

4 Instrument Ergonomics

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4.1 Endoscopic Surgery and Surgeons

Although endoscopic surgery has proven beneficial for patients because it entails less trauma and a shorter hospital stay, the procedure is quite strenuous for the surgeon. Often, limited knowledge of port placement and its dynamics accentuates this problem and adds to technical challenges faced during surgery. Surgeons often experience muscle fatigue and injuries in their hands and upper extremity because of awkward grasping and arm positioning over long periods of time.

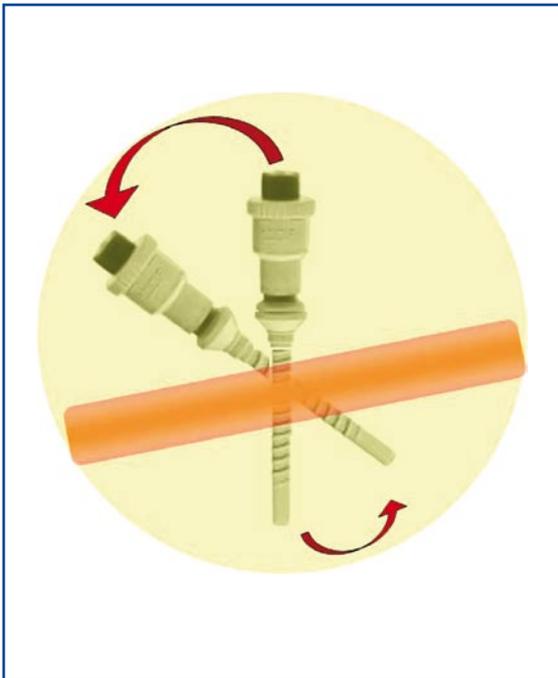
4.2 Ergonomics and Instruments

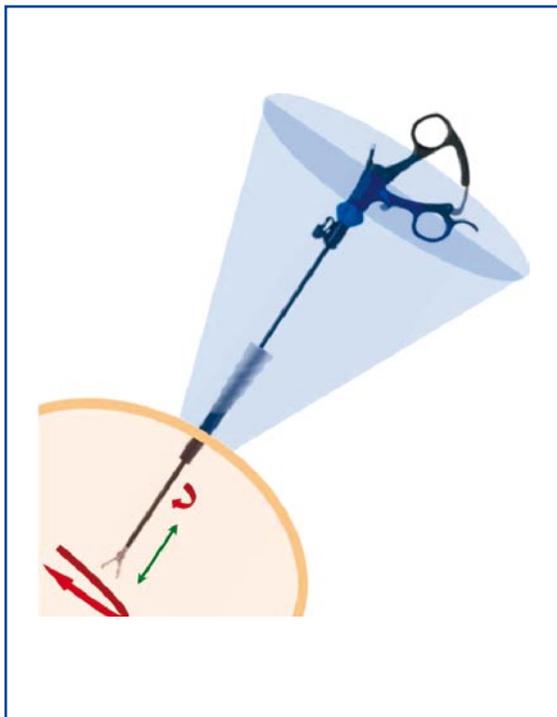
The present working conditions for endoscopic surgeons are not satisfactory and there is a clear need for more awareness regarding instrument ergonomics. Both manufacturers and surgeons focus almost entirely on the functionality of the instrument tip, leaving the hand–handle interface unattended. Surgeons are commonly too concentrated on performing the task to notice the inconveniences of the instrument during surgery.

4.2.1 Paradoxical Port Movement

The working ports inserted into the abdominal cavity have a tendency to move in different directions since the area securing the port lies approximately in the mid point. In addition, the weight of the port is not evenly distributed, which further accentuates the various degrees of movement.

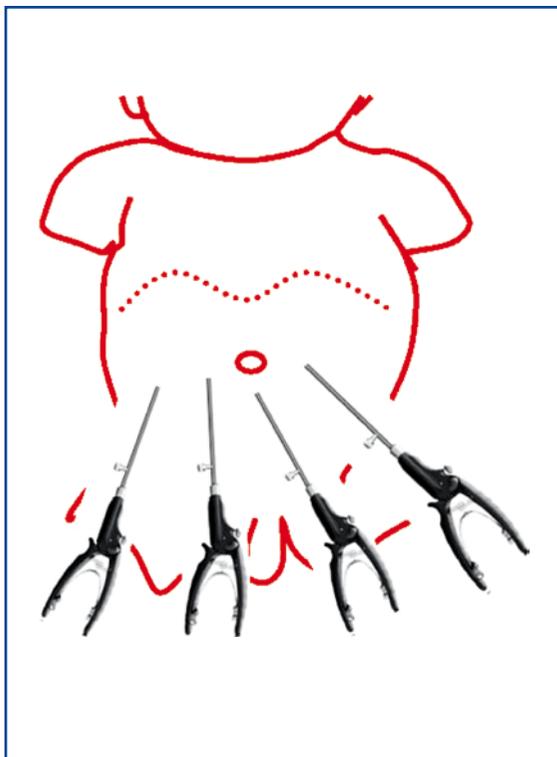
Although ports are fixed at the point of entry into the abdomen, paradoxical movements of the port are encountered every time the instruments are changed. Coordination of the surgical assistant or the scrub nurse is important to secure the ports (if required) during introduction of the instruments.





4.2.2 Working Field Perimeters

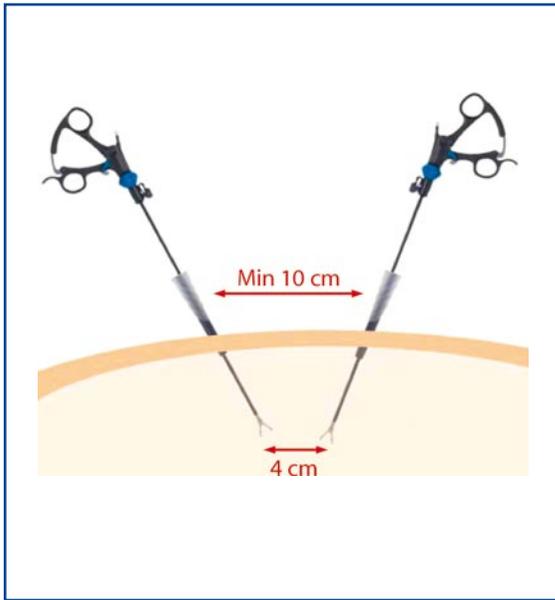
Working ports have a cone-shaped field inside and outside the abdomen. The degree of movements of both of the fields should be borne in mind when introducing the ports through the body cavities. The limitations of work fields require good understanding so as to enable the easy manipulation of tissue. Narrow work field parameters can lead to extreme technical difficulties when suturing and knot tying. An optimal work field must be worked out before any endoscopic surgery procedure is carried out.



4.2.3 Instrument Cluttering

Crowding of instruments in the abdominal cavity does not provide better access. It only leads to increased confusion and further increases the technical difficulties in trying to achieve the desired objective. Optimal number of instruments for endoscopic surgery must be utilized not only in advanced procedures, but also in basic ones.

In the pediatric abdomen, which is even smaller than that of the adult, this practice of instrument cluttering should be avoided. Instrument cluttering may be responsible for adjacent tissue injuries, since the attention of the surgeon is diverted away from the passively used instruments.



4.2.4 Working Angles

Optimum working angles are necessary for desired tissue manipulation. However, it is of paramount importance to have the best working angles in endoscopic procedures that require suturing and knotting.

A distance of 10 cm between the working ports outside the body cavity, if possible, provides a relatively good suturing field. However, inside the body cavity, a working distance of 4 cm is desired at the point where the tips of the needle holders meet to enable comfortable suturing and knotting.

4.2.5 Handle Design

The handle is the instrument's interface, where the surgeon can interact with the instrument. A good indication of a functional instrument is when the surgeon can forget about the tool and just concentrate on the job. The hand-handle interface should be "invisible" so that the tool can function merely as an extension of the arm.

4.2.7 Hand and Wrist Movements

The most important positioning of the hand is called the neutral position, or the position of rest. This occurs typically when the hand is resting in a palm-medial position with fingers slightly flexed. It is the most comfortable hand position and it is also the situation in which the hand can perform optimally with both force and precision.

4.2.6 Power Grip and Precision

The classic categorization of grips distinguishes power grips from precision grips. A power grip requires great force but little precision and vice versa. Both power-, precision, and combination grips function optimally when the hand is in its neutral position. This characteristic of grips stresses the importance of keeping the wrist in a neutral position.

4.2.8 Adaptation for Various Hand Sizes

The instrument handle should provide usability for all surgeons or be adjustable to all its users' various hand sizes, as individual fitting is often not possible with today's mass-production. For endoscopic instruments, hand size is an important determinant of difficulty of use. Individuals with small hands experience problems more commonly than those with large hand sizes.

4.2.8.1 Handle Grip Diameter

The handle should be of such a size that it permits slight overlap of the thumb and fingers of a surgeon with small hands. A handle diameter of 40–50 mm can provide sufficient support as well as allow strength to be applied for most surgeons. If the handle is too small it will not allow proper force exertion, but at the same time, strength deteriorates with a handle size above 50 mm.

4.2.9 Buttons and Springs

In endoscopic surgery the result of the procedure is determined by the surgeon's ability to keep the instrument steady during manipulation. Awkwardly positioned buttons and springs that require great force to be operated can result in jeopardizing the movements of the instrument tip. It should be possible for the user to operate buttons and springs without major repositioning of the fingers.

4.2.8.2 Handle Length and Cross-Section

Handle lengths should be at least 115 mm and allow clearance for extra large hands. If gloves are to be used, extra length must be added depending on glove type and thickness. Handles of circular cross-section (and appropriate diameter, e.g., 30–50 mm) are the most comfortable to grip.

4.2.10 Multifunctionality of Handles

Putting too many functions in one handle can render its use more difficult to learn, harder to remember, or simply confusing for surgeons. It is especially important to keep the functionality of the handle simple when the task itself is complicated, as in endoscopic surgery.

When it comes to endoscopic surgical instruments, less is really a lot more.

Recommended Literature

1. Berguer R, Hreljac A (2004) The relationship between hand size and difficulty using surgical instruments: A survey of 726 laparoscopic surgeons. *Surg Endosc* 18:508–512
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3. Vereczkel A, Bubb H, Feussner H (2003) Laparoscopic surgery and ergonomics – it's time to think of ourselves as well. *Surg Endosc* 17:1680–1682