KALS Kandy Academy of Laparoscopic Surgery

Ergonomics In Laparoscopy

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Why is laparoscopic surgery more difficult than traditional open surgery?

- Require a higher level of expertise.
- Long learning curve with extensive training and regular updates to skills and knowledge.
- Prolonged duration leads to reduced efficiency.

Limitations in laparoscopic surgery

1.Visual limitations

- Limited Depth Perception
- Limited and indirect view
- Mirror Effect

2. Limitations in instrument handling

- Constrained/limited operating field
- Restricted Movements
  Fulcrum Effect
- Reduced Tactile Feedback
  Scaling Effect
- Decoupling visual and motor axes
  Tremor enhancement

Ergonomics

- Ergonomics is **the study of the interactions between individuals and their workspace layout and environment** to optimize performance, comfort, and safety.

- In the context of laparoscopic surgery, ergonomic principles are particularly vital.

Why ergonomic matters

- Ergonomics is especially important in laparoscopy
- Port sites are fixed once inserted
- Poor positioning cannot be easily corrected later
- Proper theatre layout reduces strain on the surgeon
- Correct instrument placement improves comfort and control
- Training in ergonomic principles lowers musculoskeletal injury risk
- Improves surgical efficiency
- Enhances patient safety
- Leads to better surgical outcomes

Important aspects of ergonomics in laparoscopy

1. Body posture and positioning
2. Workstation set up – Monitors and other equipment
3. Physical environment control
4. Instrument design and handling

Body posture and positioning

- Laparoscopic surgery can lead to significant strain on the surgeon’s body, leading to

  - Neck pain and spondylitis
  - Shoulder pain/ backache
  - Hand, finger, and joint pain
  - Tenosynovitis
  - Burning eyes
  - Stress exhaustion

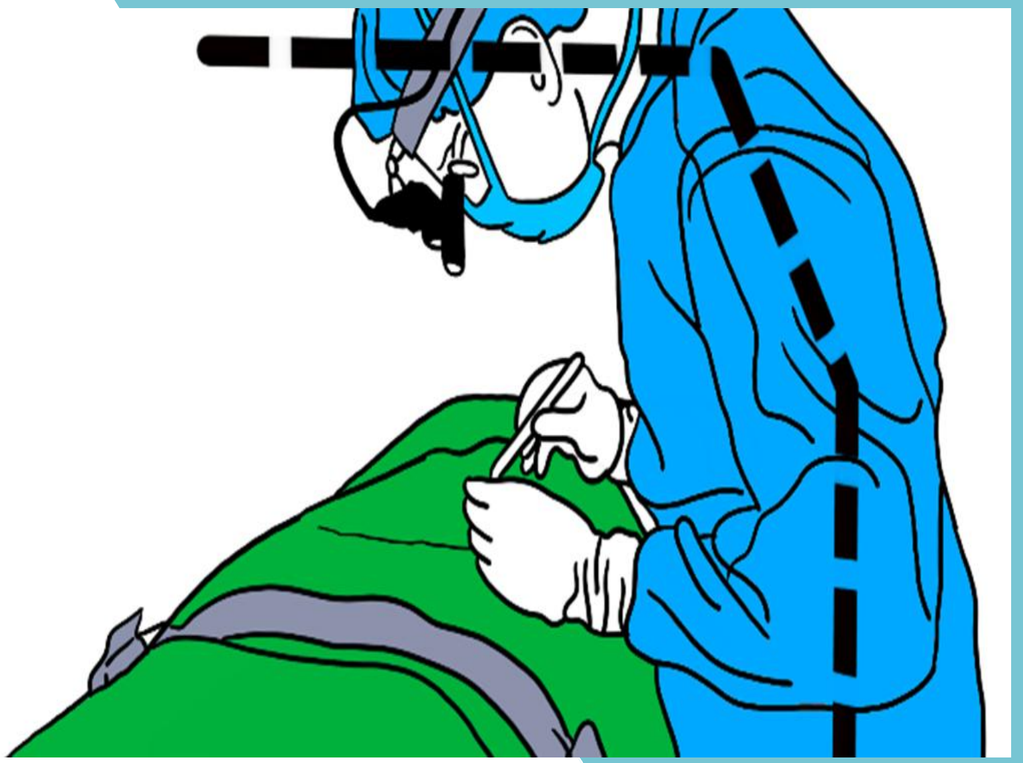
Ideal body posture

- Straight back
- Relaxed stance
- slightly flexed neck
- Slight downward gaze
- No instruments , clamps between surgeon and OT table

Incorrect body posture

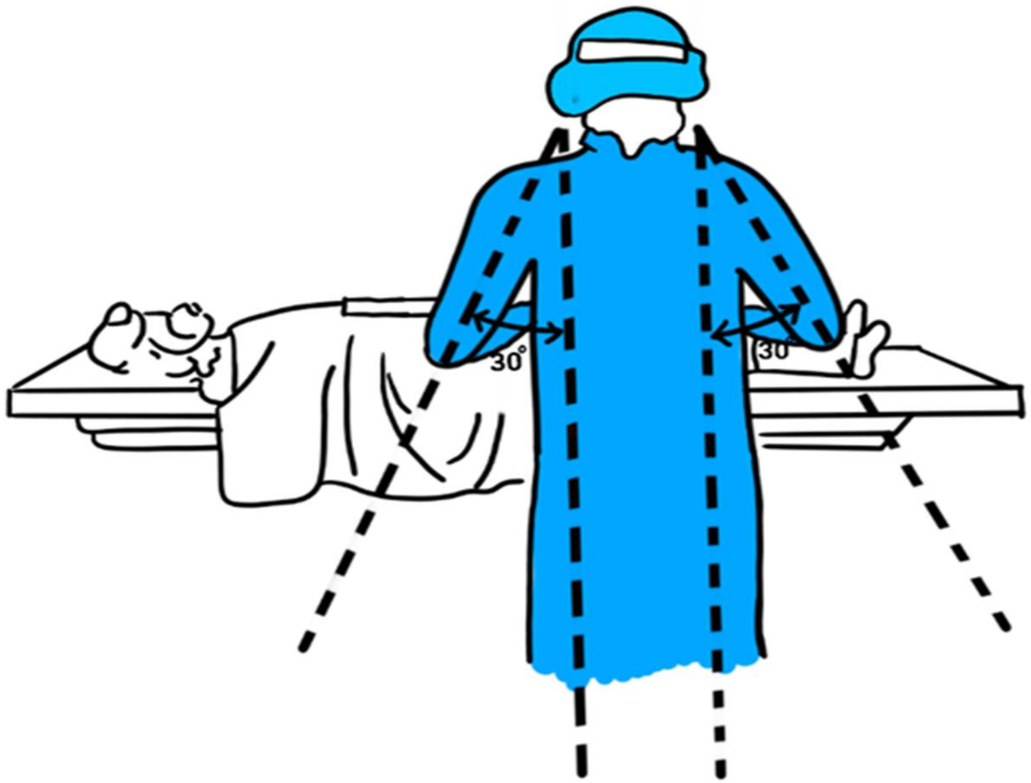
- Hunched back
- Flexed neck

- Will cause strain on back and shoulder muscles



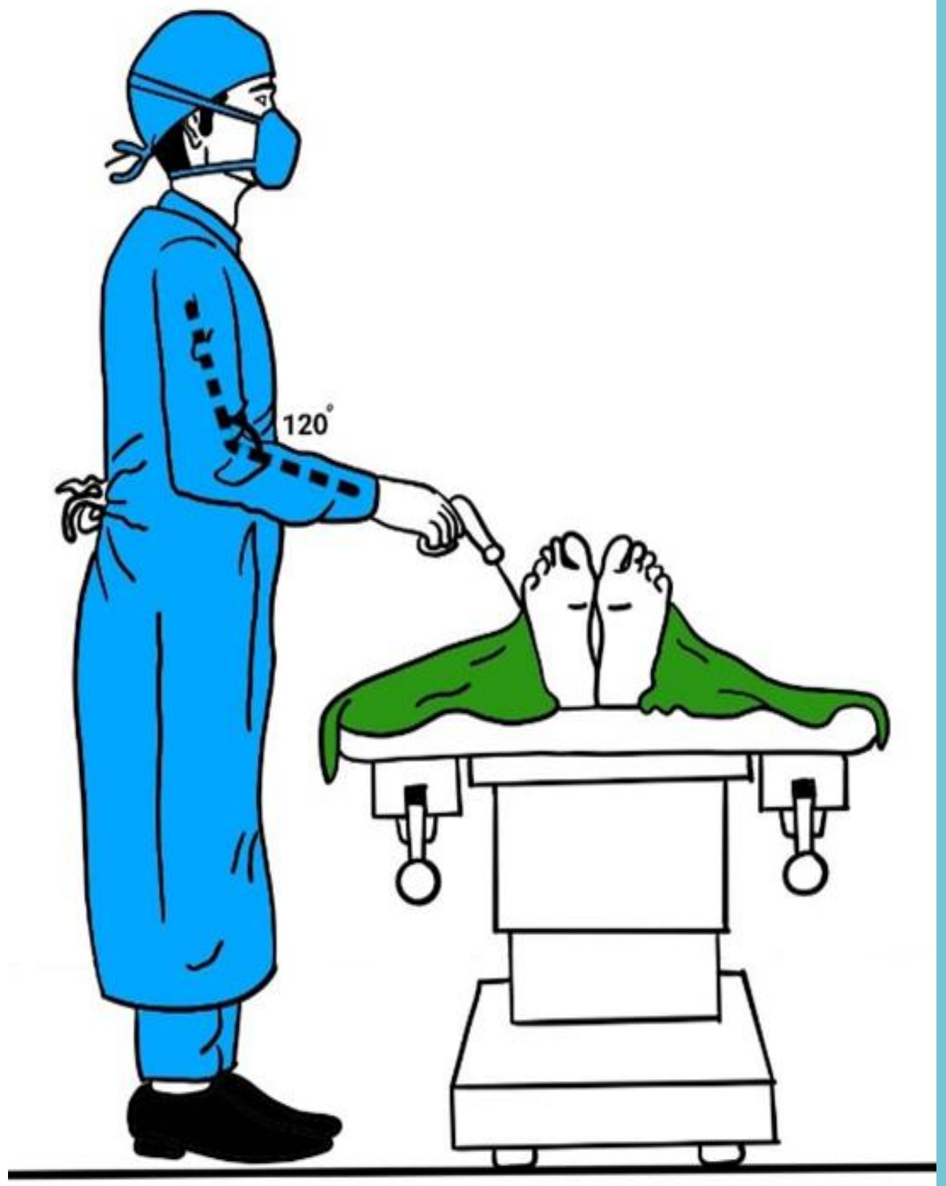
Instrument handling

- The angle between the surgeon’s body and the arm:
  - surgeon's arms should be slightly abducted
  - Retroverted
  - rotated inward at shoulder level, in a resting position, maintaining a 15˚-30˚ angle.



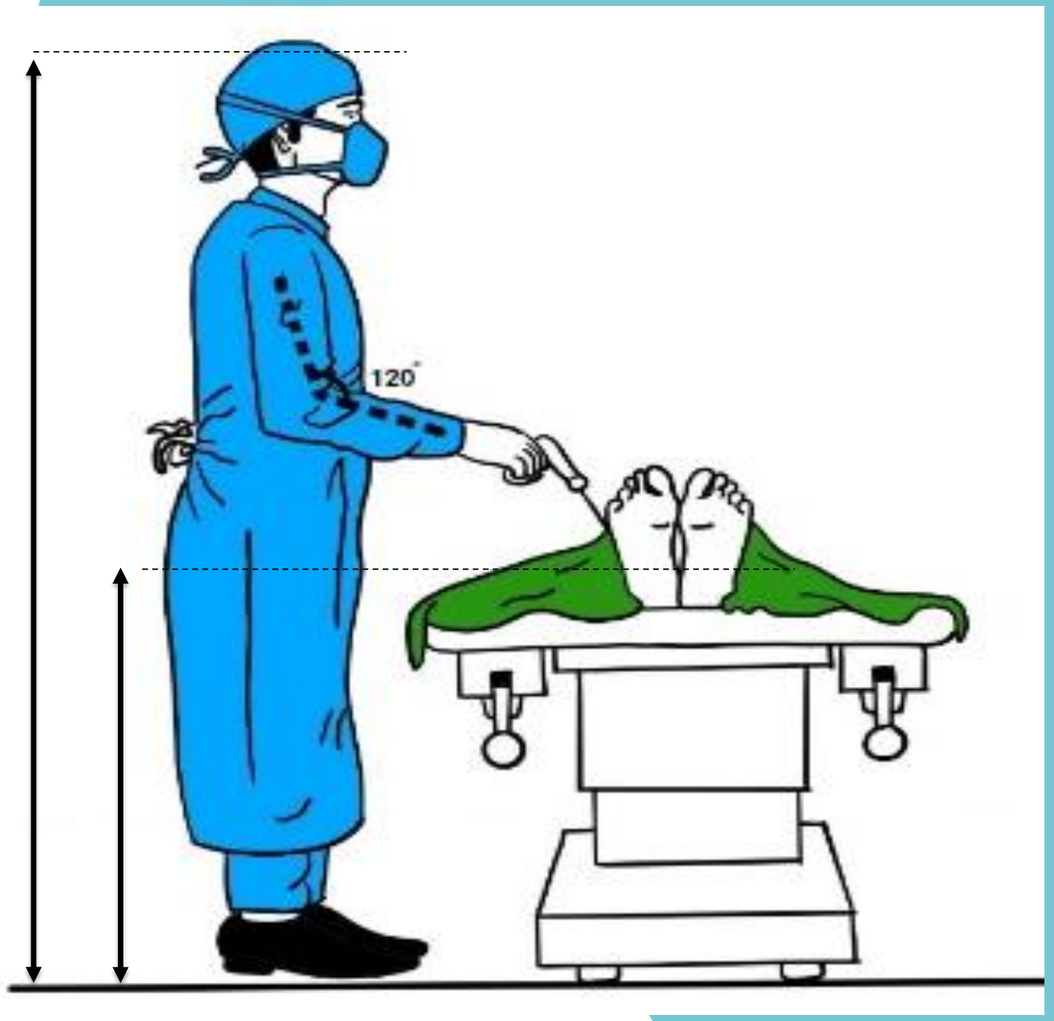
Instrument handling

- An arm–forearm angle of about 120° is ideal, guided by proper table height.
- The wrists remain slightly extended, with fingers positioned for relaxed, efficient grasping.



Operating table

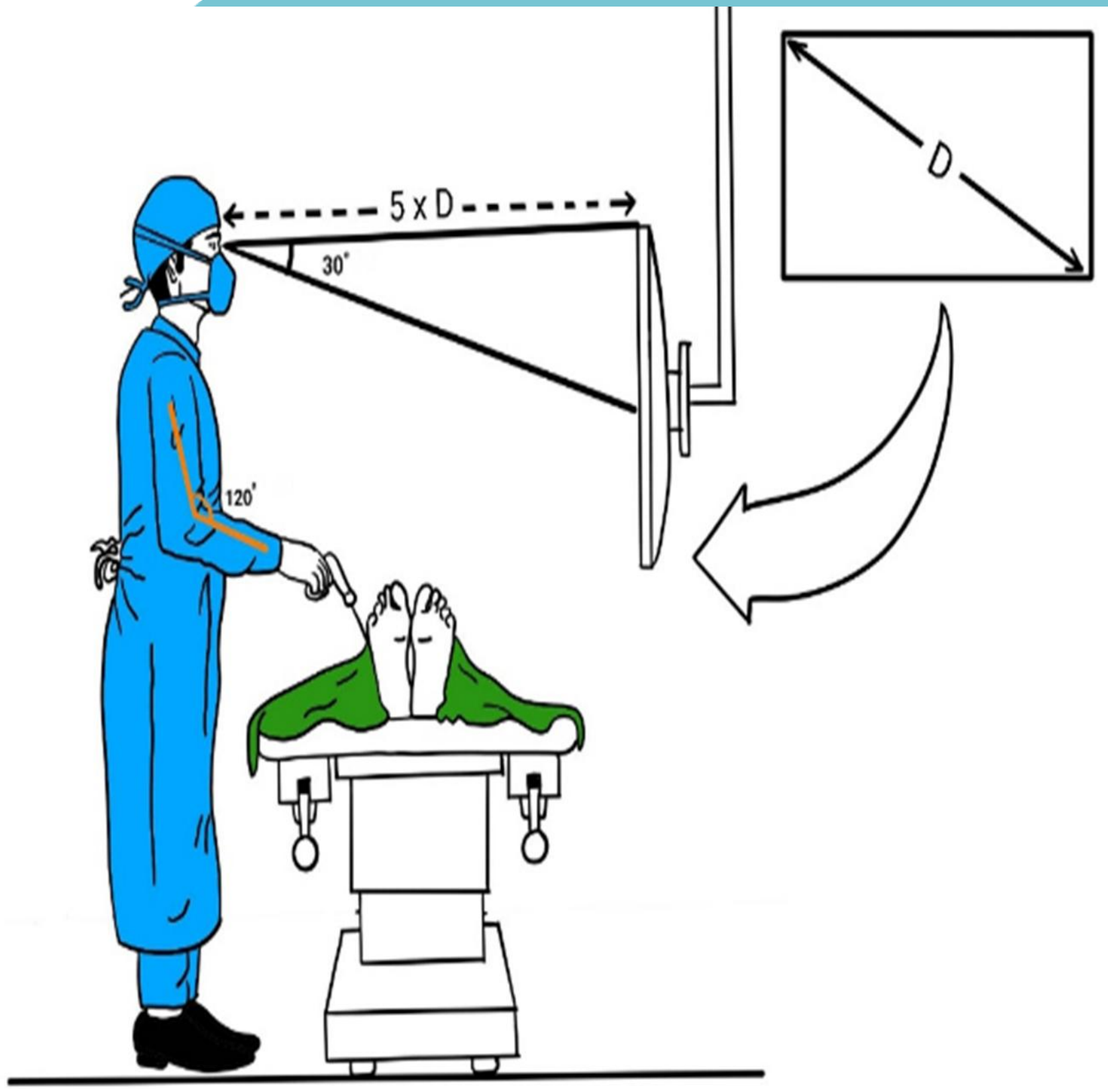
- The operating table should be slightly below the surgeon’s hip level
- Height of the operating table = Height of the surgeon(m) × 0.49



Placement of the monitor

- The monitor should be placed
  - Directly in front of the surgeon
  - On the side of the target organ
  - Slightly below eye level
  - Allowing a neutral head position with a gentle downward gaze.

- The monitor should be placed
  - Distance - 5 times the diagonal length of the monitor



Coaxial alignment

- Involves positioning the surgeon, surgical site, and monitor along the same line.

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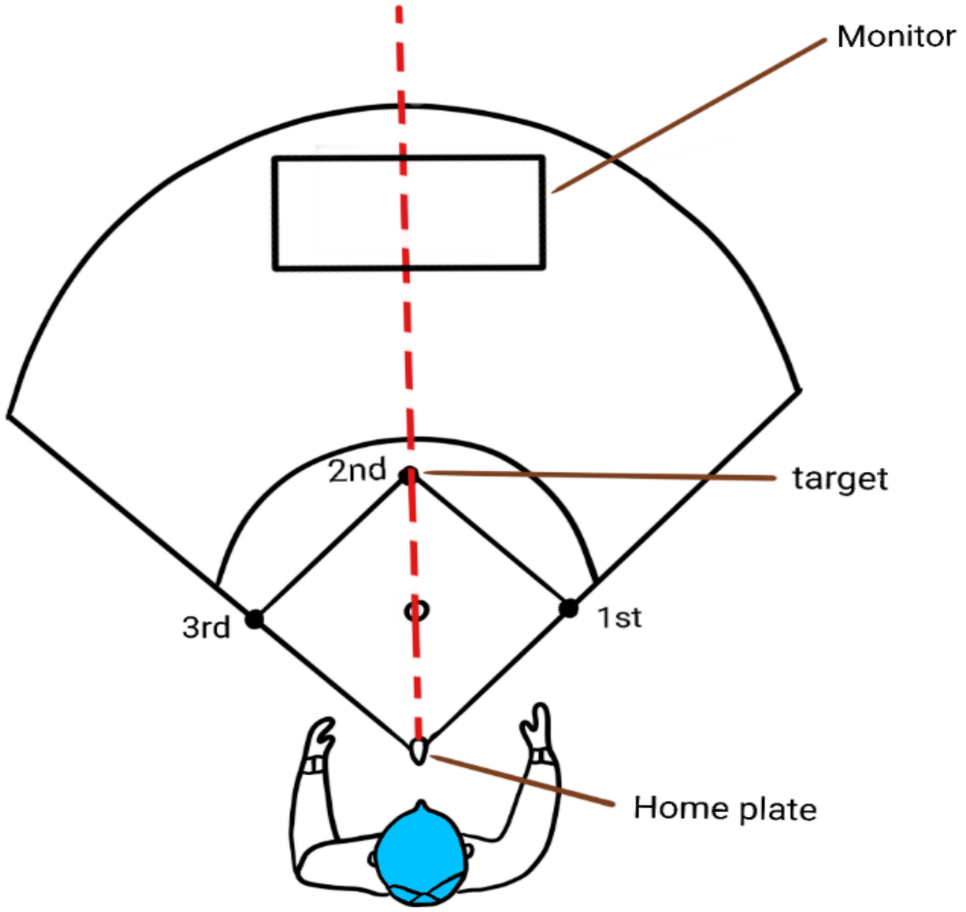
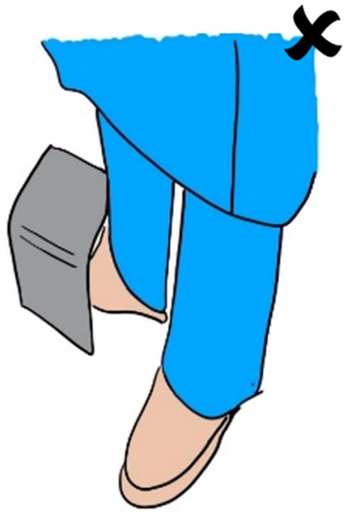


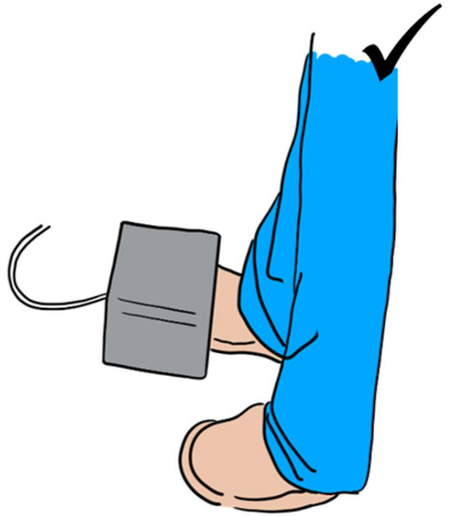
Co axial aligment surgeon

Positioning of the foot pedal

- The foot pedal for electrocautery devices should be positioned in alignment with the surgeon's body orientation.

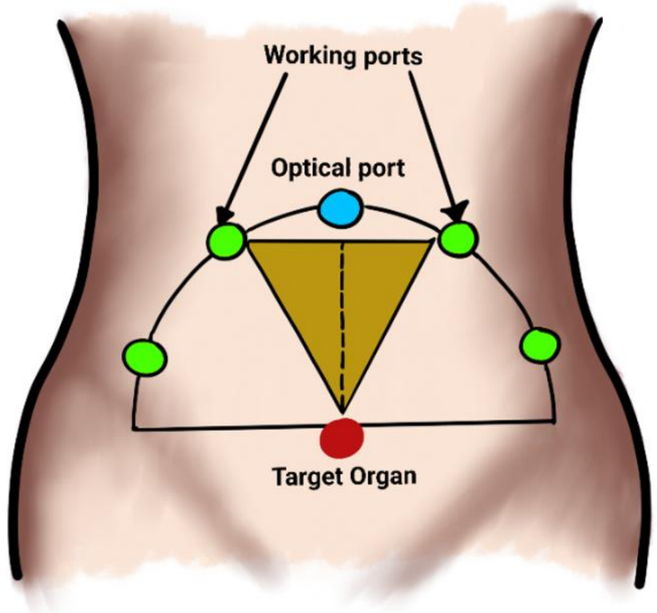


The incorrect placement of the foot pedal; Placement of the foot pedal in a different direction from surgeon's body causing awkward foot positions, physical discomfort and inefficiency.



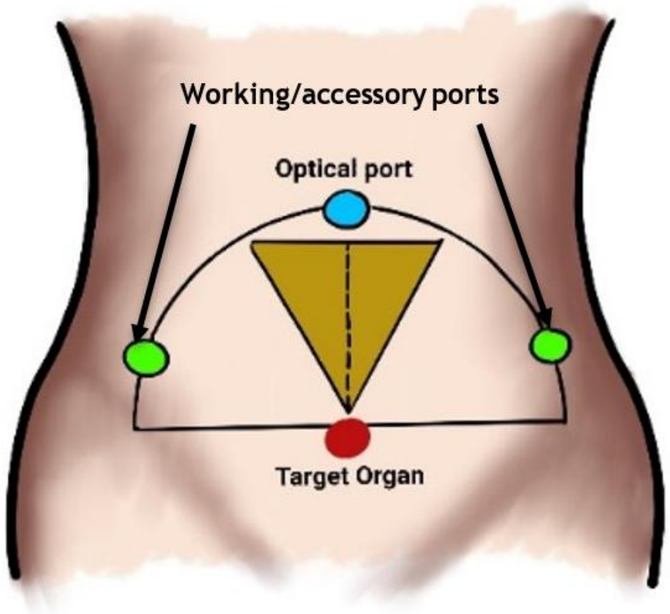
The correct placement of the foot pedal; The foot pedal is positioned is the same direction of the surgeon's orientation preventing unnecessary body rotation.

Port placement



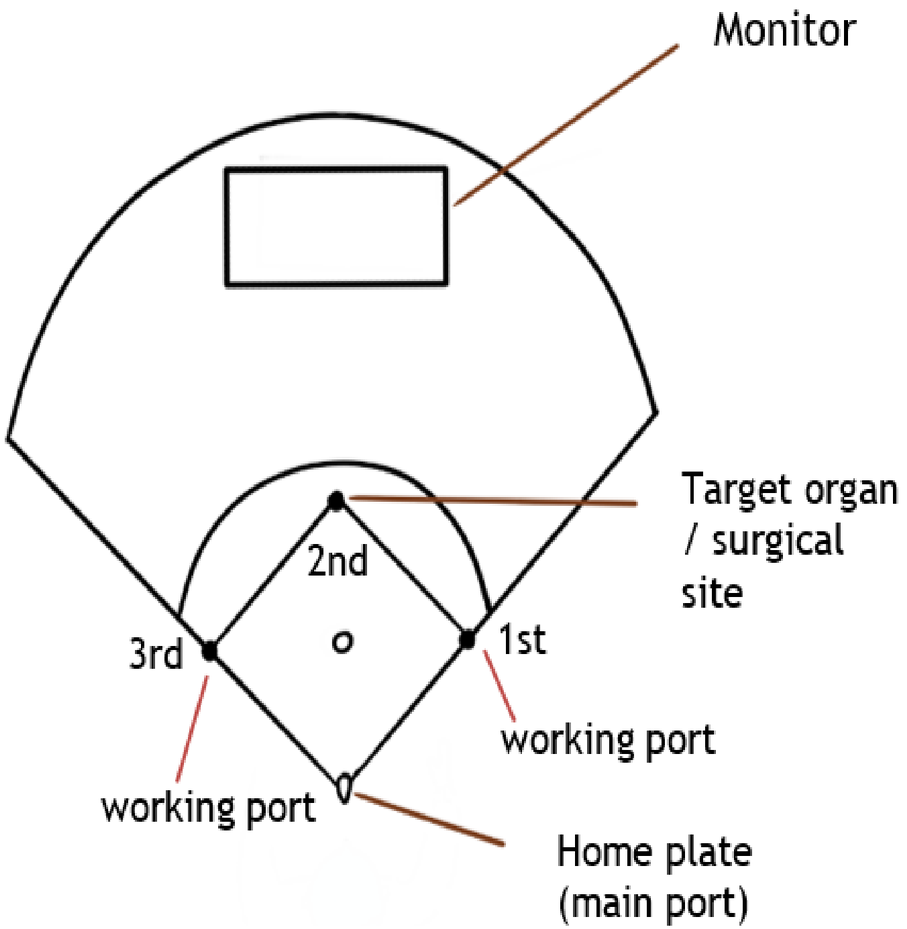
- Once the ports are set – cannot be changed.
- Improper placement – makes manipulation difficult and sometimes limited length.
- 1:1 intracorporeal–extracorporeal ratio ensures optimal control, while poorly placed ports increase strain and reduce accuracy.

- 2 important concepts
  - Baseball/diamond concept
  - Sectorization



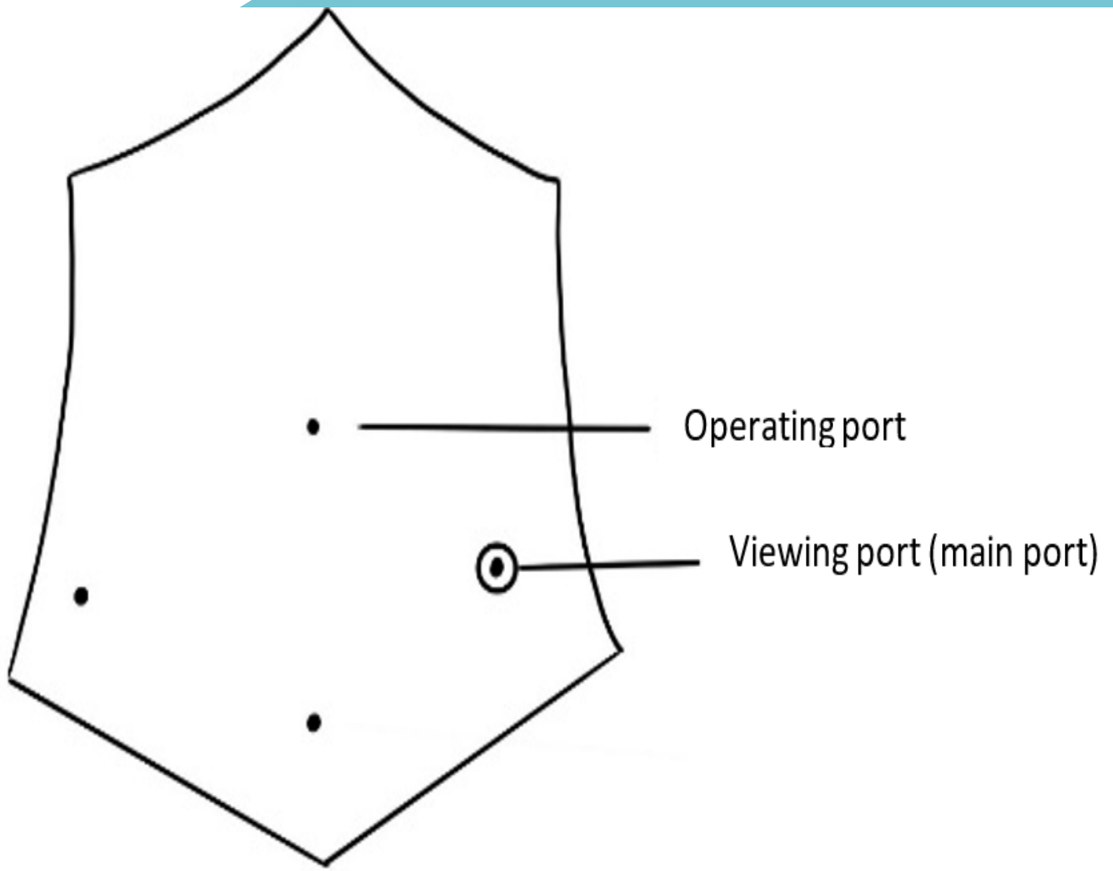
Triangulation/ Baseball diamond concept

- Placement of trocars in a triangular manner
- Target organ should be about 15 cm from the camera port – centrally placed
- Other trocars – placed in an arc
- 5-7 cm on either side of the camera port
- Allows instruments to work freely at 60-90 degrees to prevent clashing



Sectorization

- Uses a lateral port as the optical port
- This technique requires advanced ergonomic understanding and greater hand-eye coordination.

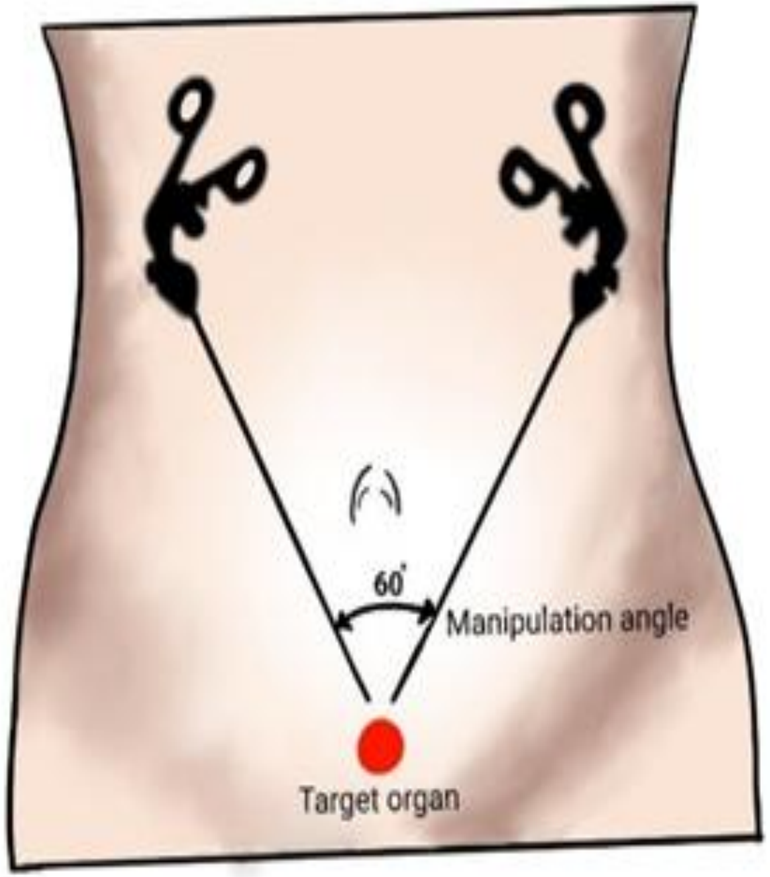


Sectoriztion: The use of lateral port as the main/optical port.

Ergonomics and Laparoscopic Instruments

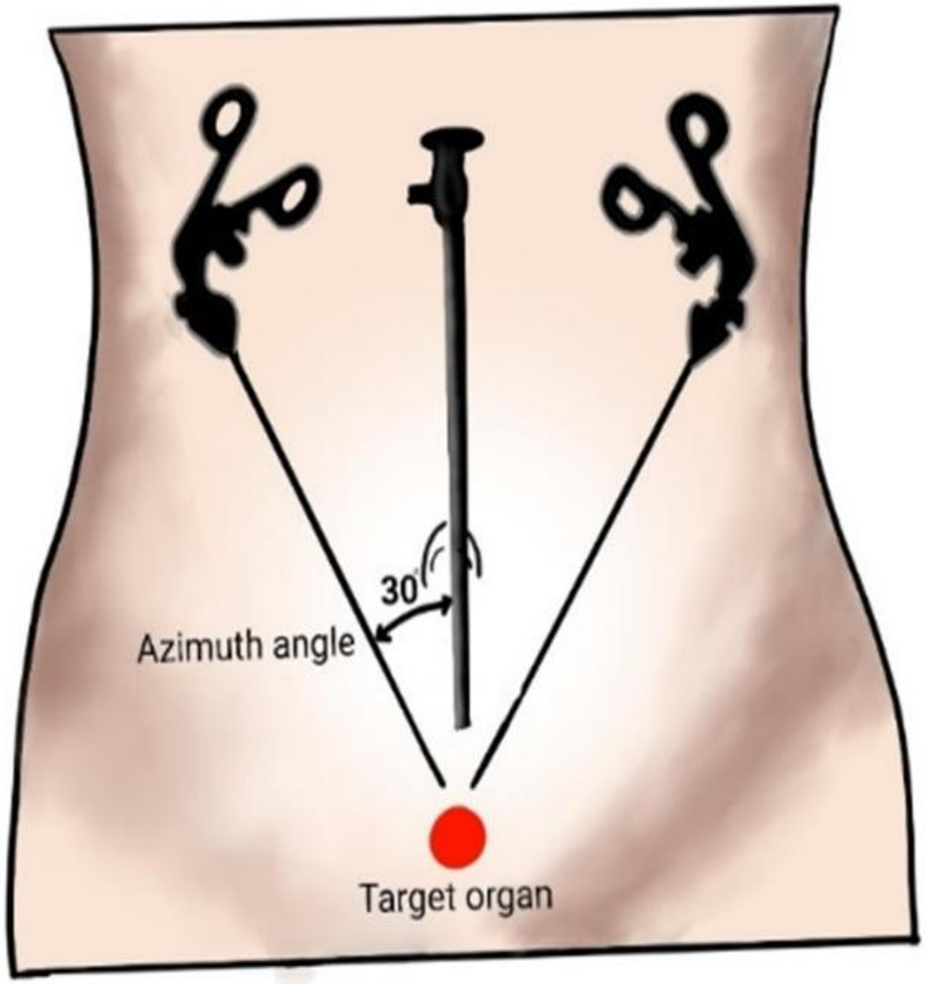
Manipulation angle

- It’s the angle between two manipulators.
- They converge at 60˚ at the surgical site



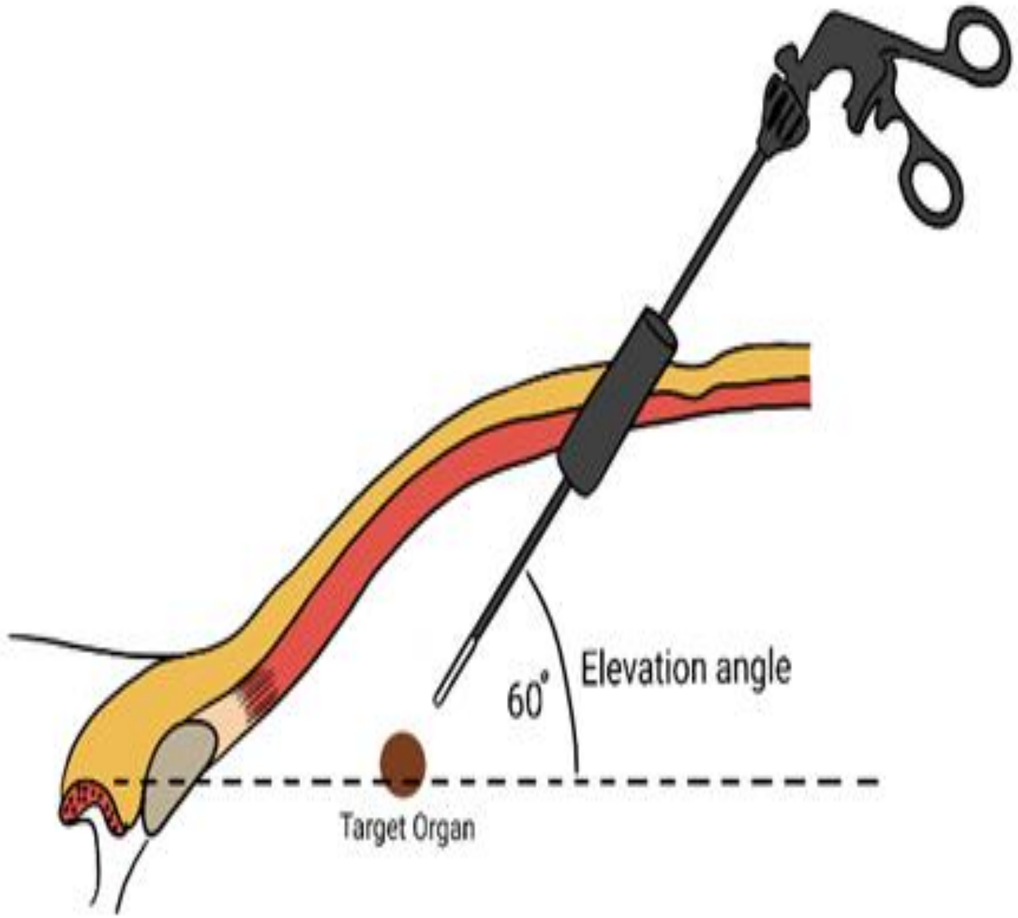
Azimuth angle

- Angle between the scope and the working instrument
- Ideally should be equal on both sides
- Half of the manipulation angle



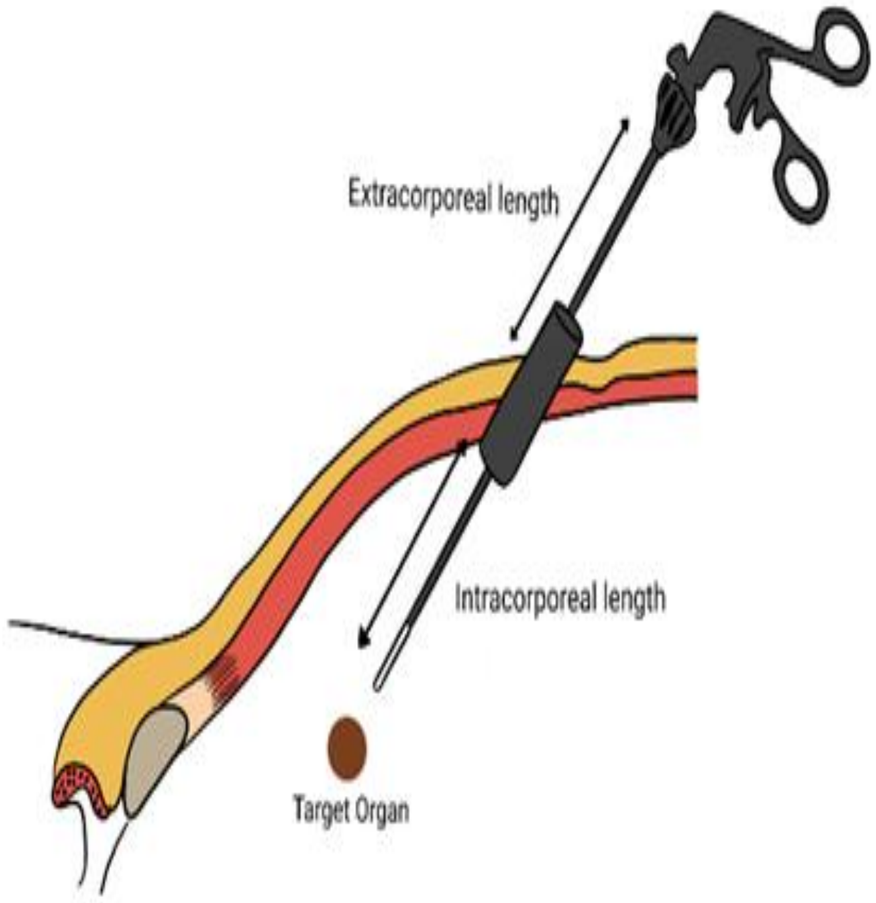
Elevation angle

- Angle of the instrument with the horizontal line
- Ideally 60˚
- Should be equal to manipulation angle



The Length of the instruments

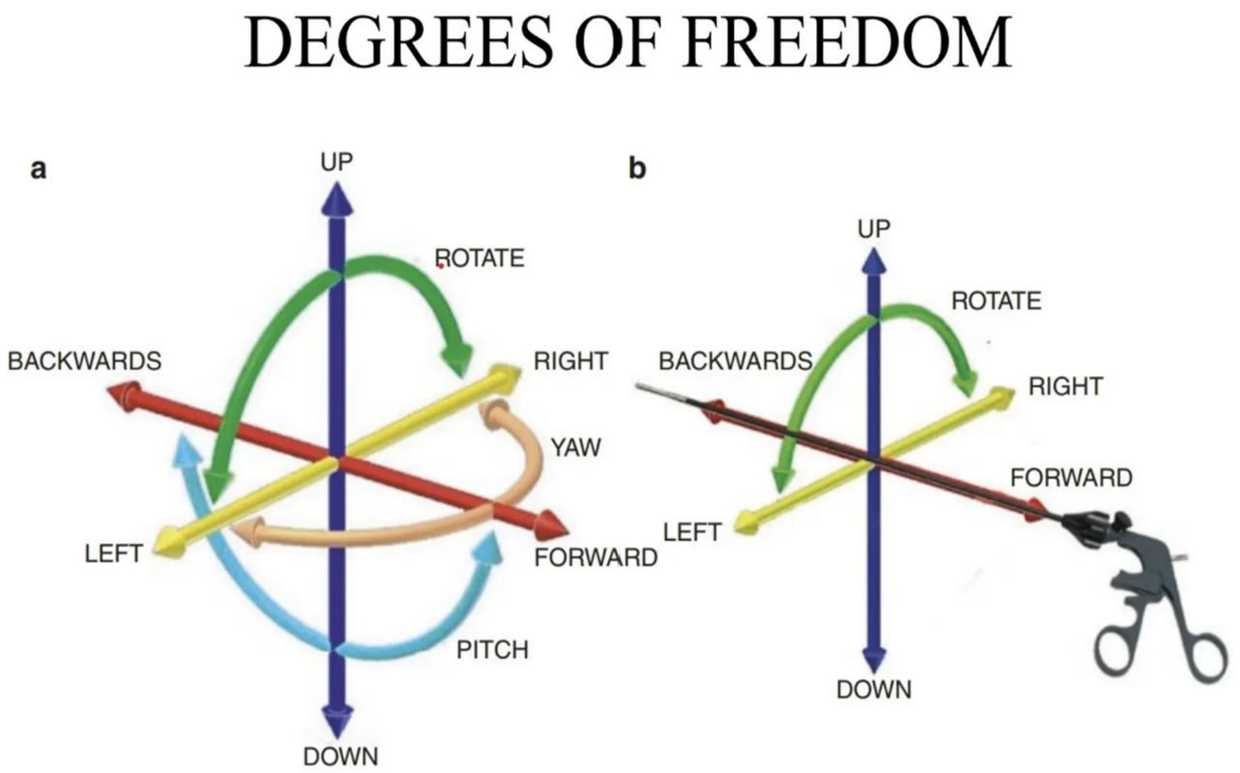
- Instrument length in laparoscopic surgery should be tailored to patient size
  - 36 cm for most adults
  - 45 cm for tall or obese adults
  - 28 cm for smaller adults
- Maintaining a 1:1 intracorporeal–extracorporeal (I/E) ratio optimizes instrument control and efficiency.
- Deviations from this ratio result in,
  - Increase external arm movements
  - Leading to greater muscle strain
  - Fatigue
  - Reduced task performance.



I/E Length Ratio = 1:1

Degrees of Freedom

- Potential for movement of the instrument in one direction or around the instrument axis,
- Open surgery 6 degrees of freedom.
- Laparoscopy – Motion limited to 4 degrees of freedom



Summary

- Maintain the correct position of the body and limbs
- Know your instruments – design, length, and limitations
- Place equipment properly – monitor, ports, table, and pedals
- Recognize your limitations and avoid sustained awkward postures
- Practice precise and ergonomic movements to reduce fatigue and error

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