ROMEOS GLADIATOR RULE: KNOTS, STITCHES AND KNOT TYING TECHNIQUES
A Tutorial Based On A Few Simple Rules – New Concepts to Teach Suturing Techniques in Laparoscopic Surgery

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Classification of Knots in Laparoscopy

The following knots are the most commonly used in laparoscopy:

- **Basic Knots**
  - Half knot
  - Slip knot / demi-clé

- **Complete Knots**
  - Square knot – sequence of two identical half knots
  - Surgical knot – blocking sequence of half knots
  - Slip knot – blocking sequence of slip knots / demi-clé
  - Slip knot – Roeder’s knot

1. Classification of knots most commonly used in laparoscopy.

1.0 Classification of Knots in Laparoscopy

1.1 Classification

1.1.1 The Half Knot

This is an incomplete and unreliable knot since it is very easy to untie. To tie this knot, both ends of the suture must be pulled in opposite directions with uniform tension in the same plane. The main characteristic is that a hypothetical midline divides this knot in two symmetrically identical parts (Fig. 2).

1.1.2 The Slipknot / Demi-Clé

This is another basic, unreliable, incomplete and asymmetric knot which does not have enough strength to maintain approximation of the wound edges. When tying this knot, each thread has a different role, one remains inactive and the other, called active thread, forms the knot by wrapping around the other one (Fig. 3).

**Active and Passive Threads.** The passive thread is the one that remains inactive during tying, and the active thread plays an active role during knotting in that it is always wrapped around the passive thread (Fig. 3).

The half knot and the slipknot / demi-clé are the cornerstones of a building called knot, which is composed of a correct sequence of half knots and/or slipknots.

Our learning objective is to simplify and standardize laparoscopic suturing techniques. Based on our daily surgical experience, we have developed a training system with exercises designed to enable our students to learn three knots and three suturing techniques that can be easily and safely performed: Laparoscopic suturing must be uncomplicated and reproducible.

\[\text{from French: nœd demi-clé}\]

1 Classification of knots most commonly used in laparoscopy.

2 Half knot.

3 The slip knot / demi-clé.

4 Classification of laparoscopic suturing techniques.
1.2 Laparoscopic Suturing Techniques

Laparoscopic suturing techniques are classified as intracorporeal and extracorporeal (Fig. 4).

1.2.1 Intracorporeal Technique

In the intracorporeal technique, the knot is made inside of the abdominal cavity using two instruments; these can be two needle holders or one needle holder and one assistant forceps.

1.2.2 Extracorporeal Technique

In the extracorporeal technique, the knot is made completely outside of the abdominal cavity. Afterwards, it is pushed inside the abdomen with a knot pusher, which could be a slipknot pusher or a Roeder’s knot pusher.

1.3 The Knot’s Blocking Sequence: Intracorporeal and Extracorporeal

The knot’s blocking sequence is a series of half knots and/or slip knots, that confer to the knot the maximum grip, which is equal to the maximum tensile strength of the suture that will always break close to the knot. The blockade is total and any force applied in an attempt to move the knot in one or the opposite direction will inevitably fail; it will only result in breakage of the suture (Figs. 5–9).

Based on our concept, we consider three different knots to be memorized and three knotting techniques for a fast and safe approximation of wound edges. These are easy to learn and the technique is reproducible:

1. Intracorporeal knot (Fig. 6)
2. Extracorporeal slipknot (locking sequence of slipknots) (Fig. 8)
3. Extracorporeal sliding knot (Roeder’s Knot) (Fig. 9)

In order to meet all demands of laparoscopic suturing, a good command of the technique is required, essentially involving only a few but well-chosen knots.

1.3.1 The Blocking Sequence of an Intracorporeal Knot

Based on our concept, we consider three different knots to be memorized and three knotting techniques for a fast and safe approximation of wound edges. These are easy to learn and the technique is reproducible:

1. Intracorporeal knot (Fig. 6)
2. Extracorporeal slipknot (locking sequence of slipknots) (Fig. 8)
3. Extracorporeal sliding knot (Roeder’s Knot) (Fig. 9)

In order to meet all demands of laparoscopic suturing, a good command of the technique is required, essentially involving only a few but well-chosen knots.
1.3.2 The Slip Knot Blocking Sequence

The blocking sequence of a slip knot.

1.3.3 The Roeder Knot Blocking Sequence

The Roeder knot blocking sequence.
2.0 Theory of Parallel Axes: The Ideal or Perfect Stitch and the Gladiator Rule for Knot Tying in Laparoscopy

2.1 Description of Axes, Angles and Planes

For a better understanding of the perfect stitch, a rationale will be given explaining the relationship between $P$ and $F$ Axes, $T$ Plane, and Entry Angle $A$ (Fig. 1) because the concept of the perfect stitch is based on a specific combination of these four elements (Figs. 1–4).

In the perfect stitch, the needle – perpendicular to the $P$ axis of the needle holder – penetrates the tissue with an entry angle $A$ of 90° in relation to the $F$ axis of the wound. Considering this, it is concluded that both axes, $P$ and $F$, are parallel to each other, confirming the theory of parallel axes (Fig. 4). This always applies when the entry angle $A$ is not greater than 45° (Fig. 1).

In laparoscopy, due to fixed trocar sites, the perfect point is not always feasible. To overcome this difficulty and in an attempt to get as close as possible to the ideal of a perfect stitch, all surgical skills of the trainee should be focused on the idea that one could use both hands to achieve the best position of the needle holder. Positioning of the needle in the needle holder’s jaws at an angle equal or greater than 110° affords the user a greater variety of options regarding the most appropriate trajectory of needle entry, thereby helping to achieve the perfect stitch.

At the beginning of a surgical procedure, the most ergonomic site for trocar placement should be planned in accordance with the area that needs to be sutured. This will facilitate establishing the best parallelism condition between the $P$ axis of the needle holder and the $F$ axis of the wound, allowing the suture to be made easily.

Modifying the angles, the trainee should be able to meet as close as possible the ideal of a perfect stitch. Changing the position of the $P$ axis of the needle holder in relation to the $F$ axis of the wound, one should always seek for the perfect parallelism condition significantly facilitating the stitch.

1. The perfect stitch. $P$ (main rotation axis of the needle holder), $A$ (entry angle in relation to the $F$ axis of the wound), $F$ (wound’s medial virtual axis), $T$ (plane of the needle loaded in the needle holder).

2. The perfect stitch. $A$ (entry angle in relation to the $F$ axis of the wound), $B$ (plane of the needle loaded in the needle holder).

3. The perfect stitch.

4. The perfect stitch. $P$ and $F$ axes must be parallel.
Understanding the interrelations between axes, planes and angles, we conclude that making a stitch consists in ‘solving’ a geometric problem. From this concept emerges the idea of using in our basic courses models that reproduce the ideal conditions of a perfect stitch. In this way, we are able to establish a training situation, that is different from real surgical conditions. The trainee is gradually moving to a more complex situation that approximates to the real surgical condition, still not matching the ideal, but staying true to the concept of a perfect stitch, choosing from a variety of specifically designed multiangular training models (ETR1, ETR2, ETR3, see Figs. 5–7).
2.2 Realistic Endotrainer and Geometric Models

In order to perform a basic training, it suffices to use the multiangular models with a conventional endotrainer offering ample space, like the ‘box trainer’. However, in an advanced training program, teaching suturing angles found in real pathologies, it is mandatory that exercises be performed on special models in a realistic endotrainer designed for training under next-to-realistic anatomic conditions (Figs. 8–11).

The Realistic Endotrainer is a perfect reproduction of human anatomy, that allows:

- to insert synthetic models of abdominal and pelvic organs with and without pathology, even giving the option of simulating bleeding (Fig. 7).
- to perform laparoscopic procedures with an assistant while using the same equipment and instruments routinely employed in the OR (using the correct ergonomics).
- to simulate suture angles with the same haptic feedback as in surgery, placing the stitch with the same suture tension, and loading the needle in the needle holder under similar conditions as in daily practice (Figs. 9, 10).

Multiangular geometric models allow to develop motor coordination and stereotaxis which are mandatory in laparoscopic surgery for placing perfect stitches. The trainee is well-advised to start with simple suturing angles (stitches placed from left to right with needle holder in the right hand) (Fig. 9–11).

Multiangular geometric models.

New multiangular training models. The starting point to learn.

Model for simulating the presence of a myoma on the posterior wall of the uterus. Simulation of suturing angle with vertical $P$ axis through the suprapubic trocar.
2.3 The Gladiator Rule: A Universal Suturing Technique

With the Gladiator Rule – which will be described below – we are placed in the position to master any entry angle occurring in daily surgical practice; the operating surgeon will never be in trouble, therefore we consider this knotting rule as universal and applicable for suturing in laparoscopy.

To demonstrate the flexibility of the technique, we will propose two essential premises.

The Gladiator Rule applies to:
- all lengths of the thread,
- all instruments placed in any angle and position.

The Gladiator Rule anticipates the use of the main needle holder, the jaws of which are constantly kept wide open in order to expedite the knotting phases (Fig. 12).

The opened jaws serve as a gripping hook that transforms a portion of the thread’s horizon into a condition of parallelism with the P axis of the needle holder (see Theory of Parallel Axes) and also keeps the thread aligned, thus preventing it from slipping off the surgical instrument.

During knotting, the needle holder performs a clockwise turn (from 6 to 12 o’clock) or counter-clockwise turn (from 12 to 6 o’clock) with jaws opened. The maneuver resembles the ‘Pollex Versus’ gesture used by Roman emperors to announce a verdict of condemnation or mercy to losing gladiators.

The Gladiator Rule was introduced in 2004 at the IRCAD course on ‘Advanced Techniques in Operative Gynecological Endoscopy’. In October 2006, the rule was presented during the 15th Annual Congress of the European Society for Gynecological Endoscopy (ESGE) in Strasbourg, France, and was published in Italian in the same year. A recently published article by MEREU et al. refers to the same topic.

According to the Gladiator Rule, the main needle holder with jaws opened performs a rotation around the thread’s horizon using always the left hand in a coordinated manner. The reverse movement of the left hand is made smoothly, facilitating the thread to wrap around the suture instrument and preventing it from slipping off due to inconvenient movements.

When knot-tying is done with trocars in a lateral position, the Thread’s Horizon must be placed in the best possible horizontal position, always to the right (Fig. 12).

When knotting with the main needle holder in the central position (suprapubic trocar), the Thread’s Horizon is usually located at a slightly higher level (2 o’clock position), almost forming a diagonal on the monitor (Fig. 13).

The more the Thread’s Horizon is aligned with the P axis of the needle holder, the more simplified is the knotting; a simple, slightly rotational movement of the needle holder around its longitudinal axis is enough to cause the thread to wrap around the shaft. Next, while keeping the thread securely on the shaft of the needle holder, a coordinated movement is made to grasp the end of the suture. The maneuvers to execute this movement are trained in our advanced courses.

1. IRCAD, Strasbourg, France.


2.3.1 Preparation for Knot Tying: Reference Points

During preparation for knot tying, a few reference points need to be defined that are highly essential for proper application of the Gladiator Rule (Fig. 14).

2.3.2 Home Base

The first reference point is the Home Base, which is defined as the virtual space or cylindrical area where the knot is placed (Fig. 15).

If the trainee remains at the Home Base utilizing the maximum length of the thread at all times, it is possible to circumvent the video camera's inherent drawback of two-dimensional vision. As a result, the needle-thread-system is maintained without the need for constant readjustment of tautness.

Successful knot tying requires the trainee to stay as close as possible to the home base. If the opposite is done and the trainee moves away, considerable problems will arise when attempting to perform the maneuver described in section 2.3.

2.3.3 The Thread’s Horizon

The second reference point is the Thread’s Horizon, which is defined as the rectilinear portion of the thread. It is created by displacing the thread to the right, opposite to the assistant forceps (Fig. 16).

While the assistant forceps maintains a position within a radius of 2–3 cm from the needle's connection point with the thread, the main needle holder is used to tighten the free portion of the suture completely, pulling the strand to the right and, in turn, creating a segment that is as rectilinear as possible, defined as the Thread’s Horizon (Fig. 16).

This maneuver has the dual purpose of approximating the instrument tips allowing them to work in close proximity, almost in touch with each other, and secondly, serves to provide a reference point needed to adequately complete the blocking sequence of the knot.

The Thread’s Horizon is designed to facilitate wrapping the thread around the needle holder and enables the trainee to define the starting point – either above or below the horizon. This maneuver not only simplifies the decision as to which knot should be made, but always allows to perform the correct blocking sequence!
2.4 The Gladiator Rule: Knot Tying

The sequence of movements required for knot tying is preceded by a maneuver of the main needle holder wrapping the thread around its shaft. Henceforth, both instruments (needle holder and assistant forceps) must work together using back and forth movements without getting in each other’s way, particularly during on-axis rotation of the needle holder.

The more the $P$ axis of the main needle holder is aligned with – or parallel to – the Thread’s Horizon, wrapping of the thread around the shaft is facilitated, allowing the first stage of knot tying to be completed.

Once the Thread’s Horizon has been established according to the Gladiator Rule, the main needle holder is ready to go about making the turns with the thread forming the true knot.

2.5 The Gladiator Rule: Exercises

Right hand exercises with needle holder in the right lateral trocar.

- The Gladiator Rule applied above the thread’s horizon (Exercise 1)
- The Gladiator Rule applied below the thread’s horizon (Exercise 2)

2.5.1 The Gladiator Rule Applied Above the Thread’s Horizon

The maneuver involves that the trainee places a perfect stitch in the model while remaining at the Home Base (Figs. 17, 18). The Thread’s Horizon will be located in lateral (3 o’clock) position, forming a horizontal line parallel to the base of the monitor (Fig. 19).
To perform the maneuver and make the turns of the needle holder above the thread’s horizon, the following should be done: starting above the *Thread’s Horizon*, the main needle holder with jaws opened is rotated on-axis (Fig. 20), first performing a 180°-clockwise rotation downward (*Pollex versus* movement), followed by another 180°-clockwise rotation upward, and ending up with the jaws in 12 o’clock position (Fig. 22).

The next starting point of the needle holder’s jaws is the 6 o’clock position. A clockwise circular movement is performed, passing through 9 o’clock position, nearly touching the jaws of the assistant needle holder, and finally arriving at 12 o’clock position (jaws upward). While completing the 180°-upward rotation, the assistant forceps is guided upward, parallel and close to the *P axis* of the main needle holder, to ensure that the suture does not slip off the needle holder (Figs. 20–22).

During intracorporeal suturing, when the needle holder starts knot tying above the thread’s horizon, and if the second half knot is a blocking one, the maneuver must be performed with the needle holder in an inverted position (below the *Thread’s Horizon*). This is a typical example of a blocking sequence.
2.5.2 The Gladiator Rule Applied Below the Thread’s Horizon

To perform the maneuver and make the turns of the needle holder below the thread’s horizon, the following should be done: contrary to the previous exercise, the starting point of the needle holder’s opened jaws is the 12 o’clock position (Fig. 23). Once the suture has been taken up, the needle holder performs a 180°-turn counter-clockwise on its P axis, passes through 9 o’clock position, and finally arrives at 6 o’clock position (Figs. 23, 24).

The circular movement of the needle holder is done on its P axis; the authors therefore propose the auxiliary notion, that the laparoscopic surgeon should regard the main needle holder as a ‘screwdriver’ or a ‘fork’ that is twirled to wrap spaghetti around its tines, but without completing a 360° rotation. The needle holder should make a 180° turn until arriving at the 6 o’clock position. Following the Gladiator Rule, a second knot is made above the Thread’s Horizon by rotating the needle holder clockwise and ending up with opened jaws in 12 o’clock position. In this way, the surgical knot is completed.

In order to facilitate suture knotting, the trainee should start with the main needle holder in the right hand, which is convenient for the general surgeon who remains in triangular position with the assistant forceps, however this configuration is anti-ergonomic for the gynecologist.

2.6 Real Situation in Gynecology: Ergonomics of Intracorporeal Suturing Through a Suprapubic Trocar

In order to simulate more complex circumstances of knot tying a gynecologist is commonly faced with in daily practice, the Gladiator Rule is applied by using the main needle holder at a more vertical P axis through a suprapubic trocar.

While introducing the main needle holder – which is always used in the dominant right hand – through a central suprapubic trocar (Fig. 27), the left hand is now more involved in the surgical field. The task now at hand requires that the trainee have obtained a certain level of proficiency through a regular training regime.

The objective of our technique in gynecology is to perform knot tying easily and quickly using the needle holder in the right hand through a suprapubic trocar, since this hand almost always will be in the most ergonomic position and most proximal to the workspace.

With regular training it will be possible to achieve a good command of the technique allowing the trainee to make sutures with both hands, swiftly and in an almost fatigue-free way. During initial stages of training, the right hand performs the finest movements while the left hand is being trained to assist in knot tying.
2.7 The Gladiator Rule in Gynecology (Suprapubic Position): Exercises

The dominant (right) hand guides the main needle holder through the suprapubic trocar:

- Applying the Gladiator Rule with clockwise movement (Fig. 27)
- Applying the Gladiator Rule with counter-clockwise movement (Fig. 32)
- Maneuvers used to tighten the knot properly (Fig. 31)

In suprapubic position, the stitch must be done with the right hand in lateral position to achieve a moderate entry angle not exceeding 45° (Fig. 25). Subsequently, we start the knotting maneuver in an extremely vertical position with an entry angle of 90° relative to the suture plane (P axis angled 90° in relation to F axis of the wound) (Figs. 26, 27).

This is a typical ergonomic position in gynecology, but has shown to be also useful in the training of a general surgeon because it teaches to deal smoothly and rapidly with complex angles impeding a perfect triangulation.
2.7.1 The Gladiator Rule Applied Clockwise with the Right Hand in Central Position (Low Suprapubic Trocar)

The needle holder is behind the Thread’s Horizon relative to the viewer’s position, in this case, with opened jaws (Fig. 27).

The assistant forceps brings the Thread’s Horizon close to the needle holder. The Thread’s Horizon, in this case, should be positioned at a higher level and aligned as parallel as possible to the $P$ axis of the needle holder. Initially, an opposite movement is made with the needle holder to take up the suture, followed by a 180°-clockwise rotation, during which the assistant forceps in the left hand facilitates the downward movement and the crossover for wrapping up the thread. Once the needle holder has passed the Thread’s Horizon and the turn is complete, the assistant forceps in the left hand is raised a bit toward the $P$ axis to prevent slippage of the suture (Figs. 28–31).

In order to perform the blocking sequence, in the next step, the thread always needs to be pulled opposite to the movement previously made. In this case, the needle holder is placed in front of the Thread’s Horizon with opened jaws facing away from the camera. (See 2.7.2 The Gladiator Rule Applied Counter-Clockwise).

28 The needle holder performs a clockwise turn.

29 Using the left hand, the assistant forceps facilitates the descending movement and the crossover for wrapping the thread.

30 The assistant forceps in the left hand is raised a bit toward the $P$ axis to prevent slippage of the suture.

31 Flat knot.
2.7.2 The Gladiator Rule Applied Counter-Clockwise

In order to make the second turn, the needle holder is placed in front of the Thread’s Horizon relative to the viewer’s position while performing a 180° clockwise rotation. Prior to completing the next turn, the needle holder has to resume its initial position (Figs. 32–35).

2.8 Maneuver to Tighten the Knot

Based on our concept, the first square knot is made applying a simple rule, called the Crossing Rule:

\textit{Crossing of instruments to create a flat knot is permissible only in the case of stitches made from right to left.}

The first intracorporeal knot needed in a laparoscopic setting will be a square knot (sequence of two throws), which in this case is created by crossing instruments, as soon as the thread – which has already been twisted once – is pushed downward to complete the first knot (see page 20, Fig. 36).
In order to facilitate the crossing maneuver, a few simple considerations should be borne in mind. Taking as a reference the point where the stitch has been made from right to left relative to the wound, and thus with the thread aligned rectilinear, the tip of the suture faces to the right while the needle faces to the left, the crossing rule is defined as follows:

The starting point of the knotting maneuver is located above the Thread’s Horizon. A flat knot is created by crossing the instruments such that the assistant forceps passes over the needle holder (which simultaneously passes underneath). For this rule to be applied properly, the thread should be wrapped around the needle holder which is rotated clockwise for this purpose (Fig. 36).

Once the flat knot has been made, both forceps again pick up the ends of the thread in proximity to the knot. The knot is tightened by pulling the strands into opposite directions along the axis that crosses the knot; this will produce the desired approximation of tissue edges (Fig. 37).
The starting point of the second half knot is located below the *Thread’s Horizon*. The needle holder performs a turn, which is always made in opposite direction to the one performed for the first knot, but in this case, the thread is already in the correct position and there is no need to cross it (Fig. 38). We usually encourage the trainee to block the flat knot immediately and not to wait until the second half knot is formed, because any traction applied to the knot during its construction can increase tension in the square knot and result in accidental migration of tissue edges (Figs. 38–40).

Some expert surgeons recommend the use of the non-dominant (left) hand instead of the dominant one, also for knot tying and for guiding the needle holder. The technique gives the benefit of eliminating the need to cross instruments, because a flat knot is automatically formed when the primary needle holder is used with the non-dominant hand to establish the *Thread’s Horizon* on the left side.

In our basic and advanced courses we advise our participants only to improve dexterity of the non-dominant (left) hand, but we do not teach them to use it for knot tying. Instead, our preference is to enhance the natural accuracy of the dominant (right) hand for knot tying, since 90% of surgeons are natural right-handers. Taking advantage of the fluidity of motion of a right-handed person, we can teach more easily how to perform knot tying with shorter threads, where accuracy is critical. We advise our participants to gradually develop motor skills of the right hand in suprapubic position where knot tying is facilitated if centesimal precision movements are made.

Shaping dexterity of the non-dominant (left) hand in order to use it as the dominant hand is a key aspect only in our Master Courses and Top Master Courses, addressing any kind of suturing and knotting techniques. In terms of knot tying, the authors advise candidates of these courses to go about shaping dexterity of the non-dominant (left) hand only after an adequate level of perfection allows them to swiftly perform sutures and knots with the dominant (right) hand, at any angle and with any length of thread.

A basic rule that is usually followed in gynecology is, that stitches be made with the left or right hand, whereas knot tying, in both cases, should be restricted to the dominant (right) hand in the center or suprapubic position. Therefore, the authors believe it is reasonable to ‘pay the price’ of one more surgical step (crossing of instruments, needed to get the flat knot into position) and in turn, to profit from better ergonomics.

38 The second half knot is made in opposite direction to the first one. Initially, a 180°-clockwise rotation upward is made, with the jaws finally arriving in 12 o’clock position.

39 Both instruments pick up the thread close to the center of the knot, which is tightened by evenly pulling the strands into opposite directions.

40 The second half knot of the blocking sequence is made in opposite direction to the first one.
3.0 The Stitch and Maneuvers to Load the Needle in the Needle Holder

3.1 Loading the Needle in the Needle Holder: The Equilibrium Points of the Needle

Prior to placing a stitch, it is mandatory that you have made yourself familiar with the technique used to load the needle in the needle holder. A few basic rules on how to load the needle correctly and definitions on equilibrium points \((PM, PX \text{ and } PB)\) are worth making yourself familiar with since they will facilitate proper handling of the needle \((\text{Figs. 1, 2})\).

3.2.1 The Needle and its Orientation

To orientate the needle, the suture must be picked up with the assistant forceps, approximately 5 cm from the connection point of the thread and the needle.

The needle should be handled like a puppet (via the thread), that is suspended on strings in the air or placed in the operative field with the convex surface facing toward the viewing point and the needle tip showing to the left allowing the user to proceed in a right-to-left direction when placing the stitch with the right hand \((\text{Fig. 3})\).
In order to place a reverse stitch, the needle should be positioned with its convex surface facing toward the viewing point but with the needle tip showing to the right allowing the user to proceed in a left-to-right direction with the right hand (Fig. 4).

Of course, the inverted orientation of the needle – i.e., from left to right for a reverse stitch made with the right hand – is also a feasible option for a stitch made from left to right with the left hand.

Even though we are fully aware of the importance of training motor skills of the left hand when placing a stitch and tying laparoscopic knots, we will not go into details here, because this manual covers mainly right-hand basic exercises.

### 3.2.2 Use of the PX Point to ‘Wake Up the Needle’ and Perform the ‘Hair Pulling Maneuver’

The PX point is located at the junction between the middle third and the last third of the needle. It is the ideal site to pick up the needle and perform a maneuver called ‘hair pulling’, which in a figurative sense means, that the needle is transformed in an ‘awake state’, with the concave surface showing upward. While keeping the needle securely loaded in the main needle holder, the assistant forceps pulls the thread tight, exerting traction in a vertical direction toward the abdominal wall. Finally, the proximal end of the needle should be angled at 110° with respect to the needle holder’s $P$ axis (Figs. 5–7).
Keep in mind that the needle should always be manipulated like a puppet. Once put in an ‘awake state’ with the ‘Hair Pulling’ Maneuver, the needle’s position and orientation can be fine-tuned by pulling the suture proximally or distally, always parallel to the P axis. In this way, the angle of the needle’s alignment with respect to the needle holder’s P axis can be opened or closed as required (Figs. 8, 9).

3.2.3 Use of the PM Point for the ‘Grinding Coffee Maneuver’

The PM Point is located exactly in the center of the needle. Once the needle has been loaded, the equilibrium point is installed by exerting traction to the thread allowing the needle to be rotated, and the loading position to be readjusted accordingly. To perform rotation, either the needle holder or the assistant forceps may be used depending on the suture position.

It is of paramount importance that the thread be always readily accessible to the forceps which applies traction, finally resulting in a 180° rotation of the needle. We therefore called it the ‘Grinding Coffee Maneuver’, which can be performed in a vertical or horizontal direction.

‘Grinding Coffee Maneuver’ in Horizontal Direction

The needle is picked up at the PM point with the needle holder or assistant forceps and is kept in equilibrium, while the jaws are not in a fully closed position. The needle should always be loaded leaving the free end of the thread on the side of the contralateral hand that exerts traction on the suture. The thread is grasped at about 5 cm (Fig. 10) from the proximal end of the needle (swage) which makes a 180° rotation in horizontal direction. Upon completion of this maneuver, the orientation of the needle’s convexity has been turned upside down or vice versa, thereby changing the direction of the needle tip (Figs. 10–12).
‘Grinding Coffee Maneuver’ in Vertical Direction

The needle is picked up at the PM point with the needle holder or assistant forceps. Always keep in mind, that the needle should be loaded with the free end of the thread running on the side of the contralateral hand that exerts traction on the suture. The thread is grasped at about 5 cm from the swage to perform a 180° turn, in this case, in vertical direction. Upon completion of this maneuver, the orientation of the needle’s convexity has been turned from right to left or vice versa, thereby changing the direction of the needle tip (Figs. 13–15).
3.2.4 The Flag Point (PB)

The Flag Point (PB) is the needle’s ‘strategic equilibrium point’ used to perform the so-called ‘Flag Maneuver’, which allows to change the needle’s direction.

Shown below is how repositioning of the needle from right to left is performed by a simple rotation, without a change in the orientation of the needle’s convexity, which always faces downwards, with the fulcrum running through the Flag Point (PB) (Figs. 16–19).

16 The assistant forceps grasps the needle at the PB point.
17 Change in the needle’s direction from right to left.
18 Change in the needle’s direction from left to right.
19 Change in the needle’s direction from left to right.
3.2.5 Use of the Flag Point for the ‘Roller Coaster’ Maneuver

In order to perform this maneuver, the needle is grasped at the Flag Point keeping the needle balanced while making sure that the jaws of the needle holder are not in a fully closed state. The needle should be placed in the needle holder with the suture facing the assistant forceps, which will create suture tension.

The suture is held approximately 2 cm from the point where the suture is attached to the needle holder, and traction is applied distally with the assistant forceps while simultaneously rotating the needle holder 45 degrees downwards; then proximal traction is applied to the suture.

With this maneuver, we go from a right stitch in the right hand to a right stitch in the left hand (Figs. 20–23).
Proximal tension is applied on the suture in order to grasp the needle with the assistant forceps and to change its orientation.
3.3 Fine Adjustment of the Needle

Once the needle has been loaded in the needle holder and assumes a ‘convexity downward position’ at an angle of 110° with respect to P axis, we can use one last maneuver called ‘Fine Adjustment’. In order to increase or reduce the angle between the needle’s longitudinal axis and the P axis of the needle holder, the assistant forceps is used to apply little pressure at the needle’s PB Point (to increase the angle) or at the PM Point (to reduce the angle) (Fig. 24).

The resulting angulation of the needle with respect to the needle holder’s P axis can be evaluated and checked against the anticipated path that the needle will take (and thus, the exit site where it will emerge, once it has been passed blindly through the tissue), with the so-called ‘Cross Verification Maneuver’ (Fig. 25). The maneuver involves that the needle be loaded in the needle holder at the point of maximum convexity while drawing an imaginary line that traverses the wound margins or anatomical structure to be pierced through. This should allow to accurately define the path the needle will usually follow during tissue transfixion. The trajectory that the needle will take is identical with this imaginary line (Fig. 25).

24 Fine adjustment of the needle’s position.

The depth of tissue transfixion will depend on the position and entry angle at which the needle is pierced through the tissue. Keeping the arm in a neutral position, a smooth counterclockwise rotation of the wrist is made first to place the needle such, that its concavity faces completely toward the tissue (Fig. 26). Next, a 180° turn is made clockwise to pass the needle deeply through the tissue (Figs. 27–28).

26 Keeping the arm in a neutral position, a smooth counterclockwise rotation of the wrist is made first to place the needle such, that its concavity faces completely toward the tissue.
Performing an intermediate rotation of the wrist while keeping the arm in a neutral position allows the needle to be passed at an intermediate depth through the tissue (Fig. 29).

If a minimum rotation of the wrist is made with the arm in neutral position, the needle will be passed through the tissue at a superficial depth (Fig. 30).

### 3.4 The Perfect Stitch: Step-by-Step Exercises

The following step-by-step exercises involve the use of various training models. A series of perfect stitches are made using the main needle holder in the right hand.

1. Use of a geometrical model placing stitches via the right lateral trocar at an angle not exceeding 45°.
2. Use of a hemicylindrical model placing via the right lateral trocar.
3. Use of a cylindrical model placing stitches via the suprapubic trocar (vertical \( P \) axis).
4. Use of a hemicylindrical model placing stitches via the suprapubic trocar.

#### 3.4.1 Use of a Geometrical Model Placing Stitches Via the Right Lateral Trocar At An Angle Not Exceeding 45°

Consistent with the Concept of the Perfect Stitch all maneuvers and underlying rules described herein so far, need to be applied in this training session.

First, a geometric model is placed on the cover plate of the endo-trainer's Douglas pouch, making sure that the \( F \) axis of the wound is parallel to the \( P \) axis of the needle holder.

One stroke of the "Figure-of-X" shown on the geometrical model needs to be parallel to the projection of the needle holder's \( P \) axis onto the surface plane of the model. The needle holder is inserted in the right lateral trocar and aligned at a working angle ranging from 45° to 60° to establish the parallelism condition required for the perfect stitch.

As shown in Fig. 31, the model needs to be anchored temporarily to the cover plate of the Douglas pouch using a toothpicks or pins.
Prior to going ahead and placing the first stitch in the model, all maneuvers that have already been learned – how to load the needle in the needle holder, how to align the needle holder, and how to perform the cross verification maneuver – should be completed successfully (Fig. 32).

In the next step, a few stitches are made from right to left with the needle holder in the right lateral trocar, following the small perforations on the model, beginning at the posterior outer margin and ending in the center, which should not be crossed (Figs. 33–35).

The exercise should be repeated as often as necessary until the stitches are perfectly parallel to each other, (see Fig. 35), making sure that the exit stitches run precisely through the perforations on the training model.

Using both hands in a coordinated manner is mandatory while pulling out the running suture, which is started at the posterior outer margin of the training model (Fig. 36).
Prior to proceeding with the first stitch of this exercise, all maneuvers that have already been learned — how to load the needle in the needle holder, how to align the needle holder, and how to perform the cross verification maneuver — should be completed successfully. In the next step, the starting point of the running suture is the center of the training model. This time, the stitches are placed in reverse direction, i.e., from left to right using the right hand (Figs. 37–39).

The exercise should be repeated as often as necessary until the stitches are perfectly parallel to each other (see Fig. 35), making sure that the exit stitches run precisely through the perforations on the training model.

3.4.2 Use of a Hemicylindrical Model Placing Stitches Via the Right Lateral Trocar

Take care that the $F$ axis (of the wound) is parallel to the $P$ axis of the needle holder which is inserted in the right lateral trocar.

The hemicylindrical model is placed on the cover plate of the Douglas pouch making sure that the $F$ axis (wound) is aligned with a diagonal that runs from 10 o’clock to 4 o’clock (Fig. 40).

The medial axis of the groove in the model should be parallel to the projection of the needle holder’s $P$ axis onto the base of the model. The needle holder is inserted in the right lateral trocar and aligned at a working angle ranging from 45° to 60° to establish the parallelism condition required for the perfect stitch.

Following proper alignment of the model, it is anchored in the Douglas pouch with toothpicks or pins.

All maneuvers that have already been learned — how to load the needle in the needle holder, how to align the needle holder, and how to perform the cross verification maneuver — should be completed successfully.

Once the first ‘Figure-of-X’ stitch has been placed, the Gladiator Rule is applied to tie the knot, completing the step with the correct blocking sequence. The exercise aims at practicing ‘Figure-of-X’ invaginating sutures. The first stitch is inserted deeply for hemostasis and the second one serves to approximate wound margins. In this training situation, the stitch is inserted at a blind spot when suturing on the left side of the model (Fig. 41).
‘Figure-of-X’ stitch with application of Romeo’s gladiator rule for knot tying with the correct blocking sequence.
3.4.3 Use of a Cylindrical Model Placing Stitches Via the Suprapubic Trocar (Vertical P Axis)

In this training section, the working angle is 0°. The P axis of the needle holder should be parallel to the F axis of the wound. The theory of parallelism is once again confirmed by an exercise, where the site of the needle holder is changed to a suprapubic position. Therefore, the P axis of the needle holder is aligned in a fully vertical position, which is a common situation in modern laparoscopic gynecology.

The exercise involves that a cylindrical model is placed on the cover plate of the Douglas pouch taking care that the F axis is in a fully vertical position. The model should be temporarily anchored in this position with toothpicks or pins (Figs. 42, 43).

Cylindrical model mimicking anatomical circumstances that involve a vertical F axis (wound).

Placement of a running suture with vertical P axis via the suprapubic trocar.
3.4.4 Use of a Hemicylindrical Model Placing Stitches Via the Suprapubic Trocar (Vertical P Axis)

Similarly to the previous one, this exercise also involves that the model is placed on its base resulting in a working angle of 0°. Again, the P axis of the needle holder is aligned parallel to the F axis of the wound. In this exercise, wound closure is practiced by placing three ‘Figure-of-X’ stitches by guiding the needle holder via the suprapubic trocar (Figs. 44, 45).

44 The hemicylindrical model is placed on its base resulting in a vertical F axis.

45 ‘Figure-of-X’ stitches placed on a hemicylindrical model with the needle holder’s P axis in a fully vertical position.
3.4.5 The ‘Wheel of Death’

The ‘Wheel of Death’ is placed above the model covering the pouch. The purpose of this auxiliary training module is to identify the hand that should be used as well as to perform the most appropriate stitch and to readjust the orientation of the needle in order to practice the various suturing angles usually encountered in a real surgical setting.

It is beyond the scope of this book to show all the angles offered by a versatile model such as this. Nevertheless, we included the basic training exercises in this edition.

The student should place a suture by following the motion sequence shown in the figures below:

The color codes indicate the hand and type of stitch that is ergonomically correct for each position. These color codes apply to all exercises described for the ‘Wheel of Death’.

The correct sequence no. 1 is the following: 8-1, 1-2, 2-0, 0-8.

- Right hand - reverse stitch
- Left hand - right stitch
- Right hand - right stitch
- Left hand - reverse stitch

The correct sequence no. 2 is the following: 8-0, 0-2, 2-1, 1-8, 8-7, 7-0, 0-3.

- Left hand - right stitch
- Right hand - reverse stitch
- Right hand - right stitch
- Left hand - reverse stitch
The ‘Wheel of Death’ training module allows to perform a variety of motion sequences that have been designed to promote the student’s understanding of laparoscopic suturing principles. This versatile module may also be used to perform an exercise called ‘The Sun’.

The correct sequence for this exercise is the following: 6-0, 0-2, 2-1 (external suture), 1-0, 0-5, 5-4 (external suture), 4-0, 0-8, 8-7 (external suture), 7-0, 0-3.

- Left hand - right stitch
- Right hand - reverse stitch
- Left hand - reverse stitch

Performing the ‘Sun’ exercise on the ‘Wheel of Death’. 
Flat or one-dimensional models like the ones shown above are designed to train surgeons being introduced to endoscopic surgery. In our training model, the advanced student becomes much more familiar with the three-dimensional suture angles encountered during in vivo surgery. To achieve this, we also use three-dimensional models that help students understand the correct placement of the needle in the needle holder and the best hand for a given angle.

Three-dimensional models require bimanual action and wrist rotation in order to properly place the suture. For this reason, students in our courses are trained gradually in order to develop a good degree of bimanual dexterity that facilitates a comfortable performance of three-dimensional exercises that have been designed to reenact those encountered in a real life situation in the operating room. (Fig. 50).
Appendix

Setup of the Realistic Endotrainer for Training Laparoscopic Suturing

1. Realistic Endotrainer.
2. Endotrainer with upper part opened.
3. Abdominal cavity with synthetic abdominal organs.
4. In order to prepare the endotrainer, uterus and intestine are lifted out of the pelvic region.
5. Both uterus and intestine are fixed to the upper abdomen with toothpicks or pins.
Recommended Literature


LYRA Laparoscopic Simulator
Instruments and Videoendoscopic Equipment
Recommended Set for Basic Course (per working station)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26003 AA</td>
<td>1 HOPKINS® Straight Forward Telescope 0°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: green</td>
</tr>
<tr>
<td>26003 BA</td>
<td>1 HOPKINS® Forward-Oblique Telescope 30°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, fiber optic light transmission incorporated, color code: red</td>
</tr>
<tr>
<td>26120 JL</td>
<td>1 VERESS Pneumoperitoneum Needle, with spring-loaded blunt inner cannula, Luer-Lock, autoclavable, diameter 2.1 mm, length 13 cm</td>
</tr>
<tr>
<td>30103 MTR</td>
<td>1 TERNAMIAN EndoTIP Cannula, with thread and rotatable insufflation stopcock, size 11 mm, working length 10.5 cm, color code: green</td>
</tr>
<tr>
<td>30120 GH</td>
<td>1 Trocar, with conical tip, without insufflation stopcock, size 6 mm, working length 6 cm, color code: black-white, for use with instruments size 5 mm</td>
</tr>
<tr>
<td>30120 H</td>
<td>2 Trocar only, with conical tip, size 6 mm</td>
</tr>
<tr>
<td>33332 MD</td>
<td>1 CLICKLINE KELLY Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with Luer-Lock irrigation connector for cleaning, double action jaws, size 5 mm, length 36 cm</td>
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<tr>
<td>33332 ML</td>
<td>1 CLICKLINE KELLY Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with Luer-Lock irrigation connector for cleaning, double action jaws, long, size 5 mm, length 36 cm</td>
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<tr>
<td>33332 CC</td>
<td>1 CLICKLINE CROCE-OLMI Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, atraumatic, fenestrated, curved, size 5 mm, length 36 cm</td>
</tr>
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<td>33332 SN</td>
<td>1 CLICKLINE SCHNEIDER Lymph Node Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with Luer-Lock irrigation connector for cleaning, single action jaws, atraumatic, size 5 mm, length 36 cm</td>
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<tr>
<td>33332 ME</td>
<td>1 CLICKLINE MAHES Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with Luer-Lock irrigation connector for cleaning, single action jaws, with multiple teeth, width of jaws 4.8 mm, for atraumatic and accurate grasping, size 5 mm, length 36 cm</td>
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<td>33332 KW</td>
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<tr>
<td>34321 MS</td>
<td>1 CLICKLINE METZENBAUM Scissors, rotating, dismantling, insulated, with connector pin for unipolar coagulation, with Luer-Lock connector for cleaning, double action jaws, curved, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>34321 EK</td>
<td>1 CLICKLINE Hook Scissors, rotating, dismantling, with connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, tips of jaws not crossing, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26173 SP</td>
<td>1 SZABO-BERCI Needle Holder “PARROT-JAW™”, with diamond coated jaws, straight handle, with ratchet, size 5 mm, length 33 cm, for suture material 2/0 – 4/0, needle size SH (Ethicon), EN-S (Sk), V 20 (USSC), for use with trocars size 6 mm</td>
</tr>
<tr>
<td>26173 KAL</td>
<td>1 KOH Macro Needle Holder, with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position right, jaws curved to left, size 5 mm, length 33 cm, for use with suture material size 0/0 to 7/0 and needle sizes BV, SH or CT-1</td>
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<tr>
<td>26173 KAR</td>
<td>1 KOH Macro Needle Holder, with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position left, jaws curved to right, size 5 mm, length 33 cm, for use with suture material size 0/0 to 7/0 and needle sizes BV, SH or CT-1</td>
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<tr>
<td>26596 CL</td>
<td>1 CICE Knot Tier, CLERMONT-FERRAND model, for extracorporeal knotting, size 5 mm, length 36 cm</td>
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<tr>
<td>26596 D</td>
<td>1 Knot Tier, for extracorporeal knotting, with open and closed end, size 5 mm, length 36 cm</td>
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<tr>
<td>TP 100 ES</td>
<td>1 TELE PACK X LED, endoscopic video unit for use with all KARL STORZ TELECAM one-chip camera heads and video endoscopes, incl. LED light source similar to Xenon technology, with integrated digital Image Processing Module, 15” LCD TFT-monitor with LED backlight, USB/SD memory module, color systems PAL/NTSC, power supply 100 - 240 VAC, 50/60 Hz</td>
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<tr>
<td>2021240</td>
<td>1 TELECAM One-Chip Camera Head, color system NTSC, autoclavable, soakable, gas-sterilizable, with integrated Parfocal Zoom Lens, f = 14 – 28 mm (2x), 2 freely programmable camera head buttons, including plastic container 39301 ACT for sterilization</td>
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<tr>
<td>495 NCSC</td>
<td>1 Fiber Optic Light Cable, with straight connector, extremely heat-resistant, safety lock, diameter 4.8 mm, length 250 cm</td>
</tr>
<tr>
<td>26344 L2</td>
<td>1 LYRA Laparoscopic Simulator, for laparoscopic and robot-assisted surgery, including the urinary tract, complete</td>
</tr>
<tr>
<td>26344 LE</td>
<td>2 Neoderme Organ, abdominal wall</td>
</tr>
</tbody>
</table>

It is recommended to check the suitability of the product for the intended procedure prior to use.
Recommended Set for use in Master and TOP Master Courses (per working station)

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<td>1 CLICKLINE Hook Scissors, rotating, dismantling, with connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, tips of jaws not crossing, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26173 SP</td>
<td>1 SZABO-BERCI Needle Holder “PARROT-JAW”™, with diamond coated jaws, straight handle, with ratchet, size 5 mm, length 33 cm, for suture material 2/0 – 4/0, needle size SH (Ethicon), EN-S (Skii), V 20 (USSC), for use with trocars size 6 mm</td>
</tr>
<tr>
<td>26173 HS</td>
<td>1 Handle Attachment, ergonomic, for use with Needle Holders 26173 SC/SE/CO/CE/SP and Assistant Needle Holders 26173 SA/SD/DW/DQ/QR, autoclavable</td>
</tr>
<tr>
<td>26173 KL</td>
<td>1 KOH Macro Needle Holder, with tungsten carbide insert, ergonomic handle with ratchet, ratchet position on top, jaws curved left, size 5 mm, length 33 cm, for use with suture material size 0/0 to 7/0 and needle sizes BV, SH or CT-1</td>
</tr>
<tr>
<td>30173 RA0</td>
<td>1 KOH Macro Needle Holder, dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, jaws curved to left, with tungsten carbide inserts, with ergonomic handle, axially, disengageable ratchet, ratchet position top, size 5 mm, length 33 cm, for use with suture material size 0/0 – 7/0</td>
</tr>
<tr>
<td>30173 LAO</td>
<td>1 KOH Macro Needle Holder, dismantling, with LUER-Lock irrigation connector for cleaning, single action jaws, jaws curved to left, with tungsten carbide inserts, with ergonomic handle, axially, disengageable ratchet, ratchet position top, size 5 mm, length 33 cm, for use with suture material size 0/0 – 7/0,</td>
</tr>
<tr>
<td>26173 KE</td>
<td>1 KECKSTEIN Needle Holder, size 5 mm, length 33 cm, for use with Handle Attachment Set 26173 KEA/KEB/KEC</td>
</tr>
<tr>
<td>26173 KEA</td>
<td>1 Handle Attachment Set, small, autoclavable, for 26173 KE</td>
</tr>
<tr>
<td>26173 CN</td>
<td>1 CADIÈRE Needle Holder, with tungsten carbide insert, straight handle, with ratchet and large Handle Attachment, size 5 mm, length 33 cm</td>
</tr>
<tr>
<td>26596 CL</td>
<td>1 CUSCHIERI Needle Holder ROTAGRIP, with rotating handle, straight jaws, size 5 mm, length 33 cm</td>
</tr>
<tr>
<td>26596 D</td>
<td>1 OICE Knot Tier, CLERMONT-FERRAND model, for extracorporeal knotting, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26596 MA</td>
<td>1 Knot Tier, for extracorporeal knotting, with open and closed end, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26596 K</td>
<td>1 MANGESHIKAR Knot Tier, for extracorporeal knotting, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26596 SK</td>
<td>1 KECKSTEIN Knot Tier, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>26596 KY</td>
<td>1 KOECKERLING Knot Tier, for extracorporeal knotting, size 5 mm, length 36 cm</td>
</tr>
<tr>
<td>20133101-1</td>
<td>1 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</td>
</tr>
<tr>
<td>26596 TC</td>
<td>1 IMAGE1 Camera Head, max. resolution 1920 x 1080 pixels, for monitors</td>
</tr>
<tr>
<td>TH 104</td>
<td>1 IMAGE1 S H3-3Z Three-Chip FULL HD Camera Head, IMAGE1 S compatible, autoclavable, max. resolution 1920 x 1080 pixels, 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 S and IMAGE1 HUB™ HD/HD</td>
</tr>
<tr>
<td>26173 NBL</td>
<td>1 Cold Light Fountain XENON 300 SCB, with KARL STORZ-SCB, with integrated anti-fog pump, 300 Watt Xenon bulb and KARL STORZ light connection, power supply 100-125/220-240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>9526 NBL</td>
<td>1 Fiber Optic Light Cable, with straight connector, extremely heat-resistant, safety lock, diameter 4.8 mm, length 250 cm</td>
</tr>
<tr>
<td>9526 NF</td>
<td>1 26° HD Monitor with LED Backlight, wall-mounted with VESA 100 adaption, color systems PAL/NTSC, max. screen resolution 1920 x 1080, image format 16:9, power supply 100 – 240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>26344 L2</td>
<td>1 Pedestal, for monitors</td>
</tr>
<tr>
<td>26344 LNF</td>
<td>1 LYRA Laparoscopic Simulator, for laparoscopic and robot- assisted surgery, including the urinary tract, complete</td>
</tr>
<tr>
<td>26344 LE</td>
<td>1 Nederme Organ, suturing model, for use with LYRA laparoscopy and NOTES Trainer</td>
</tr>
<tr>
<td>26344 LE</td>
<td>2 Nederme Organ, abdominal wall</td>
</tr>
</tbody>
</table>
HOPKINS® Telescopes
Diameter 10 mm, length 31 cm
Trocar size 11 mm

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

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

VERESS Pneumoperitoneum Needles

VERESS Pneumoperitoneum Needle,
with spring-loaded blunt inner cannula,
LUER-Lock, autoclavable,
diameter 2.1 mm, length 13 cm
TERNAMIAN EndoTIP Cannula
Size 11 mm

with connector for insufflation
for use with telescopes diameter 10 mm

United States patents 5,478,329 and 5,630,805

<table>
<thead>
<tr>
<th>Size:</th>
<th>11 mm:</th>
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<tbody>
<tr>
<td>Working length:</td>
<td>10.5 cm</td>
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<tr>
<td>Color code:</td>
<td>green-white</td>
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</tbody>
</table>

TERNAMIAN EndoTIP Cannula including:
- Cannula, with thread and rotatable insufflation stopcock
- Multifunctional Valve

Accessory
Telescope Stopper, sterile, for single use, package of 12

30103 TMR
30103 TM
30103 M1
30103 CS

Trocars
Size 6 mm

without connector for insufflation
for use with instruments size 5 mm

<table>
<thead>
<tr>
<th>Size:</th>
<th>6 mm:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working length:</td>
<td>6 cm</td>
</tr>
<tr>
<td>Color code:</td>
<td>black-white</td>
</tr>
</tbody>
</table>

Trocar, with conical tip including:
- Plastic Cannula, with thread and silicone leaflet valve
- Trocar only

30120 GH
30120 G
30120 H
CLICKLINE Dissecting and Grasping Forceps
Size 5 mm, length 36 cm

33332 MD CLICKLINE KELLY Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, double action jaws, size 5 mm, length 36 cm, including:
MANHES Metal Handle, with ratchet
Outer Sheath, insulated
Forceps Insert

33332 ML CLICKLINE KELLY Dissecting and Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, double action jaws, long, size 5 mm, length 36 cm, including:
MANHES Metal Handle, with ratchet
Metal Outer Sheath, insulated
Forceps Insert

33332 CC CLICKLINE CROCE-OLMI Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, single action jaws, atraumatic, fenestrated, curved, size 5 mm, length 36 cm, including:
MANHES Metal Handle, with ratchet
Outer Sheath, insulated
Forceps Insert

33332 SN CLICKLINE SCHNEIDER Lymph Node Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, single action jaws, atraumatic, size 5 mm, length 36 cm, including:
MANHES Metal Handle, with ratchet
Outer Sheath, insulated
Forceps Insert

33332 ME CLICKLINE MANHES Grasping Forceps, rotating, dismantling, without connector pin for unipolar coagulation, with LUER-Lock irrigation connector for cleaning, single action jaws, with multiple teeth, width of jaws 4.8 mm, for atraumatic and accurate grasping, size 5 mm, length 36 cm, including:
Metal Handle, with MANHES style ratchet
Metal Outer Sheath, insulated
Forceps Insert
CLICKLINE Grasping Forceps and Scissors

**CLICKLINE Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, atraumatic, fenestrated, size 5 mm, length 36 cm, including:
- MANHES Metal Handle, with ratchet
- Outer Sheath, insulated
- Forceps Insert

**CLICKLINE MATKOWITZ Grasping Forceps**, rotating, dismantling, without connector pin for unipolar coagulation, with irrigation connection for cleaning, double action jaws, tips of jaws not crossing, size 5 mm, length 36 cm, including:
- MANHES Metal Handle, with ratchet
- Metal Outer Sheath, insulated
- Forceps Insert

**CLICKLINE METZENBAUM Scissors**, rotating, dismantling, insulated, with connector pin for unipolar coagulation, with Luer-Lock connector for cleaning, double action jaws, curved, size 5 mm, length 36 cm, including:
- Plastic Handle, without ratchet
- Metal Outer Sheath
- Scissors Insert

**CLICKLINE Hook Scissors**, rotating, dismantling, with connector pin for unipolar coagulation, with irrigation connection for cleaning, single action jaws, tips of jaws not crossing, size 5 mm, length 36 cm, including:
- Plastic Handle, insulated, without ratchet
- Outer Sheath, insulated
- Scissors Insert
SZABO-BERCI Needle Holders “PARROT-JAW®”

Special features:
- Diamond coating for optimum safety in securing the needle in every position
- Ease of operation, precise adjustable ratchet or easy and safe positioning of the needle

Please note:
Using the needle holder with a needle larger than recommended may result in a mechanical damage to the instrument.
**KOH Macro Needle Holders**

*Size 5 mm*

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

<table>
<thead>
<tr>
<th>Length</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>43 cm</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distal Tip</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>26173 KAL KOH <em>Macro Needle Holder</em>, with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position right, jaws curved to left</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>26173 KAR KOH <em>Macro Needle Holder</em>, with tungsten carbide insert, ergonomic straight handle with disengageable ratchet, ratchet position left, jaws curved to right</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distal Tip</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image6.png" alt="Image" /></td>
<td>26173 KL KOH <em>Macro Needle Holder</em>, with tungsten carbide insert, ergonomic handle with ratchet, ratchet position on top, jaws curved to left</td>
</tr>
</tbody>
</table>
KOH Macro Needle Holder

**NEW**
dismantling, size 5 mm
Operating instruments, lengths 33 and 43 cm,
with axial handle for use with trocars size 6 mm

<table>
<thead>
<tr>
<th>Length</th>
<th>Handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td>30173 AO</td>
</tr>
<tr>
<td>43 cm</td>
<td></td>
</tr>
</tbody>
</table>

**Single action jaws**

<table>
<thead>
<tr>
<th>Working Insert</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173 R</td>
<td>KOH Macro Needle Holder, jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0</td>
</tr>
<tr>
<td>30173 L</td>
<td>KOH Macro Needle Holder, jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0</td>
</tr>
</tbody>
</table>

**Metal Outer Sheaths**
Size 5 mm

30173 A

30173 A **Metal Outer Sheath**, with LUER-Lock connector for cleaning, size 5 mm, length 33 cm

30178 A **Same**, length 43 cm
KECKSTEIN Needle Holder

with detachable handles, size 5 mm
Operating instruments, length 33 cm, for use with trocars size 6 mm

Special Features:
- 1 needle holder, 3 different handle jackets (small, medium, large)
- For different-sized hands
- Fully autoclavable
- Easily clicked into place
- Lightweight, plastic handle jackets fit comfortably in the hand

Please note:
Using the needle holder with a needle larger than recommended may result in a mechanical damage to the instrument.
**CADIERE Needle Holder**

*New*

Size 5 mm

Operating instruments, length 33 cm, for use with trocars size 6 mm

Special Features:

- Lightweight construction with plastic handles
- Large handles are also suitable for surgeons with larger hands
- Proven ratchet functionality
- Distal 2-cm marking at 5 and 10 cm
- Jaws curved to left

**CUSCHIERI Needle Holder ROTAGRIP**

*New*

with rotating handle attachment, size 5 mm

Operating instruments, length 33 cm, for use with trocars size 6 mm

Special Features:

- Ergonomic and rotating handle attachment: Muscle exertion is distributed among all five fingers when closing the grip holder
- Striated grip for a better hold
- Removable handle attachment for hygienic purposes
- Straight jaw

Please note:
Using the needle holder with a needle larger than recommended may result in a mechanical damage to the instrument.
Knot Tiers

Size 5 mm
Operating instruments, length 36 cm,
for use with trocars size 6 or 11 mm with reduction sleeve

26596 CL  CICE Knot Tier, CLERMONT-FERRAND model, for extracorporeal knotting, size 5 mm, length 36 cm

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

26596 MA MANGESHIKAR Knot Tier, for extracorporeal knotting, size 5 mm, length 36 cm

26596 K KECKSTEIN Knot Tier, size 5 mm, length 36 cm including:
Handle
Outer Sheath, with knife
Thread Guide

26596 SK KÖCKERLING Knot Tier, for extracorporeal knotting, size 5 mm, length 36 cm
TELE PACK X LED  NEW
Sample Configuration

TP 100ES

endoscopic video unit for use with all KARL STORZ TELECAM one-chip camera heads and video endoscopes, incl. LED light source similar to Xenon technology, with integrated digital Image Processing Module, 15" LCD TFT-monitor with LED backlight, USB/SD memory module, color systems PAL/NTSC, power supply 100 - 240 VAC, 50/60 Hz including:

USB Silicone Keyboard, with touchpad, US character set
USB Flash Drive, 4 GB
Mains Cord
Mains Cord, US version

Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power input</td>
<td>100 W</td>
</tr>
<tr>
<td>Power supply</td>
<td>100-240 VAC</td>
</tr>
<tr>
<td>Dimensions</td>
<td>450 x 350 x 150</td>
</tr>
<tr>
<td>Weight</td>
<td>7 kg</td>
</tr>
<tr>
<td>Interface</td>
<td>- video interface: DVI-D (in/out)</td>
</tr>
<tr>
<td></td>
<td>- audio: 3.5 mm phonejack (1x lateral,</td>
</tr>
<tr>
<td></td>
<td>1x rear), Line in, Line out</td>
</tr>
<tr>
<td></td>
<td>- footswitch port: 5-pin socket for two-pedal</td>
</tr>
<tr>
<td></td>
<td>footprint: 5-pin socket for two-pedal</td>
</tr>
<tr>
<td>Light source</td>
<td>- lamp: Metal halid 50 W</td>
</tr>
<tr>
<td></td>
<td>- color temperature: 5700 K</td>
</tr>
<tr>
<td></td>
<td>- average service life: approx. 1000 h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image format</td>
<td>JPG</td>
</tr>
<tr>
<td>Video codec</td>
<td>MPEG-4</td>
</tr>
<tr>
<td>Video format</td>
<td>PAL/NTSC</td>
</tr>
<tr>
<td>Memory interface</td>
<td>USB 2.0; SD memory card (SDHC compatible)</td>
</tr>
<tr>
<td>TFT monitor</td>
<td>- screen size: 15&quot;</td>
</tr>
<tr>
<td></td>
<td>- resolution: 1024 x 768</td>
</tr>
<tr>
<td></td>
<td>- contrast: 700:1</td>
</tr>
<tr>
<td>Loudspeaker output</td>
<td>2 W</td>
</tr>
</tbody>
</table>

TELECAM SL II
Camera Head

color systems PAL/NTSC, autoclavable, soakable, gassterilizable, with integrated Parfocal Zoom Lens, f = 14 – 28 mm (2x), 2 freely programmable camera head buttons, including plastic container 39301 ACT for sterilization
IMAGE1 S Camera System

**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
- Side-by-side view: Parallel display of standard image and the Visualization mode
- Multiple source control: IMAGE1 S 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**

**Side-by-side view: Parallel display of standard image and Visualization mode**
**IMAGE1 S Camera System**

Brilliant Imaging
- Clear and razor-sharp endoscopic images in FULL HD
- Natural color rendition

- Reflection is minimized
- Multiple IMAGE1 S technologies for homogeneous illumination, contrast enhancement and color shifting

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**FULL HD image**

**CLARA**

**FULL HD image**

**CHROMA**

**FULL HD image**

**SPECTRA A**

**FULL HD image**

**SPECTRA B**

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* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
IMAGE1 S Camera System

TC 200EN

TC 200EN* IMAGE1 S 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:

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 200EN* Details</th>
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</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>- 2x DVI-D</td>
</tr>
<tr>
<td></td>
<td>- 1x 3G-SDI</td>
</tr>
<tr>
<td>Format signal outputs</td>
<td>1920 x 1080p. 50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>3x</td>
</tr>
<tr>
<td>USB interface</td>
<td>4x USB, (2x front, 2x rear)</td>
</tr>
<tr>
<td>SCB interface</td>
<td>2x 6-pin mini-DIN</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.1 kg</td>
</tr>
</tbody>
</table>

For use with IMAGE1 S

IMAGE1 S CONNECT Module TC 200EN

TC 300

TC 300 IMAGE1 S 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 S CONNECT TC 200EN
including:
Mains Cord, length 300 cm
Link Cable, length 20 cm

Specifications:

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 300 (H3-Link) Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera System</td>
<td>Supported camera heads/video endoscopes</td>
</tr>
<tr>
<td>LINK video outputs</td>
<td>1x</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
Romeo's Gladiator Rule: Knots, Stitches and Knot Tying Techniques – A Tutorial Based On A Few Simple Rules

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

20133027 XENON Spare Lamp, only, 300 watt, 15 volt

IMAGE1 S Camera Heads

FOR USE WITH IMAGE1 S Camera System IMAGE1 S CONNECT Module TC 200EN, IMAGE1 S H3-LINK Module TC 300 and with all IMAGE1 HUB™ HD Camera Control Units

TH 104 IMAGE1 S H3-ZA Three-Chip FULL HD Camera Head, 50/60 Hz, IMAGE1 S 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 S and IMAGE1 HUB™ HD/HD

Specifications:

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-ZA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 104</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x 1/3&quot; CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 100 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>299 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, f = 15–31 mm (2x)</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adapter</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>

Fiber Optic Light Cable

495 NCSC Fiber Optic Light Cable, with straight connector, extremely heat-resistant, safety lock, diameter 4.8 mm, length 250 cm
Monitors

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

26" FULL HD Monitor, wall-mounted with VESA 100 adaption, color systems PAL/NTSC, max. screen resolution 1920 x 1080, image format 16:9, power supply 100–240 VAC, 50/60 Hz including:

- External 24 VDC Power Supply
- Mains Cord
Monitors

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted with VESA 100 adaption</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Inputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fibre Optic</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Outputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>Signal Format Display:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:3</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5:4</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>16:9</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PAL/NTSC compatible</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Optional accessories:
9826 SF       Pedestal, for monitor 9826 NB
9626 SF       Pedestal, for monitor 9619 NB

Specifications:

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

LYRA Laparoscopic Simulator, for laparoscopic and robot-assisted surgery, including the urinary tract, complete including:

LYRA Body Laparoscopic Simulator
- Neoderm Organ, liver
- Neoderm Organ, spleen
- Neoderm Organ, stomach
- Neoderm Organ, peritoneum
- Neoderm Organ, bowel
- Neoderm Organ, abdominal wall
- Neoderm Organ, cul-de-sac
- Neoderm Organ, vaginal block
- Neoderm Organ, uterus
- Neoderm Organ, suturing model

Optional Accessories

LYRA Laparoscopic Trainer

Trainers
LYRA Laparoscopic Trainer

- Neoderm Organ, abdominal wall
- Neoderm Organ, suturing model
with the compliments of
KARL STORZ — ENDOSKOPE