Tips and Tricks for Advanced Laparoscopic Procedures

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Then......

- Diagnostic Laparoscopy
- 1- & 2-stage Laparoscopic Orchidopexy
- Varicocelectomy
- Laparoscopic Nephrectomy and Nephroureterectomy
Now......

- Excision
  - Kidney, ureter, bladder, genital anomalies

- Reconstruction
  - Pyeloplasty
  - Ureteroureterostomy
  - Ureteral reimplantation
  - Bladder Augmentation
  - Continent catheterizable stomas
  - Fetal Surgery
Difficulties with Advanced Laparoscopic Procedures

- Duration of the procedure
- Amount of Suturing
- Multiple operative sites
- Different cavity (abdominal vs. bladder vs. uterine)
Solutions for Advanced Laparoscopic Procedure

- Duration --> ergonomics
- Suturing --> movement vectors
- Multiple sites --> port location
- Alternative cavities --> space limitation
Ergonomics

- High levels of mental & physical stress
  - 4 hrs --> surgical fatigue syndrome
    - mental exhaustion
    - reduced dexterity
    - reduced capacity for good judgement

Etiology of Mental Stress

- View of operative situation is widely separated from the field of action (Hanna et al., Ann Surg, 1998)
- 2-D view needs to be interpreted and synchronized to instrument movements
- Tip of instruments moves in opposite direction to the handle (Crothers et al., Endoscopy, 1999)
- Multiple devices need to be monitored
Etiology of Physical Stress

- Standing in a fixed position determined by placement of trocars and the position of the monitor
- Strain to eyes, head, neck and spine \(^{(Nguyen\ et\ al.,\ Am\ J\ Surg,\ 2001)}\)
- Forces needs to control lap. instruments
  - 6x greater than open surgery \(^{(Berguer\ et\ al.,\ Surg\ Endosc,\ 1999)}\)
  - Injury to nerves of the thumb and thenar \(^{(Horgan\ et\ al.,\ MITAT,\ 1997)}\)
Ergonomic Solution

- Non-neutral position of the surgeon during lap. surgery
- Instrument design
- Position of the monitor
- Foot pedal
- OR table height
- Body posture

(van Veelen et al., MITAT, 2004)
Instrument Design

1. The angle between handle and shaft must be between 14° and 50°.
2. When the handle is manipulated with a precision grip, wrist excursions must be neutral for 70% of the manipulating time.
3. When the handle is manipulated with a force grip, wrist excursions must be neutral for 70% of the manipulating time.
4. The grip opening must be between 60 and 80 mm.
5. Any disturbances (e.g. friction and spring forces) must be avoided to enable an optimal force feedback of tissue on the surgeon’s hands: if the handle is manipulated in free spaces, no friction must be experienced.
6. The handle must have a minimum width of 10 mm to prevent extreme contact area pressure.
7. The instrument must be provided with a rotation knob to allow rotation of the instrument tip. This control switch must be manipulated with the thumb or 2nd finger and when the instrument is manipulated in free spaces, no friction must be experienced.
8. The handle must allow left- and right-handed manipulation.
9. The dimensions of the finger rings must be: inner length minimal 30 mm, inner width minimal 24 mm.
10. The handle of a dissection forceps has to support a precision as well as a force grip for manipulation.
Instrument Design

1. The grasping forceps must be operated by one hand of the surgeon.
2. The handle of the grasping forceps has to support right- and left-handed manipulation.
3. The angle between handle and shaft must be between 40° and 50°.
4. The grip opening must be between 60 and 80 mm.
5. For in-line handles: the length of the grip handle may not be longer than 170 mm.
6. During manipulation, the wrist of the surgeon has to stay within the neutral zone of 20° extension, 40° flexion, 15° radial deviation and 25° ulnar deviation. During manipulation, extreme wrist excursions should not occupy more than 30% of the total manipulation time.
7. The handle of the grasping forceps must have a minimum width of 10 mm to avoid pressure areas.
8. If the handle contains finger rings, the dimensions of these finger rings must be: length 30 mm, width 24 mm.
9. Forces may not be exerted on the ball of the thumb or the palm of the hand.
10. The necessary closing force on the hand or fingers may not be more than 15 N.
11. Specific grooves in a handle for positioning the fingers must be avoided.
12. The handle of the grasping forceps has to support a “force-precision grip”.
13. Operation of the handle must be possible for different hand postures.
14. If the handle is manipulated in free spaces, no friction must be experienced.
15. The instrument must be provided with a rotation knob to allow rotation of the instrument tip. This control switch and/or other control buttons must be manipulated with thumb or forefinger and manipulated in free spaces no friction must be experienced.
16. The ratchet must be controlled without repositioning of the hand.
17. The handle must have an option to put the ratchet function on and off.
1. The needle holder must be operated by one hand of the surgeon.
2. The handle of the needle holder has to support right- and left-handed suturing.
3. The angle between handle and shaft must be between 40° and 50°.
4. For in line handles: the length of the grip handle may not be longer than 170 mm.
5. If the four fingers are used to create a grip force, the length of the area where the force will be placed may not be smaller than 93 mm.
6. During manipulation, the wrist of the surgeon has to stay within the neutral zone of 20° extension, 40° flexion, 15° radial deviation and 25° ulnar deviation. During manipulation, extreme wrist excursions should not occupy more than 30% of the total manipulation time.
7. The handle of the needle holder must have a minimum width of 10 mm to avoid pressure areas.
8. If the handle contains finger rings, the dimensions of these finger rings must be: length 30 mm, width 24 mm.
9. Forces may not be exerted on the ball of the thumb or the palm of the hand.
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11. Specific grooves in a handle for positioning the fingers must be avoided.
12. The handle of the needle holder has to support a “force-precision grip”.
13. The ratchet must be controlled without repositioning of the hand.
14. The handle must have an option to put the ratchet function on and off.
Laparoscopic Camera

1. Attaching and detaching the camera adapter to the scope must allow one-handed operation through a sterile drape.
2. During manipulation, the wrist of the user has to stay within the neutral zone of 20° extension, 40° flexion, 15° radial deviation and 25° ulnar deviation. During manipulation, extreme wrist excursions should not occupy more than 30% of the total manipulation time.
3. The diameter of the grip entity must fall between 10–90 mm, with a preferred value of 35–65 mm.
4. The length of the handle entity must fall between 72–140 mm, with a preferred value of 102–120 mm.
5. The center of mass of the entire scope assembly must be near the grasping point.
6. Operation of any function controls on the camera head, including focus and zoom adjustment, must allow one-handed operation through a sterile drape.
7. The camera head must allow manipulation with different hand postures.
8. The handle of the camera has to support right- and left-handed manipulation.
The optimal monitor position is in front of the subject, on a height between the surgeon's head and hands, in such a way that his head flexions are between 15–45° to the horizontal.
Foot Pedals

1. The design of the foot pedal must avoid a static standing posture.
2. A dorsal flexion of more than 25° to control the foot switch is not allowed.
3. The force for activation must be maximum 10 N.
4. A frequent dorsal flexion of the foot should be avoided.
5. The foot pedal should be controllable by clogs with the following (external) dimensions: maximum length 295 mm and minimum length 230 mm; maximum width 108 mm and minimum width 85 mm; maximum toe height 60 mm and minimum toe height 50 mm; and a total maximum clog height of 115 mm.
6. The foot pedal must be controlled without looking at the foot pedal.
7. The chance of accidentally activating the wrong switch function must be minimized by having a difference in control between the different functions.
8. The foot pedal must be controllable with or without clogs.
9. During control of the foot pedal the foot pedal may not move.
10. The chance of losing contact with the foot pedal must be minimal.
Operating Table

The operating surface height must lay between a factor 0.7 and 0.8 of the subjects elbow height.
Standing Support

During surgery the subject should use a standing support that is adjustable between 780 mm and 1020 mm.
Suturing
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The radius of the arc of revolution decreases as the instrument shaft is placed deeper into the patient.
Suturing - Knot tying
Suturing: Hitch Stitch

- Tension and counter-tension

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Port Location

Principle of Triangulation
Alternative Cavities

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Now, that's more ergonomic...