Ergonomics and laparoscopy

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ABSTRACT

Operative laparoscopy has changed the concept of surgery from prolonged painful recuperative periods with long scars of open surgery to short stay, painless, and cosmetically satisfying surgery. This has been achieved at the expense of surgeons’ discomfort and fatigue, thus putting both the surgeon and patient at risk. Inadequate knowledge about ergonomics together with ergonomically deficient design of laparoscopic instruments has been cited as possible causes. This paper reviews the various ergonomic variables and recommendations to make laparoscopic surgery safer.

Key words : Ergonomics, Laparoscopy

INTRODUCTION

Laparoscopic surgery is a new resource in the field of surgical practice. Since its induction in the late 1980’s, it has come up in a major way as more and more complex operations are being performed, providing the patients with less painful surgery and a more rapid recovery. Increased technological complexity and sometimes poorly adapted equipment have led to increased complaints of surgeons’ fatigue and discomfort during laparoscopic surgery. Failure to understand the ergonomics of laparoscopic surgery and ergonomically inadequate specifications of laparoscopic instruments, has further added to the surgeons’ woes. This article reviews the ergonomic problems associated with laparoscopy.

MAGNITUDE OF THE PROBLEM

The Literature yields very few articles analyzing the ergonomics of laparoscopic surgery. Majority of these studies are from the USA and Europe with very little participation from other parts of the world, though it is practiced worldwide. Studies from the USA show a cervical and upper extremity pain in 8%-12% and stiffness in 9%-18% among laparoscopic surgeons. This is alarming in the sense that the USA has one of the best structured and accredited training programmes in laparoscopy. In our country, unstructured and unaccredited short-term training programmes together with widespread and adventurous laparoscopic surgical practice are likely to increase complications not only for the surgeons but also to the patients secondarily.

ERGONOMIC VARIABLES

The important variables which have been studied include hand size, handle to tip force transmission, optimum height of the surgeon’s hand and height of the operating table, view site in relation to monitor position, and the technique of gripping the instruments.

Hand size

Hand size is an important variable to consider when designing laparoscopic hand tools. This is because laparoscopic surgeons especially women using glove sizes 6.5 or smaller experience musculoskeletal problems while using common laparoscopic instruments. Moreover, subjects who reported musculoskeletal problems performed a significantly greater percentage of laparoscopic cases and found the stapler and graspers difficult to use for a greater percentage of time than those not reporting problems.
Handle to tip force transmission\textsuperscript{[1-4,9]}

Data from the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) reveal that laparoscopic instruments suffer from ergonomically inadequate handle designs and inefficient handle to tip force transmission, which lead to surgeons’ fatigue, discomfort, and hand paresthesia.\textsuperscript{[1,4,9]} Studies quantifying forearm and thumb muscle workload by processed electromyogram (EMG) demonstrated that the peak and total muscle effort of forearm and thumb muscles were significantly greater when the grasping task was performed using the laparoscopic instrument. The EMG amplitudes generally exceed the recommended threshold limits of acceptable muscular load. EMG data and discomfort scores demonstrated a fatigue response in several muscle groups. This was found to be more prevalent among junior laparoscopic surgeons having less than two years of experience.

Optimum height\textsuperscript{[6]}

Laparoscopic surgery requires the use of longer instruments with surgeons working harder and in a more remote manner from the operating field than open surgery, thus changing the relation between the height of the surgeon’s hands and the desirable height of the operating room table.\textsuperscript{[6]}

Discomfort and difficulty ratings were lowest when instrument handles were positioned at elbow height. The position of laparoscopic instrument handles needed to be close to surgeons’ elbows’ level to minimize discomfort and upper arm and shoulder muscle work. This was found to correspond to an approximate table height of 64 to 77 cm above floor level.

Technique of gripping\textsuperscript{[1,4,5]}

Fitting the tool to the hand with optimum grip force and minimum strain is a key principle in the ergonomic design of hand tools.\textsuperscript{[1,4,5]} Electromyogram EMG during the use of laparoscopic instruments has demonstrated a 3 to 5 times higher muscle contraction force for grasping than open instruments. The two likely causes are, a three to six fold less efficient transfer of the mechanical force from handle to tip and decreased efficiency of forearm muscle force transmission across the wrist. This is due to the combined effects of a fixed point of insertion through the body wall that does not permit the surgeon to alter his or her body and arm position to facilitate manipulation at different internal instrument angles, a large external arc of arm movement due to the increased length of the instruments and the ringed pistol-type instrument handle design that forces the hand to enter the rings nearly perpendicularly, resulting in excessive flexion of the wrist. Ergonomic studies have demonstrated that forced deviation of the wrist away from the neutral position decreases the efficiency of forearm muscle action across the wrist, increases carpal tunnel pressure, and results in unnecessary fatigue and discomfort.

Palm grip hand position with the pistol handle (thumb outside the ring with the palm resting on the thumb ring) is more efficient than the finger-in-ring grasp because it significantly reduces the muscle forces required for grasping with a laparoscopic instrument. Many surgeons do, in fact, use the palm grasping hand position for sustained grasping tasks during laparoscopic surgery. Moreover, use of finger tips rather than finger base during finger-in-ring grasp during tissue dissection reduces discomfort.

AWARENESS ABOUT ERGONOMICS\textsuperscript{[4,6,9]}

Although there is an increase in the number of training programs in laparoscopic surgery, models for training and incorporation of laparoscopic training in residency programs, there is a paucity of information with respect to the ability of training programs to equip and orient surgeons to perform laparoscopic surgery in an ergonomic manner.\textsuperscript{[4,6,9]}

Majority of the surgeons performing regular laparoscopy are unaware of the complications of nerve injury and neuropraxia following improper gripping technique. Experience in laparoscopic surgery did play a major impact on knowledge about ergonomical problems. Operating for prolonged hours with eyes focused on video monitors results in eye straineyestrains among laparoscopic surgeons. Placement and adjustment of monitors had little benefit in improving the situation though experience resulted in some improvement.

RECOMMENDATIONS\textsuperscript{[1-10]}

The studies on ergonomics and laparoscopy have recommended certain inclusion criteria to make laparoscopy safer for both surgeons and patients.\textsuperscript{[1-10]}

1. Accreditation council to set the guidelines and oversee the training programmes.
2. Surgeons should undergo formal laparoscopy training utilizing using animals before performing on human subjects.
3. Manufacturers of surgical hand tools should consider hand size when designing future surgical instruments, as hand size is a significant determinant of difficulty using laparoscopic surgical instruments.
4. Improvements in the design of laparoscopic instruments are needed to decrease the work and discomfort of tissue manipulation during videoendoscopic surgery.
5. A redesign of current operating room tables may be required to meet these ergonomic guidelines.
CONCLUSION

Laparoscopic surgical technique is more taxing on the surgeon. Complex manipulative tasks using laparoscopic techniques require substantially higher upper-extremity muscle effort compared with open surgical techniques.\(^7\), \(^9\), \(^10\)

Hence, failure to understand the ergonomics of laparoscopic surgery has a potential to pose health problems for the surgeons.\(^1\)–\(^10\)

There is evidence to show that incremental acquisition of laparoscopic skills follows serial drills.\(^4\), \(^7\), \(^8\)

Thus, an individual’s technique is bound to improve with experience, and experience slightly reduces the level of fatigue, but not enough to reduce the surgeon’s surgeon’s risk category.\(^8\)

Awareness of and instruction in sound technique may help in preventing these injuries.\(^10\) However, this idea has not been corroborated in other studies that have held the design of the laparoscopic instrument to be the primary culprit in fatigue and other ergonomic problems.\(^1\), 2, –\(^3\), \(^5\), \(^6\)

As laparoscopy is associated with significant ergonomic problems, proper training and awareness among laparoscopic surgeons is essential in India. This is only possible if an authorized accreditation council sets up guidelines and oversees the training programs, thus making laparoscopy safer for both surgeons and patients.

REFERENCES

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