

Ergonomics in Laparoscopic Surgery

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Received: 31-10-2021 / Revised: 28-12-2021 / Accepted: 09-02-2022

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Conflict of interest: Nil

Abstract

Objective: Ergonomics is essential in today's practice and especially in laparoscopic surgeries due to concerns with hand movements, loss of proper view, monitor placement and longer duration. This paper aims to audit the ergonomic practice amongst laparoscopic surgeons in Bhopal, India.

Methods: To audit the ergonomic practice amongst laparoscopic surgeons in Bhopal, India. In this audit, personal assessments of 50 surgeons were done while they were performing surgery based on accepted guidelines, after taking their consent. The assessment data included demographics, surgeon's posture, monitor position and operating room configurations

Results: Majority (more than 55%) of surgeons followed proper ergonomics when keeping themselves in line with target organ and monitor, maintaining proper angles at the elbow joint and forearm. More than 60% of operating rooms had appropriately functioning tables and instruments. Less than 60% of surgeons maintained proper head and neck posture. Monitor height was more than the operating MIS surgeon's height in 33% of operating rooms.

Conclusion: Although many surgeons showed good ergonomic practice overall, it was found that there were many areas for improvement with respect to the ideal posture.

Keywords: Ergonomics Laparoscopic Surgeries, Hand Movements, Monitor Placement.

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Introduction:

The operating room has recently been complicated by the addition of laparoscopic instruments and difficult interfaces between the patient and the surgeon. Therefore, we understand the principle of Ergonomics applicable to the field of laparoscopy as much as any other surgical expertise. Ergonomics

is based on anatomy, physiology, psychology, and engineering, combined in a systems approach. The importance of ergonomics in the setting of laparoscopy cannot be over-emphasised. Studies have shown that correct ergonomics can reduce suturing time. Pressure-related chronic pain

among surgeons has been shown to be relieved by the use of ergonomically designed products. [1-3]

One of the main and basic ergonomic problems associated with laparoscopy is the surgeon's non-neutral posture during laparoscopic procedures. There are five main issues that influence the posture of the surgeon: the (hand-held) instrument, the position of the monitor, the use of foot pedals to control cautery, operating table height, and the body posture. [4,5]

Hence, it is imperative to understand the applications of ergonomics for all surgeons practicing laparoscopy as well as novices yet to be initiated into this field. The aim of this article is to provide a basic understanding of the ergonomic challenges facing the laparoscopic surgeon and some simple modifications, which can go a long way in improving their operative practice. At the outset it is helpful to identify the potential problematic areas in the practice of minimal access surgery that pose unique ergonomic difficulties not faced by non-laparoscopic surgeons.

Materials and Methods:

Study design: Observational study

Study area: Surgeons in and around Bhopal city

Study period: January 2021 – June 2021

Study population: 50 experienced surgeons were questioned

Inclusion criteria:

- Laparoscopic surgeons
- Experience of >5 years
- 15 laparoscopic surgeries in a month

Exclusion criteria:

- Inexperienced surgeon (<5 years)
- <15 laparoscopic surgeries in month

- Previous arthritis problems

Tools of data collection: Predesigned Questionnaire

OT position: A surgeon in two different positions can perform laparoscopic cholecystectomy. One is by standing on the left side of patients (preferred by Americans) and other is by standing between the legs (preferred by Europeans). Both the positions are convenient, but some find one more ergonomically better. It is usually surgeon's preference or habit of getting adjusted to the position. Though port placement is similar, there is slight change in each position.

OT table: Height of operating table should be adjusted between 64 and 77 cm above floor level since this discomfort and operative difficulty are lowest when instruments are positioned at elbow height.

Monitor position: Ergonomically, the best view for laparoscopy is with the monitor image at or within 25 optimal degrees below the horizontal plane of the eye. This leads to least neck strain according to the available studies. Standard LCD monitors placed on a low cart separate from the operating room equipment may be used for best results. It is not advisable to have a "chin-up" arrangement on the part of the surgeon. In operations where surgeons change their ports and positions, the second monitor is essential, e.g., total colectomy. Second monitor for assistants reduces strain on their neck.

Trocar placements: There is no uniform consensus about port placements for advanced laparoscopic procedures. The placement of ports is currently dictated by the surgeons' preference based on individual experience. To facilitate smooth instrument manipulation along with adequate visualisation during laparoscopy, usually trocars are placed in triangular fashion.

Neck pain and spondylosis has been observed to be a recurring complaint among surgeon. The other physical constraints reported are cervical spondylitis, shoulder pain due to abduction of shoulder (chicken wing scapula) during laparoscopy termed as "laparoscopic shoulder", backache, hand finger joint pain, tenosynovitis, burning eyes, stress exhaustion, and hand muscle injury.

Most common reason for the inability of ergonomics to be applied optimally in the

field of laparoscopy could be enumerated as the lack of complete awareness among surgeons, communication gap between the practitioners of laparoscopy and the designers of the instruments, inadequate knowledge of the potential problems for the users in the instruments created by the designers and the contradictory expert advice which reduces the credibility of ergonomics as a science.

Observation Chart

Table 1: Demographic Details

| Characteristic | Number | Percentage |
|----------------------|--------|------------|
| Sex | | |
| Male | 39 | 78% |
| Female | 11 | 22% |
| Age- | | |
| 35-40 | 20 | 40% |
| 41-50 | 18 | 36% |
| 51-60 | 12 | 24% |
| Qualification | | |
| MS | 41 | 84% |
| MS Mch | 09 | 18% |

Table 2: Knowledge about laparoscopic practices in OT

| Questions | Answers [YES/NO] | percentage (n=50) |
|---|------------------|-------------------|
| Experience in laparoscopic surgeries | >5 years | 100.00% |
| Do you experience any problem with the monitor position? | 8/42 | 16% /84% |
| Do you experience neck pain/spondylosis ? | 5/45 | 10% /90% |
| Do you experience any problem with your standing position with respect to surgery ? | 8/42 | 16% /84% |
| Do you experience any problem with the monitor position? | 14/36 | 28% /72% |
| Do you experience any problem with the table height ? | 11/39 | 22% /78% |
| shoulder pain due to abduction of shoulder (chicken wing scapula) termed as "laparoscopic shoulder" | 11/39 | 22% /78% |
| hand finger joint pain, tenosynovitis, and hand muscle injury | 6/44 | 12% /88% |

| | | |
|---|------|----------|
| burning eyes, stress exhaustion, | 4/46 | 8% /92% |
| Do you experience any problem with the trocar placement ? | 7/43 | 14% /86% |

Statistical Analysis:

The collected data was summarized by using frequency, percentage, mean & S.D. To compare the qualitative outcome measures Chi-square test or Fisher's exact test was used. To compare the quantitative outcome measures independent t test was used. If data was not following normal distribution, Mann Whitney U test was used. SPSS version 22 software was used to analyse the collected data. p value of <0.05 was considered to be statistically significant.

Results:

We saw a male predominance [78 % of study subjects] .60 % above the age of 40. Majority (more than 55%) of surgeons followed proper ergonomics when keeping themselves in line with target organ and monitor, maintaining proper angles at the elbow joint and forearm.

14% had difficulty in trocar placement .More than 60% of operating rooms had appropriately functioning tables and instruments. Less than 30% of surgeons maintained proper head and neck posture. Monitor height was more than the operating MIS surgeon's height in 22% of operating rooms.22 % and 16% had some problem with proper orientation of monitor and standing position respectively.

Neck pain and spondylosis has been observed in 10 % to be a recurring complaint among surgeon. The other physical constraints reported are cervical spondylitis, 12 % had shoulder pain due to abduction of shoulder (chicken wing scapula) during laparoscopy termed as "laparoscopic shoulder",12 % backache, hand finger joint pain, tenosynovitis.8 % had burning eyes, stress exhaustion, and hand muscle injury.

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Discussion:

Laparoscopic surgery provides patients with less painful surgery and a more rapid recovery, while requiring that surgeons work harder and in a more remote manner from the operating field. One of the main and basic ergonomic problems associated with laparoscopy is the surgeon's non-neutral posture during laparoscopic procedures. There are five main issues that influence the posture of the surgeon: the (hand-held) instrument design, the position of the monitor, the use of foot pedals to control diathermy, the poorly adjusted operating table height, and the static body posture. Van Veelen MA et al worked really hard for improved physical ergonomics of laparoscopic surgery. They gave an overview of the ergonomic guidelines that have been developed in these five areas and shows product solutions that have been developed according to these guidelines. The guidelines can be used by operating room (OR) staff to evaluate the ergonomics of their OR environment and to improve issues that do not satisfy the ergonomic guidelines. [1]

Sánchez-Margallo FM et al ,Berguer R et al did work on surgical technology and the ergonomics of laparoscopic instruments Their approach was particularly important in the design of laparoscopic surgical instruments. A review of the literature on the biomechanics of laparoscopic surgical instrument use was combined with data from the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire and demonstration station. . Cost-containment pressures on surgeons demand efficient surgery, whereas the increased technological complexity and

sometimes poorly adapted equipment have led to increased complaints of surgeon fatigue and discomfort during laparoscopic surgery. Improvements in the design of laparoscopic instruments are needed to decrease the work and discomfort of tissue manipulation during video-endoscopic surgery.[2,3]

Some Indian studies on ergonomics by De U et al, Supe AN et al and Kaur G et al provided some more insights according to the Indian scenario for example height of table etc. Laparoscopic surgery provides patients with less painful surgery but is more demanding for the surgeon. The increased technological complexity and sometimes poorly adapted equipment have led to increased complaints of surgeon fatigue and discomfort during laparoscopic surgery. Ergonomic integration and suitable laparoscopic operating room environment are essential to improve efficiency, safety, and comfort for the operating team. Understanding ergonomics can not only make life of surgeon comfortable in the operating room but also reduce physical strains on surgeon.[4,5,6]

Modi YS et al created awareness of ergonomic guidelines regarding laparoscopic surgeries, its practice among surgeons and comfort level during and after surgery. Laparoscopic surgery inconveniences surgeons by restricting their freedom of movement, causing prolonged static body postures, extreme joint positions and repetitive movements, leading to health issues among surgeons. These can be minimised by critical ergonomic adjustments. A descriptive study of laparoscopic ergonomics was done by Kumar AP et al on operating table height and its prediction. This study aims to determine the ideal height of the operating table with respect to surgeons' height, for maximum

comfort and least strain. Better application of the knowledge of principles of ergonomics will provide better surgeon comfort and thus better patient results. The OT table should ideally be placed below the level of the surgeon's umbilicus for maximum comfort. The height can be predicted, and this is to be applied by the surgeons in order to produce least strain and to provide maximum comfort.[7,8]

Kramp KH et al did ergonomic assessment of the French and American position for laparoscopic cholecystectomy in the MIS Suite. The posture of the surgeon's vertebral column was recorded intraoperatively using an electromagnetic motion-tracking system. The body angles assessed were flexion/extension of the cervical and thoracolumbar spine, axial rotation of the cervical and thoracolumbar spine, lateroflexion of the cervical and thoracolumbar spine, and the orientation of the head in the sagittal plane. For each body angle, the mean, the percentage of operation time within an ergonomic acceptable range, and the relative frequencies were calculated and compared. It was concluded that the body posture of the neck and trunk and the orientation of the head did not differ significantly between the French and American position.[9]

The field of ergonomics has been divided along the human functions: physical, sensorial and cognitive ergonomics. HM Goossens et al gave an overview of the assessment of these aspects of ergonomics in laparoscopic surgery. It was concluded that a systematic approach is needed, in which knowledge that has already been accumulated for different workplaces (for example, in industry) is applied to the surgeon's circumstances. Such an approach would lead to a set of objectively testable ergonomic requirements for all kinds of

products that are used by surgeons in the operating room.[10,11]

Wauben LS et al did a questionnaire survey of 284 surgeons on application of ergonomic guidelines during minimally invasive surgery. A total of 1,292 questionnaires were sent by email or handed out to surgeons and residents. The subjects worked mainly in Europe, performing laparoscopic and/or thoracoscopic procedures within the digestive, thoracic, urologic, gynecologic, and pediatric disciplines. Overall, the respondents reported discomfort in the neck, shoulders, and back (almost 80%). There was not one specific cause for the physical discomfort. In addition, 89% of the 284 respondents were unaware of ergonomic guidelines, although 100% stated that they find ergonomics important. The lack of ergonomic guidelines awareness is a major problem that poses a tough position for ergonomics in the operating room.[12]

Our study along with results also gave suggestions and guidelines, when designers use these to design new OR equipment, the new designs are an improvement in the field of human factors compared to the currently used laparoscopic products. When all these products are applied in the laparoscopic operating room, a new and ergonomic environment is created for the surgeon as well as for the assistants. Understanding ergonomics can not only make life of surgeon comfortable in the operating room but also reduce physical strains on surgeon.

Conclusion:

Laparoscopic surgery provides patients with less painful surgery but is more demanding for the surgeon. The increased technological complexity and sometimes poorly adapted equipment have led to increased complaints of surgeon fatigue and discomfort during laparoscopic surgery. Ergonomic integration and suitable laparoscopic operating room

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environment are essential to improve efficiency, safety, and comfort for the operating team.

Declarations:

Funding: None. **Availability of data and material:** Department of General Surgery RKDF Medical College Hospital Bhopal, India **Code availability:** Not applicable **Consent to participate:** Consent taken **Ethical Consideration:** There are no ethical conflicts related to this study. **Consent for publication:** Consent taken

What This Study Add to Existing Knowledge:

Our recommendations include adjusting height of the monitor with respect to the surgeon's height by use of foot stools or by updating operating rooms with ceiling suspended monitors, height adjustments of the operating table to facilitate maintenance of pelvic girdle symmetry with equal weight distribution while standing. Surgeons must also be advised to be aware of the prolonged and extreme degrees of joint movements and correct them accordingly. Laparoscopic surgery provides patients with less painful surgery but is more demanding for the surgeon. The increased technological complexity and sometimes poorly adapted equipment have led to increased complaints of surgeon fatigue and discomfort during laparoscopic surgery. Ergonomic integration and suitable laparoscopic operating room environment are essential to improve efficiency, safety, and comfort for the operating team. Understanding ergonomics can not only make life of surgeon comfortable in the operating room but also reduce physical strains on surgeon.

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