to stabilize the needle through this process.

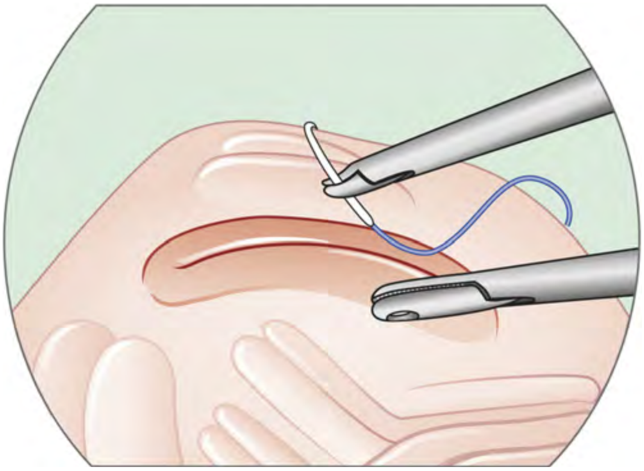

Fig. 8.2c A perpendicular relationship between the needle and the needle driver is confirmed.

8.2.2 Tissue Re-approximation

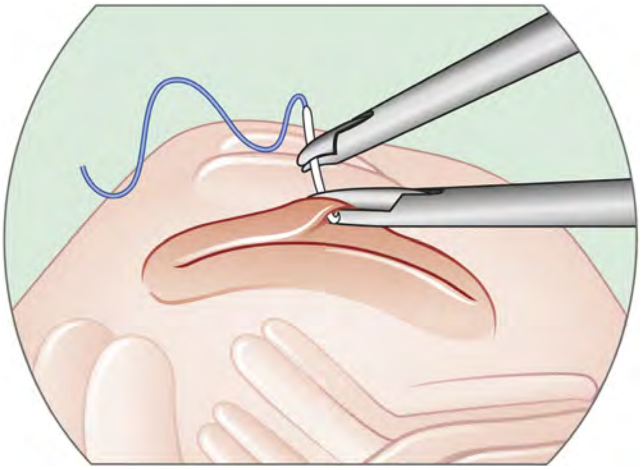

Fig. 8.2d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

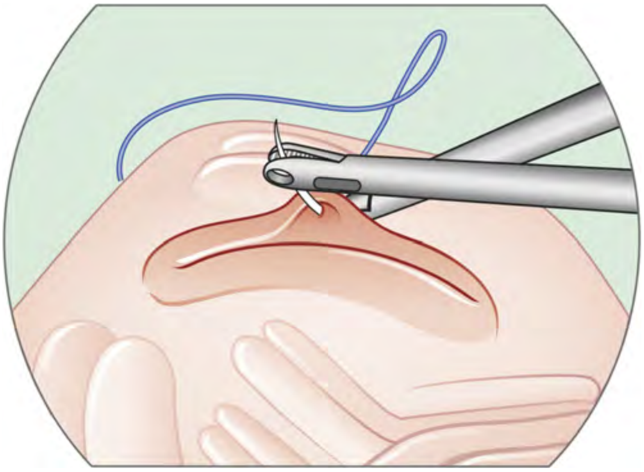

Fig. 8.2e By axial rotation of the needle driver, the needle is passed through the tissue and picked up by the assisting instrument. The assisting instrument grasps the needle at point 'B' (see insert picture of hand rotation).

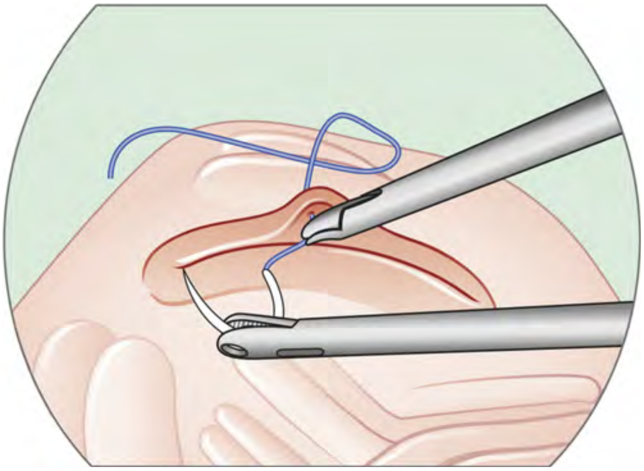

Fig. 8.2f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

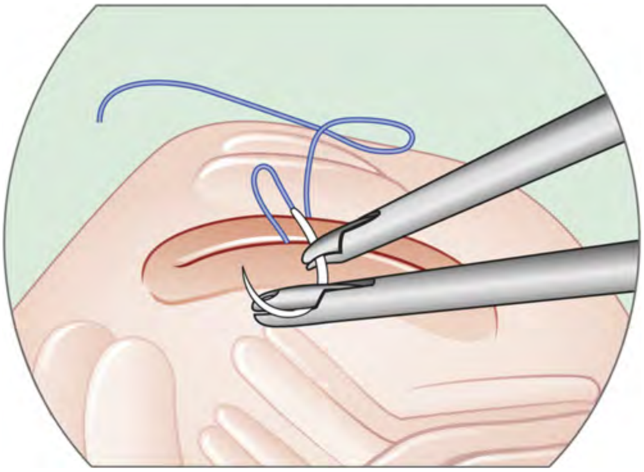

Fig. 8.2 g The needle is reset at the level of the tissue by re-grasping at point 'C'.

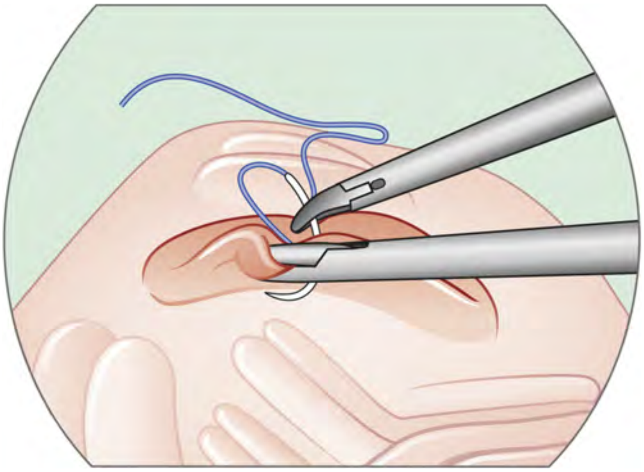

Fig. 8.2h The assisting instrument is used to grasp and 'align' the opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by axial rotation of the needle driver.

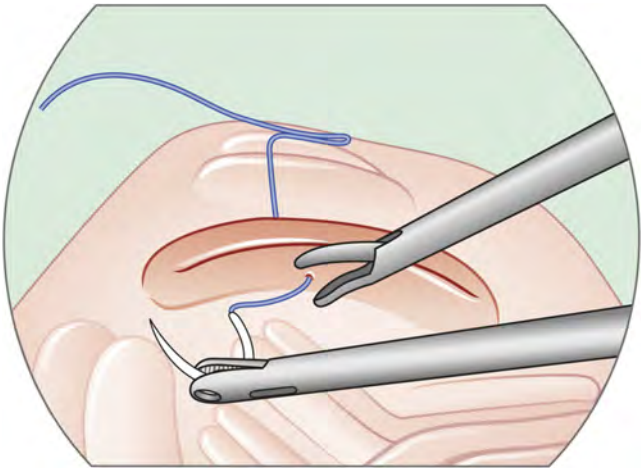

Fig. 8.2i The assisting instrument is used to grasp the needle at point 'B' and the needle is transferred.

8.2.3 Knot Tying

Loop Preparation

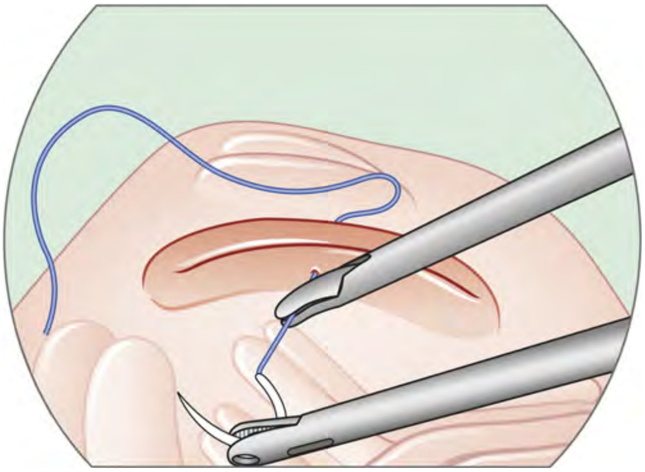

Fig. 8.2j The suture is grasped by the needle driver at point 'A'. It is important that the needle be positioned with the assisting hand so that the needle driver can grasp perpendicular to the suture.

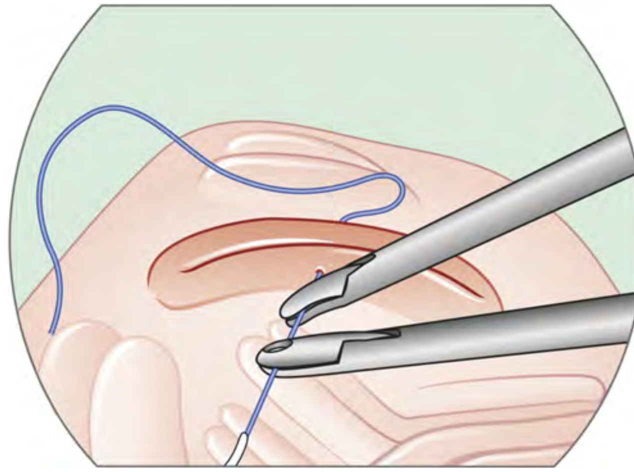

Fig. 8.2k The suture is passed from the needle driver to the assisting instrument at point 'A' so that the assisting instrument grasps the suture at a 90 degree angle (perpendicular).

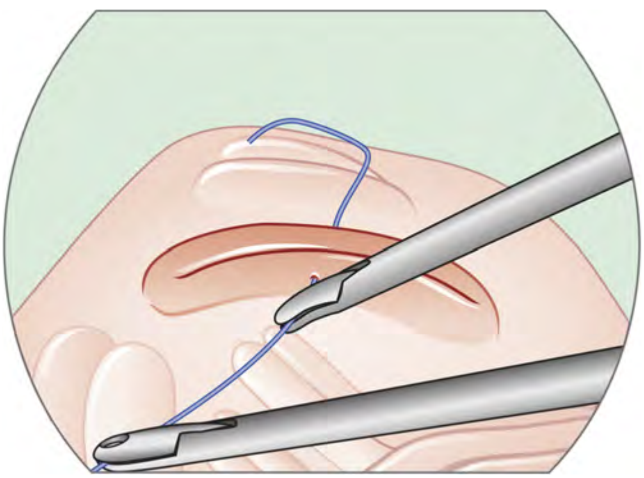

Fig. 8.2 l The suture is pulled through the tissue by moving the assisting instrument in a cephalic direction until a short tail is made. The needle driver then grasps the suture that leaves enough length to form a loop of adequate size.

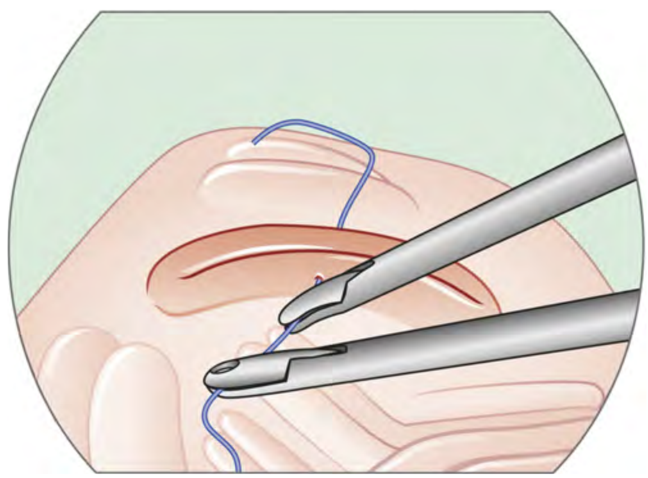

Fig. 8.2 m The assisting instrument then grasps the suture at a perpendicular angle once an adequate loop has been formed. This process of transferring the suture is referred to as "walking the line".

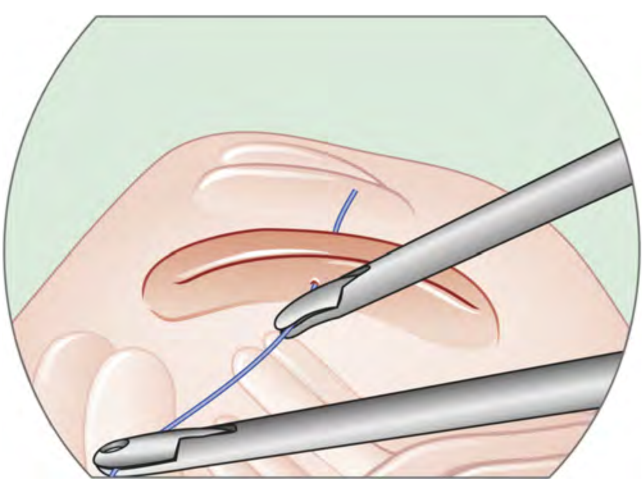

Fig. 8.2n The needle driver can be used at this time to grasp the suture at the mid-portion of the loop. This can aid in adjusting the orientation of the loop.

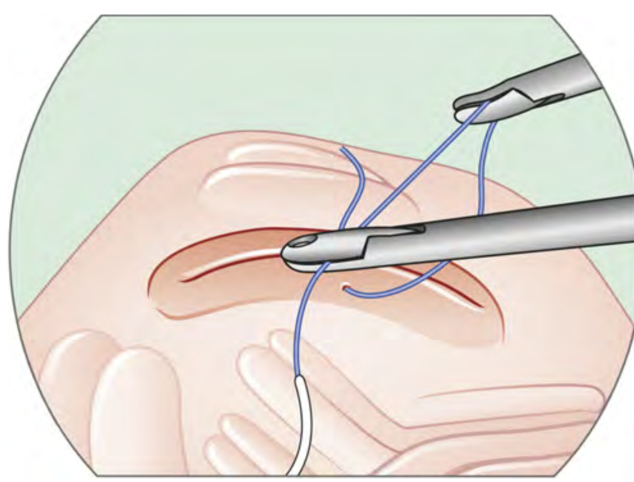

Fig. 8.2o The loop is formed by bringing the assisting instrument over the tissue where the knot is to be secured. Placing the left hand at the level of the tissue helps avoid 'lift and drift' which is a common mistake that is made when tying intracorporeal knots.

Throwing the Knot

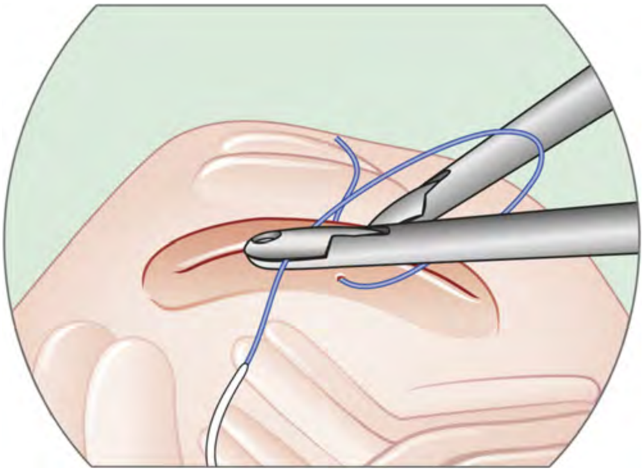

Fig. 8.2p The assisting instrument in 'supinated' (rotated) so that the suture exiting the assisting instrument is 'aligned' with the needle driver. The suture exiting the loop should lie in an oblique orientation between the horizontal and vertical axis. This allows the knot to be thrown and the loop to be maintained.

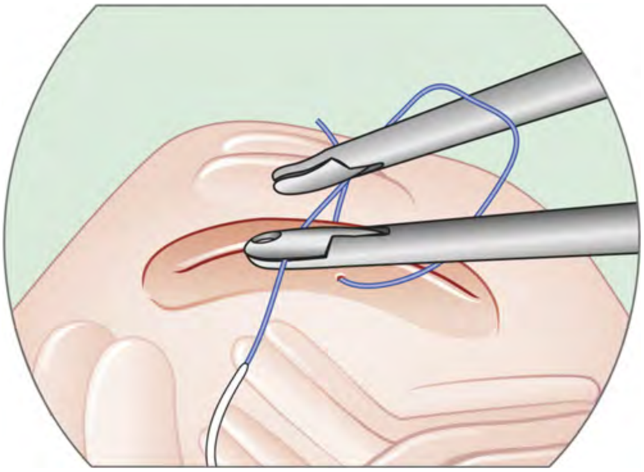

Fig. 8.2q A clockwise throw is made by wrapping the needle driver around the loop or by wrapping the loop around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the two instrument tips close to each other at the level of the tissue. If the hand holding the loop is pronated too much, it can make this step more difficult.

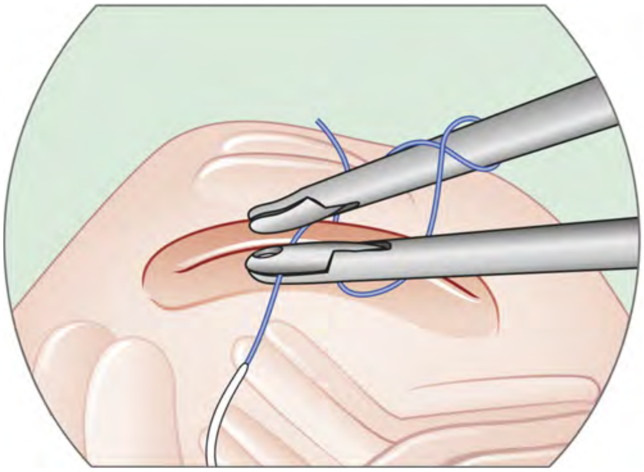

Fig. 8.2r A second throw is made if a *surgeon's knot* is preferred. This may be a difficult task without a monofilament suture.

Securing the Knot

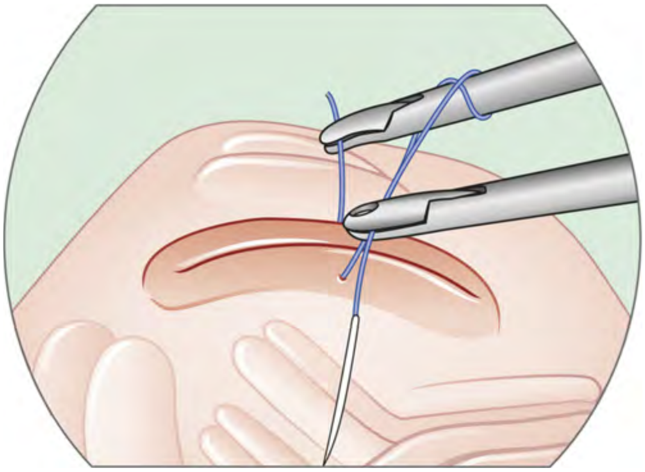

Fig. 8.2s The short tail is grasped. It is important to grasp the outer third of the tail to avoid the formation of a *bow tie knot*.

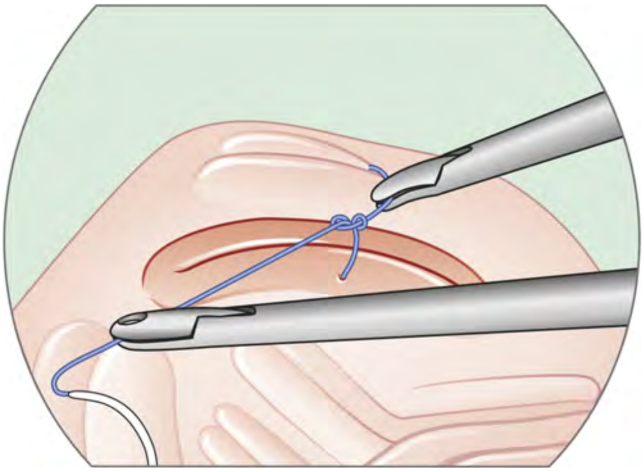

Fig. 8.2 t The assisting instrument holding the loop is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

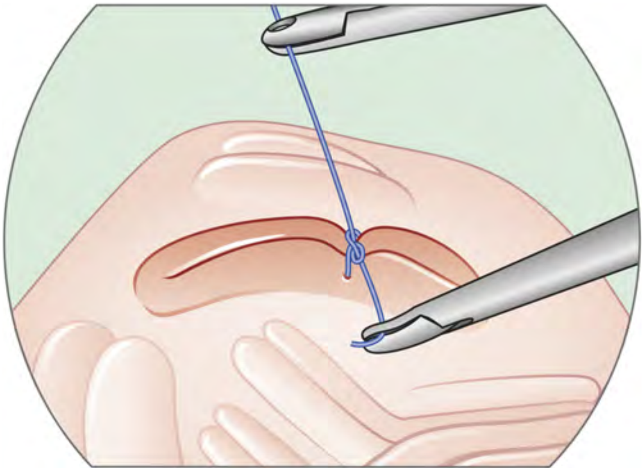

Fig. 8.2u The needle driver then moves the tail to the opposite side of the tissue while the assisting instrument holding the loop is moved in the opposite direction to secure the knot. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lays flat. It is important to keep the tail at the level of the tissue and to avoid pulling. If the needle driver pulls the suture too far, a long tail will result.

Second Throw

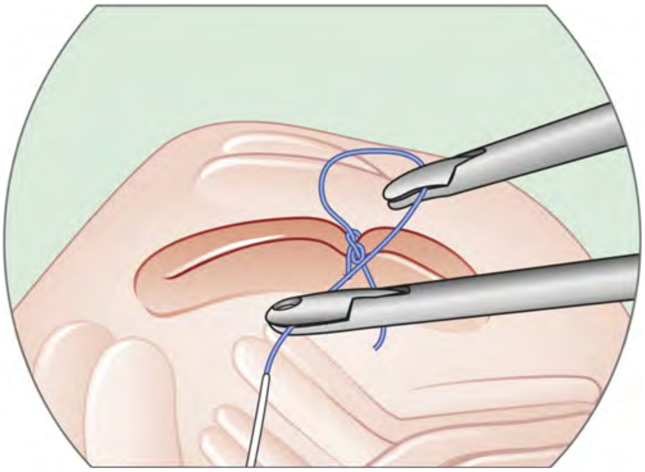

Fig. 8.2v The loop is formed by moving the assisting instrument over the first knot at the level of the tissue. This is the proper moment to adjust the length of the loop by 'walking' the suture as described earlier.

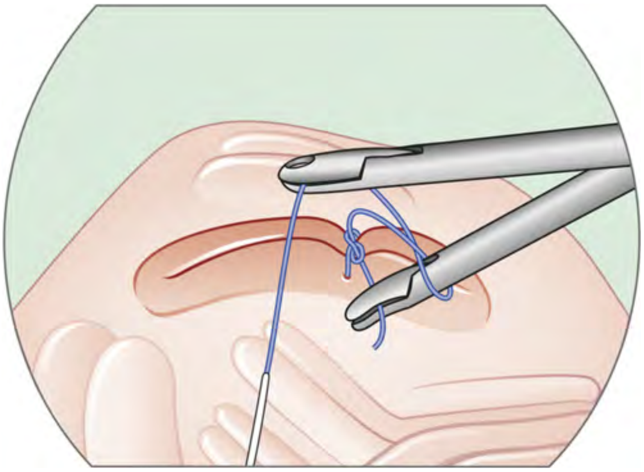

Fig. 8.2w A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

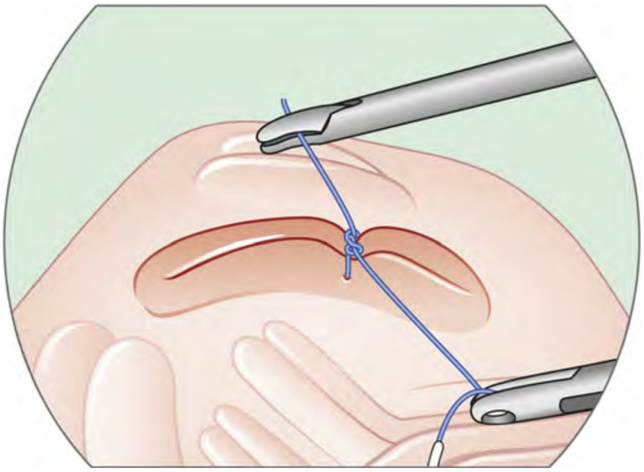

Fig. 8.2x The assisting instrument moves the loop away from the knot. The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured.

9 Ipsilateral Left Port Placement

9.1 With the Needle (Smiley) Knot Tying Technique

9.1.1 Setting the Needle

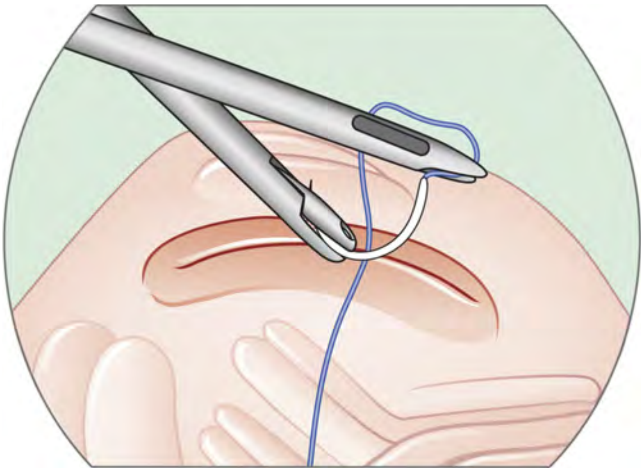

Fig. 9.1a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

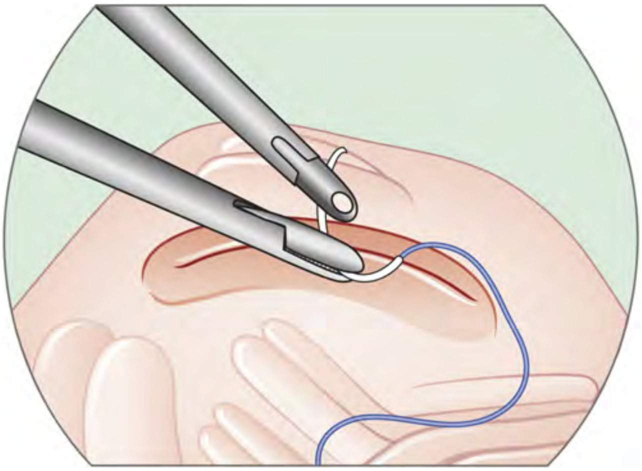

Fig. 9.1b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver grasping the needle at point 'C'. The assisting instrument is used to stabilize the needle through this process.

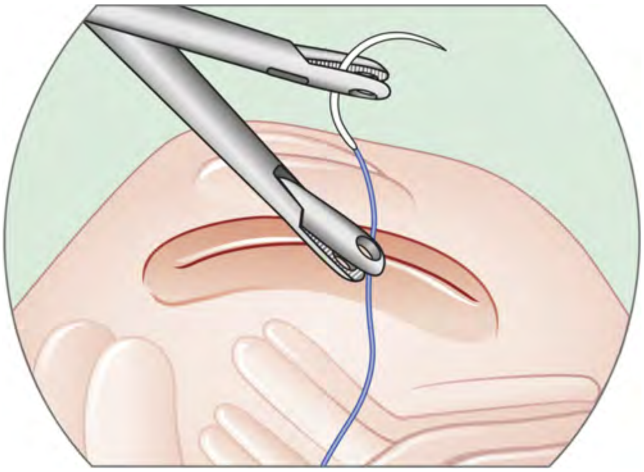

Fig. 9.1c A perpendicular relationship between the needle and the needle driver is confirmed.

9.1.2 Tissue Re-approximation

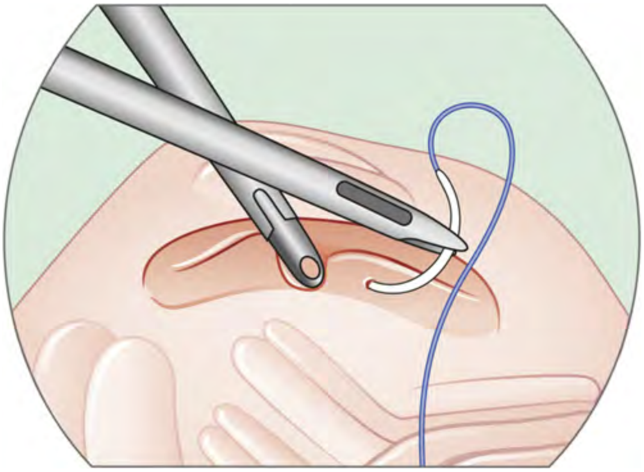

Fig. 9.1d The assisting instrument (left hand) is used to grasp the tissue and 'align' the tissue in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

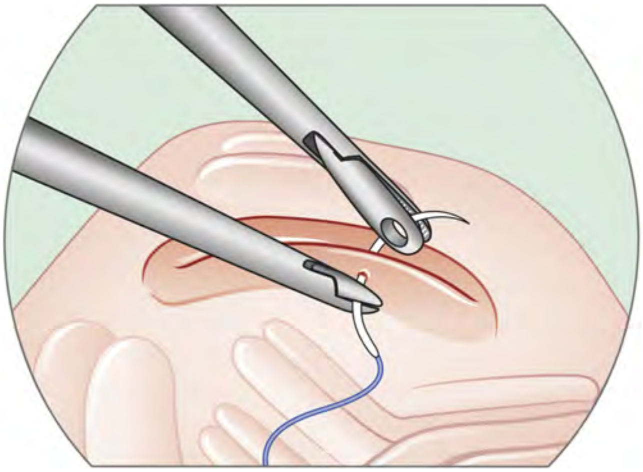

Fig. 9.1e By axial rotation of the needle driver the needle is passed through the tissue and picked up by the assisting instrument grasping the needle at point 'B'.

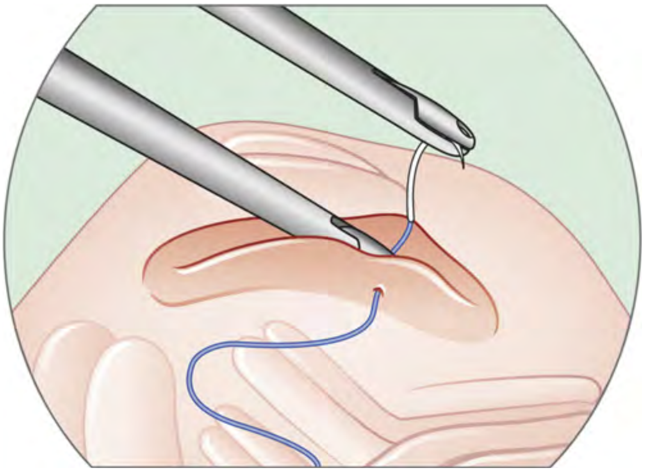

Fig. 9.1f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

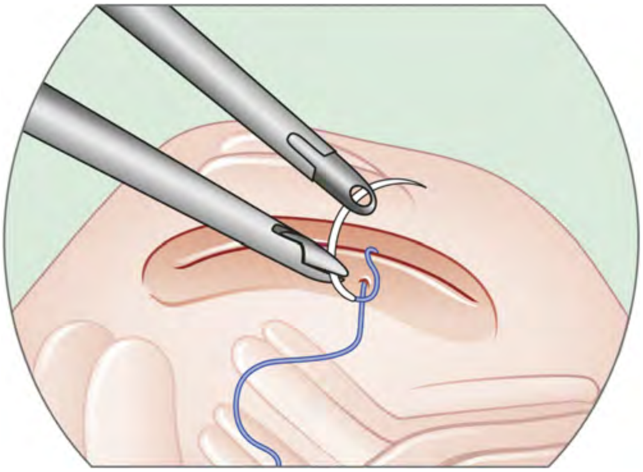

Fig. 9.1 g The needle is reset at the level of the tissue by re-grasping at point 'C'.

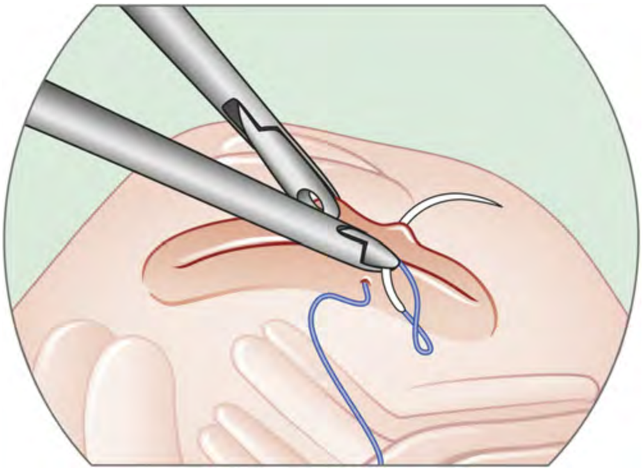

Fig. 9.1h The assisting instrument is used to grasp and 'align' this opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by axial rotation of the needle driver.

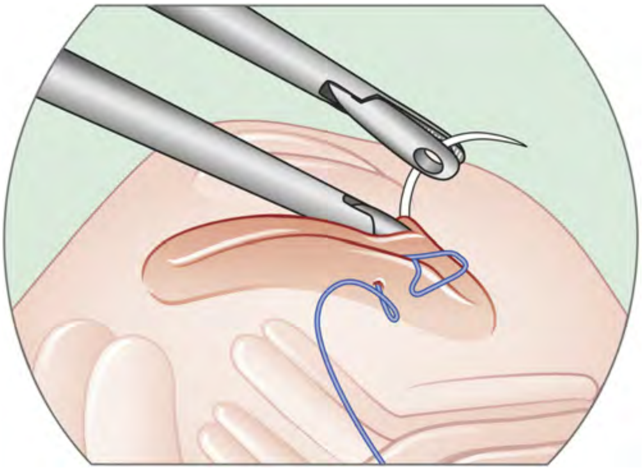

Fig. 9.1i The assisting instrument is used to grasp the needle in the middle and the needle is transferred. This allows for the best stability when throwing knots with the assistance of the needle.

9.1.3 Knot Tying

Loop Preparation

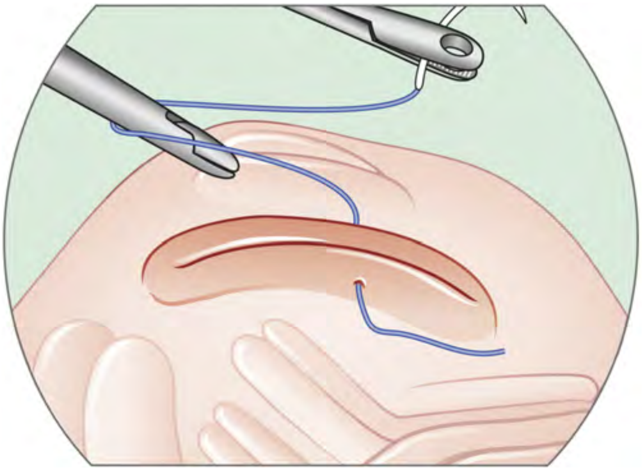

Fig. 9.1j The suture is pulled through the tissue until a short tail is formed. A pulley technique may be useful at this time.

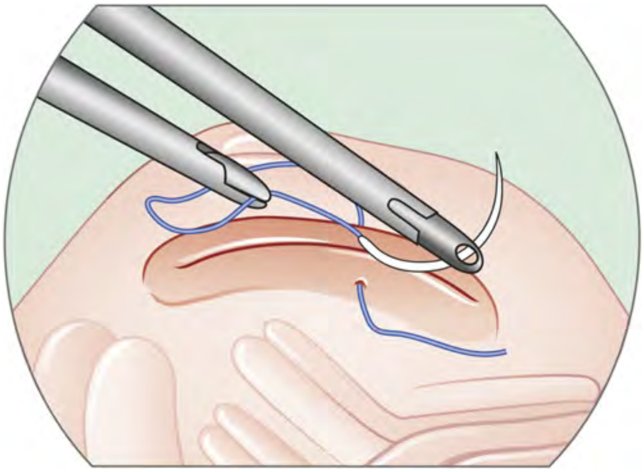

Fig. 9.1k The needle driver grasps the suture at point ‘A’ and the swedge of the needle is manipulated until the swedge forms a parallel relationship with the needle driver. Rotating the assisting instrument will also change the orientation of the swedge in relation to the needle driver.

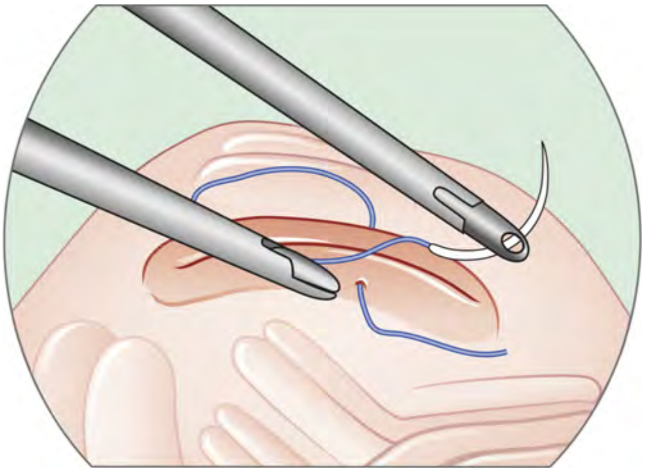

Fig. 9.1 l The loop is formed by bringing the swedge of the needle over the tissue where the knot is to be secured.

Throwing the Knot

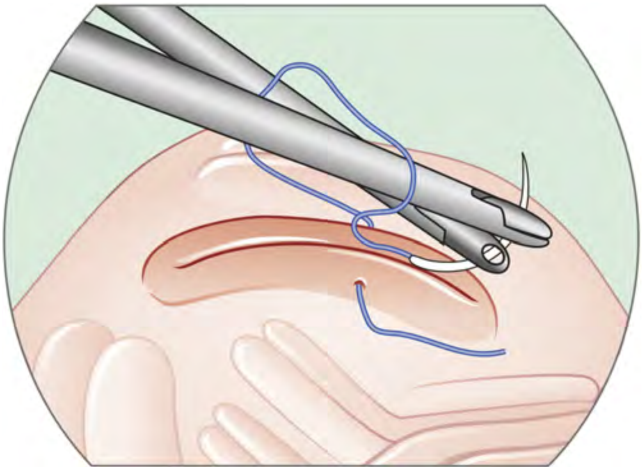

Fig. 9.1 m A clockwise throw is made by wrapping the needle driver around the swedge of the needle or by wrapping the swedge around a stationary needle driver. Many experts make these two movements simultaneously. The key to this step is keeping the tip of the needle driver close to the swedge of the needle at the level of the tissue. If the swedge of the needle is not in a parallel relationship with the needle driver, this step is made unnecessarily difficult.

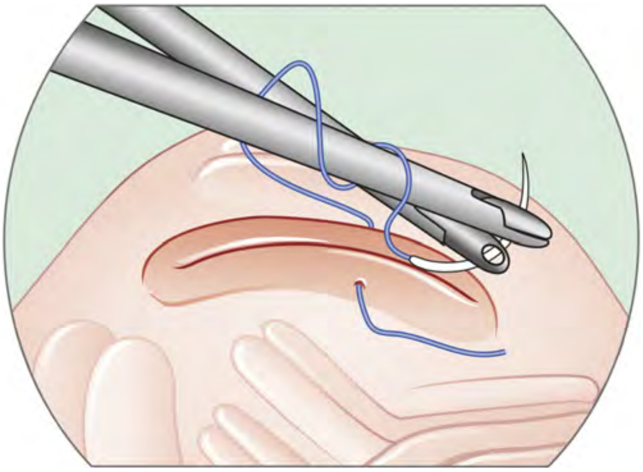

Fig. 9.1n A second throw is made if a *surgeon's knot* is preferred. Using the assistance of the needle makes the second throw much easier than performing knot tying without the needle.

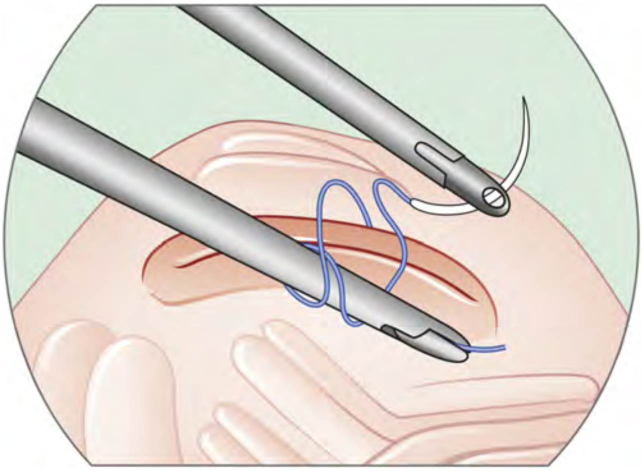

Fig. 9.1o The short tail is then grasped. It is important to grasp the outer third of the tail to avoid the formation of a *bow tie knot.*

Securing the Knot

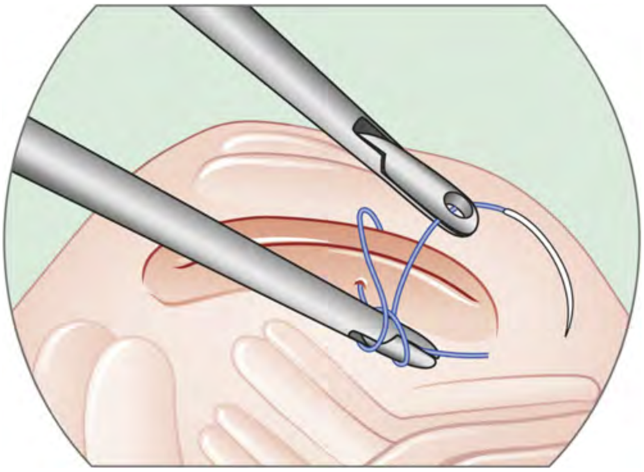

Fig. 9.1p The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'. This allows the knot to be secured without any concern for causing inadvertent needle stick injuries.

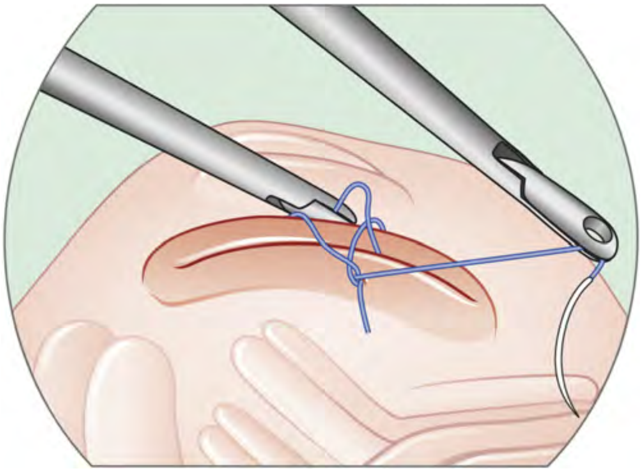

Fig. 9.1q The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

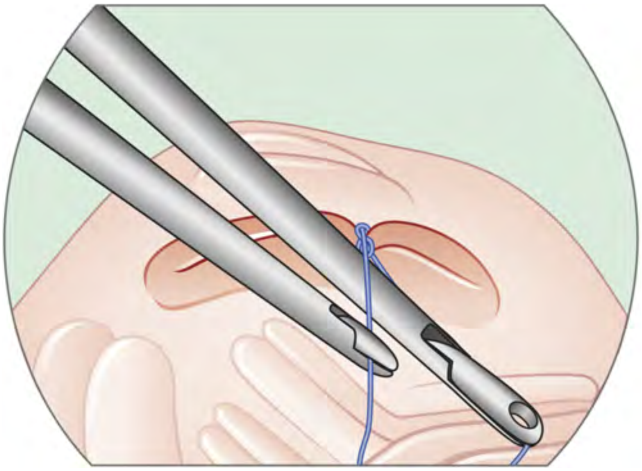

Fig. 9.1r The needle driver then moves the tail to the opposite side of the tissue and the assisting instrument holding the loop is now moved opposite the tail to secure the knot. It is important to keep the tail at the level of the tissue and to avoid pulling with the instrument holding the tail to avoid the formation of a long tail. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

Second Throw

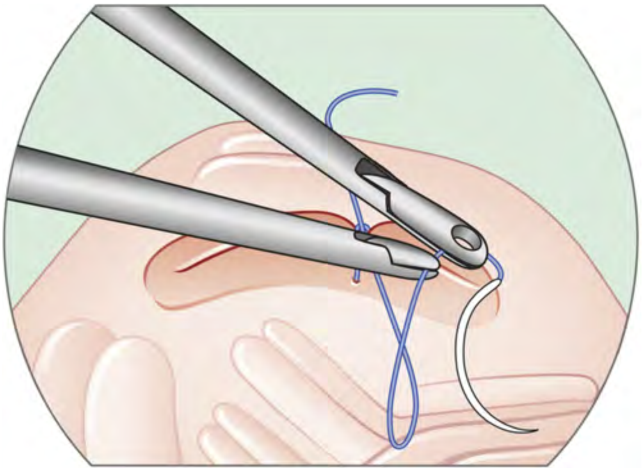

Fig. 9.1s The needle driver (right hand) now grasps the suture next to the assisting instrument at point 'A'.

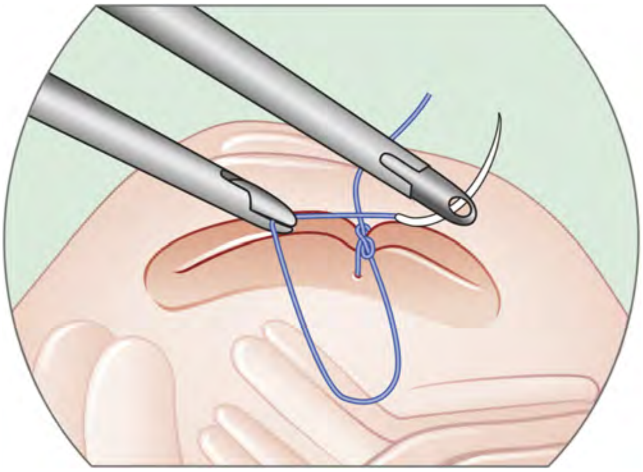

Fig. 9.1 t The assisting instrument releases the suture and grasps the needle in the middle. The needle driver manipulates the suture until the swedge of the needle assumes a parallel relationship with the needle driver and the assisting instrument moves the swedge of the needle over the first knot at the level of the tissue.

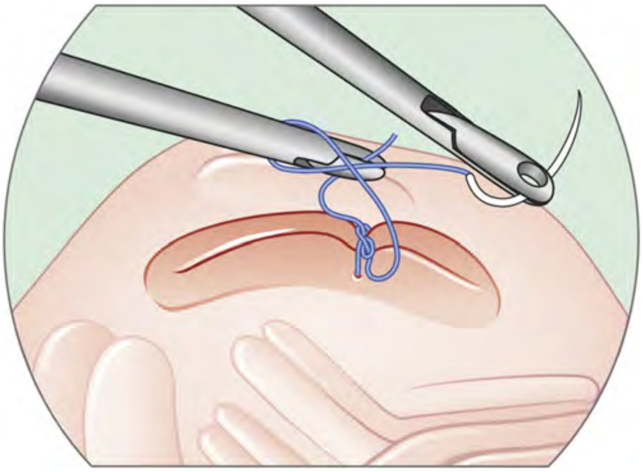

Fig. 9.1u A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

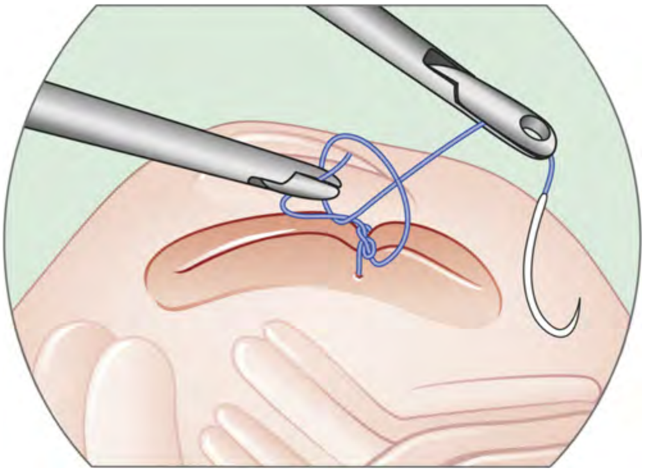

Fig. 9.1v The assisting instrument (left hand) releases the needle and grasps the suture at point 'A'.

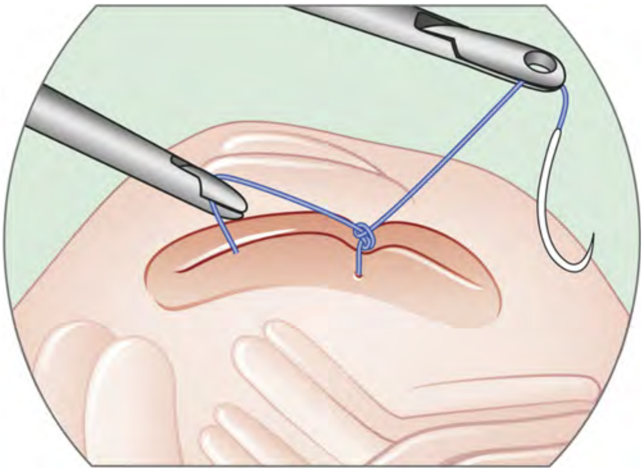

Fig. 9.1w The assisting instrument holding the suture is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

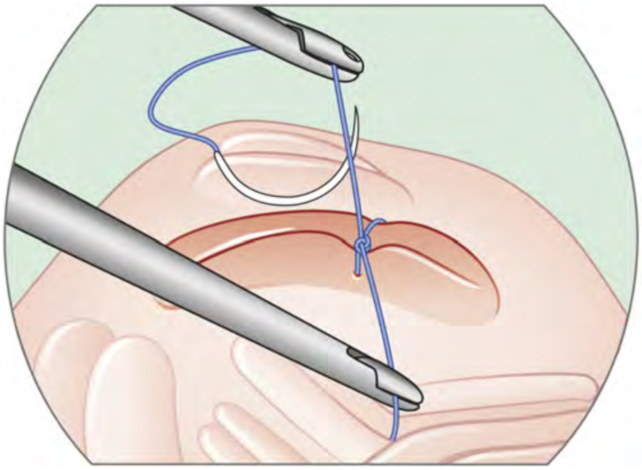

Fig. 9.1x The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lies flat.

9.2 Without the Needle (Expert) Knot Tying Technique

9.2.1 Setting the Needle

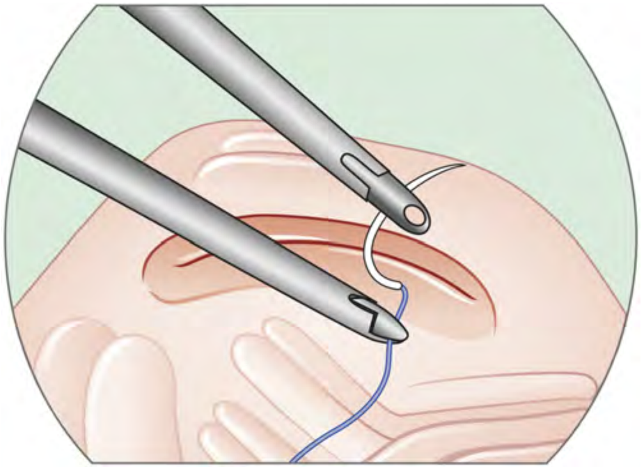

Fig. 9.2a The needle is introduced with the needle driver at point 'A' and grasped with the assisting instrument (left hand) at point 'B'.

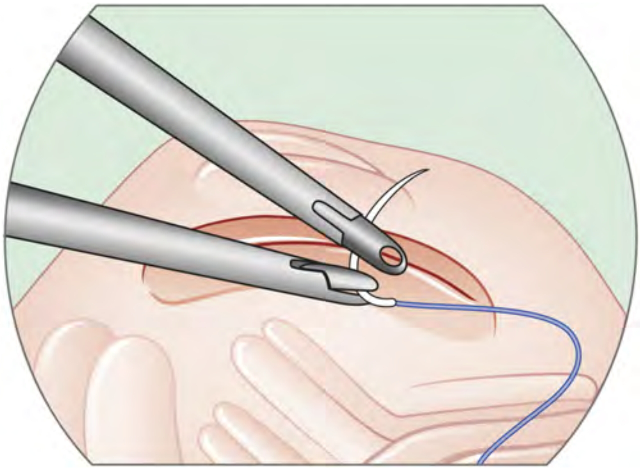

Fig. 9.2b The needle driver (right hand) is used to manipulate the needle so that it lies in a perpendicular plane to the needle driver grasping the needle at point 'C'. The assisting instrument is used to stabilize the needle through this process.

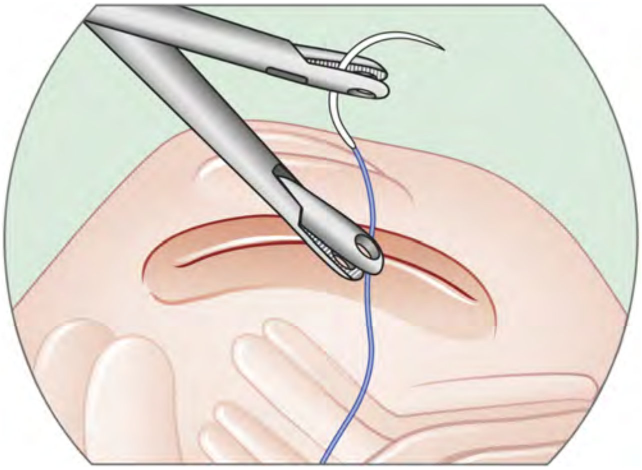

Fig. 9.2c A perpendicular relationship between the needle and the needle driver is confirmed.

9.2.2 Tissue Re-approximation

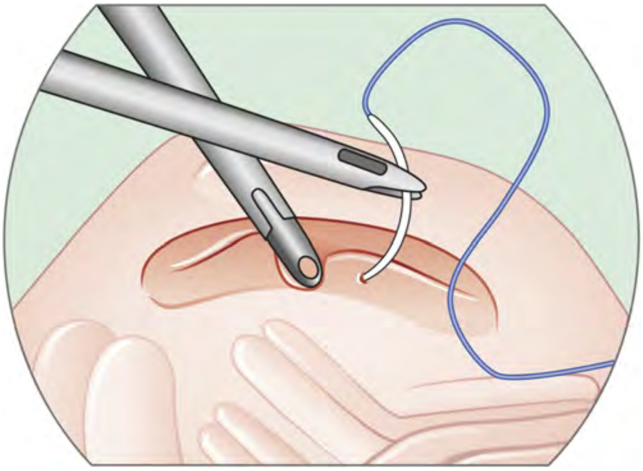

Fig. 9.2d The assisting instrument (left hand) is used to grasp the tissue and 'align' it in a plane that is parallel to the shaft of the needle driver. The needle driver is rotated so that the needle enters the tissue at a perpendicular or 90 degree angle.

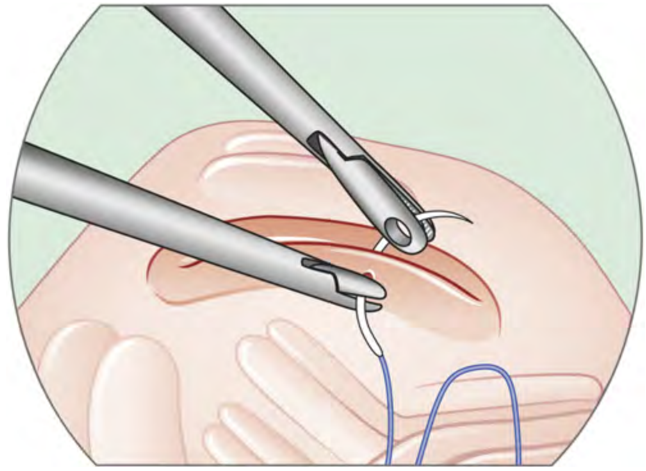

Fig. 9.2e By axial rotation of the needle driver, the needle is passed through the tissue and picked up by the assisting instrument grasping the needle at point 'B'.

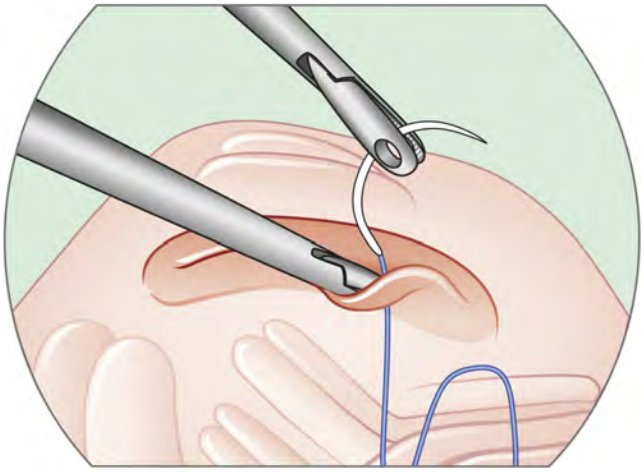

Fig. 9.2f The needle is transferred to the assisting instrument and the needle driver is used to push the tissue off the needle.

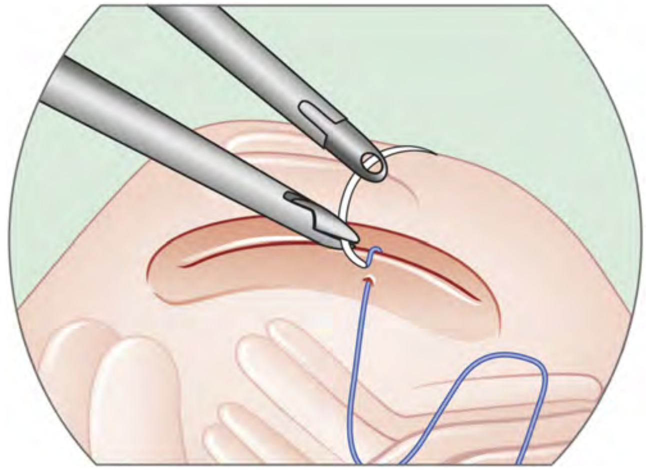

Fig. 9.2 g The needle is reset at the level of the tissue by re-grasping at point 'C'.

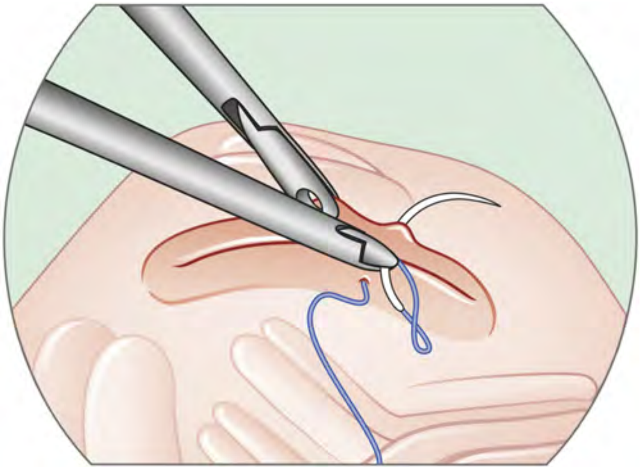

Fig. 9.2h The assisting instrument is used to grasp and 'align' the opposite side of the tissue defect in a parallel relationship with the shaft of the needle driver and the needle is passed through the tissue by axial rotation of the needle driver.

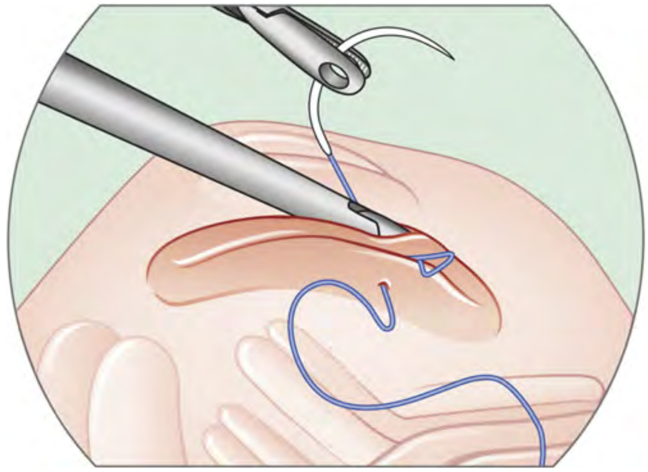

Fig. 9.2i The assisting instrument is used to grasp the needle at point 'B' and the needle is transferred.

9.2.3 Knot Tying

Loop Preparation

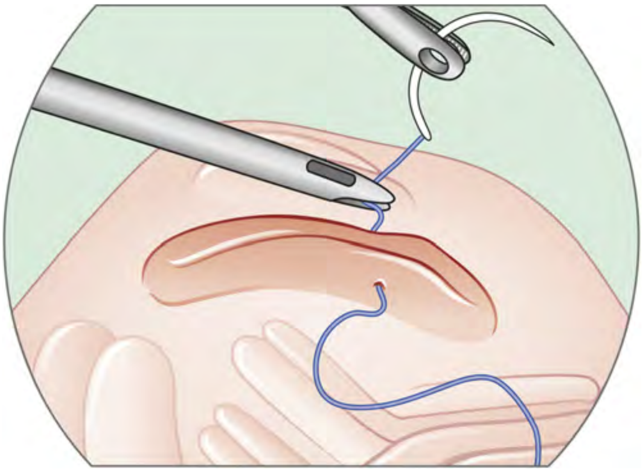

Fig. 9.2j The suture is grasped by the needle driver at point 'A'. It is important that the needle be positioned with the assisting hand so that the needle driver can grasp perpendicular to the suture.

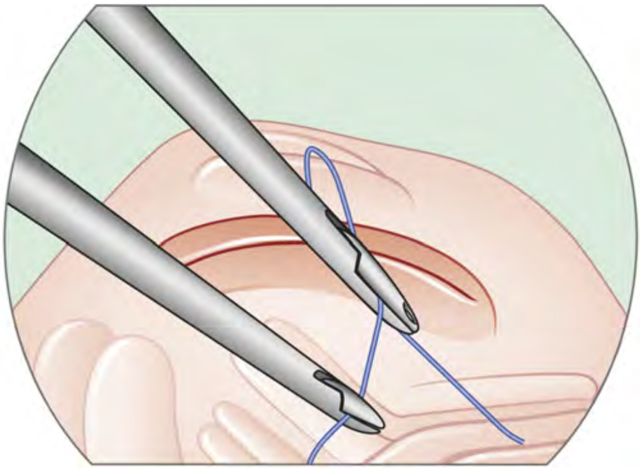

Fig. 9.2k The suture is passed from the needle driver to the assisting instrument at point 'A'.

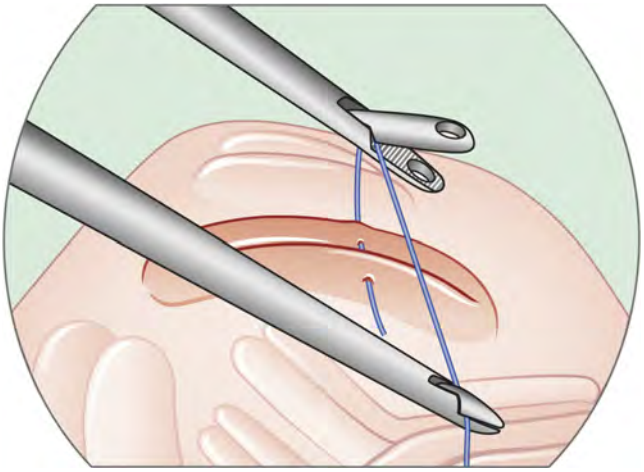

Fig. 9.2 l The suture is pulled through the tissue by moving the needle driver in a cephalic direction until a short tail is made.

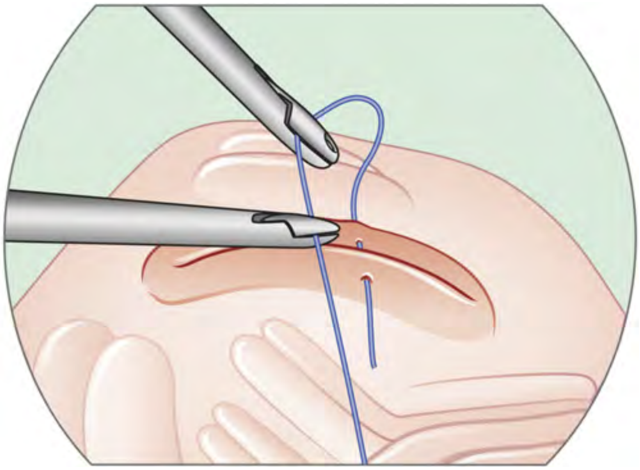

Fig. 9.2 m The assisting instrument then grasps the suture at a perpendicular angle once an adequate loop has been formed. This process of transferring the suture is referred to as 'walking the line'. The needle driver can be used at this time to grasp the suture at the mid-portion of the loop. This can aid in adjusting the orientation of the loop.

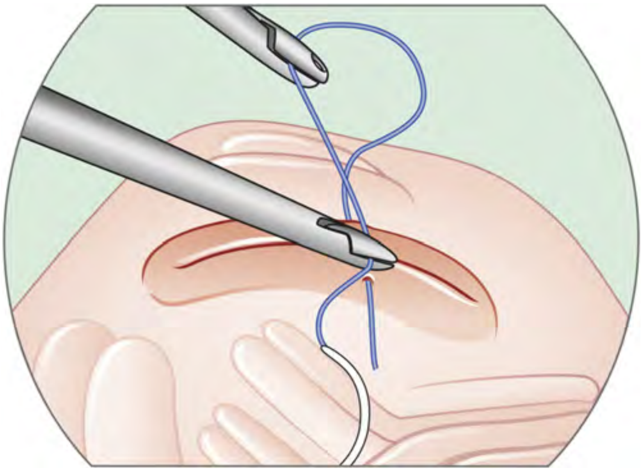

Fig. 9.2n The loop is formed by bringing the assisting instrument over the tissue where the knot is to be secured. Placing the left hand at the level of the tissue helps avoid 'lift and drift' which is a common mistake that is made when tying intracorporeal knots.

Throwing the Knot

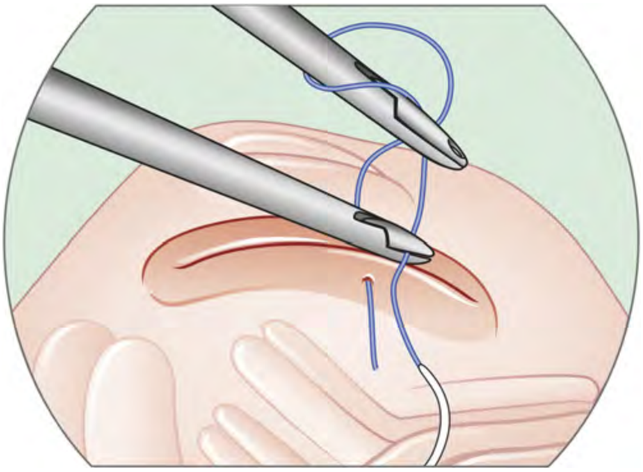

Fig. 9.2o The assisting instrument is 'supinated' (rotated) so that the suture exiting the assisting instrument is 'aligned' with the needle driver A clockwise throw is made by wrapping the needle driver around the loop or by wrapping the loop around a stationary needle driver. Many experts make these two movements simultaneously. The suture exiting the loop should lie in an oblique orientation between the horizontal and vertical axes. This allows the knot to be thrown and the loop to be maintained.

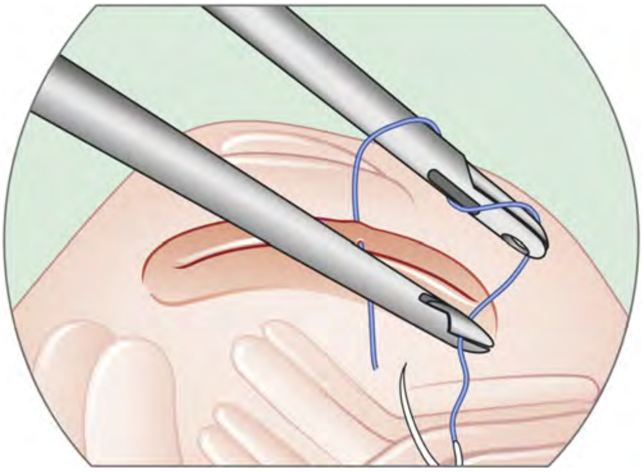

Fig. 9.2p A second throw is made if a *surgeon's knot* is preferred. This may be a difficult task without a monofilament suture.

Securing the Knot

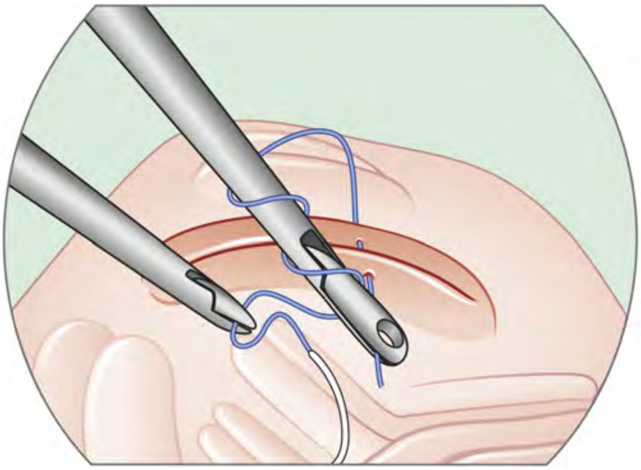

Fig. 9.2q The short tail is grasped. It is important to grasp the outer third of the tail to avoid the formation of a *bow tie knot*.

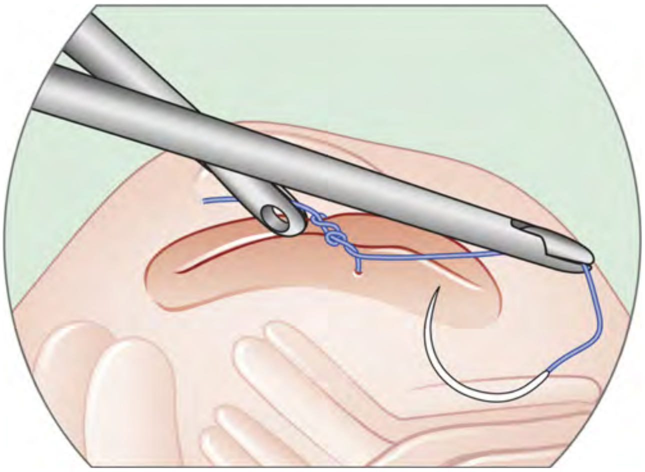

Fig. 9.2r The assisting instrument holding the loop is moved away from the tissue until the loop is away from the needle driver that is holding the tail.

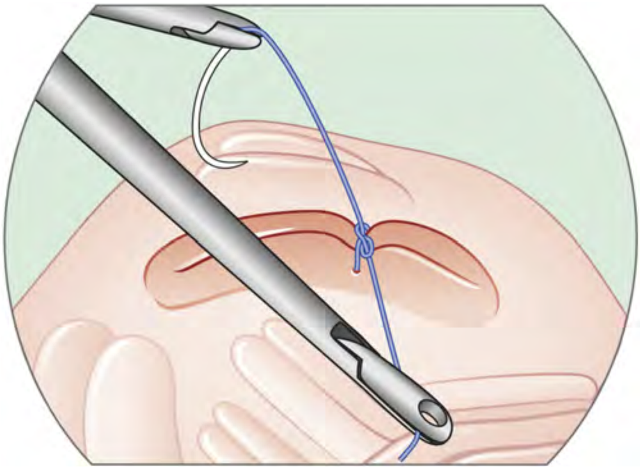

Fig. 9.2s The needle driver then moves the tail to the opposite side of the tissue while the assisting instrument holding the loop is moved in the opposite direction to secure the knot. The direction of the force applied should be at a 180 degree angle to the needle driver so that the knot lays flat. It is important to keep the tail at the level of the tissue and to avoid pulling. If the needle driver pulls the suture too far, a long tail will result.

Second Throw

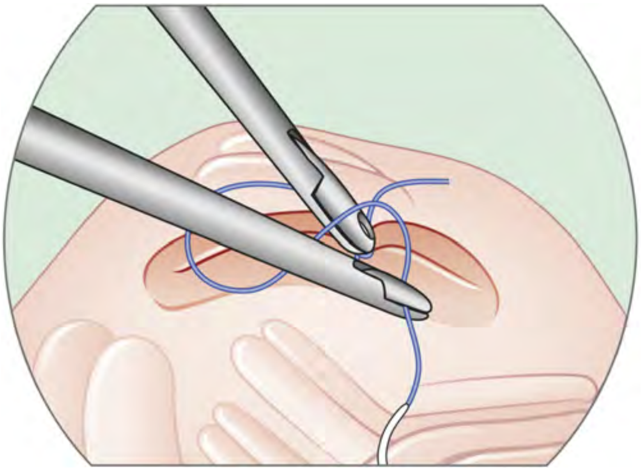

Fig. 9.2 t The loop is formed by moving the assisting instrument over the first knot at the level of the tissue. This is the proper moment to adjust the length of the loop by 'walking' the suture as described earlier.

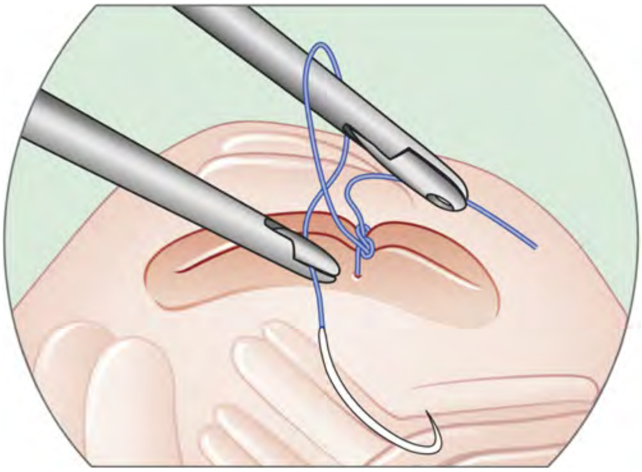

Fig. 9.2u A second throw is made in a counter-clockwise (opposite) direction and the short tail is grasped with the needle driver.

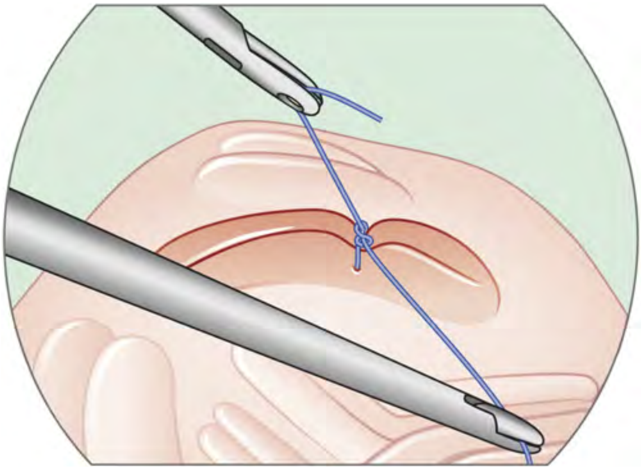

Fig. 9.2v The assisting instrument moves the loop away from the knot. The needle driver moves the tail to the opposite side of the tissue and the assisting instrument moves the loop opposite of the tail and the square knot is secured.

10 Vaginal Cuff Closure

10.1 Principles of Cuff Closure

The goal of vaginal cuff closure at the time of laparoscopic hysterectomy is to re-approximate the apex in the vagina and to provide adequate hemostasis. Inadequate closure may result in postoperative complications that include cuff dehiscence, bleeding, hematoma, or infection. Vaginal cuff dehiscence ranges from 1 %–5 % at the time of laparoscopic hysterectomy. To date, there are no studies showing the superiority of a particular vaginal cuff closure technique. Possible techniques include interrupted, figure-of-eight, and running closures. Knots may be tied extracorporeally or intracorporeally. The key to adequate tissue re-approximation is the manipulation and orientation of the vaginal cuff in relation to the needle driver. Because the axis of the laparoscopic trocar is fixed, the manipulation of the cuff by one of the assisting instruments is crucial to allow for an accurate and adequate purchase of tissue.

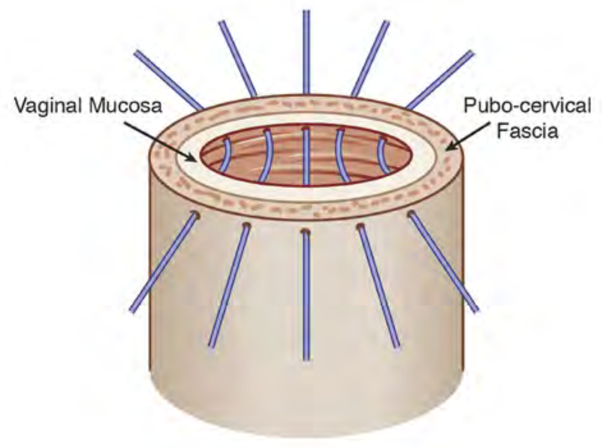

Fig. 10.1a Clinical illustration of the layers of vaginal cuff closure.

Adequate tissue re-approximation requires the re-approximation of the anterior pubocervical fascia, anterior vaginal mucosa, posterior vaginal mucosa, and posterior pubocervical fascia, and peritoneum. The uterosacral ligament complex should be incorporated into the closure of the vaginal cuff angles. If significant vaginal apex prolapse is present, a vaginal vault suspension should be considered, the techniques of which are discussed in *Chapter 12, Ureterosacral Ligament Suspension and Colposuspension.* Some surgeons advocate incorporation of the anterior vesico-uterine peritoneum, but its efficacy in preventing adhesions and dehiscence is unclear at this time. Fig. 10.1a shows a clinical illustration of the layers involved in vaginal cuff closure.

The instruments needed for closure include a needle driver with a good locking jaw and an instrument for the assisting hand. Needle drivers may be straight or curved with either axial or ergonomic handles. The ideal instrument for the assisting hand should be able to grasp the needle, hold the suture, and manipulate tissue. If there is a third port for the first surgical assist, the ideal instrument should be able to grasp and hold both the vaginal cuff and the suture. If extracorporeal knot tying is being performed, then a knot pusher is needed. This may be done with an open or closed knot pusher. Laparoscopic scissors are also needed to cut the suture and come in a variety of types. Examples of these instruments are shown in Figs. 10.1b–f.

Fig. 10.1b The SZABO-BERCI Needle Holder PARROT-JAW® with straight handle and adjustable ratchet.

Fig. 10.1c The KOH Macro Needle Holder with curved jaws, ergonomic pistol handle and disengageable ratchet.

Fig. 10.1d Close-up view of the KOH Assistant Needle Holder, straight jaws with distal hole (**1**), and the KOH Macro Needle Holder, straight jaws (**2**).

Fig. 10.1e Close-up view of the MANHES Grasping Forceps available with Cobra jaws (**1**) and Tiger jaws (**2**).

Fig. 10.1f Close-up view of the two varieties of knot pushers that come with closed (**1**) and open (**2**) tips.

10.2 Cuff Closure – Extracorporeal Knotting Technique

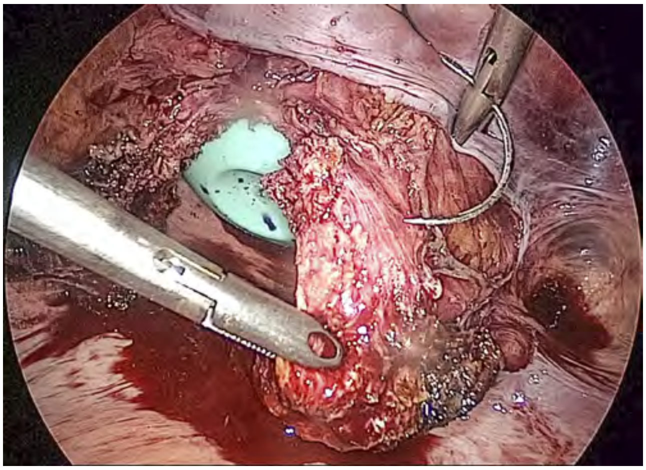

Fig. 10.2a The vaginal cuff is elevated by the surgical assistant exposing the right vaginal apex.

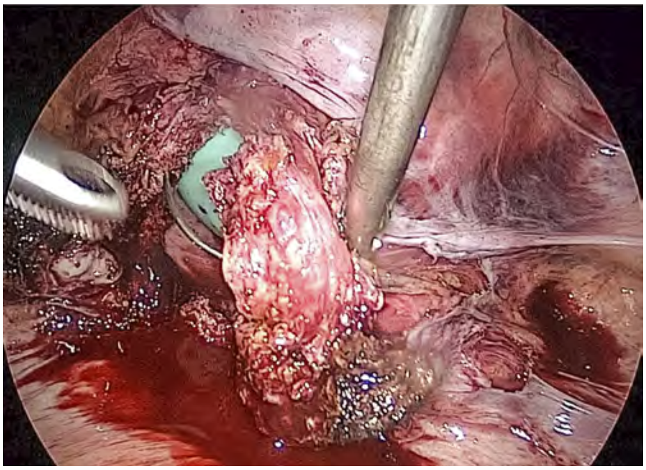

Fig. 10.2b The needle is passed through the anterior pubocervial fascia and vaginal mucosa.

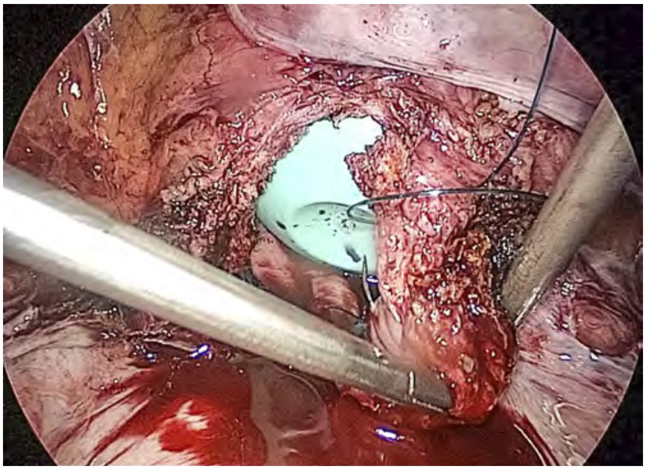

Fig. 10.2c Often the vaginal mucosa at the 3 o'clock position is incorporated into the closure. This step may require more than one passage of the needle.

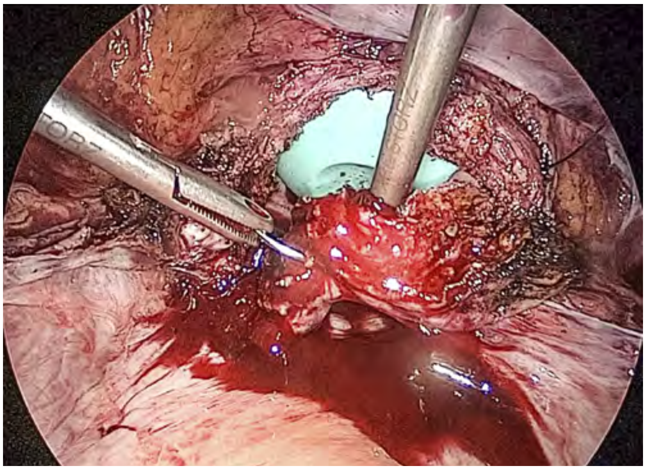

Fig. 10.2d The needle is reset and passed through the posterior pubocervical fascia, vaginal mucosa, and uterosacral ligament complex.

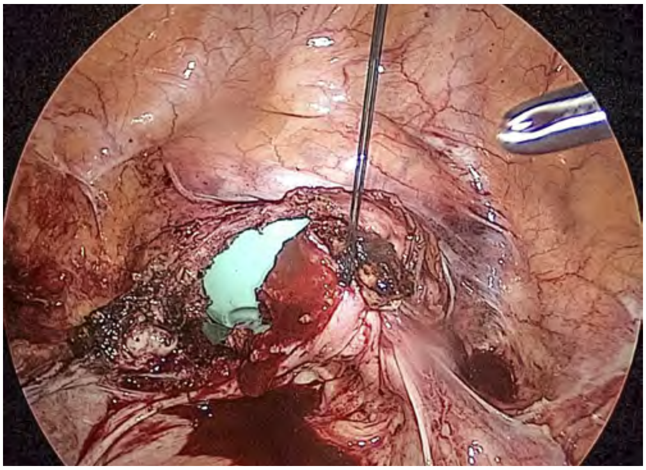

Fig. 10.2e The knot is secured with a knot pusher by placing the tension past the knot at the level of the tissue. This step is repeated 4–6 times depending on the type of suture. A sliding knot with non-alternating directions is preferred, obviating the need for an air knot.

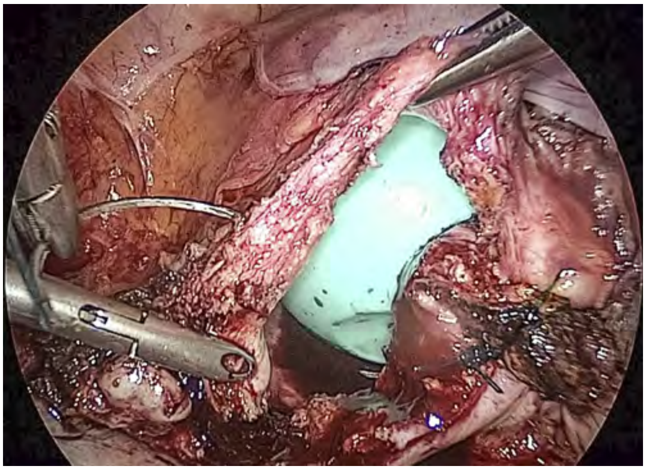

Fig. 10.2f The needle is passed through the left anterior pubocervical fascia and vaginal mucosa.

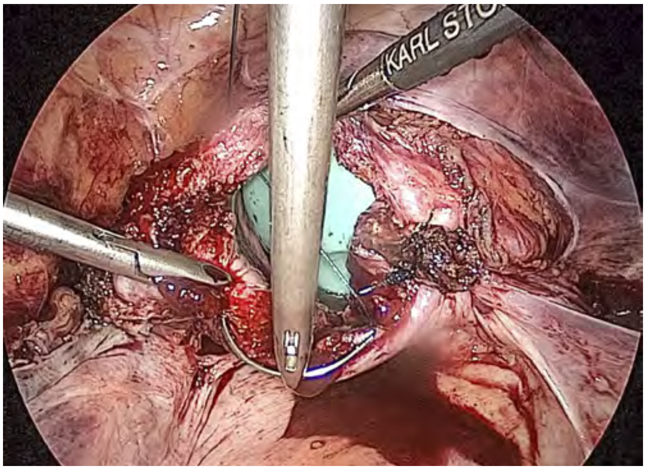

Fig. 10.2 g The vaginal mucosa is incorporated at the 9 o'clock position.

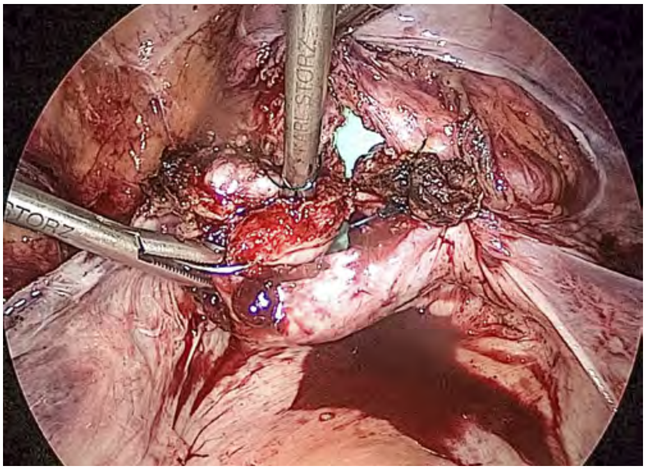

Fig. 10.2h The needle is reset and passed through the posterior pubocervical fascia, vaginal mucosa, and uterosacral ligament complex. This step may require more than one passage of the needle.

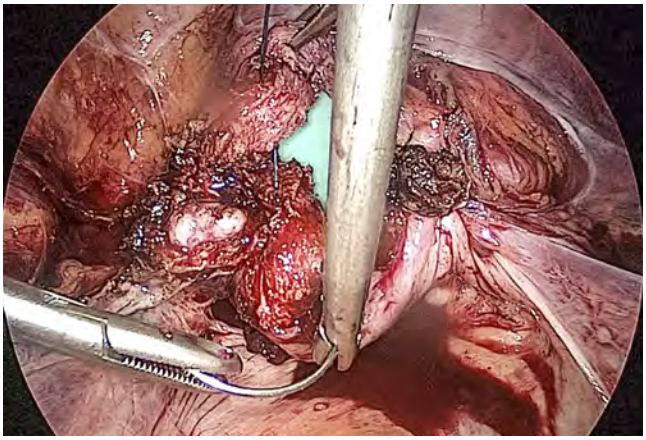

Fig. 10.2i The remaining tissue is re-approximated with incorporation of the fascia and mucosa as well as posterior peritoneum. This may require an additional 2–3 sutures and may be done with interrupted figure-of-eight sutures.

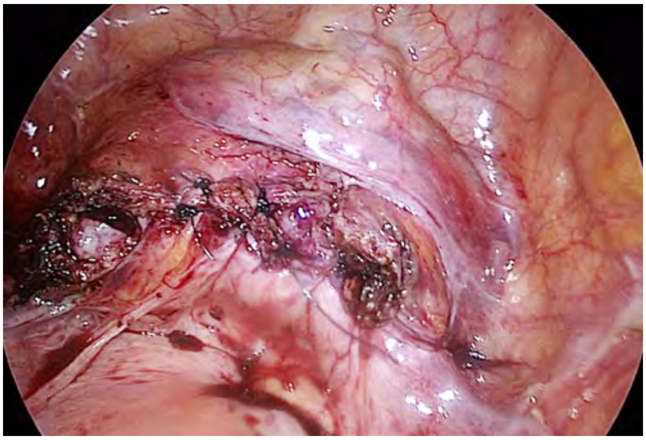

Fig. 10.2j The complete vaginal cuff closure.

10.3 Cuff Closure – Intracorporeal Knotting Technique

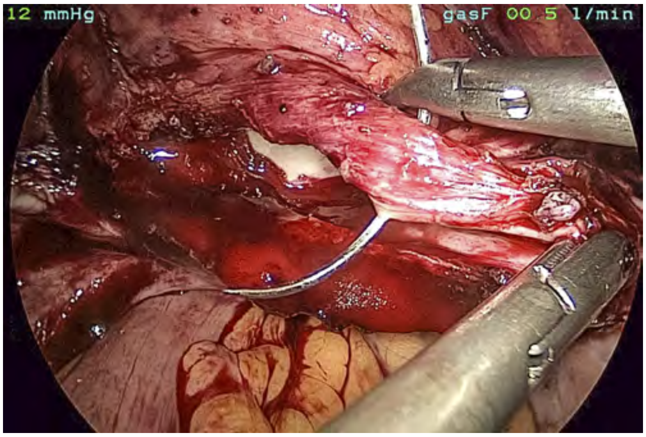

Fig. 10.3a The needle is passed through the anterior pubocervial fascia and vaginal mucosa.

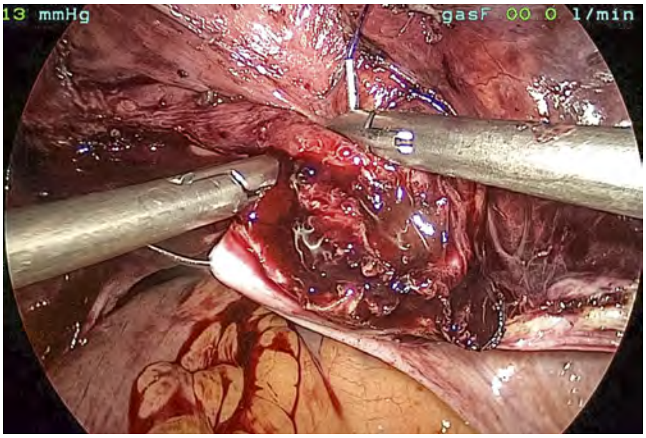

Fig. 10.3b The needle is reset and passed through the posterior pubocervical fascia, vaginal mucosa, and uterosacral ligament complex. Often the vaginal mucosa at the 3 o'clock position is incorporated into the closure. This step may require more than one passage of the needle.

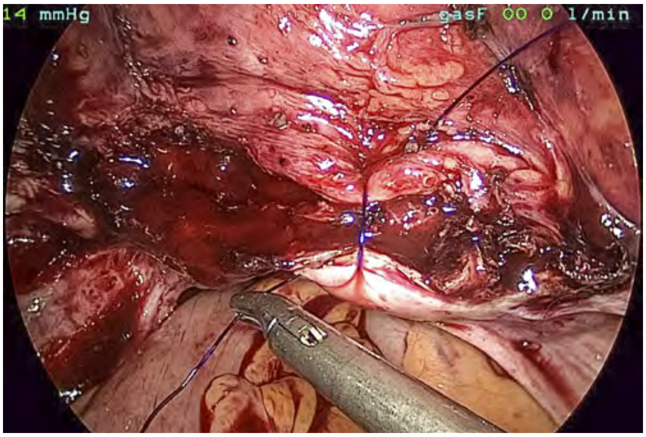

Fig. 10.3c The suture is pulled through keeping a perpendicular relationship with the needle drivers.

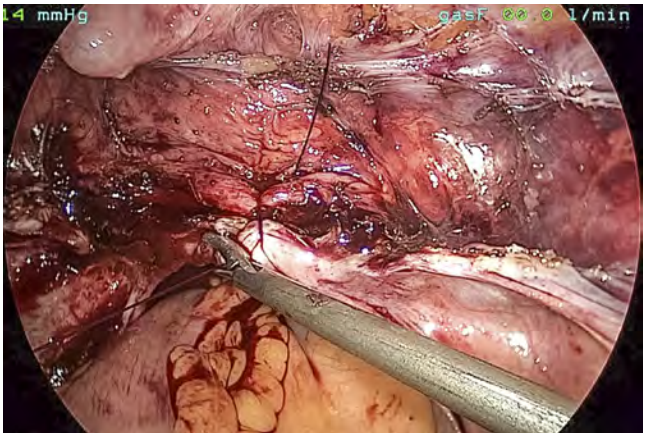

Fig. 10.3d A short tail is created.

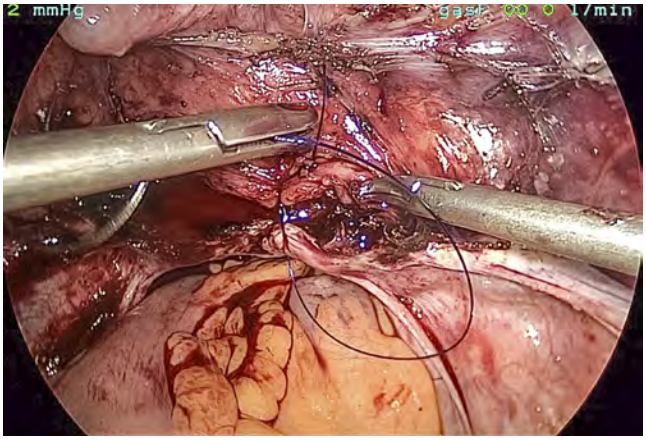

Fig. 10.3e The suture is grasped with the left hand at a perpendicular angle and moved over the knot at the level of the tissue to form the knot.

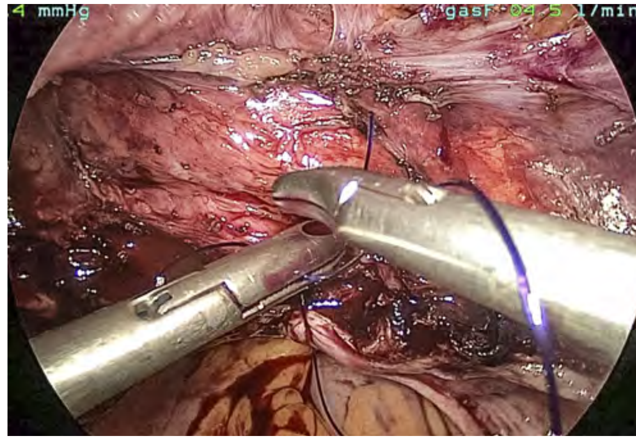

Fig. 10.3f The left hand rotated the suture so that it is in line with the right hand and the instrument is rotated clockwise around the suture. A second throw may be performed if a *surgeon's knot* is desired.

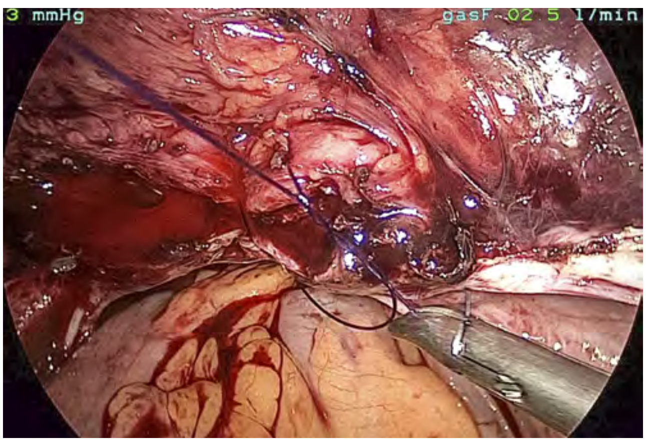

Fig. 10.3 g The short tail is grasped and the left hand moved away the knot until the loop falls away from the needle driver. The right hand moves the tail to the other side of the tissue while the left hand pulls the suture to secure the knot. Care must be taken not to pull the tail and create an elongated tail.

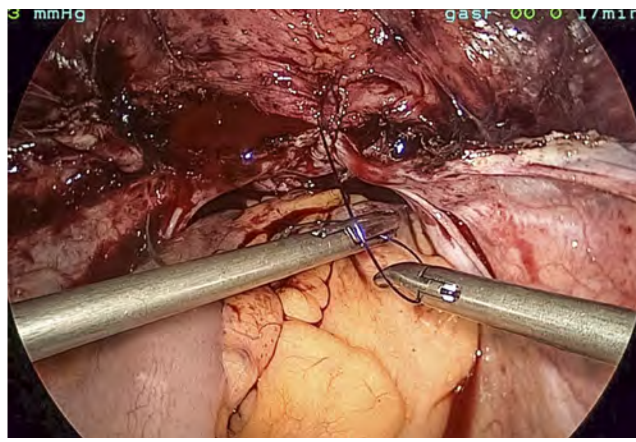

Fig. 10.3h The left hand is moved over the knot at the level of the tissue to create the loop and a throw is made in the opposite direction.

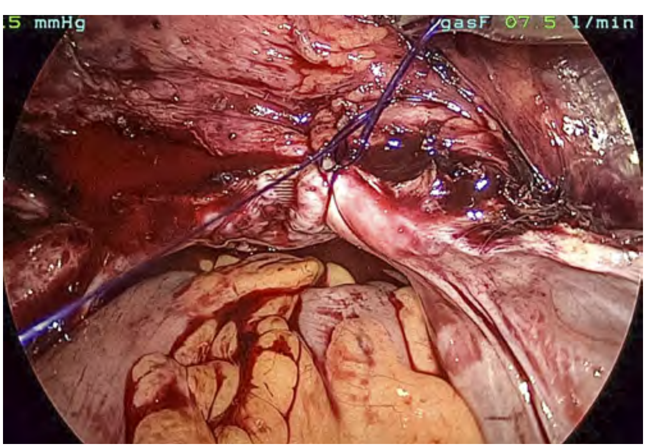

Fig. 10.3i The short tail is grasped and the left hand is used to pull the loop away from the tail.

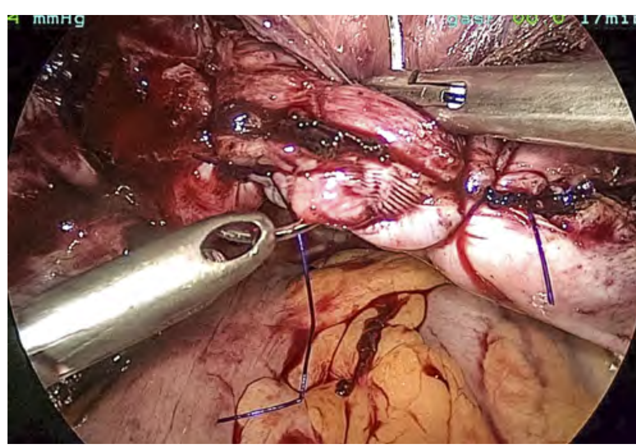

Fig. 10.3j The knot tying process is repeated until the vaginal cuff is closed.

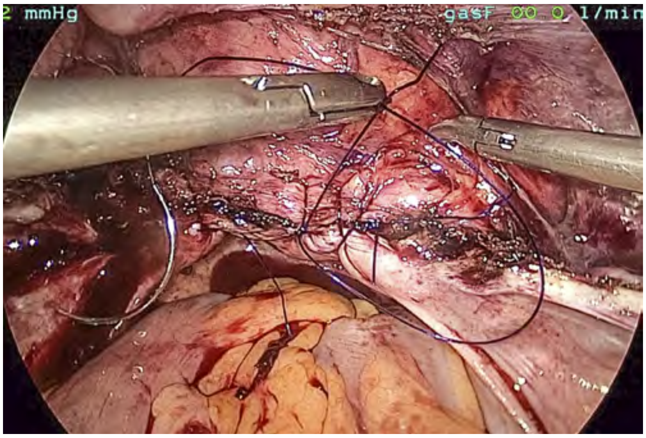

Fig. 10.3k The perpendicular and parallel relationship is vital to forming the loop.

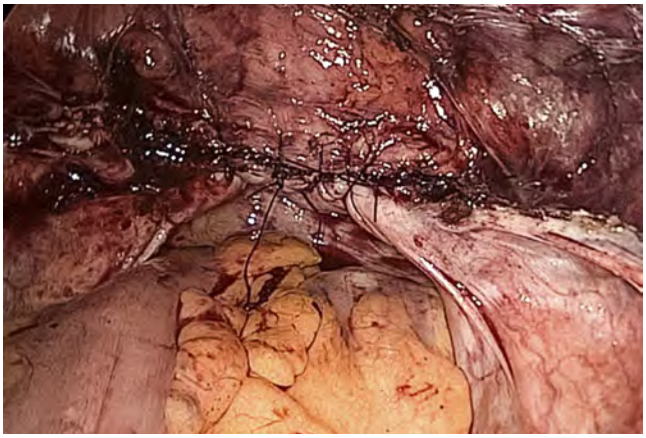

Fig. 10.3 l The vaginal cuff closure is complete.

10.4 Cuff Closure – Running Suture

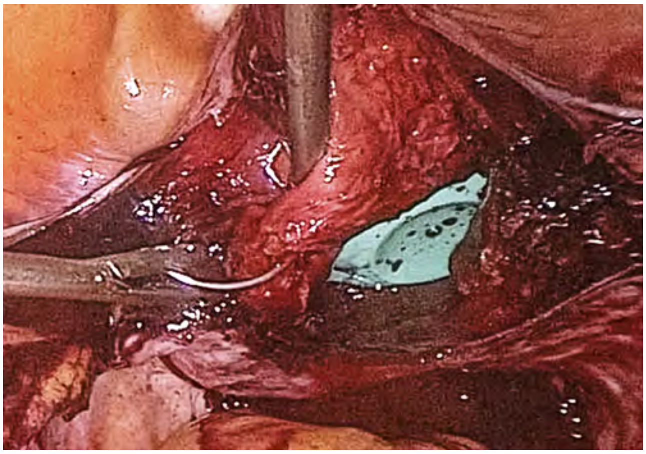

Fig. 10.4a The needle is passed through the anterior vaginal mucosa.

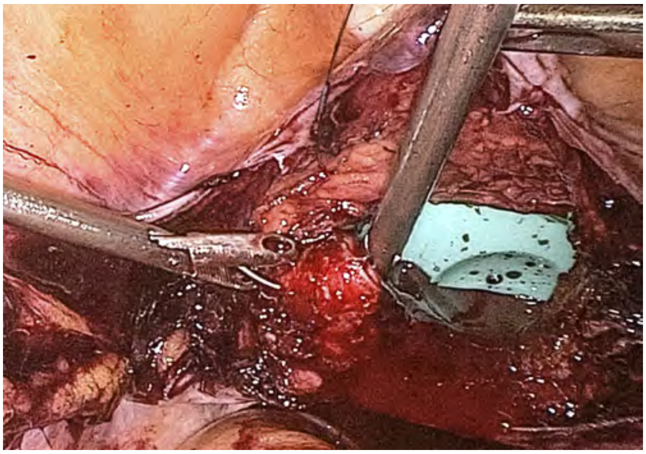

Fig. 10.4b The vaginal cuff mucosa is incorporated at the 9 o'clock position.

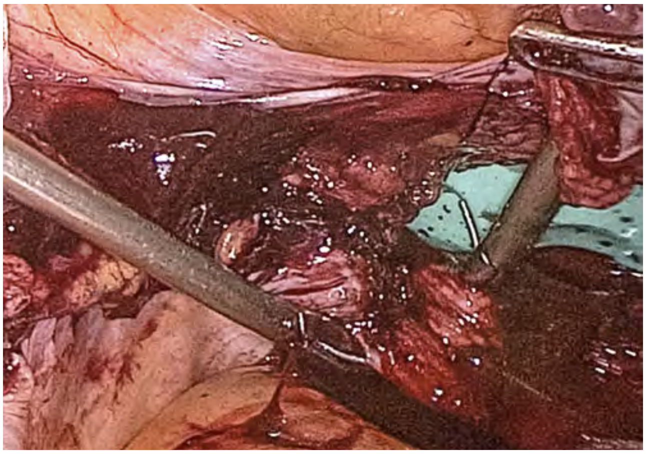

Fig. 10.4c The needle is passed through the posterior vaginal mucosa.

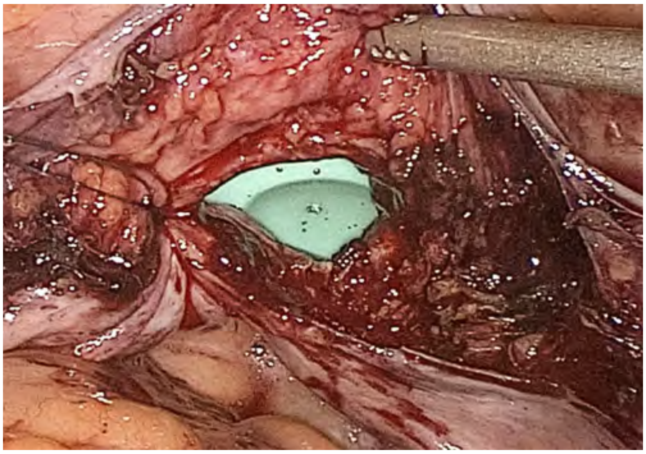

Fig. 10.4d The angle stitch is pulled through the lateral tocar and secured with a hemostat to provide traction on the vaginal cuff.

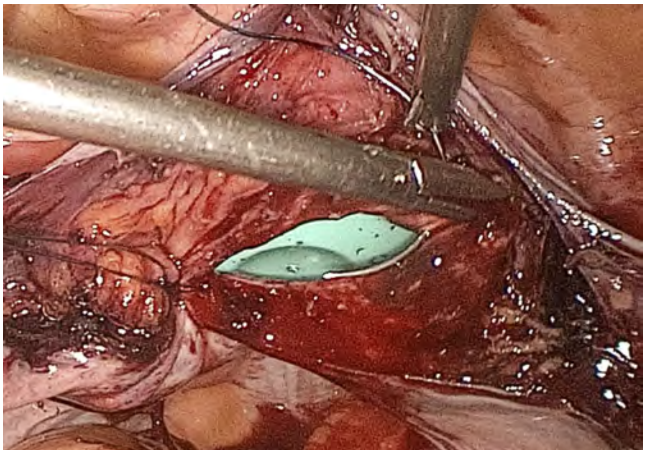

Fig. 10.4e A barbed suture is passed through the anterior pubocervical fascia and vaginal mucosa.

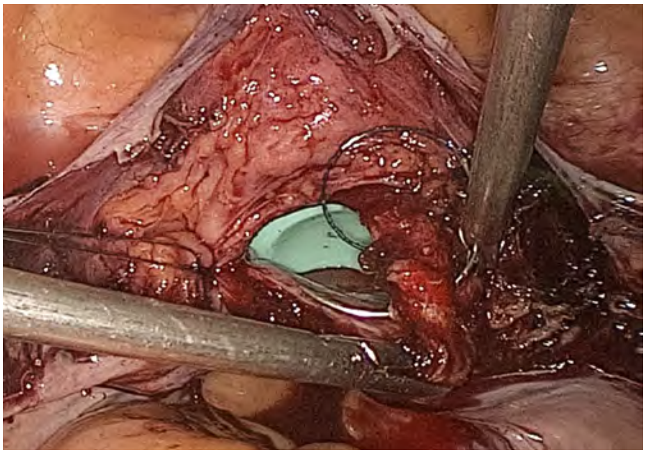

Fig. 10.4f The barbed suture is then passed through the vaginal mucosa at the 3 o'clock position.

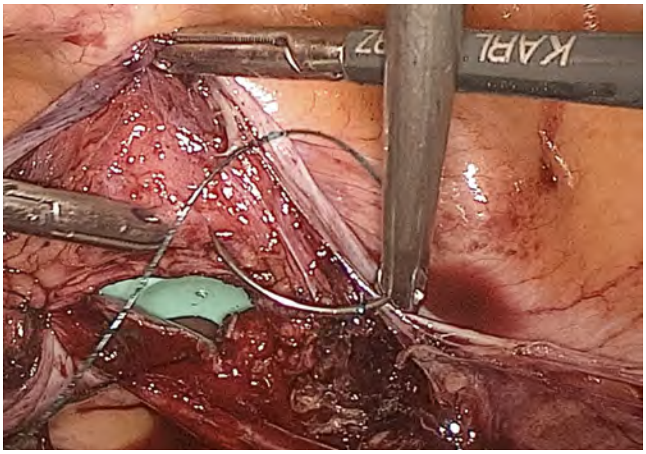

Fig. 10.4 g The barbed suture is then secured by passing the suture through the loop.

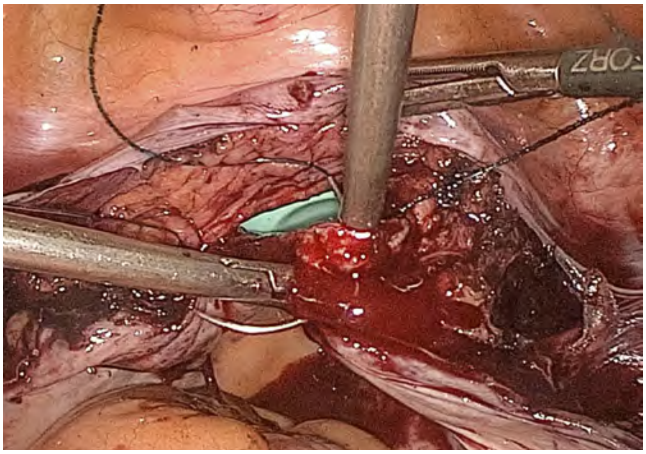

Fig. 10.4h The needle is then passed through the posterior vaginal mucosa and pubocervical fascia while incorporating the uterosacral ligament and posterior peritoneum.

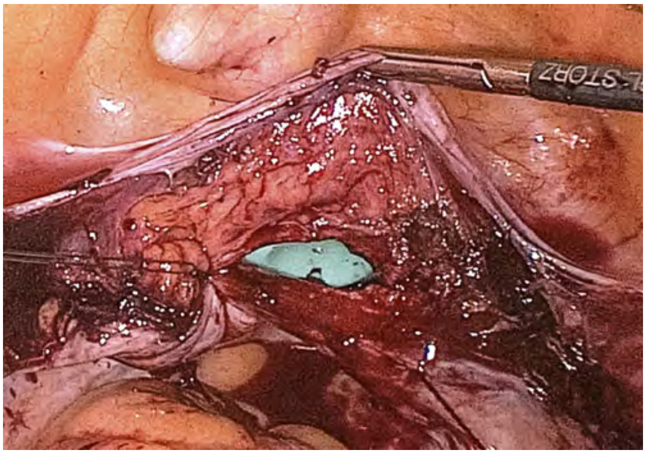

Fig. 10.4i The assistant elevates the bladder reflection while the surgeon pulls the suture through to the appropriate amount of tension.

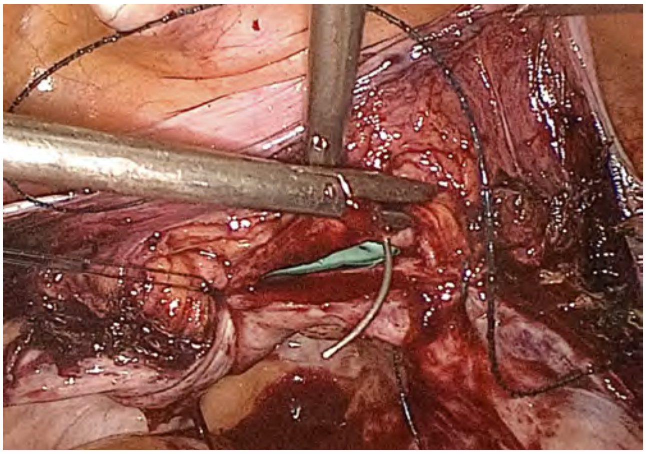

Fig. 10.4j The needle is passed through the anterior pubocervical fascia and vaginal mucosa.

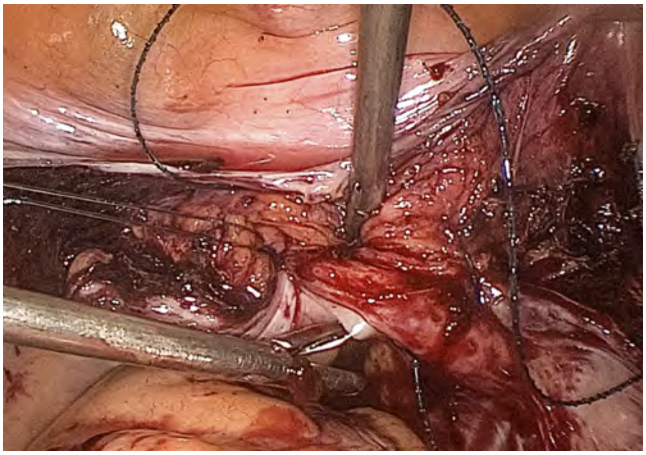

Fig. 10.4k The needle is then passed through the posterior vaginal mucosa and pubocervical fascia while incorporating the posterior peritoneum.

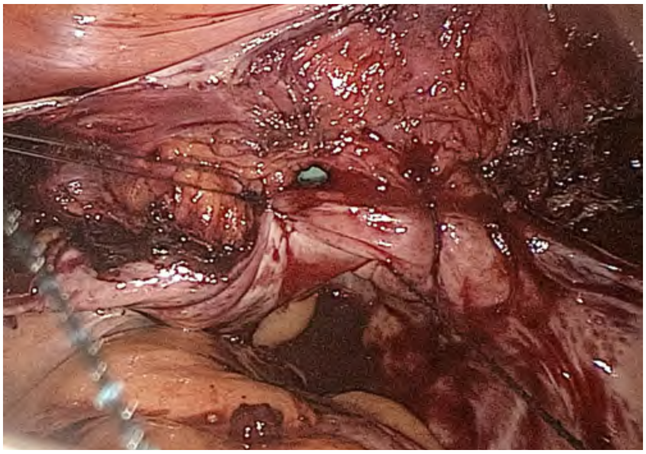

Fig. 10.4l The suture is pulled through to the appropriate amount of tension.

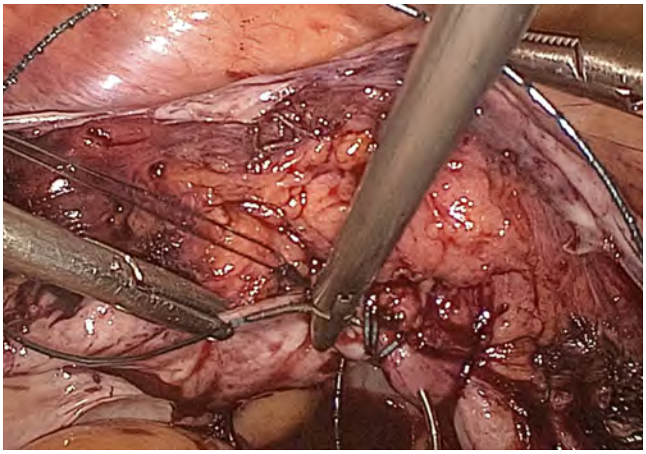

Fig. 10.4 m The barbed suture can then be passed back through the posterior portion of the cuff to help tunnel the barbed suture.

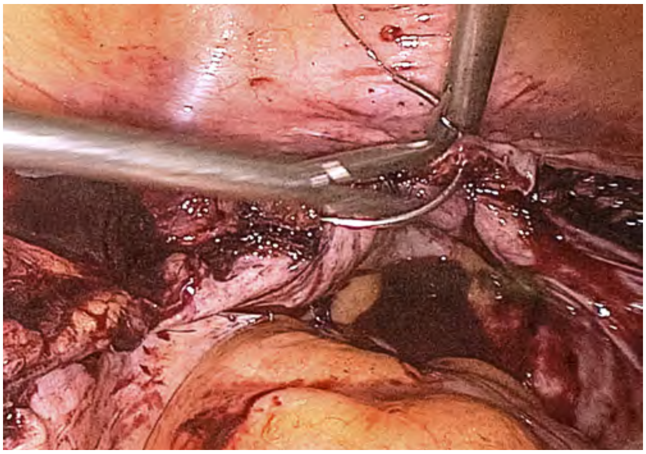

Fig. 10.4n A separate monofilament suture can be used to re-approximate the peritoneum over the vaginal cuff.

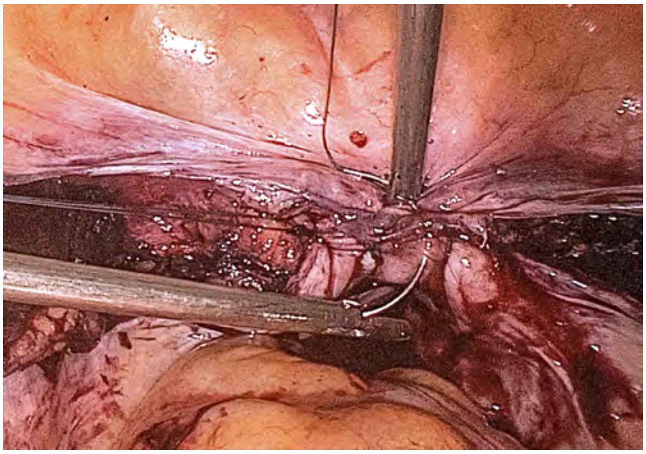

Fig. 10.4o The monofilament suture can then be passed through the posterior peritoneum.

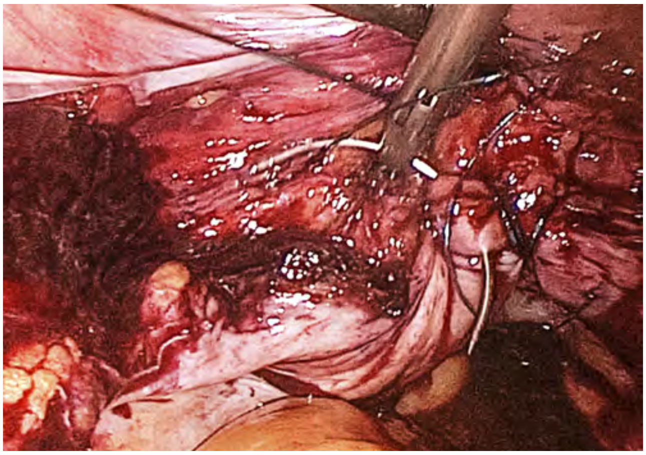

Fig. 10.4p The suture can be passed through a second time to form a figure-of-eight or a mattress suture to re-approximate the peritoneum.

Fig. 10.4q The running vaginal cuff closure is complete and the sutures can be trimmed.

11 Pelvic Floor Reconstruction

11.1 Anatomy of Pelvic Floor Defects

Cullen Richardson, in his publication entitled, 'A New Look at Pelvic Relaxation' (1976),[3] fostered a new understanding of pelvic floor defects and stated that, '*in all patients with cystoceles, there are isolated breaks in the pubocervical fascia*'. He proposed that if these 'breaks' in the endopelvic fascial hammock of the pubocervical fascia occurred in one of four specific locations, an anterior compartment hernia (i.e., a cystocele or anterior enterocele) would result. It was further suggested that isolated breaks in other areas of the endopelvic fascia accounted for all other support defects. Specifically, breaks in the rectovaginal septum cause rectoceles, while enteroceles can result from breaks between the rectovaginal septum and pubocervical fascia. In addition, it has been demonstrated that isolated breaks in the uterosacral ligament component of this network cause vaginal vault prolapse.

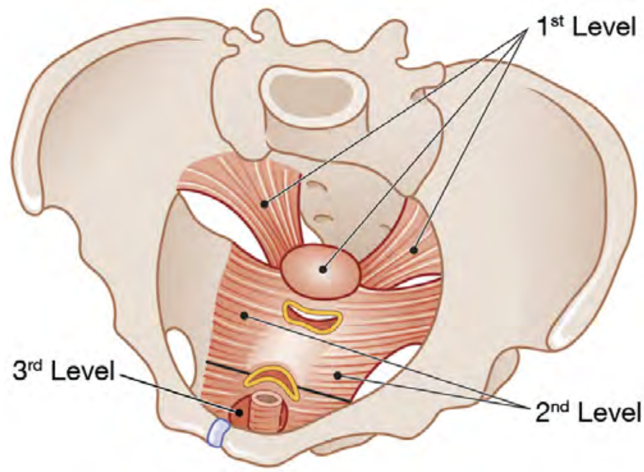

Fig. 11.1a The three levels of pelvic support.

Richardson's work underlines the concept that the endopelvic fascial network simply suspends the organs in their proper position above the levator ani muscles. If the pelvic floor muscles are damaged or relaxed for prolonged periods of time, increases in intra-abdominal pressure can further damage and expose existing weaknesses in the endopelvic fascia and pelvic musculature. It is these defects in the endopelvic fascia, in conjunction with poorly functioning levator ani muscles, that result in genital organ prolapse.

DeLancey described three levels of pelvic support.[1] (Fig. 11.1a) **Level-1** consists of the attachment of the vagina to the uterosacral ligaments and cardinal ligament complex, providing the highest level of support. The sacral colpopexy procedure mimics this support if performed appropriately. **Level-2** consists of the lateral attachment of the upper vagina to the arcus tendineus fascia pelvis (white line). A paravaginal defect occurs if there is a defect in level-2 support. **Level-3** support is provided by the attachment of the vagina to the urogenital diaphragm and provides the lowest level of support.

Mastery of laparoscopic suturing techniques is an integral part of many pelvic floor reconstructive procedures. This chapter will describe the fundamentals of laparoscopic suturing as they pertain to the following procedures: **laparoscopic sacrocolpopexy and laparoscopic uterosacral ligament suspension** (for Level-1 pelvic floor defects), **laparoscopic paravaginal repair** (for Level-2 pelvic floor defects) and **Burch colpopexy** (indicated for repair of stress urinary incontinence).

11.2 Laparoscopic Sacrocolpopexy and Cervicopexy

Laparoscopic sacrocolpopexy remains one of the most successful operations for the treatment of vaginal vault prolapse. In this procedure, an Y-shaped synthetic mesh is attached to the anterior vaginal wall, posterior vaginal wall and the anterior longitudinal ligament at the sacral promontory to suspend the vaginal vault to the level of the ischial spine.

The standard practice among most female pelvic reconstructive surgeons is to use a monofilament, large-pore, light-weight polypropylene mesh. Typically, the anterior mesh leaf is approximately 3–4 cm long and the posterior leaf is longer, at 5–6 cm, so it can be introduced deep in the rectovaginal space. The mesh is introduced into the abdominal cavity through a 10/12 cm port.

Typically, a 10-mm suprapubic port and two 5-mm ports in the left and right para-median regions (Fig. 11.2a) are utilized. The laparoscope is placed through a 10-mm

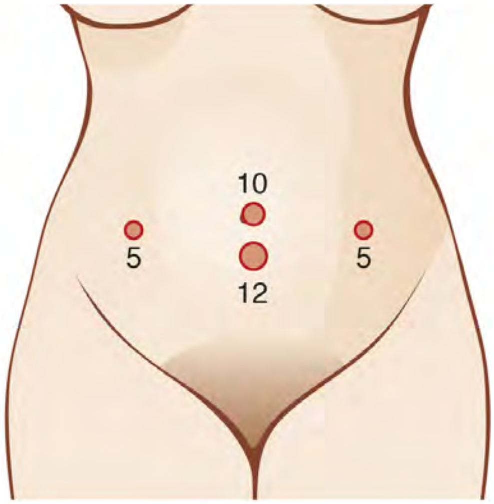

Fig. 11.2a Port placement: 10-mm suprapubic port, 12-mm infraumbilical port and two 5-mm lateral ports.

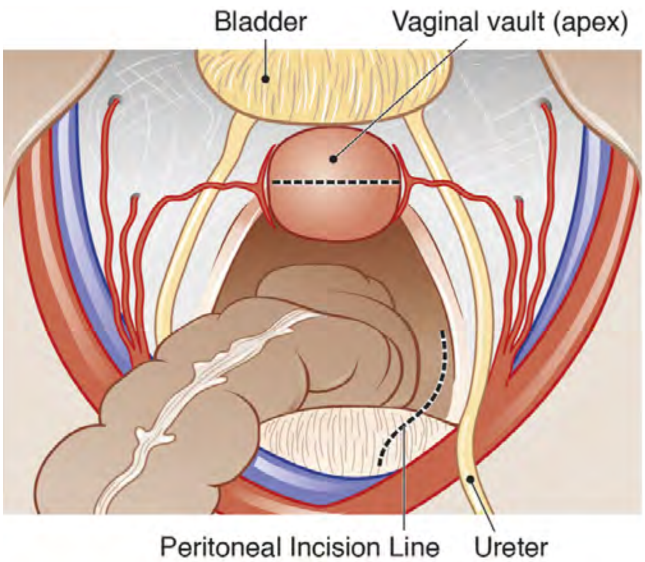

Fig. 11.2b The peritoneum overlying the vaginal vault is incised transversely while the peritoneum at the sacral promontory is incised longitudinally.

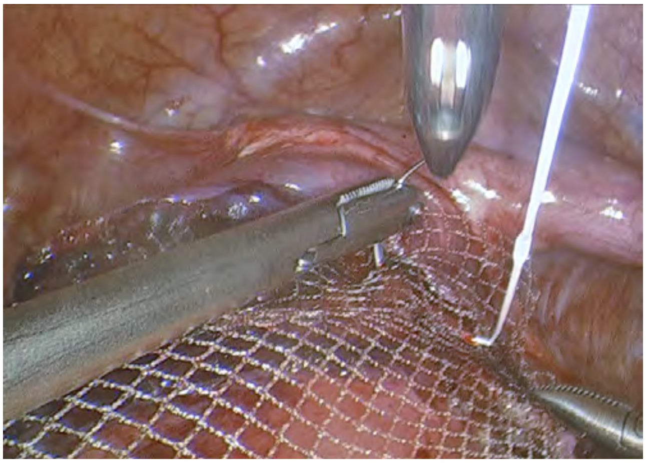

Fig. 11.2c The anterior leaf of the mesh is sutured to the pubocervical fascia.

infra-umbilical port. The surgeon stands on the patient's left side and completes all needle introduction, suturing, needle retrieval and knot tying via the left paramedian and suprapubic ports.

Once the operative ports have been placed, the vagina is elevated with an end-to-end anastomosis (EEA) sizer and the peritoneum overlying the vaginal apex is dissected anteriorly and posteriorly exposing the apex of the rectovaginal fascia. The vesicovaginal and the rectovaginal dissections are performed using a combination of sharp and blunt techniques.

After identification of the ureter, the peritoneum overlying the sacral promontory is elevated and incised longitudinally. This peritoneal incision is extended, medial to the ureter and lateral to the rectosigmoid, to the cul-de-sac (Fig. 11.2b).

Once this dissection is completed, the anterior leaf of the mesh is sutured to the pubocervical fascia with three pairs of no. 2–0, non-absorbable sutures beginning distally and working towards the rectovaginal fascia apex (Figs. 11.2c, d). Ethibond, Goretex, or Prolene is generally used here and knots are tied extracorporeally with a closed-loop knot pusher, which saves time and increases efficiency. Once the mesh is satisfactorily attached to the anterior vaginal wall and pubocervical fascia, the posterior arm of the mesh is attached to the posterior vaginal wall in a similar fashion. Four pairs of no. 2–0, non-absorbable sutures are placed, beginning distally and working towards the vaginal apex (Fig. 11.2e).

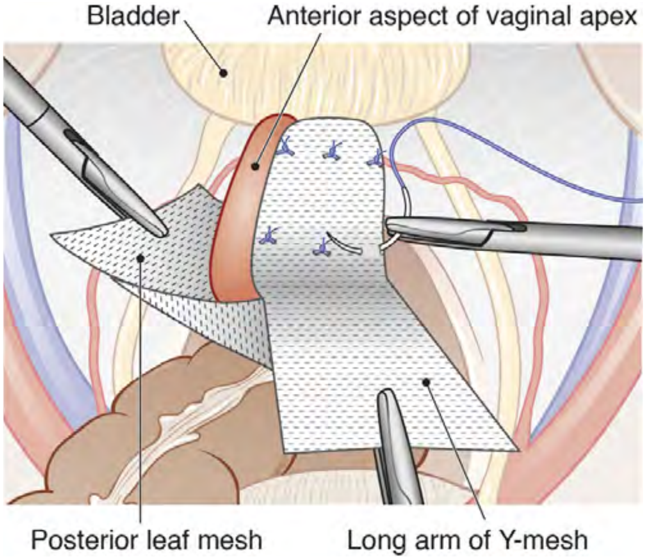

Fig. 11.2d Additional sutures are placed into the anterior leaf of the mesh as it is sutured to the pubocervical fascia.

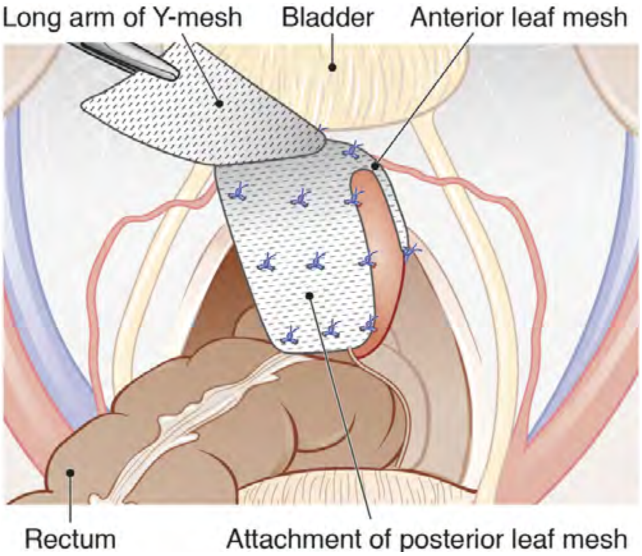

Fig. 11.2e Posterior arm of the mesh is attached to the posterior vaginal wall.

11.2.1 Sacral Mesh Attachment

After attaching the mesh to both aspects of the vagina, pelvic exam must be performed to determine the point at which the mesh tail should be sutured to the sacral ligament. One should maintain a 'tension-free' placement as the mesh will shrink after implantation. Over-tightening may cause pelvic pain, dyspareunia, and failure. The tail of the mesh is then sutured to the anterior longitudinal ligament of the sacrum (Fig. 11.2f).

The mesh may be attached here using different techniques. The mesh may be sutured to the ligament using two to four permanent sutures. Other surgeons prefer to secure the mesh to the sacrum using metal tacks.

11.2.2 Peritoneal Closure

The peritoneum over the mesh can be closed using different approaches. Some use interrupted sutures; others use a continuous running suture. It is important to ensure complete re-peritonealization to avoid contact of the mesh to bowel and possible erosion into bowel. The suggested technique involves closing the peritoneum using an absorbable suture, specifically 2.0 Monocryl® or Vicryl® (Fig. 11.2 g).

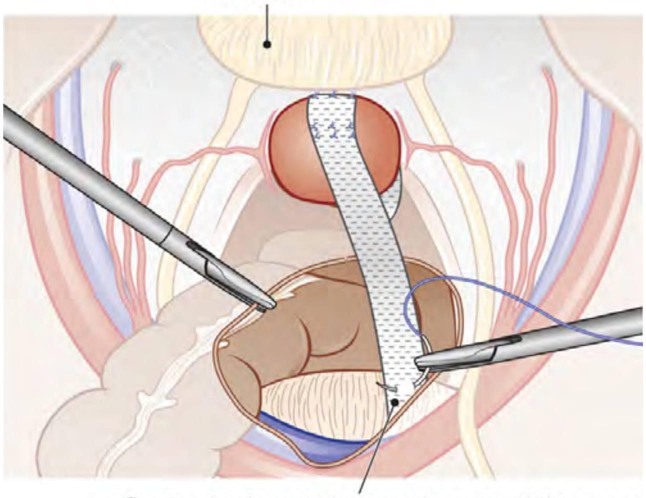

Fig. 11.2f The mesh is sutured to the anterior longitudinal ligament of the sacrum.

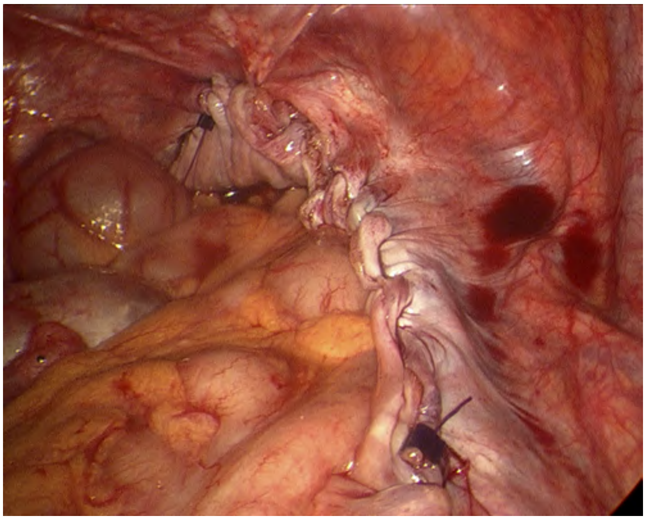

Fig. 11.2 g Peritoneum over the incision is closed.

11.3 Uterosacral Ligament Suspension

It has been demonstrated that isolated breaks in the uterosacral ligament and para-cervical ring cause vaginal vault prolapse. Uterosacral ligament suspension is a straightforward and effective procedure for women with symptomatic apical prolapse.

First, identification of the uterosacral ligaments is accomplished by elevating either the uterus using a manipulator or the apex of the vagina using a sponge stick or stent. The ligaments are seen medial to the ureter. The uterosacral ligaments can be marked for later identification by placing a vascular clip on each. Prior to doing so, it is imperative to locate the ureter at the sidewall. Some surgeons advocate a 'releasing incision', which refers to a linear peritoneal incision just beneath the ureter, using either laparoscopic scissors or the harmonic scalpel, and extending this parallel to the course of the ureter into the deep pelvis (Fig. 11.3a). This theoretically decreases the chances of ureteral kinking during uterosacral suspension.

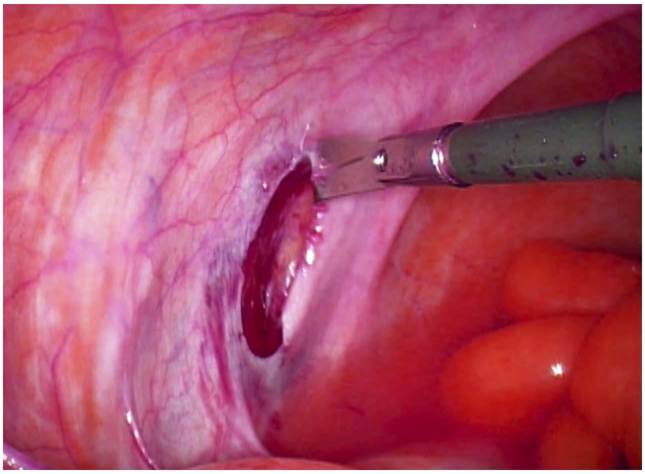

Fig. 11.3a Relaxing incision made underneath the left ureter.

Uterosacral ligament suspension is usually performed in conjunction with hysterectomy, but can be also performed with the uterus in place. Once the vaginal cuff is closed with absorbable sutures, the bladder is dissected downward and pubocervical fascia is adequately exposed (Fig. 11.3b). Some surgeons also dissect the rectovaginal septum and repair its connection to the arcus tendineus ligament.

Small, surgeon-dependent variations exist in uterosacral ligament suspension, but the core principle is to place a no. 2–0, non-absorbable (such as Ethibond) suture through the uterosacral ligament close to its origin at the sacrum (Fig. 11.3c). The suture is then passed through the pubocervical fascia anteriorly, the rectovaginal septum posteriorly, and then back through the uterosacral ligament (Figs. 11.3d–f).

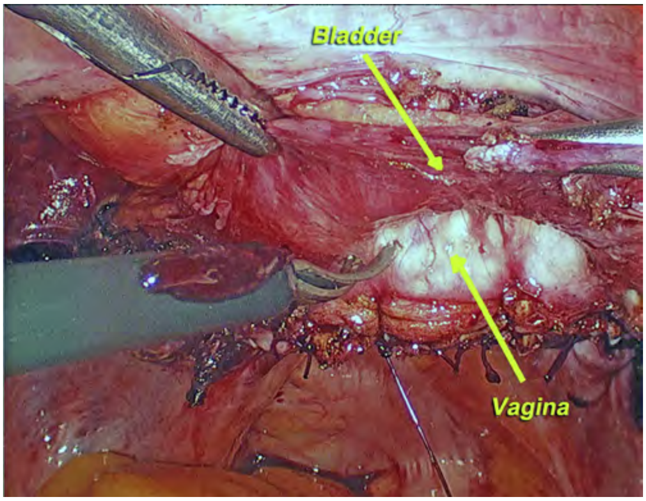

Fig. 11.3b Pubocervical fascia exposed.

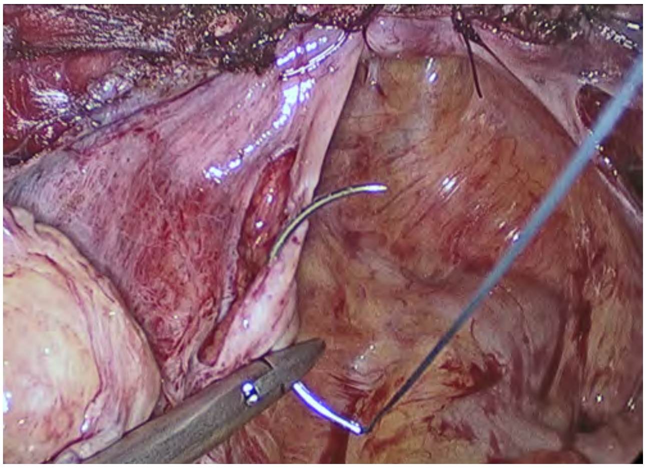

Fig. 11.3c Suture through the left uterosacral ligament close to its origin at the sacrum.

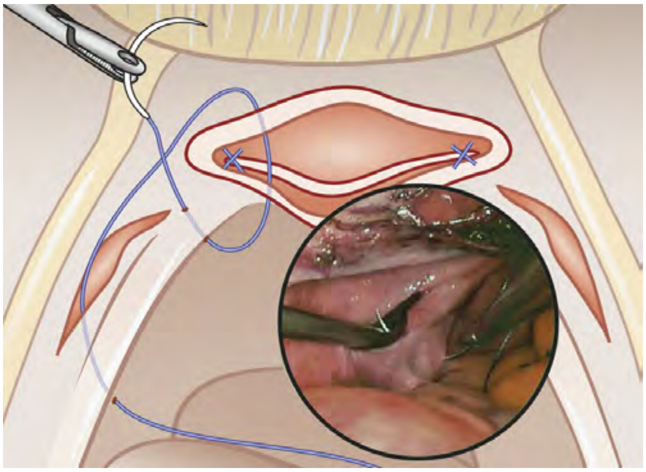

Fig. 11.3d Illustration of the uterosacral ligament suspension stitch.

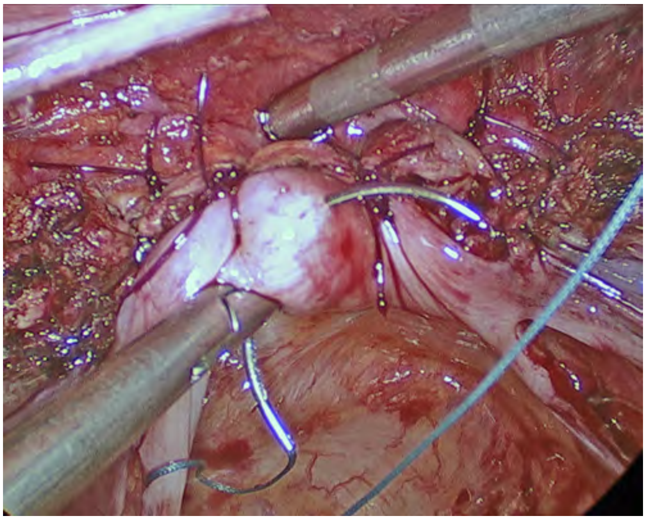

Fig. 11.3e Passing the needle through the rectovaginal septum.

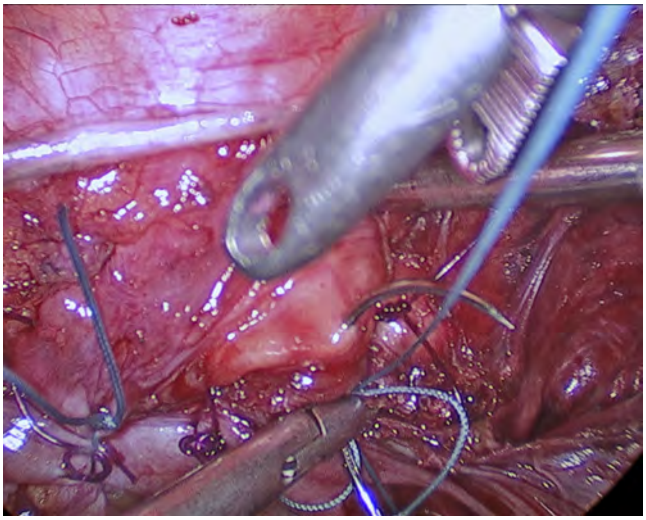

Fig. 11.3f Passing the needle through the pubocervical fascia.

Once the suture is placed on one side, another 2–0 Ethibond is placed through the uterosacral ligament on the opposite side and then through the pubocervical fascia and rectovaginal septum in a similar fashion. Both are tied down securely using extracorporeal knot tying and a closed knot pusher. The effect of bilateral uterosacral ligament suspension is shown in Fig. 11.3 g.

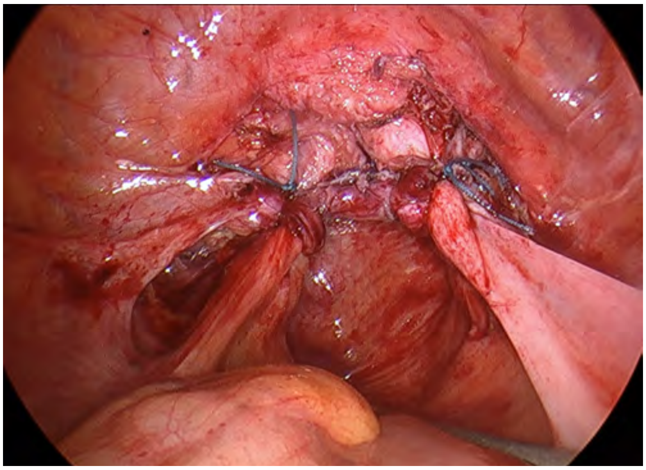

Fig. 11.3g Bilateral uterosacral ligament suspension.

11.4 Paravaginal Repair

Loss of the lateral vaginal attachments to the pelvic sidewall is termed *'paravaginal defect'* and usually results in a cysto-urethrocele and urethral hypermobility. If the patient demonstrates a cystocele secondary to a paravaginal defect diagnosed either pre- or intra-operatively, a paravaginal defect repair should be performed before the colposuspension.

The paravaginal defect repair is intended to place the anterior vaginal wall in its correct anatomic position, i. e., at the level of the arcus tendineus fascia pelvis.

11.4.1 Dissection of the Space of Retzius

As previously described, a 10/12 mm suprapubic port is utilized to introduce and remove needles. The surgeon stands on the patient's left and utilizes the left paramedian and suprapubic ports for suturing (Fig. 11.4a).

An incision is made in the peritoneum approximately three centimeters superior to the dome of the bladder between the obliterated umbilical ligaments (Fig. 11.4b). Dissection is directed caudally, toward the pubic symphysis (Fig. 11.4c).

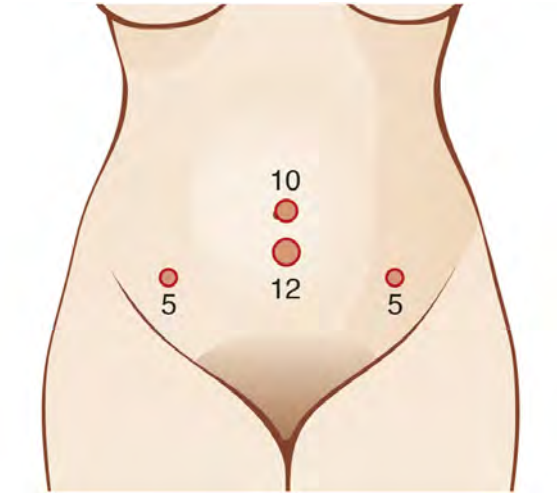

Fig. 11.4a Schematic drawing of port placement.

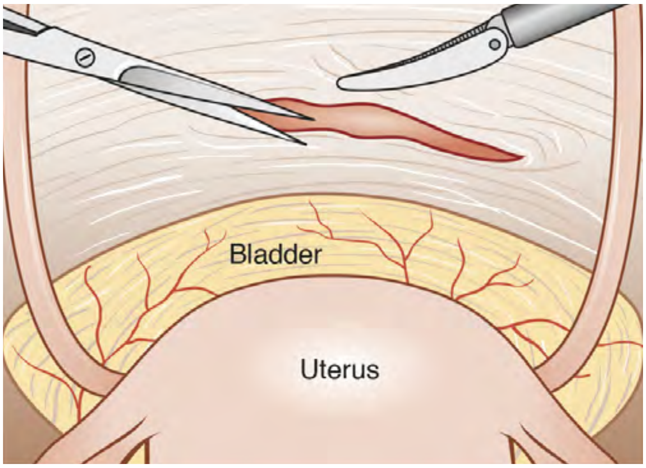

Fig. 11.4b Illustration showing the peritoneal incision made to enter the space of Retzius.

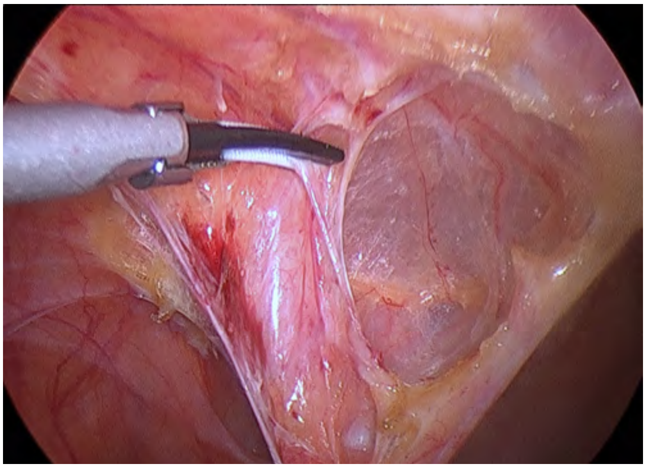

Fig. 11.4c Laparoscopic view of the peritoneal incision made to enter the space of Retzius.

After the space of Retzius has been entered and the pubic rami visualized, the bladder is drained. Identification of loose, areolar tissue confirms a proper plane of dissection. Separating the loose areolar and fatty layers using blunt dissection develops the retropubic space and blunt dissection is continued until the retropubic anatomy is visualized. The pubic symphysis and bladder neck are identified in the midline and the obturator neurovascular bundle, Cooper's ligament, and the arcus tendineus are visualized laterally. The anterior vaginal wall and its points of lateral attachment from its origin at the pubic symphysis to its insertion at the ischial spines are identified (Figs. 11.4d, e).

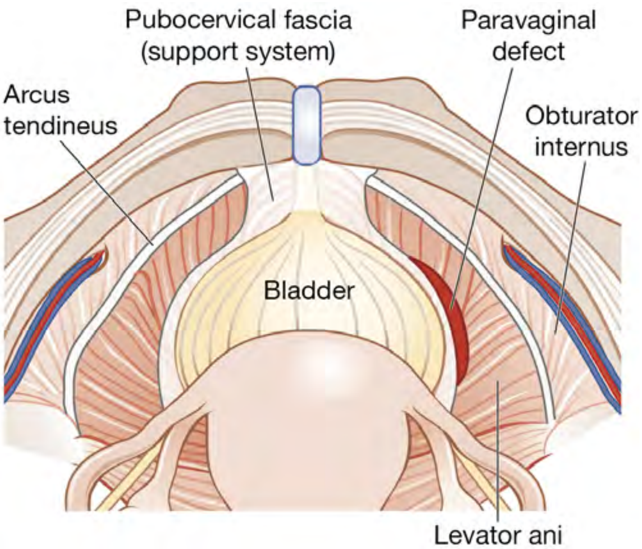

Fig. 11.4d The dissected space of Retzius with paravaginal defect on right side.

11.4.2 Equipment and Sutures

The space of Retzius is one of the most difficult areas to suture laparoscopically due to limited space and narrow angles that limit ease of suture placement and retrieval. Adjusting needle placement accordingly and utilizing a vaginal hand to elevate and manipulate the anterior vaginal wall allows the surgeon to complete all suturing from one side of the table while the assistant assumes the task of managing the camera and providing tissue retraction laparoscopically.

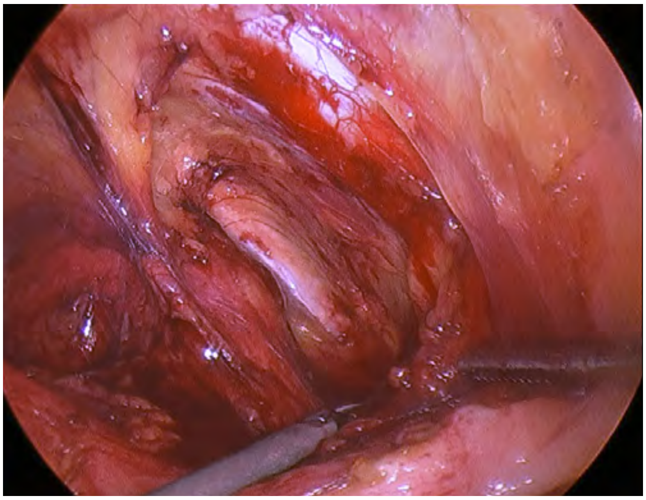

Fig. 11.4e Laparoscopic view of the dissected space of Retzius with paravaginal defect on right side.

Permanent sutures should be used for paravaginal defect repairs. The common suture of choice for pelvic reconstructive surgery is 2–0 Ethibond (Ethicon) on an SH needle. This is a braided, permanent suture. CT-1 needles can also be utilized, however, we find these needles are often too large to manipulate effectively in the space of Retzius.

Extracorporeal knot tying is much faster and more efficient than intracorporeal knot tying, again decreasing overall operating time. To tie extracorporeal knots when suturing in the space of Retzius, it is necessary to have a *minimum suture length* of 48 inches (121.92 cm).

For the paravaginal defect repair on the right side, the assistant retracts the bladder medially using a grasper and thereby exposing the retropubic space for suturing. The surgeon places his/her left hand in the vagina and elevates the anterior vaginal wall superiorly and towards the anterior abdominal wall. The first suture is placed in the pubocervical fascia at the apex of the defect on the right side. The surgeon's right hand is controlling the needle holder which has been introduced through the left lateral port. The assistant retracts the bladder away from the pubocervical fascia and the surgeon then drives the needle through the fascia (Fig. 11.4f). Maintaining elevation of the vagina with the left index finger, the needle is then retrieved using the needle driver in the right hand. Separate passes are always utilized for the vagina and the sidewall to ensure proper placement and adequate tissue bites.

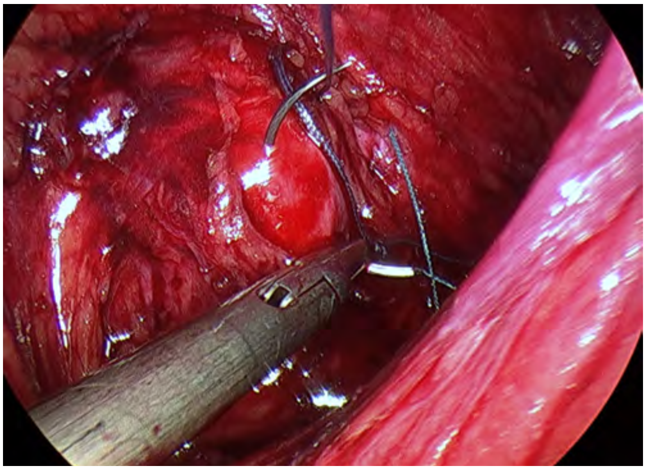

Fig. 11.4f The paravaginal repair suture through the right obturator internus muscle and the arcus tendineus fascia at its origin.

Once the needle is re-set, the surgeon passes it through the ipsilateral obturator internus muscle and the arcus tendineus fascia at its origin, 1–2 cm distal to the ischial spine. The assistant uses a grasper or retractor to keep the space visible.

The suture is then tied down extracorporeally using the closed-loop knot pusher. Three to four additional sutures are placed on the same side, using the same technique. Typically, four to five sutures are passed on each side to close the defect (Fig. 11.4 g).

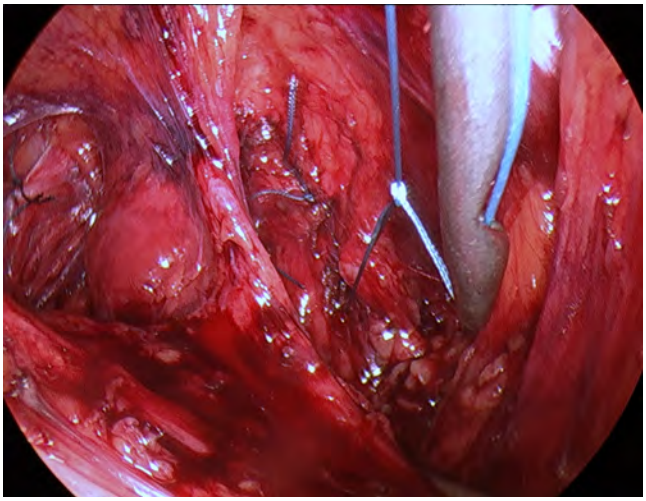

Fig. 11.4g Extracorporeal knots and completed paravaginal defect repair on patient's right side.

11.5 Laparoscopic Burch Colposuspension

Once the Space of Retzius is opened and the paravaginal repair accomplished, a laparoscopic Burch may be performed for patients with stress urinary incontinence. For the Burch procedure, a Gore-Tex®, no. 0, permanent suture on a CV-1 taper cut needle is recommended since making two passes through the pubocervical fascia is ideal. A double-pass allows for adequate tissue purchase and the nature of the Gore-Tex® suture allows it to slide very easily through the tissue, even when passed twice.

To begin, the surgeon's non-dominant hand is placed in the vagina and a finger is used to elevate the vagina. The endopelvic fascia on both sides of the bladder neck and mid-urethra is exposed. The first suture is placed 2 cm lateral to the urethra at the level of the mid-urethra (Fig. 11.5a). A figure-of-eight suture, incorporating the entire thickness of the anterior vaginal wall, excluding the epithelium, is taken and the suture is then passed through the ipsilateral Cooper's ligament (Fig. 11.5b). With the assistant's fingers in the vagina to elevate the anterior vaginal wall toward Cooper's ligament, the suture is tied down with a series of extracorporeal knots using an endoscopic knot pusher.

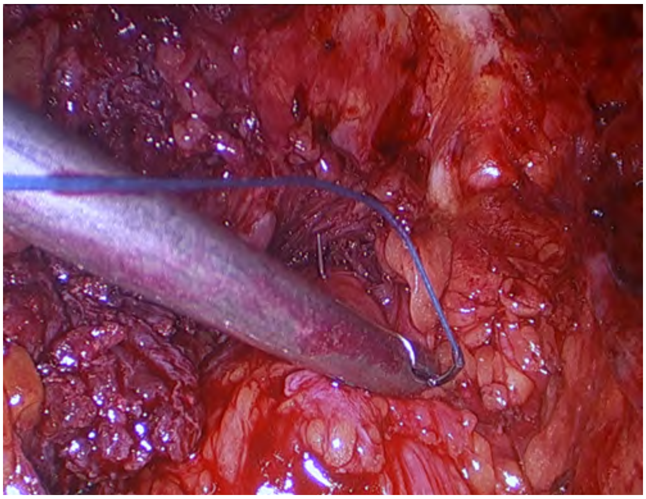

Fig. 11.5a The first mid-urethral Burch suture is placed 2 cm lateral to the urethra at the level of the mid-urethra on patient's left side.

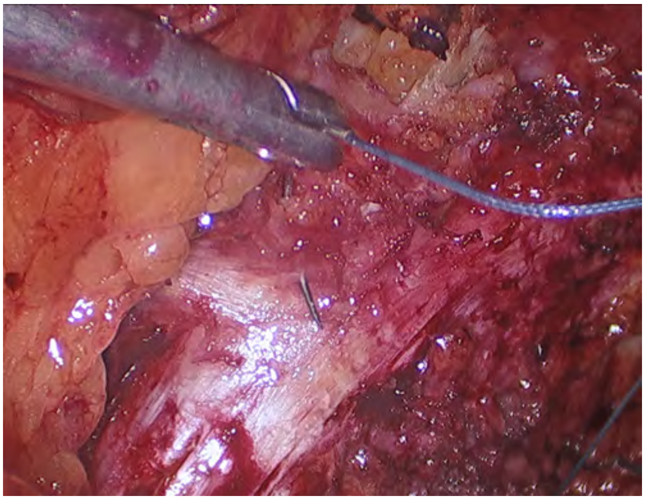

Fig. 11.5b Placing the suture through the left Cooper ligament.

An additional suture is then placed in a similar fashion at the level of the urethro-vesical junction, approximately 2 cm lateral to the bladder edge on the same side. The procedure is repeated on the opposite side. Excessive tension on the vaginal wall should be avoided when tying down the sutures and leaving a suture bridge of approximately 2–3 cm. The outcome of paravaginal repair and Burch colpopexy is shown in Figs. 11.5c, d.

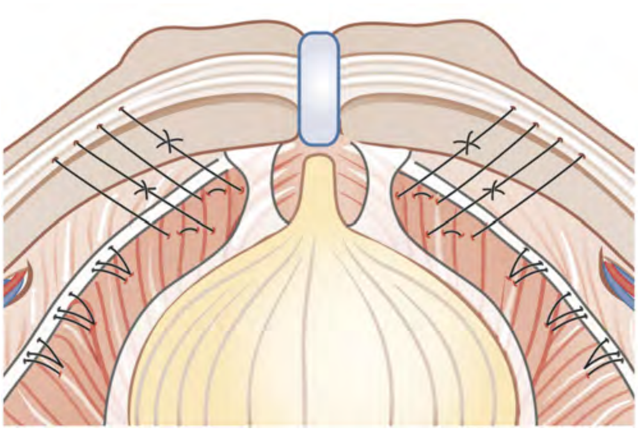

Fig. 11.5c Illustration showing the completed Burch colposuspension and paravaginal stitches.

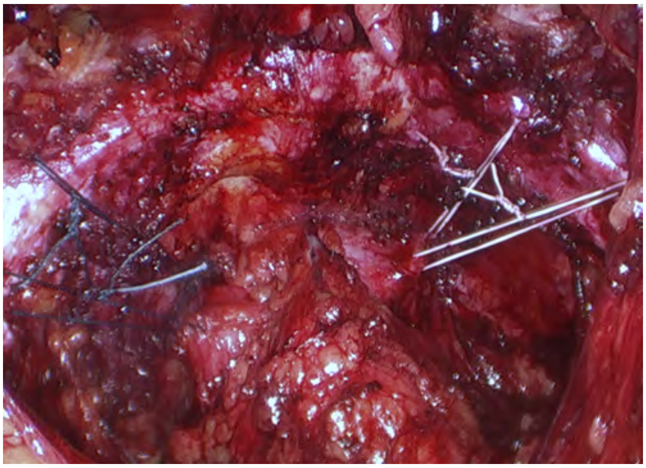

Fig. 11.5d Laparoscopic view of the completed Burch stitches.

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12 Laparoscopic Myomectomy

12.1 Introduction

Laparoscopic myomectomy is a safe and efficient procedure that requires extensive laparoscopic suturing skills. The laparoscopic approach is advantageous for patient recovery and also facilitates a panoramic view of important anatomy, potentially improving ease of dissection. Closing the defects created after myoma removal is a process which is typically accomplished in layers and with careful attention to preserving the integrity of the endometrial cavity and creating a hemostatic repair.

12.2 Port Placement and Preparation

Various port configurations can be used for myomectomy, depending primarily on the comfort and expertise of the surgeon. In patients who are not massively obese, contralateral suturing through a right (RLQ) and left lower quadrant (LLQ) port is feasible and has the advantage of improved triangulation for intra-corporeal knot tying (Fig. 12.2a). Depending on the location of the fibroid and its accessibility, suturing can also be accomplished via a lower quadrant port and a midline suprapubic port (Fig. 12.2b) as well as using ipsilateral ports (Fig. 12.2c).

When suturing contra-laterally, the surgeon typically stands on the patient's left side. Needles are introduced through the LLQ port and, assuming a horizontal incision on the uterus, each suture is placed through top layer of the defect first, then the bottom layer (Fig. 12.2d). If the ipsilateral technique or the suprapubic port is preferred, the surgeon, standing on the patient's left side, places each suture from bottom to top (Fig. 12.2e). If the ipsilateral technique is used and the surgeon is standing on the patient's right side, the suture is placed from top to bottom (Fig. 12.2f).

Fig. 12.2a Contralateral suturing through right and left lower quadrant ports.

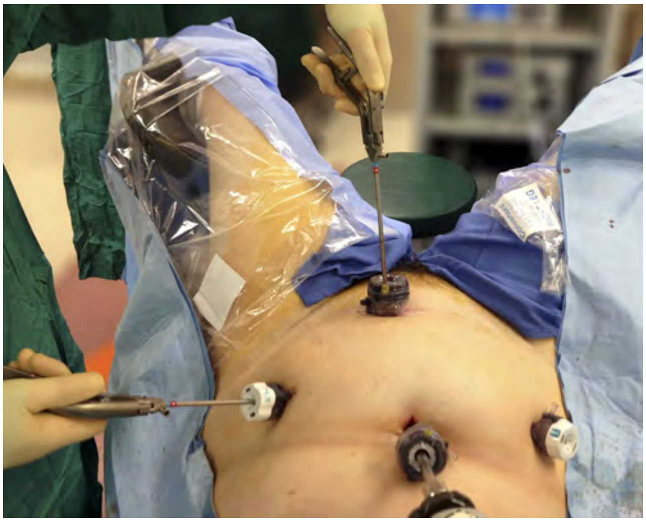


Fig. 12.2b Suturing via the left lateral port and a midline suprapubic port.

Fig. 12.2c Suturing via right sided, ipsilateral ports.

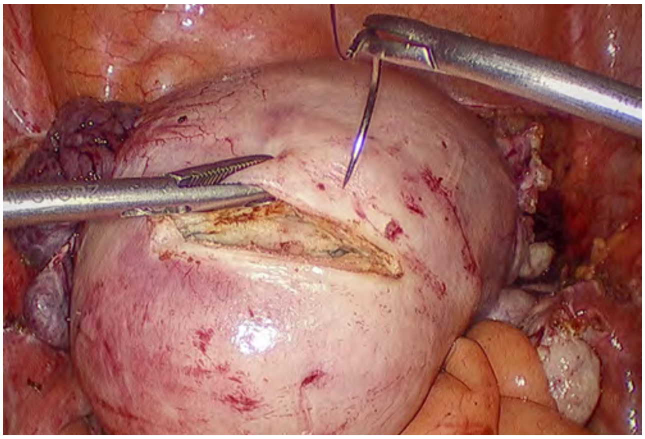


Fig. 12.2d Contralateral suturing. The needle is placed through the tissue from the top layer of the defect to the bottom.

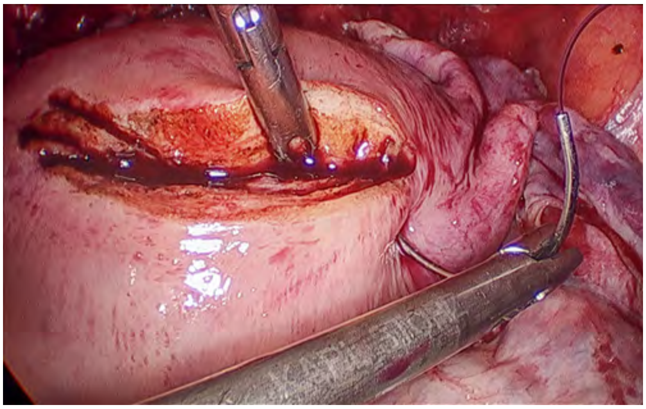


Fig. 12.2e Contralateral suturing. The needle is placed through the tissue from the top layer of the defect to the bottom.

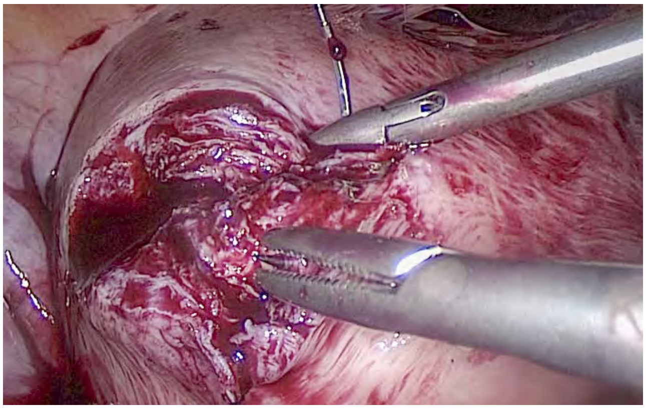


Fig. 12.2f Suprapubic port placement. The needle driver is held in the right hand, placed through the left lateral port and the needle is passed through the tissue from bottom to top.

12.3 Infiltration, Incision and Enucleation

The initial step of laparoscopic myomectomy is infiltration of dilute vasopressin. Most surgeons use a dilution of 20 units of vasopressin in 100 cc of saline or 20 units in 200 cc, depending on the volume that will be needed for the injection. The use of a 20-gauge spinal needle or a laparoscopic needle is used to infuse the solution and a laparoscopic needle driver can be used to stabilize and guide the needle into the tissue at the desired orientation (Fig. 12.3a). The primary goal is to infiltrate the pseudocapsule of the leiomyoma. This helps facilitate both vasoconstriction of the capillary bed supplying the myoma as well as aids in hydro-dissection.

Once the myometrium and pseudo capsule have been infiltrated, the myometrial incision is made. The length and axis of the incision will depend on the location and size of the leiomyoma as well as the surgeon's preference for port placement and suturing. The incision can be made with monopolar, bipolar or ultrasonic energy. The myometrial incision is carried down until the pseudocapsule is entered (Fig. 12.3b). The myoma is enucleated, using blunt and monopolar or ultrasonic energy as well as a tenaculum for traction (Fig. 12.3c). If the surgeon can maintain the dissection plane within the pseudo capsule, then blood loss can be minimized; however this can be difficult in cases involving irregularly shaped leiomyomas and adenomyomas.

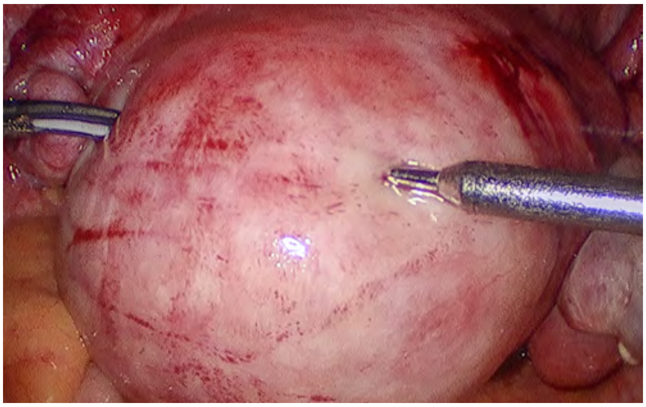


Fig. 12.3a Infiltration of the myometrium with pitressin.

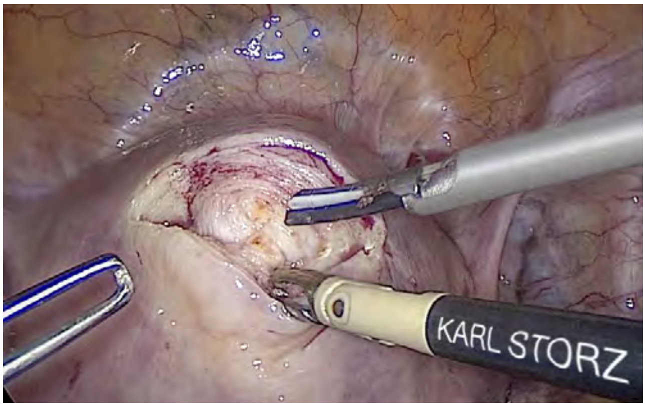


Fig. 12.3b Myometrial incision to the level of the pseudocapsule.

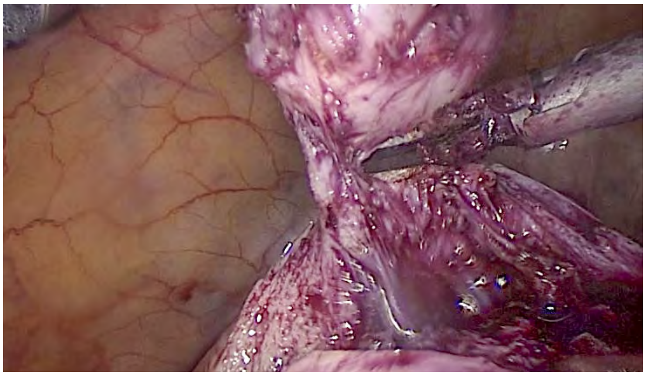


Fig. 12.3c Traction with tenaculum during myoma enucleation.

12.4 Closure

12.4.1 Endometrium

After excision of the myoma, the first step in repairing the uterus is to assess the integrity of the endometrial cavity. This is easily done via the intrauterine cannula of the uterine manipulator. Sterile saline stained with indigo carmine or methylene blue dye can be infused through the manipulator and the bed of the defect inspected laparoscopically for leakage of blue fluid. If a defect is noted, it can be repaired with either single interrupted sutures of 3–0 Monocryl or a continuous running suture of 3–0 Monocryl (Fig. 12.4a).The needle of choice for this is typically an SH or CT-2 needle.

- The angle of the endometrial defect is identified and the suture is placed just lateral to it. Intra-corporeal knot tying is preferable to decrease the likelihood of tearing the delicate endometrial tissue.
- Suturing is continued, incorporating both edges of the endometrium and, if possible, avoiding full thickness passes. Instead, effort is taken to skim the endometrium, decreasing the amount of exposed suture in the cavity and the chance of subsequent intrauterine adhesive disease. At the same time, inversion of the endometrium should also be avoided to decrease the theoretic likelihood of subsequent adenomyosis.
- Each suture should be placed approximately 0.5 cm apart and 0.5 cm from the edge of the defect.
- When the opposite angle is reached, the suture can be tied intra-corporeally. Once the endometrium has been closed satisfactorily, chromotubation is again performed to confirm adequate closure.

12.4.2 Myometrium

If the endometrium is intact, or, conversely, after the endometrial defect has been closed, attention is turned to closure of the myometrial defect. Maintaining symmetry of both sides of the myometrium as well as ensuring closure of the dead space is the key to a hemostatic repair and to easy placement of subsequent layers (Figs. 12.4b, c). There is no magic number of layers that must be placed to ensure ideal future pregnancy outcomes. Uterine rupture has been described in pregnancy even after myomectomy with a three-layer closure. It is up to the surgeon to determine what approach is ideal for a particular patient.

When closing the myometrium, two common suture materials are used:

- 2–0 Vicryl or 2–0 Monocryl with a CT-1 Needle.
- Barbed Suture (It is important to go up one size in suture caliber since the barbs are cut into the suture making the effective diameter less).
  - V-Loc™ 0, (27 mm ½ circle taper point on GS-21 needle, 15 cm).
  - Quill 0, (36 mm ½ circle taper point PDO, 14 cm x 14 cm).
  - Stratafix, SXPD2B401 (36 mm ½ circle taper point on CT1 needle, 14 cm x 14 cm).

Prior to the introduction of barbed suture technology, either 2–0 Vicryl or Monocryl on a CT-1 needle was used to reapproximate the myometrium in two layers. Suturing occurs in a typical angle-to-angle continuous running fashion, being careful not to incorporate endometrium into the closure.

Fig. 12.4a Endometrial Defect Closure.

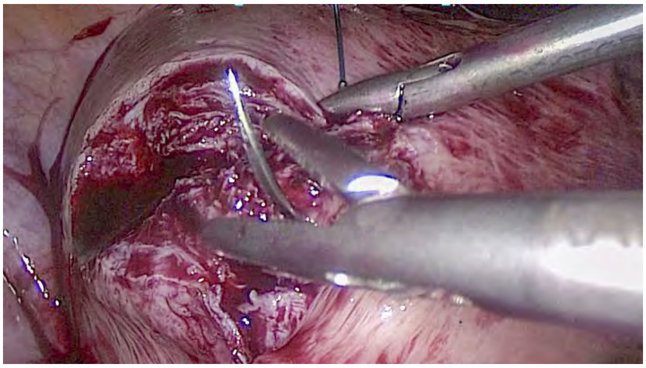


Fig. 12.4b Suturing of anterior aspect of the myometrium.

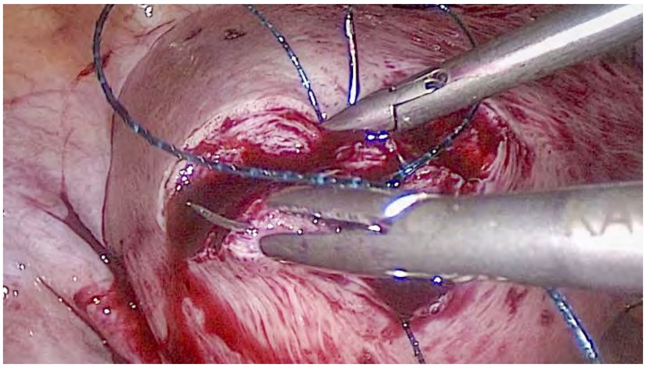


Fig. 12.4c Suturing of posterior side of the myometrium while maintaining symmetry.

- The initial angle stitch is tied intra-corporeally. Alternatively, a LAPRA-TY® clip can be placed at the end of the suture, tightening it down once the angle is closed. If a V-Loc™ is being used, the angle stitch is placed and the needle is passed through the loop and pulled through, eliminating the need for knot tying (Fig. 12.4d).
- Suturing then proceeds in a continuous running fashion, spacing each needle pass approximately 1 cm apart and tucking raw muscle edges in as progress is made. Once again, symmetry is essential. In the case of barbed suture, tensioning the suture after each pass is necessary. This should be done by pushing the myometrial tissue down rather than simply tugging on the suture (Fig. 12.4e) (which can result in frustrating breakage).
- Once the opposite angle is reached, the suture can be either tied intra-corporeally (in the case of Vicryl/Monocryl) or, if using barbed suture, several sutures can be placed in the opposite direction to prevent unraveling of the repair. The barbed suture is then tensioned and cut flush with the tissue surface.
- When the bi-directional Quill or Stratafix suture materials are used for myometrial closure, suturing is begun in the middle of the defect. Each half of the suture is then run in opposite directions (Fig. 12.4f). Again, no knot is necessary.

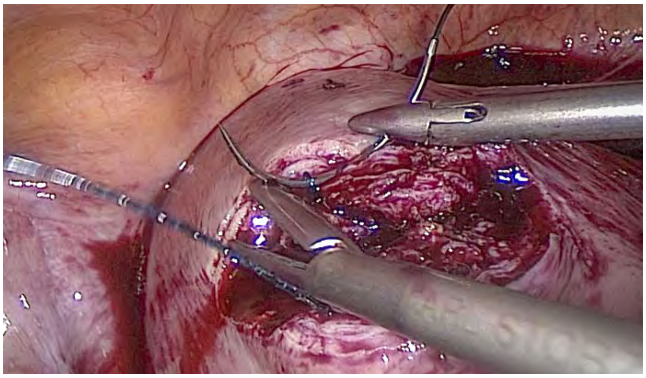


Fig. 12.4d Securing of V-Loc™ suture by passing the needle through the loop.

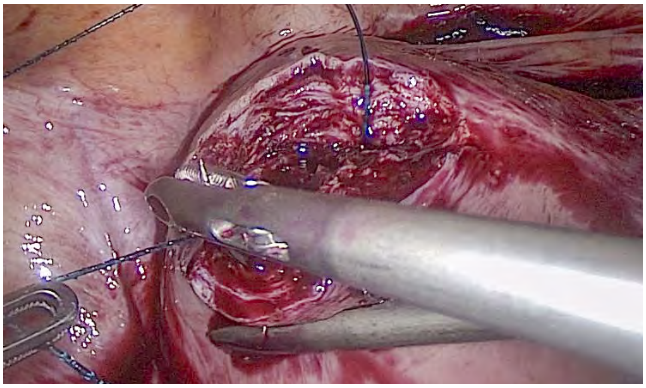


Fig. 12.4e Tightening the V-Loc™ suture with tension and countertension using two graspers.

12.4.3 Serosa

After the myometrium is re-approximated and hemostatic, the serosa is closed. Debate exists as to the optimal technique for serosal closure: continuous, running suture (Fig. 12.4 g). versus the 'in-to-out' baseball stitch technique and is described in more detail in the next section 12.5. At our institution, the baseball technique is preferable as this minimizes suture exposure and may decrease adhesion formation. Regardless of the technique chosen, each needle pass must be made 0.5–1.0 cm apart and approximately 0.5 cm deep. The LAPRA-TY® clip can be placed at the end of the closure or an intra-corporeal knot can be tied. A monofilament suture such as 3–0 Monocryl on a CT 1 or SH needle is used to close the uterine serosa.

Once the serosa is closed, careful inspection for hemostasis is performed. Any areas with persistent bleeding are typically managed using a bipolar electrosurgical device (if superficial and focal) or by placing additional figure-of-eight sutures. The pelvis is irrigated and when no further bleeding is noted, an adhesion barrier, such as Gynecare Interceed®, may be placed over the suture line to decrease adhesion formation.

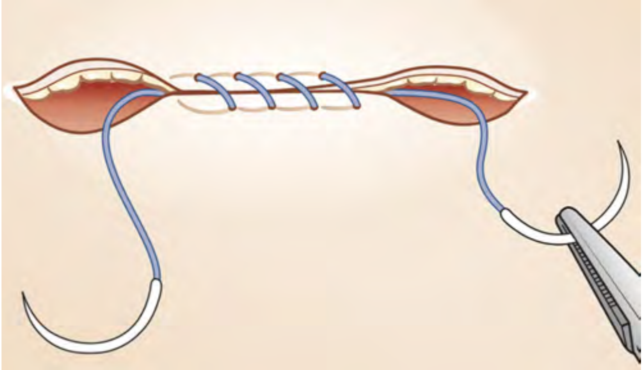


Fig. 12.4f Illustration showing the Quill suture. Each half of the suture is run in opposite directions.

12.4.4 Pedunculated Fibroids and Small Defects

If the myomectomy site is small, such as after a narrow-stalk, pedunculated fibroid has been removed, single interrupted sutures with 2–0 Monocryl or Vicryl on a CT1 needle can be placed for hemostasis. It is adequate hemostasis and lack of exposed raw edges that will decrease adhesion formation.

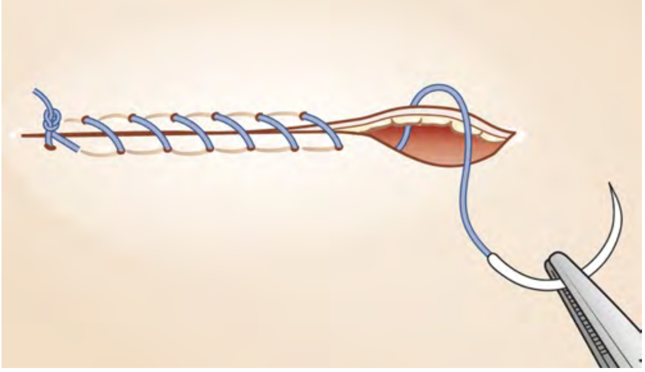


Fig. 12.4g Illustration showing the serosal closure running suture.

12.5 Baseball Stitch

A baseball suture has been the classic technique described for closure of the serosa for myomectomy. This type of closure exposes less suture than a running closure. Theoretically, this leads to less scar formation, however there is a lack of well-designed studies showing benefits of one particular suturing technique over another. Performing a baseball stitch laparoscopically requires the ability to suture with both the right and left hand. The technique for a laparoscopic baseball stitch is illustrated in Fig. 12.5a.

After the needle is set in the right hand, the left hand is used to position the tissue in the proper axis and the needle is passed through the tissue inside out (Fig. 12.5b). The left hand is then used to stabilize the tissue and the right hand grabs the needle near the tip and rotates the needle out of the tissue (Fig. 12.5c). **Notice that the needle is passed inside out through the tissue with the right hand and the tip of the needle is again grasped by the right hand.** While the needle is held close to the tip in the right hand, the left hand then grasps the suture about 1 cm from the needle hub (Fig. 12.5d) and rotates the needle approximately 180 degrees around its axis. The needle is reset in the left hand as shown in (Fig. 12.5e).

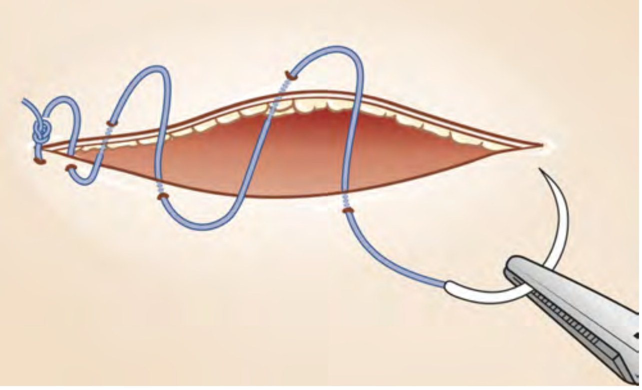


Fig. 12.5a Illustration showing the baseball stitch.

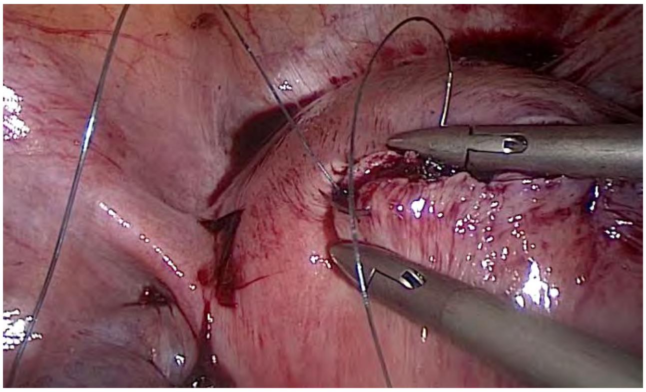


Fig. 12.5b The needle is passed through the tissue inside to out with the right hand.

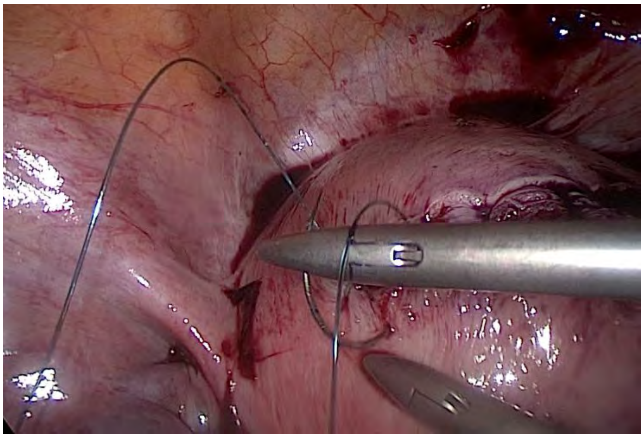


Fig. 12.5c Right hand grasps the tip of the needle and rotates it out of the tissue.

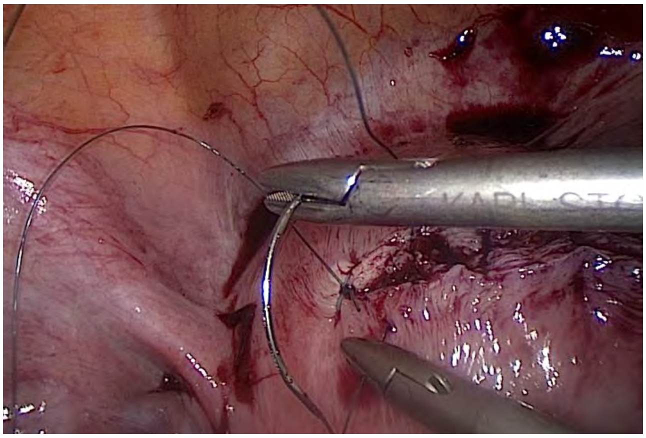


Fig. 12.5d Left hand grasps the suture and rotates it to load backhand.

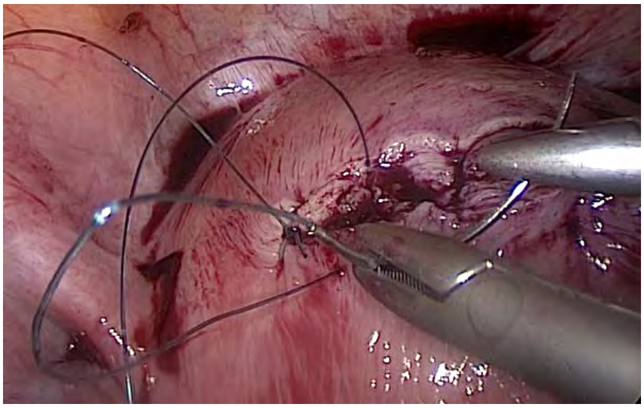


Fig. 12.5e Left hand grasps the needle.

The right hand is used to position the tissue in the proper axis and the left hand passes the needle inside out through the tissue (Fig. 12.5f). The left hand is used to grasp the tip of the needle and rotate the needle out of the tissue (Fig. 12.5g). **Notice that the needle is passed inside out through the tissue by the left hand and the tip of the needle is again grasped by the left hand.** While the tip of the needle is held with the left hand, the right hand grasps the suture at point 'A' about 1 cm from the needle hub and rotates the needle around its axis (Fig. 12.5h). The needle is reset in the right hand and the process is repeated (Fig. 12.5i) until the incision is closed (Fig. 12.5j).

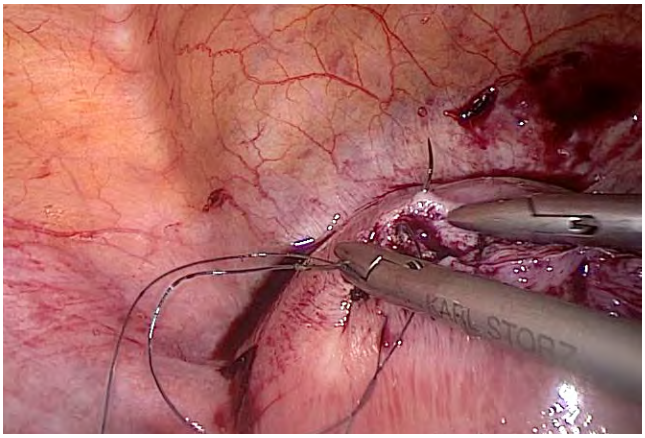


Fig. 12.5f Left hand passes the needle inside out.

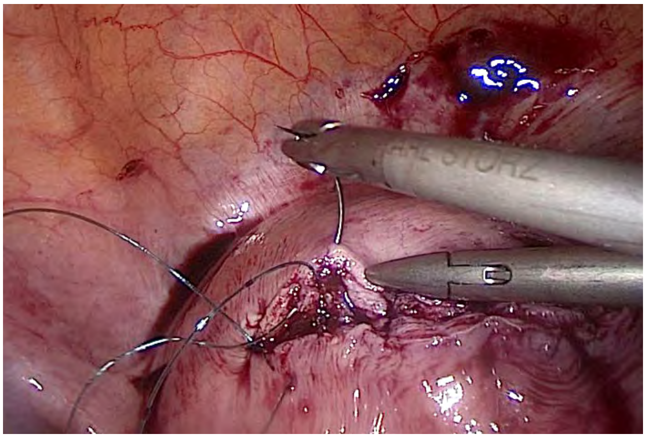


Fig. 12.5 g Left hand grasps the needle tip and rotates the needle out of the tissue.

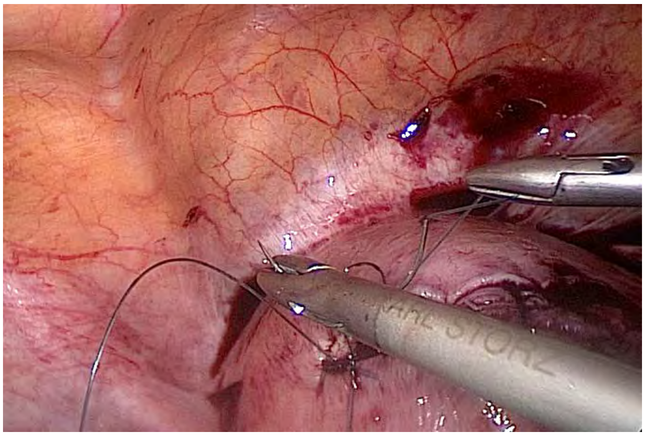


Fig. 12.5h Right hand grasps the suture and rotates it till the needle is loaded forehand.

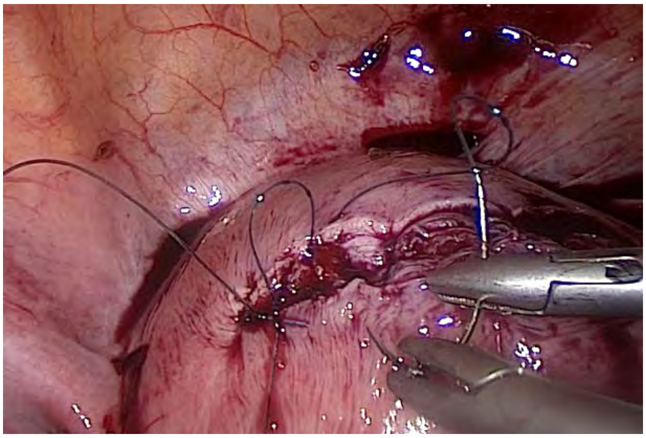


Fig. 12.5i Right hand grasps the needle for the next stitch, inside to out.

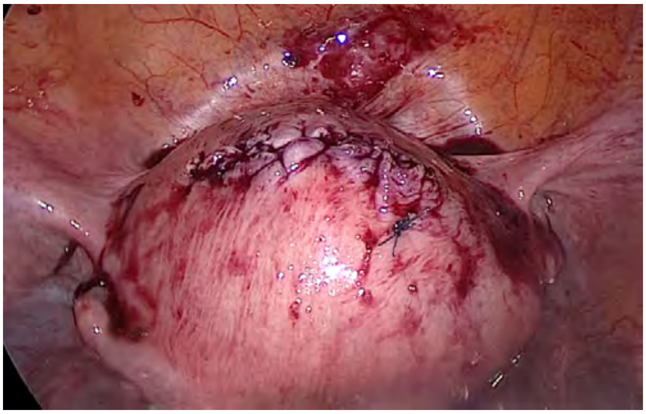


Fig. 12.5j Completed baseball closure.

13 Urologic Complications: Cystotomy and Ureteral Repair

13.1 Preliminary Considerations

13.1.1 Introduction

The incidence of urinary tract injury during laparoscopic hysterectomy ranges from 1 to 2%.

As laparoscopic techniques have been refined, the feasibility of repairing injuries to the bladder or ureters laparoscopically has increased. However, many such injuries are not recognized intra-operatively, increasing morbidity for the patient and liability for the surgeon. This chapter will describe techniques for preventing, identifying and repairing injuries to the urinary tract during gynecologic laparoscopic surgery.

13.1.2 Prevention

A thorough knowledge of pelvic anatomy including the course of the ureter through the pelvis and its relationship to reproductive structures is paramount in avoiding injuries. With regard to the ureter, injury during total laparoscopic hysterectomy (TLH) is most likely to occur distally, as it courses beneath the uterine artery and within the cardinal ligament prior to entering the bladder. Other areas at particular risk for injury are at the pelvic brim proximal to the infundibulopelvic ligament as well as lateral to the uterosacral ligament at the pelvic sidewall.

The likelihood of injury to the bladder may increase when dense adhesions are present at the bladder peritoneal reflection on the lower uterine segment in patients with prior cesarean sections, as well as with use of improper surgical technique including blunt dissection of the bladder flap. The most common part of the bladder involved in injuries during laparoscopic surgery is the dome.

A recent expert consensus by *Janssen et al.* (2011)[2] asked experts in gynecologic laparoscopy to weigh in on techniques that can prevent bladder and ureteral injury. Consensus existed for the following recommendations: a uterine manipulator should be used to stretch the uterine vascular pedicle away from the ureter, the uterine vascular pedicle should be well-dissected and skeletonized prior to sealing/transection, coagulation of the uterine vessels should occur perpendicular to their course and close to the uterus, in the event of adhesions, normal anatomy must be restored and paravesical spaces developed first, and ureterolysis should be performed at the infundibulopelvic ligament and uterine vascular pedicle only if anatomy is distorted.

The routine use of ureteral stenting to prevent injuries during TLH is not recommended. In fact, some have described an increased difficulty in dissection and increased risk of injury with stents. Avoidance of the use of energy devices in the vicinity of the ureter, careful blunt dissection to separate pelvic peritoneum and ureter medially from lateral neurovascular structures when ureterolysis is required and usage of linear releasing incisions in peritoneum lateral to the ureter in cases of scarring or entrapment may also prove useful in preventing ureteral injury (*Shirk et al., 2006*).[5]

For difficult bladder dissections, sharp dissection with traction and counter-traction should be employed rather than blunt dissection. Retrograde filling of the bladder through a three-way Foley catheter may be utilized to delineate surgical planes.

13.1.3 Recognition

Most urinary tract injuries incurred during laparoscopic gynecologic surgery have little long-term morbidity to the patient if recognized and repaired intra-operatively. It is unrecognized injuries that can result in fistula, febrile morbidity, loss of renal function and additional surgery. Several modalities for detecting injuries exist and should be employed whenever there is concern.

Retrograde Bladder Filling
- used for detecting cystotomy;
- fill bladder through Foley catheter using 250–300 cc normal saline;
- saline may be mixed with indigo carmine to enable laparoscopic visualization of small injuries.

Cystoscopy
- routinely performed at many institutions after TLH;
- IV indigo carmine allows ease of visualization of ureteral jets;
- if jets not visualized, stent may be passed to check for obstruction.

IV indigo carmine
- can be performed with simultaneous, laparoscopic inspection of segments of the ureters to check for spill into peritoneal cavity

13.2 Bladder Injury and Repair

After careful identification of a cystotomy (Fig. 13.2a), repair may be performed laparoscopically using either a single- or double-layer closure. Our practice is typically a double-layer closure. Suturing can be accomplished using a variety of port configurations. A suprapubic port may be convenient depending on the specific location of the cystotomy.

Fig. 13.2a Cystotomy at bladder dome identified.

The corner of the cystotomy is identified and repair is begun using an absorbable suture such as 2-0 or 3-0 polyglycolic acid on a small-caliber needle (Figs. 13.2b, c). Intracorporeal knot tying is used to prevent excessive tension on the repair (Fig. 13.2d). Since closure is more directed toward re-approximation rather than hemostasis, suturing is performed in a running, unlocked fashion to prevent tissue strangulation and necrosis (Figs. 13.2e, f).

The bladder is then retrograde filled to ensure the repair is water-tight. A Foley catheter is typically left in place for 7–10 days.

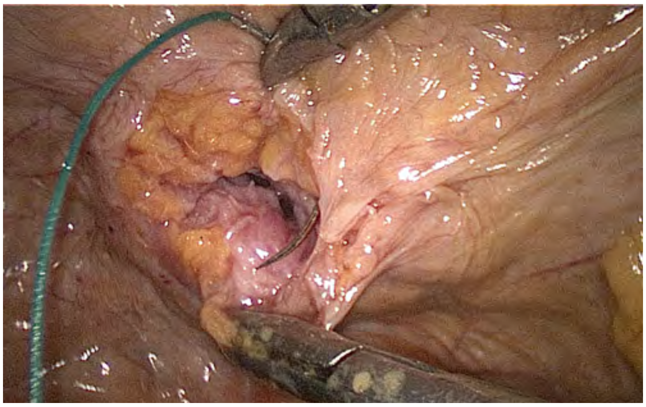


Fig. 13.2b Repair is begun using 3-0 absorbable suture. The stitch is placed through serosa and muscularis layers.

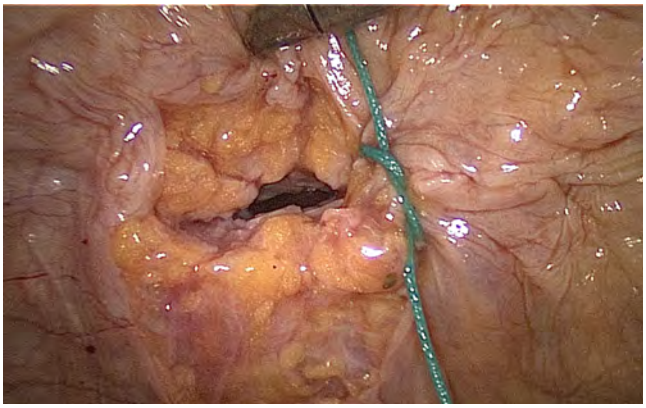
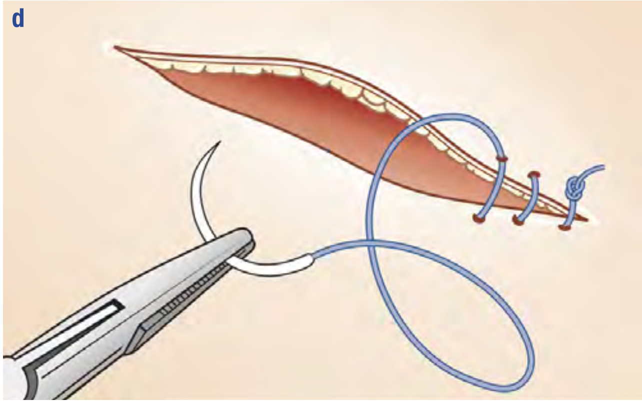


Fig. 13.2c Suture is anchored using intra-corporeal knot tying to avoid undue tension on the bladder wall.



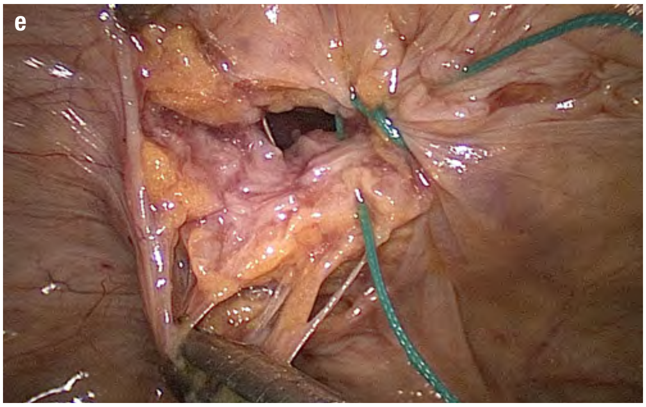


Fig. 13.2d,e Defect is closed in a continuous running fashion. A second layer may be placed if desired.

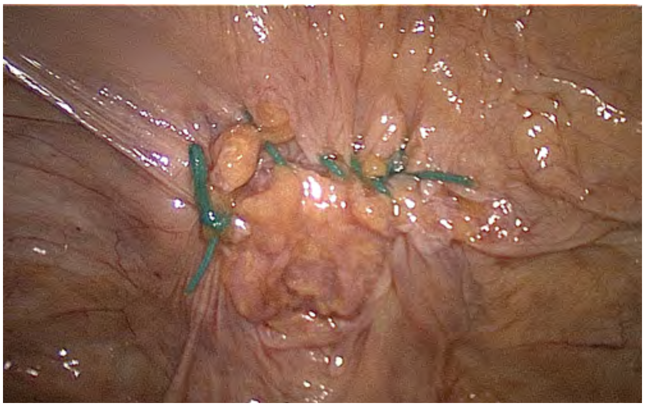


Fig. 13.2f Completed cystotomy closure.

13.3 Ureteral Injury and Repair

Minor or crush injuries to the ureter without thermal damage or transection can be managed by placing a stent for 4–6 weeks.

Injury to the upper and middle thirds of the ureter is typically repaired with ureteroureterostomy. Most surgeons place a ureteral stent first and perform the repair over it (Fig. 13.3a). In the event of thermal injury, the damaged portion of the ureter should be excised. Each end of the transected ureter can either be spatulated or trimmed at a 45 degree angle to increase surface area and theoretically decrease the likelihood of stricture.

General practice is to re-approximate the ends of the cut ureter using a small needle and absorbable suture (Fig. 13.3b) and intra-corporeal knot tying is used to secure each one (Figs. 13.3c, d), taking care to avoid excessive tension on the ureter. Four to six full-thickness interrupted sutures are placed circumferentially (Figs. 13.3e, f).

After repair (Fig. 13.3g), IV indigo carmine may be given to ensure no leak persists (Fig. 13.3h). A double-J stent is typically left in place for the next 4–6 weeks and a Foley catheter remains for 7–10 days. Some advocate placement of a retroperitoneal Jackson-Pratt (JP) drain to remain during the immediate postoperative period for monitoring for leak.

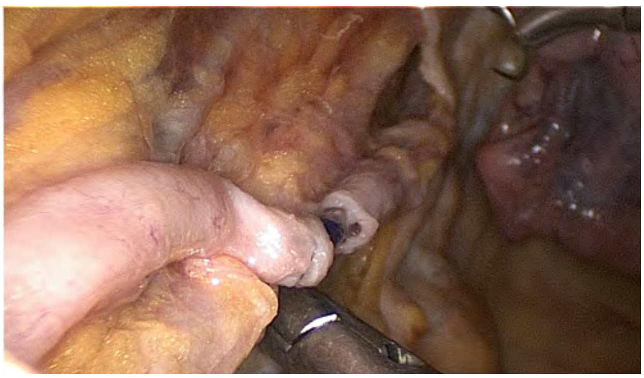


Fig. 13.3a A partial transection of the right ureter just below the level of the pelvic brim is noted and a ureteral stent is placed to facilitate re-approximation.

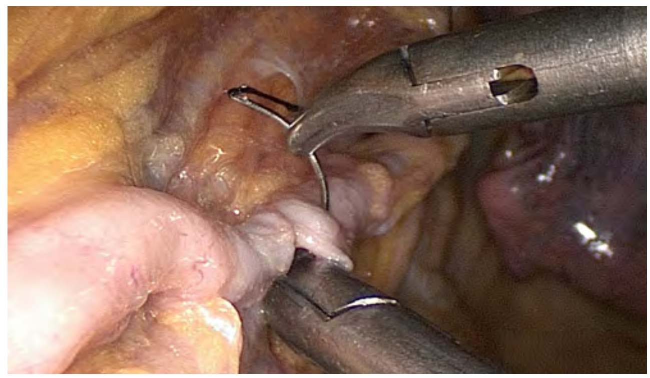


Fig. 13.3b Interrupted sutures are placed through the entire ureteral wall.

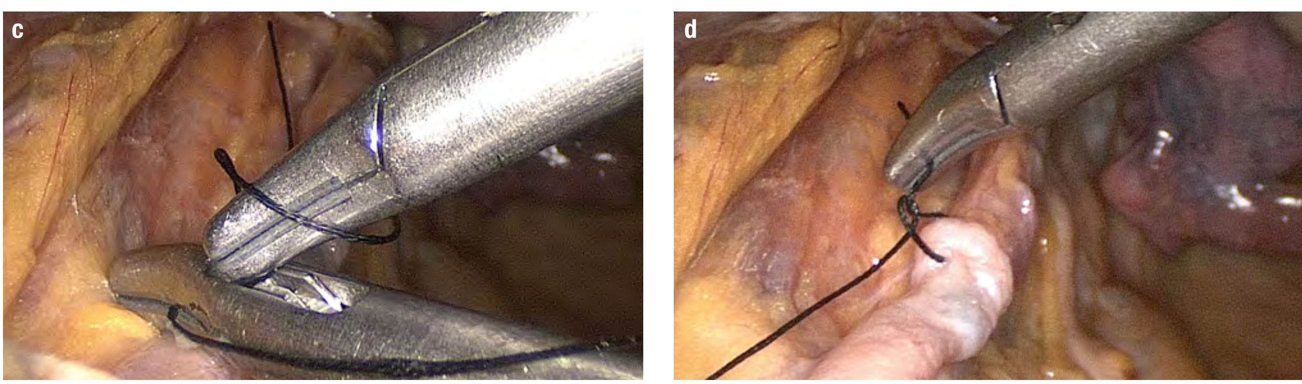


Fig. 13.3c,d Intra-corporeal knot tying is performed.

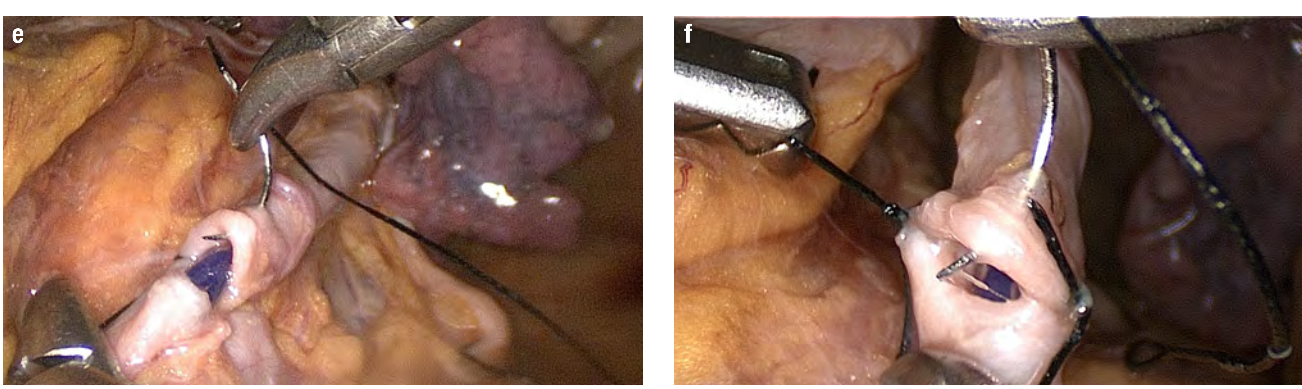


Fig. 13.3e,f A second and then third interrupted suture is placed, incorporating full-thickness bites on both edges of the defect.

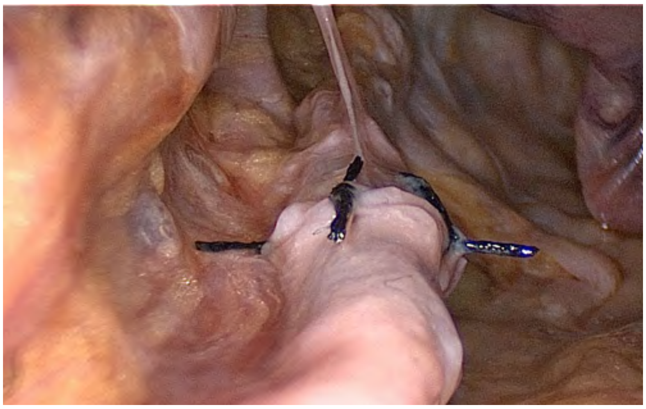


Fig. 13.3g Repair completed.

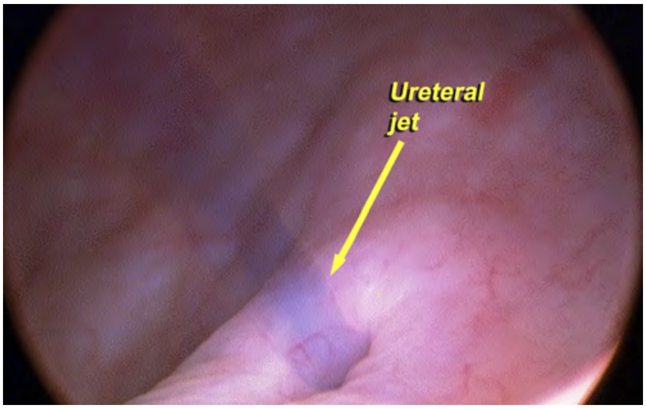


Fig. 13.3h Cystourethroscopic view of a ureteral jet confirming unimpeded flow from the ureteral orifices.

Injury to the lower third of the ureter proximal to its entry into the bladder can be repaired via ureteroneocystotomy with or without a psoas hitch.

The bladder is mobilized by dissecting the space of Retzius, then the bladder is deviated toward the psoas muscle on the side of the ureteral injury. The bladder is sutured to the psoas muscle with interrupted, delayed absorbable sutures-2-0 or 1-0. Another option is to create a bladder flap and suture it into a tubular structure into which the ureter is implanted.

An omental flap may be created to cover the injury site and increase vascular supply as the repair heals.

13.4 Postoperative Care, Surveillance and Follow-up

For small cystotomies, after removal of the Foley catheter and assurance that patient is voiding normally, no additional radiographic studies are needed.

For larger injuries to the bladder as well as ureteral transections, it is typical practice to obtain an intravenous pyelogram to ensure there is neither stricture, hydronephrosis, nor leak. Recommendations about when to perform this study vary from 2–6 weeks post-operatively. Some surgeons may repeat this study again several months later.

13.5 Long-term Outcomes

With prompt recognition and repair of urinary tract injuries resulting from laparoscopic gynecologic surgery, the majority of patients will have a full recovery without long-term sequelae.

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14 Bowel Suturing

14.1 Introduction

Bowel injuries during gynecologic laparoscopic surgery can occur during trocar placement, adhesiolysis, resection of endometriotic implants or by applying energy close to the bowel. If the injury is recognized intraoperatively, it can often be fixed laparoscopically.

14.2 Stomach Injury and Repair

Injuries to the stomach can occur during left upper quadrant trocar placement (Fig. 14.2a). To prevent such complications, it is important to ensure the patient has an orogastric or nasogastric tube placed to gentle suction prior to trocar placement at Palmer's point.

Consensus among many general surgeons is that in the event of a single, 5-mm trocar injury to the stomach, repair is typically unnecessary, but some still repair these small injuries in a single layer using 2–0 or 3–0 Vicryl suture. However, if the injury involves a 10/12 mm trocar, this larger defect should be repaired in all circumstances. Typically, a 2–0 or 3–0 Vicryl suture may be used to place a single figure-of-eight suture over the injury (Fig. 14.2b). Imbricating sutures are then placed over the initial closure (Figs. 14.2c–f).

Following repair, a nasogastric tube tube is left in place for 24–48 hours postoperatively.

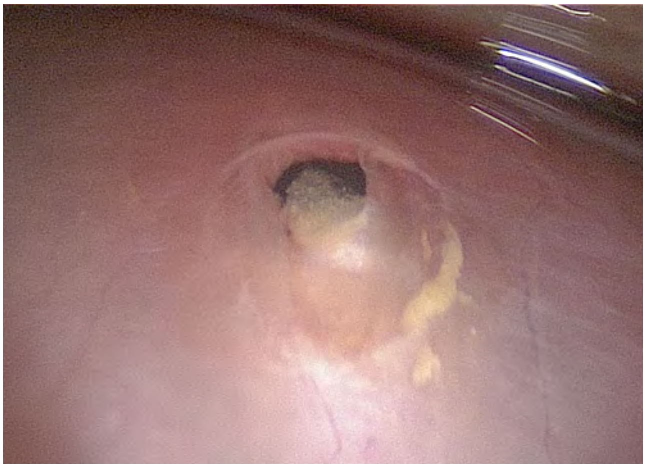

Fig. 14.2a Stomach injury.

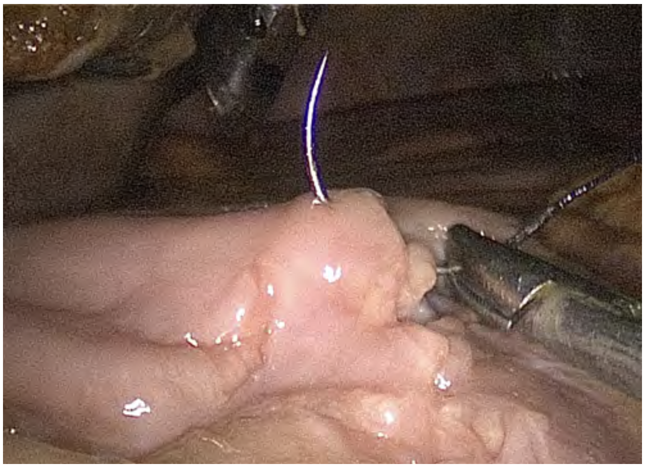

Fig. 14.2b Full-thickness purchase with SH needle, 2–0 or 3–0 Vicryl, figure-of-eight suture.

Fig. 14.2c Imbricating sutures.

Fig. 14.2d Final result after laparoscopic repair of trocar injury to stomach.

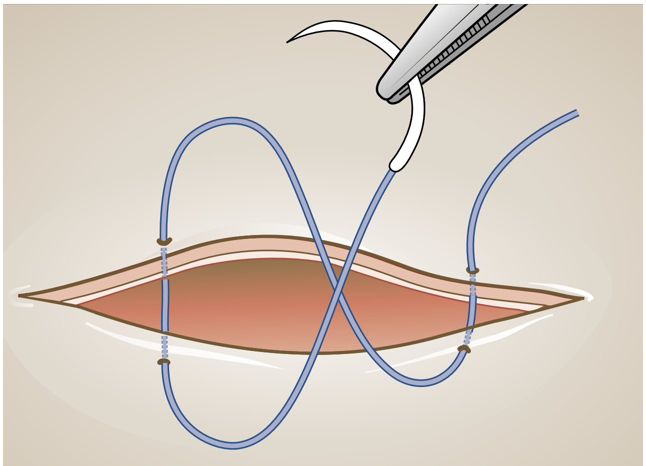

Fig. 14.2e Figure-of-eight-stitch through stomach wall.

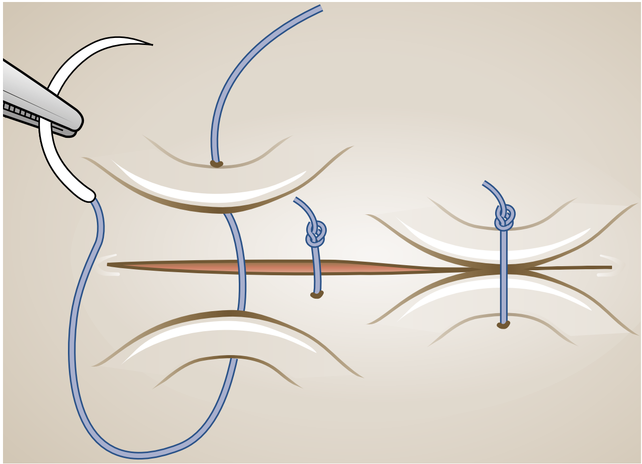

Fig. 14.2f Imbricating stitches as second layer.

14.3 Small Bowel Injury and Repair

Small bowel injuries most commonly occur when adhesions are present and with initial trocar placement especially in patients with previous abdominal surgery. Identification of the injury is important in preventing post-operative morbidity.

14.3.1 Serosal Injury

Superficial injuries to the small bowel which do not involve the mucosa can be re-approximated using interrupted sutures of 2–0 or 3–0 Vicryl (Fig. 14.3c). Imbricating sutures are then placed through the serosa and muscularis layers covering the injury (Fig. 14.3a,d). An SH needle is preferred and intracorporeal knot tying is used to decrease tension on the site (Fig. 14.3b,d).

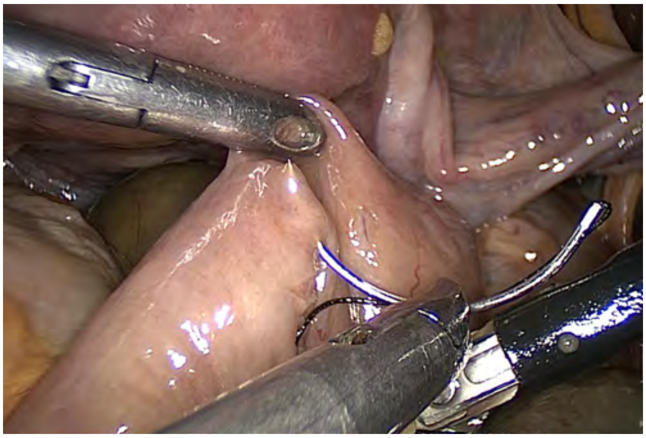

Fig. 14.3a Imbricating suture on small bowel.

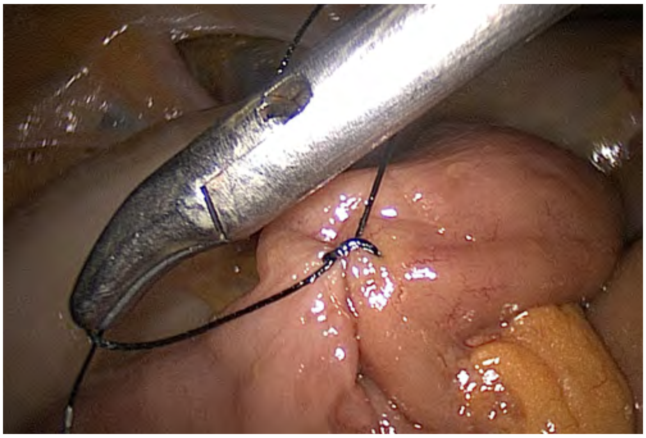

Fig. 14.3b Imbricating suture on small bowel with intracorporeal knot.

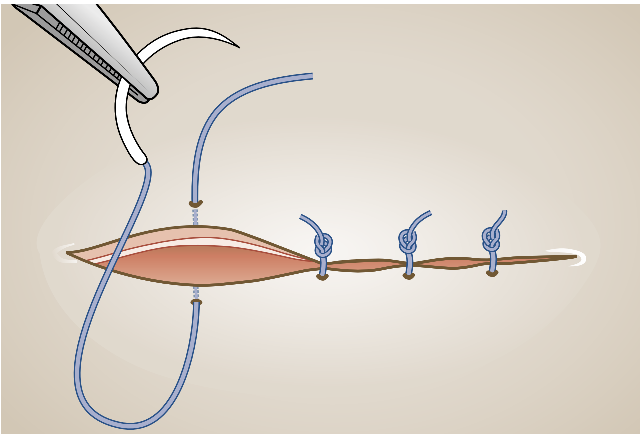

Fig. 14.3c Interrupted stitches through bowel muscularis and serosa

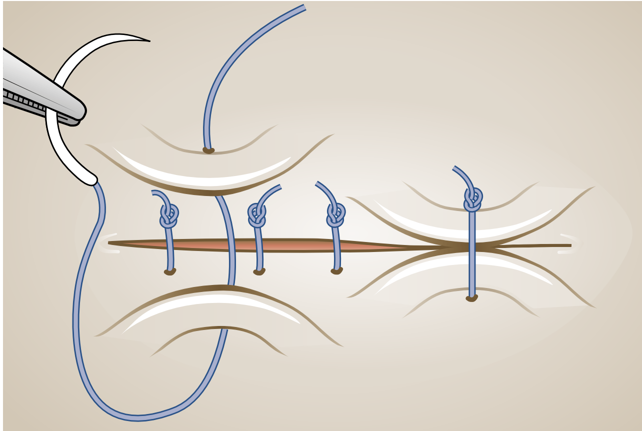

Fig. 14.3d Imbricating stitch through bowel muscularis and serosa.

14.3.2 Transmural Injury

Simple lacerations to the small bowel that do not involve the mesentery can be closed transversely, using laparoscopic suturing techniques. Transverse closure is optimal as it avoids narrowing of the bowel lumen as the defect heals.

To begin, the edges of the defect may be trimmed, if irregular. A simple, interrupted suture of 2–0 or 3–0 silk is placed at each corner of the defect and used to elongate the laceration transversely (Fig. 14.3e). Next, simple, interrupted sutures are placed approximately 2–3 mm apart to close the remainder of the injury. A finer needle, such as an SH, is used given the delicacy of the tissue. Each suture should incorporate 4–5 mm of serosa and the edge of mucosa on each side of the laceration (Fig. 14.3f,h). Intracorporeal knot tying is used to avoid placing excessive tension on the tissue.

Depending on surgeon preference and the visual integrity of the repair, an addition layer of interrupted imbricating silk sutures can be placed through the serosa and muscularis on each side of the repaired laceration to reinforce the closure (Fig. 14.3 g,i).

The site is then copiously irrigated with sterile saline and inspected for hemostasis and adequate repair.

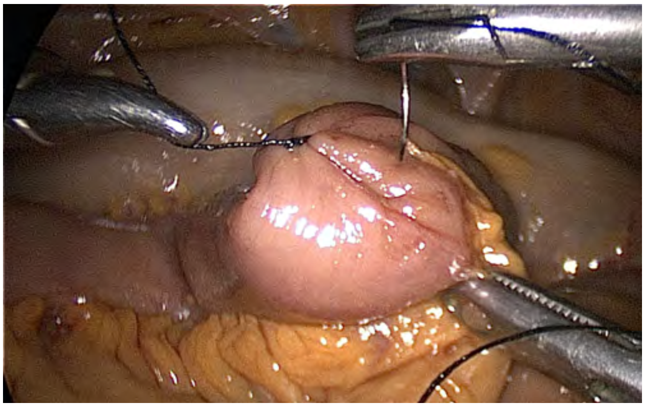

Fig. 14.3e Simple interrupted suture incorporating 4–5 mm of serosa.

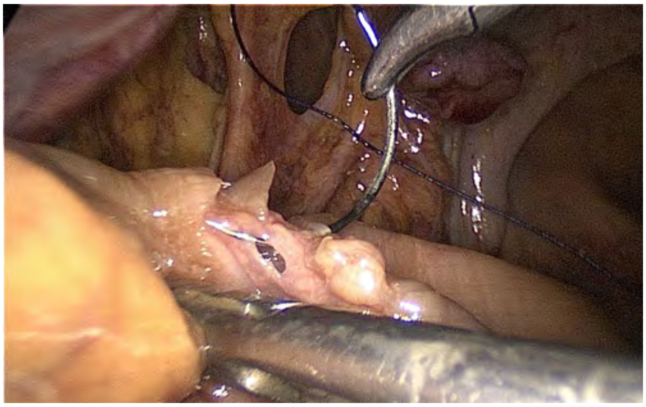

Fig. 14.3f Interrupted suture incorporating 4–5 mm of serosa and the edge of the mucosa.

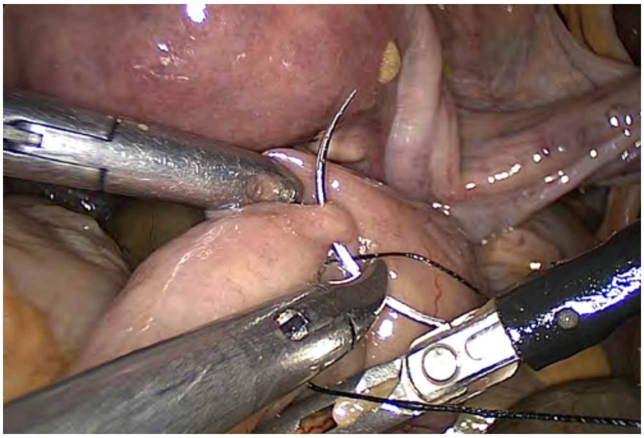

Fig. 14.3g Imbricating layer using 2–0 or 3–0 silk on an SH needle involving only serosa and muscularis.

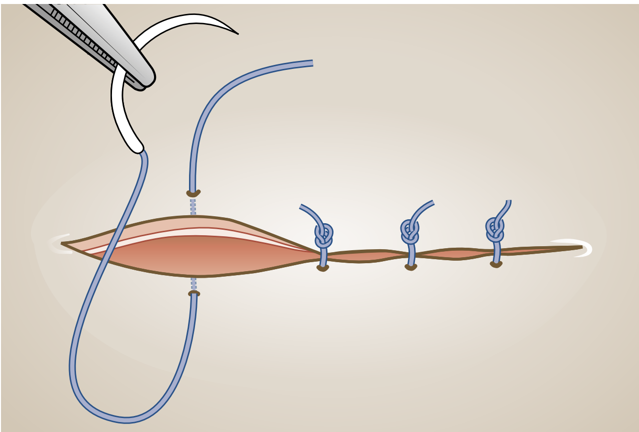

Fig. 14.3h Interrupted stitches using 2–0 or 3–0 vicryl or silk.

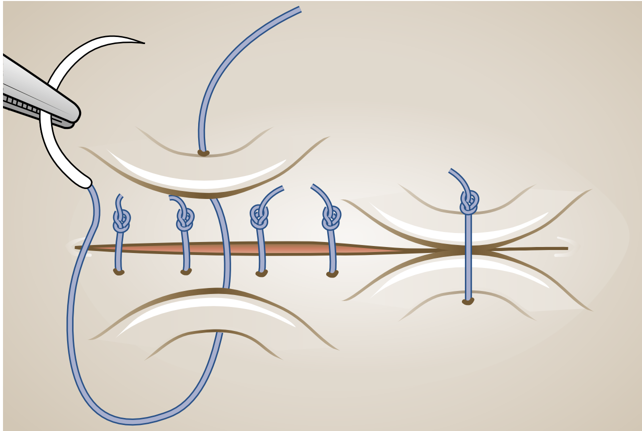

Fig. 14.3i Imbricating stitch using 2–0 or 3–0 silk on an SH needle involving only serosa and muscularis.

14.3.3 Thermal Injury

Thermal injuries to the small bowel may involve a more extensive repair. Superficial injuries not involving the full thickness of the bowel wall can be oversewn with interrupted sutures of 2–0 or 3–0 Vicryl on an SH needle. Again, these sutures should be placed in a transverse orientation to avoid constriction of the bowel lumen (Fig. 14.3j).

In a single, full-thickness thermal injury, the edges of the affected tissue should be excised sharply to expose healthy, vascularized tissue. Repair then occurs in a similar fashion as outlined in section *14.4.3 Transmural Injuries*.

Multiple thermal injuries or devascularization of a portion of the small bowel may require resection with re-anastomosis. For these more complicated injuries, intraoperative consultation with a general or colorectal surgeon is highly recommended.

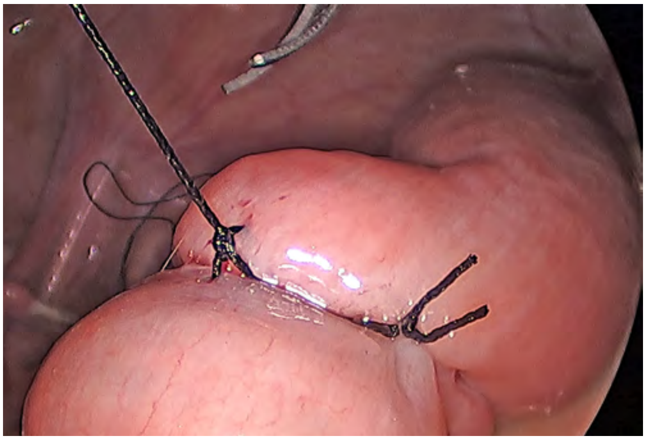

Fig. 14.3j Imbricating suture after thermal injury.

14.4 Large Bowel and Colon

The portion of the large bowel most commonly encountered in benign gynecologic surgery is the rectosigmoid. Injury can occur during adhesiolysis, deep pelvic dissections or resection of extensive endometriosis.

When an injury is recognized, it is important to assess the extent of the injury, whether or not it is isolated and whether there is peritoneal fecal contamination. If fecal contamination is minimal and the laceration does not compromise blood supply, repair is managed by primary closure.

14.4.1 Serosal Injury

Simple, superficial lacerations of the large bowel without involvement of the bowel mucosa can be closed transversely to minimize the potential risk of stricture of the bowel lumen. The choice of suture is a 3–0 or 2–0 absorbable suture material such as Vicryl or Monocryl. Simple stitches are placed through bowel serosa and muscularis in a transverse direction till the defect is closed (Fig. 14.4a–d).

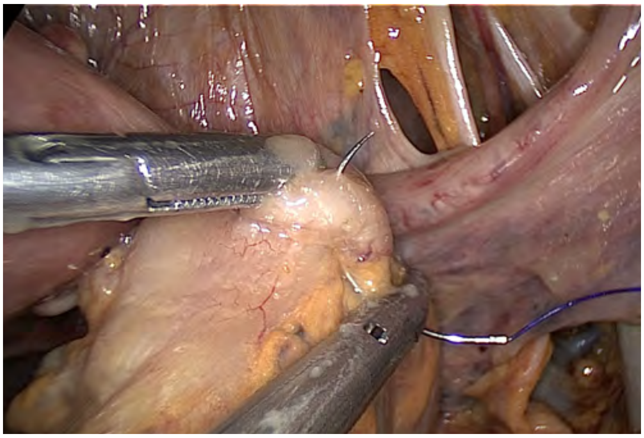

Fig. 14.4a Repair of simple superficial injury not involving the mucosa.

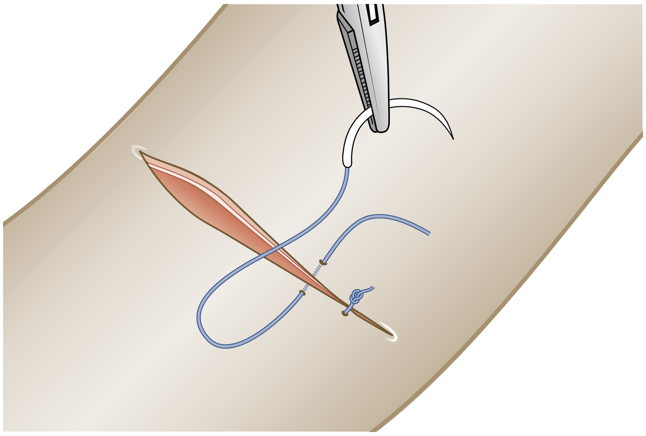

Fig. 14.4b Simple interrupted suture incorporating 4–5 mm of serosa and the edge of the mucosa on each side using 2–0 or 3–0 vicryl or silk.

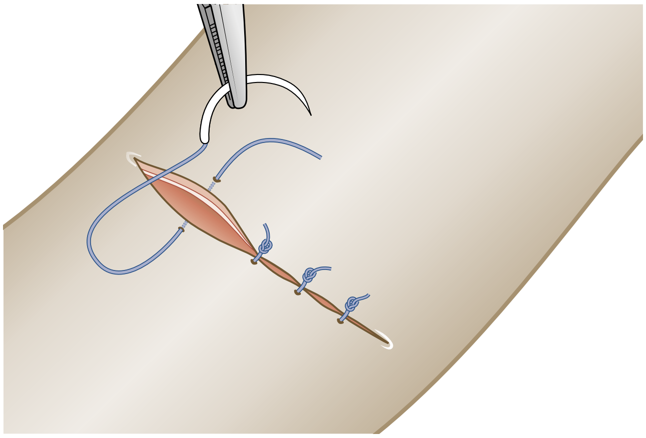

Fig. 14.4c Interrupted stitch through bowel wall using 2–0 or 3–0 vicryl or silk.

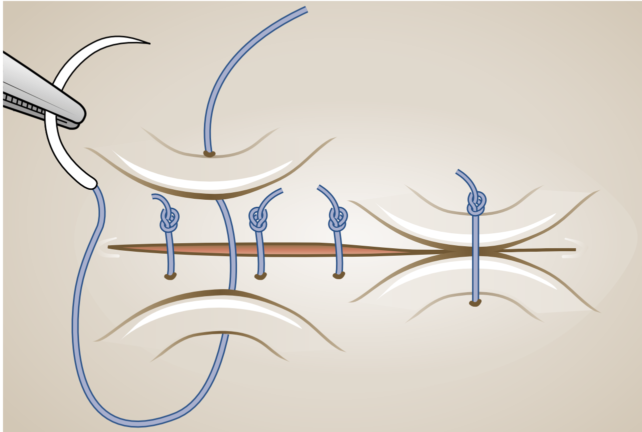

Fig. 14.4d Imbricating stitch through large bowel muscularis and serosa using 2–0 or 3–0 silk.

14.4.2 Transmural Injury

If there is a full-thickness injury to the large bowel, a 3–0 silk suture on an SH needle is used for a through-and-through closure (Fig. 14.4e). Simple interrupted sutures are placed till the entire defect is closed. This is followed by a second, imbricating layer of 3–0 silk suture, taking care to purchase only muscularis and serosa and also placed in an interrupted fashion (Fig. 14.4f). Again, intracorporeal knot tying is performed (Fig. 14.4 g).

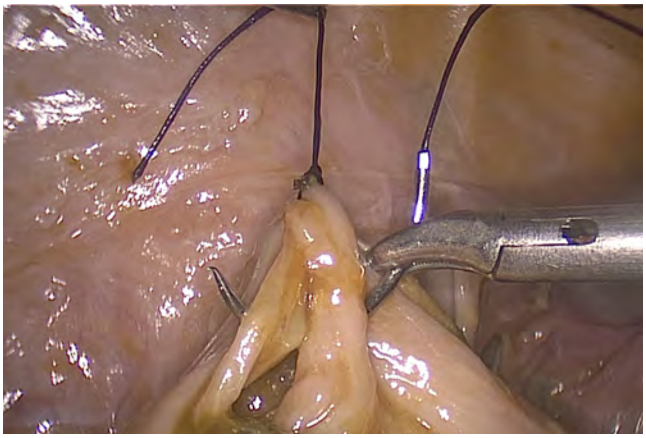

Fig. 14.4e Transverse closure of a transmural injury with 3–0 silk.

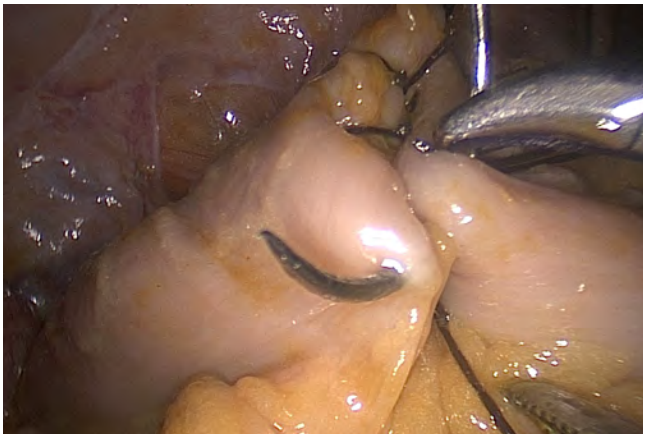

Fig. 14.4f Imbricating transmural suture with 3–0 silk.

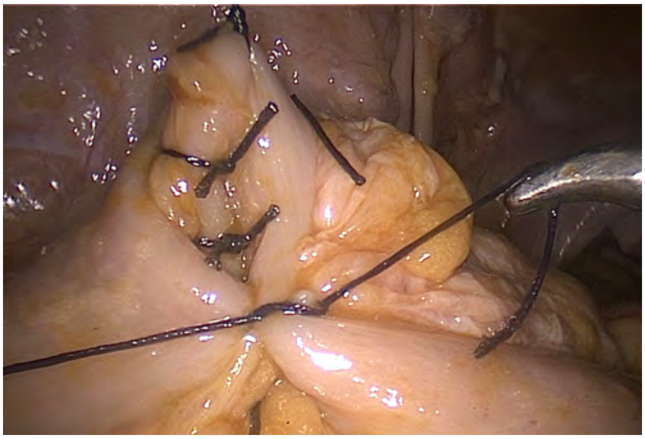

Fig. 14.4g Intracorporeal knot on the imbricating second-layer.

Some surgeons alternatively use a single layer, transmural closure using 2–0 silk on SH needle in an interrupted fashion. Initial sutures are placed at each angle of the laceration and are used for gentle traction. Remaining interrupted sutures can be then be placed to close the remainder of the injury (Fig. 14.4h).

The area is then copiously irrigated with saline solution. Integrity of the repair is verified by filling the pelvis with fluid, compressing the proximal sigmoid superior to the injury, then inserting air into the rectum with TUMI syringe versus a proctoscope. The pool of fluid in the pelvis is inspected for bubbles, which would indicate a persistent defect.

When there has not been previous bowel preparation, injuries to distal sigmoid colon and rectum are repaired as above and then diverted proximally with an end sigmoid colostomy. If viability is in question, the colon should be divided distal to the injury using GIA stapling device. The proximal aspect of this division is then brought out of the abdominal wall to serve as a colostomy.

When the gynecologic surgeon encounters any type of bowel injury, requesting an intraoperative consultation from General Surgery / Colorectal Surgery is appropriate. Though simple serosal injuries can be managed easily and safely without formal consultation, complicated or extensive injuries may require bowel resection and/or colostomy. Depending on one's expertise with managing bowel injuries, obtaining a prompt opinion from a specialist when faced with an unexpected complication is always prudent.

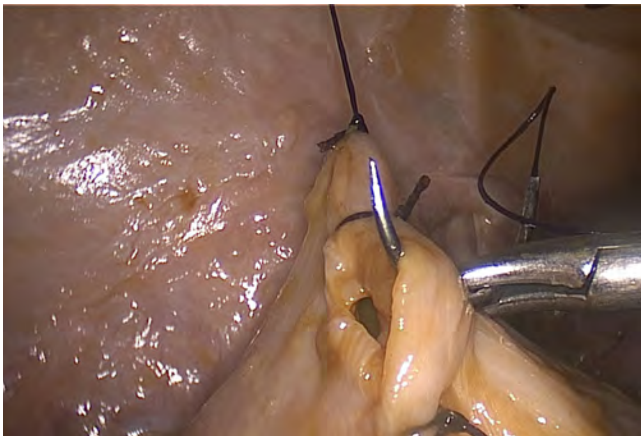

Fig. 14.4h Single-layer, transmural closure using 2–0 silk.

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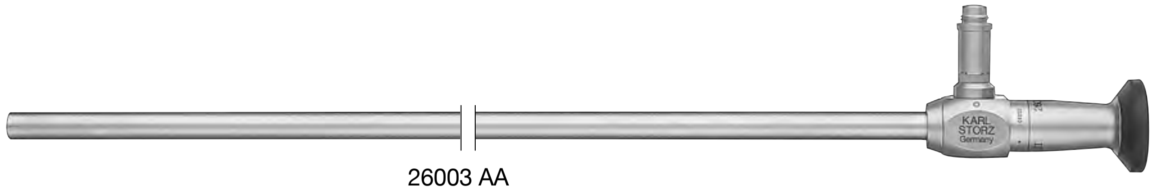
Diameter 10 mm, length 31 cm and 32 cm
Trocar size 11 mm



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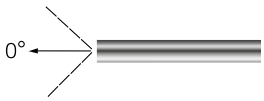
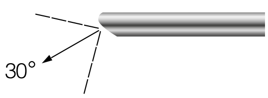
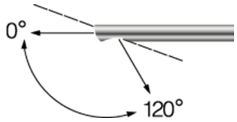


26003 AA **HOPKINS® Straight Forward Telescope 0°,**
enlarged view, diameter 10 mm, length 31 cm,
autoclavable,
fiber optic light transmission incorporated,
color code: green



26003 BA **HOPKINS® Forward-Oblique Telescope 30°,**
enlarged view, diameter 10 mm, length 31 cm,
autoclavable,
fiber optic light transmission incorporated,
color code: red

26003 AE



26003 AE **ENDOCAMELEON® HOPKINS® Telescope,**
diameter 10 mm, length 32 cm,
autoclavable,
variable direction of view from 0° – 120°,
adjustment knob for selecting the desired direction of view,
fiber optic light transmission incorporated,
color code: gold

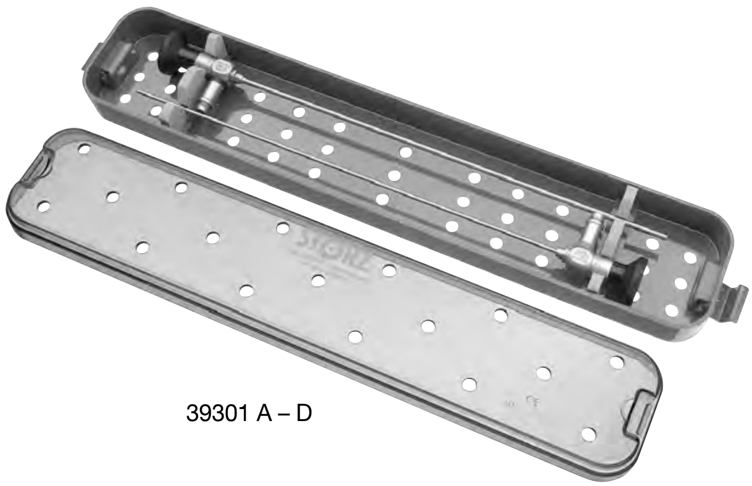
VERESS **Pneumoperitoneum Needle**

26120 JL

26120 JL VERESS **Pneumoperitoneum Needle,**
with spring-loaded blunt inner cannula, LUER-Lock,
autoclavable, diameter 2.1 mm, length 13 cm

It is recommended to check the suitability of the product for the intended procedure prior to use.

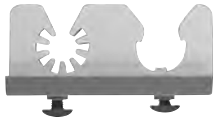
Plastic Container for Sterilizing and Storage of Two Telescopes



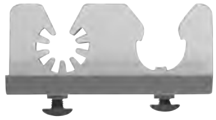
39301 A – D

39301 C **Plastic Container for Sterilization and Storage of two Telescopes,**
perforated, with transparent lid,
with silicone telescope holder,
external dimensions (w x d x h): 520 x 90 x 45 mm,
for 10 mm Laparoscopy Telescopes and similar,
including:
Bottom Part
Lid
Silicone Telescope Holder

Silicone Telescope Holder



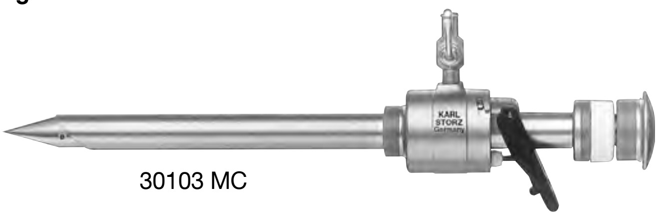
39301 CH



39301 CH **Silicone Telescope Holder,** for two telescopes,
up to size 10 mm,
i. e. for use with plastic containers 39301 B to D

Trocars and Accessories

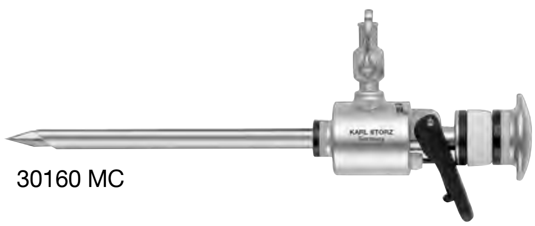
Size 6 mm and 11 mm, working length 10.5 cm



30103 MC

30103 MC **Trocar,** with conical tip, with insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green,

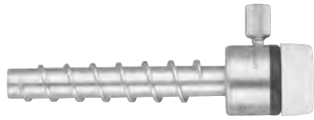
including:
Cannula, without valve
Trocar only
Multifunctional Valve



30160 MC

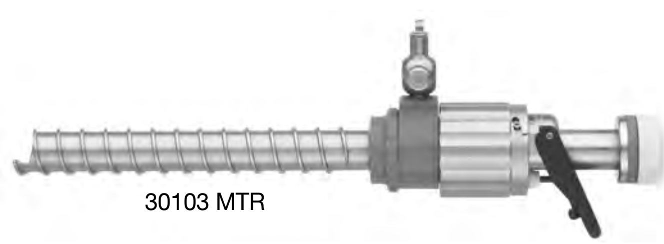
30160 MC **Trocar,** with conical tip, insufflation stopcock, size 6 mm, working length 10.5 cm, color code: black,

including:
Cannula, without valve
Trocar only
Multifunctional Valve



30160 MC

30160 S **Thread Sleeve,** for trocar size 6 mm, color code: black



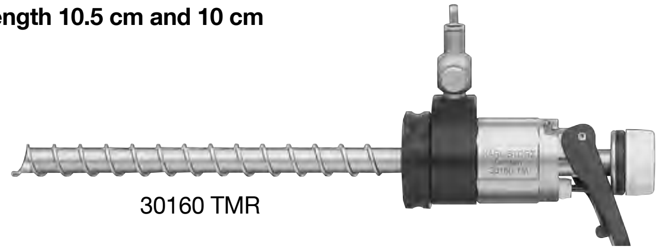
30103 MTR

30103 MTR **TERNAMIAN EndoTIP® Cannula,** with thread and rotatable insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green

including:
Cannula
Multifunctional Valve
Telescope Stopper, sterile, package of 12

Trocars

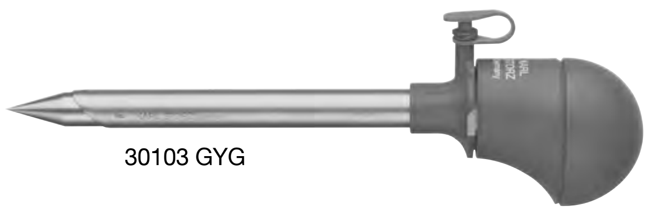
Size 6 mm and 11 mm, working length 10.5 cm and 10 cm



30160 TMR

30160 TMR **TERNAMIAN EndoTIP® Cannula,**
with thread and rotatable insufflation stopcock,
size 6 mm, working length 10.5 cm,
color code: black

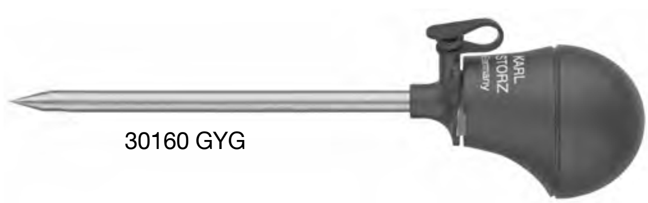
including:
Cannula
Multifunctional Valve
Telescope Stopper, sterile, package of 12



30103 GYG

30103 GYG **Trocar,** with conical tip,
with LUER-Lock connector for insufflation,
size 11 mm length 10 cm,
color code: green

including:
Cannula
Trocar only
Valve Seal

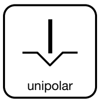


30160 GYG

30160 GYG **Trocar,** with conical tip,
with LUER-Lock connector for insufflation,
size 6 mm, length 10 cm,
color code: black

including:
Cannula
Trocar only
Valve Seal

CLICKLINE Grasping Forceps



33351 ME

33351 ME **CLICKLINE** MANHES **Grasping Forceps,**
rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
with LUER-Lock irrigation
connector for cleaning,
single action jaws, multiple teeth,
width of jaws 4.8 mm,
for atraumatic and accurate grasping,
size 5 mm, length 36 cm,
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Forceps Insert

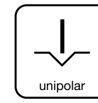
33351 MG **CLICKLINE** MANHES **Grasping Forceps,**
"tiger jaws", rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
with LUER-Lock irrigation connector for cleaning,
single action jaws, 2 x 4 teeth,
size 5 mm, length 36 cm,
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Forceps Insert

33351 MA **CLICKLINE** MANHES **Grasping Forceps, "cobra jaws",**
rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
with LUER-Lock irrigation connector for cleaning,
single action jaws, 1 x 2 teeth,
size 5 mm, length 36 cm,
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Forceps Insert

33361 ON

33361 ON **CLICKLINE Grasping Forceps,**
rotating, dismantling,
without connector pin for unipolar coagulation,
with LUER-Lock irrigation connector for cleaning,
single action jaws,
with especially fine atraumatic serration, fenestrated,
size 5 mm, length 36 cm,
including:
Metal Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Forceps Insert

CLICKLINE Grasping Forceps and Scissors



34351 MS

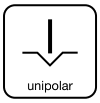
33351 ML **CLICKLINE** KELLY **Dissecting and Grasping Forceps,**
rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
LUER-Lock connector for cleaning,
double action jaws, long,
size 5 mm, length 36 cm,
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Forceps Insert

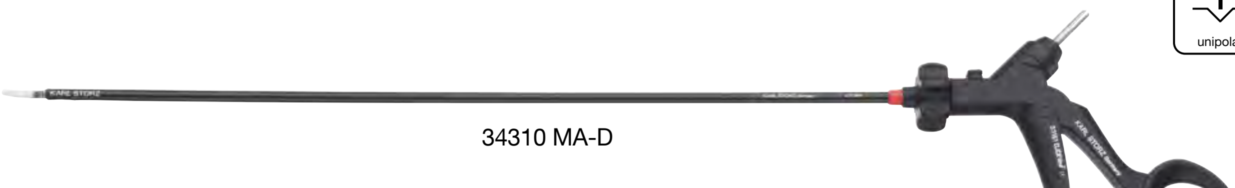
34351 MS **CLICKLINE** METZENBAUM **Scissors,**
rotating, dismantling, with connector pin for unipolar coagulation,
with LUER-Lock irrigation connector for cleaning,
double action jaws, curved, length of jaws 15 mm,
size 5 mm, length 36 cm
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Scissors Insert

34351 MD **CLICKLINE Scissors,**
rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
with LUER-Lock irrigation connector for cleaning,
double action jaws, straight,
size 5 mm, length 36 cm
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Scissors Insert

34351 EH **CLICKLINE Hook Scissors,**
rotating, dismantling, insulated,
with connector pin for unipolar coagulation,
with LUER-Lock connector for cleaning,
single action jaws,
size 5 mm, length 36 cm
including:
Plastic Handle, without ratchet, with larger contact area
Metal Outer Sheath, insulated
Scissors Insert

CLICKLINE Single use Scissors



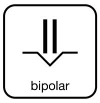



34310 MA-D

34310 MA-D **CLICKLINE Scissors Insert,**
with Outer Sheath, curved,
double action jaws, spoon-shaped jaws,
length of blades 17 mm,
size 5 mm, length 36 cm,
sterile, for single use, package of 10

34310 MS-D **CLICKLINE** METZENBAUM **Scissors,**
curved, length of blades 12 mm,
double action jaws, size 5 mm, length 36 cm,
sterile, for single use, package of 10

RoBi® Grasping Forceps



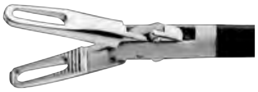

38651 MD

38651 MD **RoBi®** KELLY **Grasping Forceps,**
CLERMONT-FERRAND model, rotating,
dismantling, with connector pin for bipolar
coagulation, especially suitable for dissection,
double action jaws,
size 5 mm, length 36 cm,
color code: light blue

including:
RoBi® Plastic Handle, without ratchet
RoBi® Metal Outer Sheath
RoBi® Forceps Insert

38651 ML **RoBi®** KELLY **Grasping Forceps,**
CLERMONT-FERRAND model, rotating, dismantling,
with connector pin for bipolar coagulation, double action jaws,
especially suitable for dissection, size 5 mm, length 36 cm,
color code: light blue

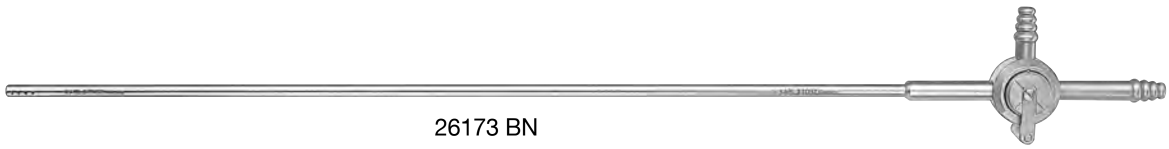
including:
RoBi® Plastic Handle, without ratchet
RoBi® Metal Outer Sheath
RoBi® Forceps Insert



38651 ON **RoBi® Grasping Forceps,**
CLERMONT-FERRAND model, rotating, dismantling,
with connector pin for bipolar coagulation,
with especially fine atraumatic serration, fenestrated jaws,
double action jaws, size 5 mm, length 36 cm,
color code: light blue

including:
RoBi® Plastic Handle, without ratchet
RoBi® Metal Outer Sheath
RoBi® Forceps Insert

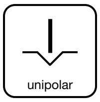
Suction and Irrigation Tube



26173 BN

26173 BN **Suction and Irrigation Tube,** with lateral holes, anti-reflex surface, with two-way stopcock for single hand control, size 5 mm, length 36 cm

MANHES **High Frequency Needle**



30675 ND

30675 ND MANHES **High Frequency Needle,** for splitting and coagulation, insulated, retractable, with connector pin for unipolar coagulation, length 31 cm

Coagulating and Dissecting Electrodes

26775 UF

26775 UF **Coagulating and Dissecting Electrode,** L-shaped, with connector pin for unipolar coagulation, size 5 mm, length 36 cm

26775 UE **Coagulating and Dissecting Electrode,** insulated sheath, with connector pin for unipolar coagulation, spatula-shaped, blunt, size 5 mm, length 36 cm

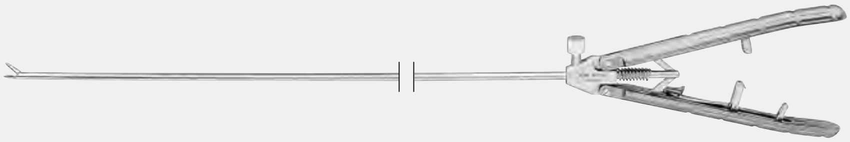
High Frequency Cords

26005 M **Unipolar High Frequency Cord,** with 5 mm plug, length 300 cm, for AUTOCON® II 400 SCB system (111, 115, 122, 125), AUTOCON® II 200, AUTOCON® II 80, KARL STORZ AUTOCON® system (50, 200, 350) and Erbe type ICC

26176 LE **Bipolar High Frequency Cord,** for AUTOCON® II 400 SCB system (111, 113, 115, 122, 125), AUTOCON® II 200, AUTOCON® II 80, KARL STORZ Coagulator 26021 B/C/D, 860021 B/C/D, 27810 B/C/D, 28810 B/C/D, AUTOCON® series (50, 200, 350), Erbe-Coagulator, T and ICC series, length 300 cm

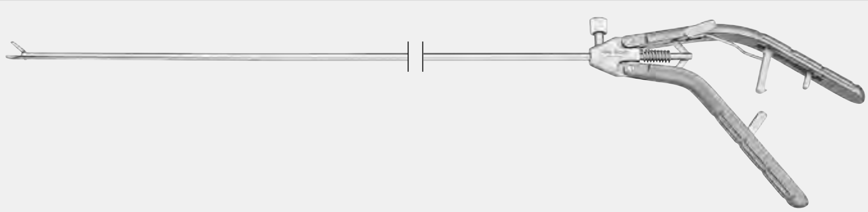
KOH **Macro Needle Holders**
KOH **Assistant Needle Holder**

Size 5 mm
Operating instruments, **lengths 33 and 43 cm**,
for use with trocars size 6 mm

Length	Instrument
33 cm	
43 cm	

Distal tip	Instrument	
	26173 KAF 26178 KAF	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position right, jaws straight
	26173 KAL 26178 KAL	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position right, jaws curved to left
	26173 KAR 26178 KAR	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position left, jaws curved to right

Size 5 mm
Operating instruments, **lengths 33 and 43 cm**, with pistol handle
for use with trocars size 6 mm

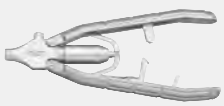
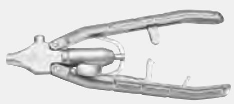
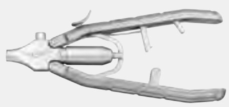
Length	Instrument
33 cm	
43 cm	

Distal tip	Instrument	
	26173 KPF 26178 KPF	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic pistol handle with disengageable ratchet, ratchet position left, jaws straight
	26173 KPL 26178 KPL	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic pistol handle with disengageable ratchet, ratchet position left, jaws curved to left
	26173 KPR 26178 KPR	KOH **Macro Needle Holder,** with tungsten carbide insert, ergonomic pistol handle with disengageable ratchet, ratchet position right, jaws curved to right
	NEW 26173 KG	KOH **Assistant Needle Holder,** ergonomic pistol handle with disengageable ratchet, ratchet position left, straight jaws with distal hole

KOH **Macro Needle Holder**

dismantling

Size 5 mm
Operating instruments, **lengths 33 and 43 cm**,
for use with trocars size 6 mm

Length	Handle		
	30173 AR	30173 AL	30173 AO
33 cm			
43 cm			

Single-action jaws

Working Insert	Complete Instrument		
30173 R	30173 RAR	30173 RAL	30173 RAO
30178 R	30178 RAR	30178 RAL	30178 RAO
	KOH **Macro Needle Holder,** jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0		

30173 L	30173 LAR	30173 LAL	30173 LAO
30178 L	30178 LAR	30178 LAL	30178 LAO
	KOH **Macro Needle Holder,** jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7		

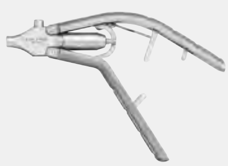
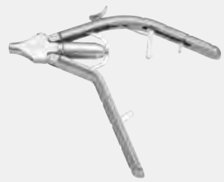
30173 F	30173 FAR	30173 FAL	30173 FAO
30178 F	30178 FAR	30178 FAL	30178 FAO
	KOH **Macro Needle Holder,** straight jaws, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0		

30173 G	30173 GAR	30173 GAL	30173 GAO
NEW 	KOH **Macro Assistant Needle Holder,** straight jaws		

KOH **Macro Needle Holder**

dismantling

Size 5 mm
Operating instruments, **lengths 33 and 43 cm**,
for use with trocars size 6 mm

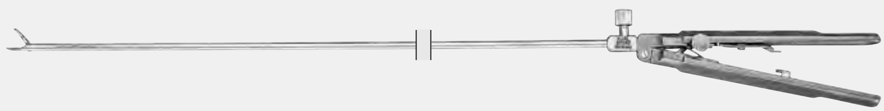
Length	**Handle**		
	30173 PR	30173 PL	30173 PO
33 cm			
43 cm			

Single-action jaws

Working Insert	**Complete Instrument**		
30173 R	30173 RPR	30173 RPL	30173 RPO
30178 R	30178 RPR	30178 RPL	30178 RPO
	KOH **Macro Needle Holder,** jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0		
30173 L	30173 LPR	30173 LPL	30173 LPO
30178 L	30178 LPR	30178 LPL	30178 LPO
	KOH **Macro Needle Holder,** jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0		
30173 F	30173 FPR	30173 FPL	30173 FPO
30178 F	30178 FPR	30178 FPL	30178 FPO
	KOH **Macro Needle Holder,** straight jaws, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0		
30173 G	30173 GPR	30173 GPL	30173 GPO
	KOH **Macro Assistant Needle Holder,** straight jaws		

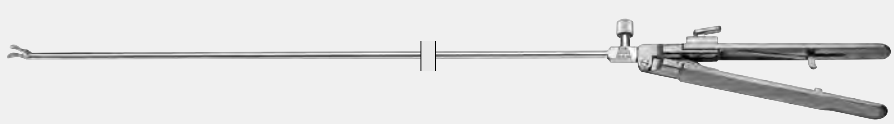
SZABO-BERCI **Needle Holders “PARROT-JAW®”**

Size 5 mm
Operating instruments, **lengths 33 and 43 cm**,
for use with trocars size 6 mm

Length	Instrument
33 cm	

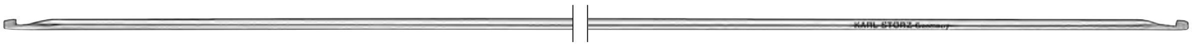
Distal tip	Instrument	
	26173 SC	SZABO-BERCI **Needle Holder “PARROT-JAW®”,** straight handle, with ratchet, for suture material 2/0 – 4/0, needle sizes SH (Ethicon), EN-S (Ski), V-20 (USSC)
	26173 SE	SZABO-BERCI **Needle Holder “PARROT-JAW®”,** jaws with tungsten carbide inserts, straight handle, with ratchet, for suture material 2/0 – 4/0, needle sizes SH (Ethicon), EN-S (Ski), V-20 (USSC)
	26173 CQ	SZABO-BERCI **Needle Holder “PARROT-JAW®”,** straight handle, with ratchet, for suture material 4/0 – 6/0, needle sizes RB (Ethicon), CV-23 (USSC
	26173 CE	SZABO-BERCI **Needle Holder “PARROT-JAW®”,** jaws with tungsten carbide inserts, straight handle, with ratchet, for suture material 4/0 – 6/0, needle sizes RB (Ethicon), CV-23 (USSC))

with diamond coated jaws

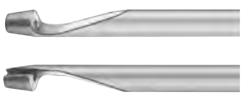
Length	Instrument
33 cm	

Distal tip	Instrument	
	26173 SP	SZABO-BERCI **Needle Holder “PARROT-JAW®”,** with diamond coated jaws, straight handle, with ratchet, for suture material 2/0 – 4/0, needle sizes SH (Ethicon), EN-S (Ski), V 20 (USSC)

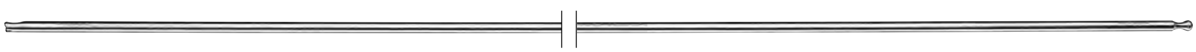
Knot Tier and Palpation Probe



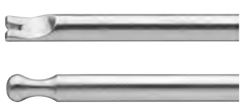
26596 D



26596 D **Knot Tier,** for extracorporeal knotting, with open and closed end, size 5 mm, length 36 cm



26596 SM



26596 SM **Knot Tier and Palpation Probe,** size 5 mm, length 50 cm

IMAGE1 SPIES™ Camera System *NEW*

:spies®

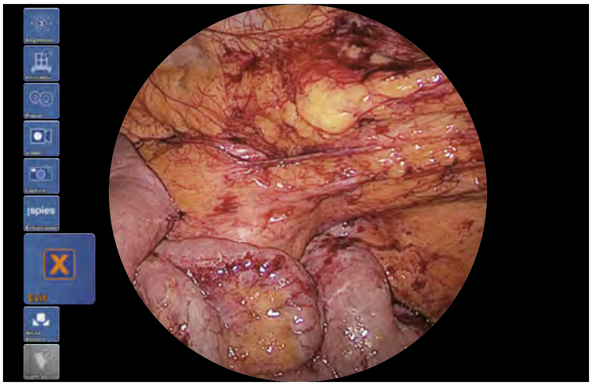
Economical and future-proof

- **Modular concept for flexible, rigid and 3D endoscopy as well as new technologies**
- **Forward and backward compatibility with video endoscopes and FULL HD camera heads**
- **Sustainable investment**
- **Compatible with all light sources**

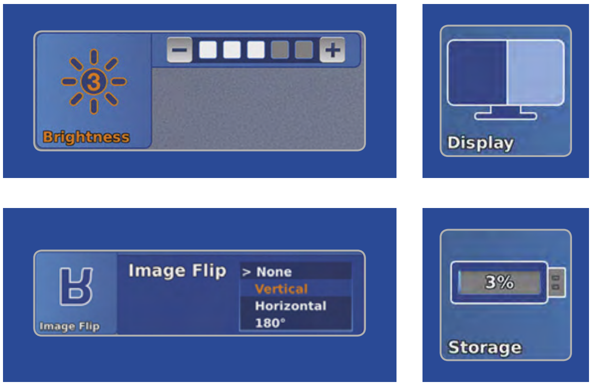
Innovative Design

- **Dashboard: Complete overview with intuitive menu guidance**
- **Live menu: User-friendly and customizable**
- **Intelligent icons: Graphic representation changes when settings of connected devices or the entire system are adjusted**
- **Automatic light source control**
- **SPIES™ VIEW: Parallel display of standard image and the SPIES™ mode**
- **Multiple source control: IMAGE1 SPIES™ allows the simultaneous display, processing and documentation of image information from two connected image sources, e.g., for hybrid operations**

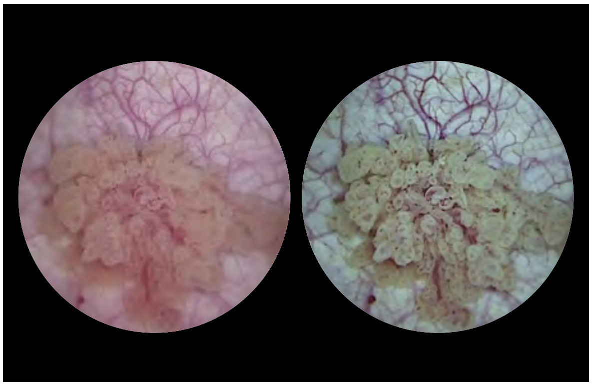
Dashboard



Live menu



Intelligent icons



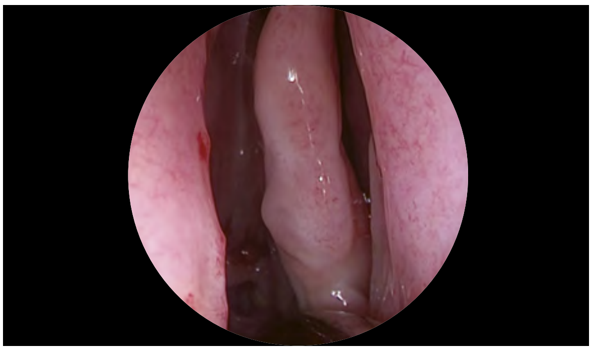
SPIES™ VIEW: Parallel display of standard image and SPIES™ mode

IMAGE1 SPIES™ Camera System NEW

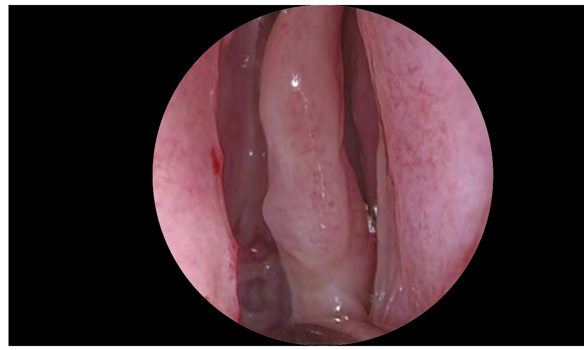
:spies®

Brillant Imaging

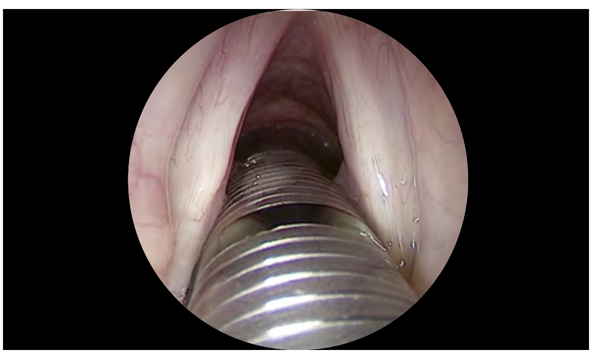
- **Clear and razor-sharp endoscopic images in FULL HD**
- **Natural color rendition**
- **Reflection is minimized**
- **Three SPIES™ technologies for homogeneous illumination, contrast enhancement and color shifting**



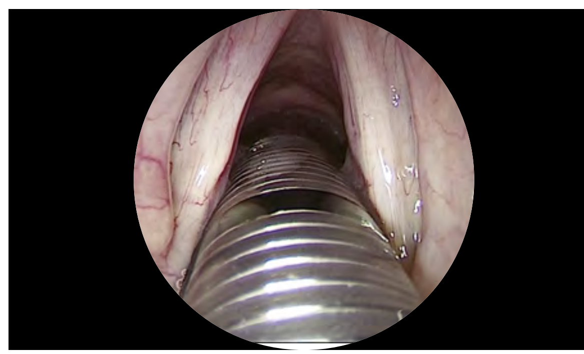
FULL HD image



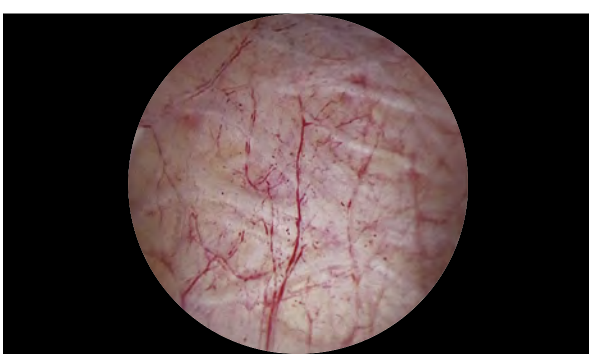
SPIES™ CLARA



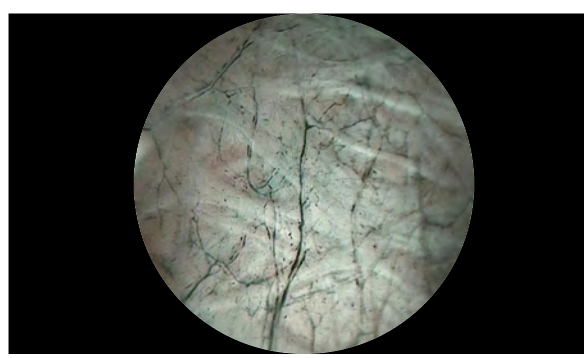
FULL HD image



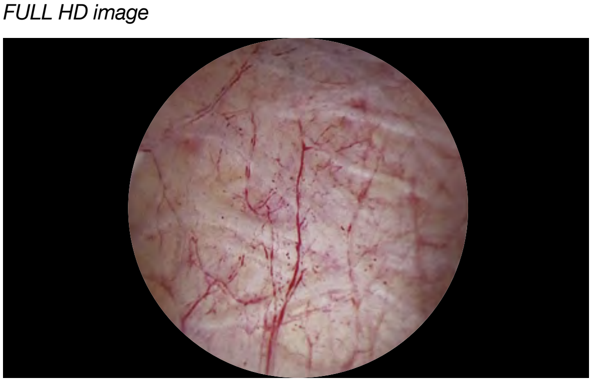
SPIES™ CHROMA



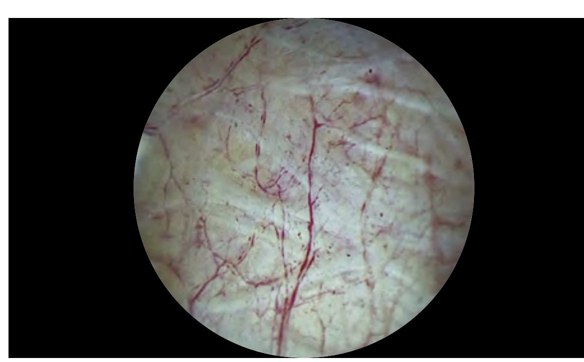
FULL HD image



SPIES™ SPECTRA A



FULL HD image



SPIES™ SPECTRA B

IMAGE1 SPIES™ Camera System NEW

TC 200EN

TC 200EN* **IMAGE1 CONNECT™**, connect module, for use with up to 3 link modules, resolution 1920 x 1080 pixels, with integrated KARL STORZ-SCB and digital Image Processing Module, power supply 100 – 120 VAC/200 – 240 VAC, 50/60 Hz
including:
Mains Cord, length 300 cm
DVI-D Connecting Cable, length 300 cm
SCB Connecting Cable, length 100 cm
USB Flash Drive, 32 GB, USB silicone keyboard, with touchpad, US

***Available in the following languages:** DE, ES, FR, IT, PT, RU

Specifications:

HD video outputs	- 2x DVI-D - 1x 3G-SDI
Format signal outputs	1920 x 1080p, 50/60 Hz
LINK video inputs	3x
USB interface SCB interface	4x USB, (2x front, 2x rear) 2x 6-pin mini-DIN

Power supply	100 – 120 VAC/200 – 240 VAC
Power frequency	50/60 Hz
Protection class	I, CF-Defib
Dimensions w x h x d	305 x 54 x 320 mm
Weight	2.1 kg

For use with IMAGE1 SPIES™
IMAGE1 CONNECT™ Module TC 200EN

TC 300

TC 300 **IMAGE1 H3-LINK™,** link module, for use with IMAGE1 FULL HD three-chip camera heads, power supply 100 – 120 VAC/200 – 240 VAC, 50/60 Hz,
for use with IMAGE1 CONNECT™ TC 200EN
including:
Mains Cord, length 300 cm
Link Cable, length 20 cm

Specifications:

Camera System	**TC 300 (H3-Link)**
Supported camera heads/video endoscopes	TH 100, TH 101, TH 102, TH 103, TH 104, TH 106 (fully SPIES™-compatible) **22** 2200 55-3, **22** 2200 56-3, **22** 2200 53-3, **22** 2200 60-3, **22** 2200 61-3, **22** 2200 54-3, **22** 2200 85-3 (compatible without SPIES™ function)
LINK video outputs	1x
Power supply	100 – 120 VAC/200 – 240 VAC
Power frequency	50/60 Hz
Protection class	I, CF-Defib
Dimensions w x h x d	305 x 54 x 320 mm
Weight	1.86 kg

IMAGE1 SPIES™ Camera Heads *NEW*

:spies®

For use with IMAGE1 SPIES™ camera system
IMAGE1 CONNECT™ Module TC 200EN, IMAGE1 H3-LINK™ Module TC 300
and with all IMAGE 1 HUB™ HD Camera Control Units

TH 100

TH 100 **IMAGE1 H3-Z SPIES™ Three-Chip FULL HD Camera Head,**
50/60 Hz, SPIES™ compatible, progressive scan, soakable,
gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens,
focal length f = 15 – 31 mm (2x), 2 freely programmable camera head
buttons, for use with IMAGE1 SPIES™ and IMAGE 1 HUB™ HD/HD

TH 103

TH 103 **IMAGE1 H3-P SPIES™ Three-Chip FULL HD Pendulum Camera Head,**
50/60 Hz, SPIES™ compatible, **with pendulum system and fixed focus,**
progressive scan, soakable, gas- and plasma-sterilizable,
focal length f = 16 mm, 2 freely programmable camera head buttons,
for use with IMAGE1 SPIES™ and IMAGE 1 HUB™ HD/HD

Specifications:

IMAGE1 FULL HD Camera Heads	**H3-Z SPIES™**	**H3-P SPIES™**
Product no.	TH 100	TH 103
Image sensor	3x ⅓" CCD chip	3x ⅓" CCD chip
Dimensions w x h x d	39 x 49 x 114 mm	35 x 47 x 88 mm
Weight	270 g	226 g
Optical interface	integrated Parfocal Zoom Lens, f = 15–31 mm (2x)	pendulum system, fixed focus f = 16 mm
Min. sensitivity	F 1.4/1.17 Lux	F 1.4/1.17 Lux
Grip mechanism	standard eyepiece adaptor	standard eyepiece adaptor
Cable	non-detachable	non-detachable
Cable length	300 cm	300 cm

IMAGE1 SPIES™ Camera Heads *NEW*

For use with IMAGE1 SPIES™ camera system
IMAGE1 CONNECT™ Module TC 200EN, IMAGE1 H3-LINK™ Module TC 300
and with all IMAGE 1 HUB™ HD Camera Control Units

TH 104

TH 104 **IMAGE1 H3-ZA SPIES™ Three-Chip FULL HD Camera Head,** 50/60 Hz, SPIES™ compatible, **autoclavable,** progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15 – 31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 SPIES™ and IMAGE 1 HUB™ HD/HD

Specifications:

IMAGE1 FULL HD Camera Heads	H3-ZA SPIES™
Product no.	TH 104
Image sensor	3x ⅓" CCD chip
Dimensions w x h x d	39 x 49 x 100 mm
Weight	299 g
Optical interface	integrated Parfocal Zoom Lens, f = 15–31 mm
Min. sensitivity	F 1.4/1.17 Lux
Grip mechanism	standard eyepiece adaptor
Cable	non-detachable
Cable length	300 cm

39301 Z3TS **Plastic Container for Sterilization and Storage** of camera heads **IMAGE1 H3-Z, H3-ZA, H3-FA, H3-Z SPIES™, H3-ZA SPIES™ and H3-FA SPIES™, autoclavable,** suitable for use with steam, gas and hydrogen peroxide sterilization, Sterrad® compatible, external dimensions (w x d x h): 385 x 255 x 75 mm

Please note: The instrument displayed is not included in the plastic container.
Only camera heads marked “autoclave” can be placed in the tray for steam sterilization.

39301 PHTS **Plastic Container for Sterilization and Storage** of camera heads **IMAGE1 H3-P, H3-ZI, H3-P SPIES™ and H3-ZI SPIES™, autoclavable,** suitable for use with steam, gas and hydrogen peroxide sterilization, Sterrad® compatible, external dimensions (w x d x h): 385 x 255 x 75 mm

Please note: The instrument displayed is not included in the plastic container.
Only camera heads marked “autoclave” can be placed in the tray for steam sterilization.

Monitors

9619 NB

9619 NB

19" HD Monitor,
color systems **PAL/NTSC,** max. screen resolution 1280 x 1024, image format 4:3, power supply 100 – 240 VAC, 50/60 Hz, wall-mounted with VESA 100 adaption,
including:
External 24 VDC Power Supply
Mains Cord

9826 NB

9826 NB

26" FULL HD Monitor,
wall-mounted with VESA 100 adaption,
color systems **PAL/NTSC,**
max. screen resolution 1920 x 1080,
image fomat 16:9,
power supply 100 – 240 VAC, 50/60 Hz
including:
External 24 VDC Power Supply
Mains Cord

Monitors

KARL STORZ HD and FULL HD Monitors	19"	26"
Wall-mounted with VESA 100 adaption	9619 NB	9826 NB
Inputs:		
DVI-D	●	●
Fibre Optic	–	–
3G-SDI	–	●
RGBS (VGA)	●	●
S-Video	●	●
Composite/FBAS	●	●
Outputs:		
DVI-D	●	●
S-Video	●	–
Composite/FBAS	●	●
RGBS (VGA)	●	–
3G-SDI	–	●
Signal Format Display:		
4:3	●	●
5:4	●	●
16:9	●	●
Picture-in-Picture	●	●
PAL/NTSC compatible	●	●

Optional accessories:

9826 SF **Pedestal,** for monitor 9826 NB

9626 SF **Pedestal,** for monitor 9619 NB

Specifications:

KARL STORZ HD and FULL HD Monitors	19"	26"
Desktop with pedestal	optional	optional
Product no.	9619 NB	9826 NB
Brightness	200 cd/m² (typ)	500 cd/m² (typ)
Max. viewing angle	178° vertical	178° vertical
Pixel distance	0.29 mm	0.3 mm
Reaction time	5 ms	8 ms
Contrast ratio	700:1	1400:1
Mount	100 mm VESA	100 mm VESA
Weight	7.6 kg	7.7 kg
Rated power	28 W	72 W
Operating conditions	0–40°C	5–35°C
Storage	-20–60°C	-20–60°C
Rel. humidity	max. 85%	max. 85%
Dimensions w x h x d	469.5 x 416 x 75.5 mm	643 x 396 x 87 mm
Power supply	100–240 VAC	100–240 VAC
Certified to	EN 60601-1, protection class IPX0	EN 60601-1, UL 60601-1, MDD93/42/EEC, protection class IPX2

Cold Light Fountain XENON 300 SCB

20133101-1 **Cold Light Fountain XENON 300 SCB**
with built-in antifog air-pump, and integrated
KARL STORZ Communication Bus System SCB
power supply:
100–125 VAC/220–240 VAC, 50/60 Hz

including:
Mains Cord
SCB Connecting Cable, length 100 cm

20133027 **Spare Lamp Module XENON**
with heat sink, 300 watt, 15 volt

20133028 **XENON Spare Lamp,** only,
300 watt, 15 volt

Fiber Optic Light Cable

495 NCS **Fiber Optic Light Cable,**
with straight connector, extremely heat-resistant,
diameter 4.8 mm, length 250 cm

AUTOCON® II 400 SCB

20535201-125 **AUTOCON® II 400 High End, Set SCB**
power supply 220 - 240 VAC, 50/60 Hz,
HF connecting sockets:
Bipolar combination, Multifunction,
Unipolar 3-pin + Erbe Neutral electrode
combination 6.3 mm, jack and 2-pin,
System requirements: SCB R-UI Software
Release 20090001-43 or higher

including:
AUTOCON® II 400, with KARL STORZ SCB
Mains Cord
SCB Connecting Cable, length 100 cm

ENDOFLATOR® 40 SCB *NEW*

Recommended System Configuration

Special Features:

- **High degree of patient safety due to CF application part**
- **Ease of use thanks to touch screen control**
- **Clear, adjacent displays for set value and actual value facilitate monitoring of the insufflation process**
- **Fast and reliable insufflation via an adjustable flow rate up to 40 l/min**
- **Innovative sensitive mode with special safety limits for sensitive applications**
- **Automatic adjustment of insufflation rate to diverse instrument resistance values ensures the fastest possible insufflation**
- **Fully automatic, electronically controlled gas refill (e. g. in case of gas loss when changing instruments)**
- **SECUVENT® Safety System: Constant monitoring of intraabdominal pressure; any overpressure is reduced immediately**
- **SCB model with connections to the KARL STORZ Communication Bus (KARL STORZ-SCB)**

UI400 S1 **ENDOFLATOR® 40 SCB,** with integrated SCB module, power supply 100 – 240 VAC, 50/60 Hz
including:
Mains Cord, length 300 cm
SCB Connecting Cable, length 100 cm
Universal Wrench
Insufflation Tubing Set*, with gas filter, sterile, for single use, package of 5

Specifications:

Operating mode	- high-flow mode - sensitive mode
Gas flow	- sensitive mode: 0.1–15 l/min - high-flow mode: 1–40 l/min
Pressure	- sensitive mode: 1–15 mmHg - high-flow mode: 1–30 mmHg
Gas	CO_2
Measuring/control system	electronic
Parameter display	- set pressure - actual pressure (intraabdominal) - gas flow - gas consumption: 0–999 l - status indicator for gas supply

SECUVENT® safety system	●
Power supply	100–240 VAC, 50/60 Hz
Dimensions w x h x d	305 x 164 x 315 mm
Weight	6 kg
Certified to	IEC 601-1, CE acc. to MDD

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany

ENDOFLATOR® 50 SCB NEW

with Speed-flow Insufflation (50 l/min), Recommended Standard Set Configuration

Special Features:

- **Ease of use due to large, color 7" touch screen**
- **Simultaneous display of set values and actual values facilitate monitoring of the insufflation process**
- **Automatic adjustment of insufflation rate to diverse instrument resistance values ensures the fastest possible insufflation**
- **Fully automatic, electronically controlled gas refill (e.g. in case of gas loss when changing instruments)**
- **SECUVENT® Safety System: Constant monitoring of intraabdominal pressure**
- **Very high gas flow capacity of up to 50 l/min**
- **Especially suitable for providing a high gas flow when using smoke generating techniques**
- **Powerful high-flow mode for fast insufflation of large gas volumes up to 50 l/min**
- **A High-Capability Trocar (HiCap®) is a recommended option**
- **Tubing set with integrated heating element for preheating gas to body temperature to prevent peritoneum from cooling down**
- **SCB model with connections to the KARL STORZ Communication Bus (KARL STORZ-SCB)**

UI500 S1 **ENDOFLATOR® 50 SCB,** with integrated SCB module, power supply 100 – 240 VAC, 50/60 Hz
including:
Mains Cord, length 300 cm
3x **Insufflation Tubing Set*,** with integrated gas heater and gas filter, for single use, sterile
5x **Insufflation Tubing Set*,** with gas filter, for single use, sterile
Universal Wrench
SCB Connecting Cable, length 100 cm

Specifications:

Operating mode	- high-flow mode - sensitive mode
Gas flow	- sensitive mode: 0.1–15 l/min - high-flow mode: 1–40 l/min
Pressure	- sensitive mode: 1–15 mmHg - high-flow mode: 1–30 mmHg
Gas	CO_2
Measuring/control system	electronic
Parameter display	- set pressure - actual pressure (intraabdominal) - gas flow - gas consumption: 0–999 l - status display gas consumption

SECUVENT® safety system	●
Gas heating	●
Power supply	100–240 VAC, 50/60 Hz
Dimensions w x h x d	305 x 164 x 315 mm
Weight	7.7 kg
Certified to	IEC 601-1, CE acc. to MDD

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany

HAMOU® **ENDOMAT® with KARL STORZ SCB**

Suction and Irrigation System

26331101-1 HAMOU® **ENDOMAT® SCB,**
power supply 100 – 240 VAC, 50/60 Hz
including:
Mains Cord
5x **HYST Tubing Set*,** for single use
5x **LAP Tubing Set*,** for single use
SCB Connecting Cable, length 100 cm
VACUsafe Promotion Pack Suction*, 2 l

Subject to the customer's application-specific requirements additional accessories must be ordered separately.

*This product is marketed by mtp.
For additional information, please apply to:

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany

HYSTEROMAT E.A.S.I™

26340001-1 **HYSTEROMAT E.A.S.I.™ Set,**
power supply 100 – 240 VAC, 50/60 Hz,
HYSTEROMAT E.A.S.I.™: SCB ready,
compatible from RUI Release 44,
including:
Mains Cord
SCB Connecting Cable, length 100 cm
* **Basic Tubing Set,** for single use

Recommended accessories:

* 031717-10 **IRRIGATION tubing set,** for single use, sterile, package of 10, for use with KARL STORZ HYSTEROMAT E.A.S.I.™

* 031217-10 **SUCTION tubing set,** for single use, sterile, package of 10, for use with KARL STORZ HYSTEROMAT E.A.S.I.™

Optional accessories:

26340330 **Two-Pedal Footswitch,** one-stage, digital, for use with HYSTEROMAT E.A.S.I.™

*This product is marketed by mtp.
For additional information, please apply to:

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46,
78579 Neuhausen ob Eck, Germany

Data Management and Documentation

KARL STORZ AIDA® – Exceptional documentation

The name AIDA stands for the comprehensive implementation of all documentation requirements arising in surgical procedures: A tailored solution that flexibly adapts to the needs of every specialty and thereby allows for the greatest degree of customization.

This customization is achieved in accordance with existing clinical standards to guarantee a reliable and safe solution. Proven functionalities merge with the latest trends and developments in medicine to create a fully new documentation experience – AIDA.

AIDA seamlessly integrates into existing infrastructures and exchanges data with other systems using common standard interfaces.

WD 200-XX* **AIDA Documentation System,**
for recording still images and videos,
dual channel up to FULL HD, 2D/3D,
power supply 100-240 VAC, 50/60 Hz

including:

USB Silicone Keyboard, with touchpad
ACC Connecting Cable
DVI Connecting Cable, length 200 cm
HDMI-DVI Cable, length 200 cm
Mains Cord, length 300 cm

WD 250-XX* **AIDA Documentation System,**
for recording still images and videos,
dual channel up to FULL HD, 2D/3D,
including SMARTSCREEN® (touch screen),
power supply 100-240 VAC, 50/60 Hz

including:

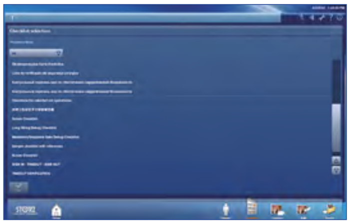
USB Silicone Keyboard, with touchpad
ACC Connecting Cable
DVI Connecting Cable, length 200 cm
HDMI-DVI Cable, length 200 cm
Mains Cord, length 300 cm

*XX Please indicate the relevant country code
(DE, EN, ES, FR, IT, PT, RU) when placing your order.

Workflow-oriented use

Patient

Entering patient data has never been this easy. AIDA seamlessly integrates into the existing infrastructure such as HIS and PACS. Data can be entered manually or via a DICOM worklist.
ll important patient information is just a click away.

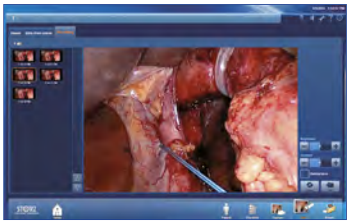


Checklist

Central administration and documentation of time-out. The checklist simplifies the documentation of all critical steps in accordance with clinical standards. All checklists can be adapted to individual needs for sustainably increasing patient safety.

Record

High-quality documentation, with still images and videos being recorded in FULL HD and 3D. The Dual Capture function allows for the parallel (synchronous or independent) recording of two sources. All recorded media can be marked for further processing with just one click.



Edit

With the Edit module, simple adjustments to recorded still images and videos can be very rapidly completed. Recordings can be quickly optimized and then directly placed in the report.
In addition, freeze frames can be cut out of videos and edited and saved. Existing markings from the Record module can be used for quick selection.

Complete

Completing a procedure has never been easier. AIDA offers a large selection of storage locations. The data exported to each storage location can be defined. The Intelligent Export Manager (IEM) then carries out the export in the background. To prevent data loss, the system keeps the data until they have been successfully exported.

Reference

All important patient information is always available and easy to access. Completed procedures including all information, still images, videos, and the checklist report can be easily retrieved from the Reference module.

Equipment Cart

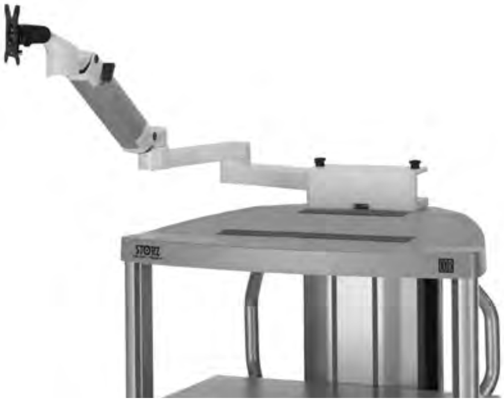
UG 220

UG 220 **Equipment cart**
wide, high, rides on 4 antistatic dual wheels
equipped with locking brakes 3 shelves,
mains switch on top cover,
central beam with integrated electrical subdistributors
with 12 sockets, holder for power supplies,
potential earth connectors and cable winding
on the outside,

Dimensions:
Equipment cart: 830 x 1474 x 730 mm (w x h x d),
shelf: 630 x 510 mm (w x d),
caster diameter: 150 mm

inluding:

Base module equipment cart, wide
Cover equipment, equipment cart wide
Beam package equipment, equipment cart high
3x **Shelf,** wide
Drawer unit with lock, wide
2x **Equipment rail,** long
Camera holder



UG 540

UG 540 **Monitor swivel arm,**
height and side adjustable,
can be turned to the left or the right side,
swivel range 180°, overhang 780 mm,
overhang from centre 1170 mm,
load capacity max. 15 kg,
with monitor fixation VESA 5/100,
for usage with equipment carts UG xxx

Recommended Accessories for Equipment Cart

UG 310

UG 310 **Isolation Transformer,**
200 V–240 V; 2000 VA with 3 special mains socket,
expulsion fuses, 3 grounding plugs,
dimensions: 330 x 90 x 495 mm (w x h x d),
for usage with equipment carts UG xxx

UG 410

UG 410 **Earth leakage monitor,**
200 V–240 V, for mounting at equipment cart,
control panel dimensions: 44 x 80 x 29 mm (w x h x d),
for usage with isolation transformer UG 310

UG 510

UG 510 **Monitor holding arm,**
height adjustable, inclinable,
mountable on left or rigth,
turning radius approx. 320°, overhang 530 mm,
load capacity max. 15 kg,
monitor fixation VESA 75/100,
for usage with equipment carts UG xxx

with the compliments of

KARL STORZ — ENDOSKOPE