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## A descriptive study of laparoscopic ergonomics: operating table height and its prediction

\*Dr. Prem Kumar, \*Dr. Sindhu S, \*Dr. Meenakshi Yeola

\*Assistant Professor, Dept of General Surgery, BMCRI, Bangalore

\*Post Graduate, Dept of General Surgery, BMCRI, Bangalore

\*Professor of General Surgery, Jawaharlal Nehru Medical College, Nagpur

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### Abstract

**Introduction** 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. Better application of the knowledge of principles of ergonomics will provide better surgeon comfort and thus better patient results. This study aims to determine the ideal height of the operating table with respect to surgeons' height, for maximum comfort and least strain.

**Study Design** Descriptive study

**Materials and methods** 30 surgeons were included in the study. Heights of the tables at which they were comfortable operating and using endotainers were measured and was tabulated against their heights. The ratio of operating table height to the surgeon's height was calculated. Pearson coefficient was used to determine the relationship between OT (operating theatre) table height and surgeons' height.

**Results** The maximum surgeon height was 185cm and the least was 154 cm (mean = 169.47cm;SD= 8.41). The maximum height of the OT table used was 88 cm and the least was 67cm, (mean = 75.57 cm; SD= 5.91). A linear correlation was noted between surgeons' heights and OT table height. OT table height can be predicted with the surgeon's height by using the formula:

OT table height =  $-0.199 + 0.45 \times \text{surgeon's height}$

**Conclusion** 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.

**KEYWORDS** OT table height, ergonomics, surgeons' height

### INTRODUCTION

The term "ergonomics" is derived from the

Address for correspondence and reprint requests to: Dr.  
Sindhu S14, 7<sup>th</sup> cross, 5<sup>th</sup> main, Srinidhi Layout,  
Konanakunte, Bangalore 560062 Email  
[sindhu.sivakumar@gmail.com](mailto:sindhu.sivakumar@gmail.com) Ph. No.: +919844184300  
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Greek word 'ergon' meaning work and 'nomos', meaning law [1]. It is defined as the science of refining the design of products to optimise them for human uses. Sometimes known as human factors engineering, it is the technology of work design and is based on human biological sciences – anatomy, physiology and psychology [2]. It simply means: "fitting the job to the worker"[1]. The

term was defined in 1949 and has ensured benefit and safety in many areas [3].

Since its introduction in 1901 by Kelling, laparoscopic surgery has evolved greatly over the years, beginning with its introduction by the use of cystoscope into the abdominal cavity, to the development of robotic surgery [4]. With these advancements, though the field of surgery was revolutionised, this era also saw a rise in the strain experienced by the surgeons, and as a result, a consequent rise in health issues of the surgeons. The initial phase of laparoscopic surgery also witnessed increased complications among patients, most of which could have been avoided by the application of principles of ergonomics [5].

Laparoscopic surgery has shown to have better quality of life outcomes than open surgery [6]. Yet, laparoscopic surgery causes a great deal of inconvenience to surgeons by restricting their freedom of movement during the surgery, causing adoption of prolonged static body postures, extreme joint positions and repetitive movements. The ergonomics risk factors for the surgeon include body posture, organisation of the work space in the operating room (including monitor, the operating table, foot pedals), and surgical instruments [7].

Health issues reported by laparoscopic surgeons include eye strain, neck pain, back ache, numbness and tingling sensation in palms and fingers, carpal tunnel syndrome [8]. Shoulder pain due to abduction of shoulders (chicken wing scapula) during laparoscopic surgeries (termed as laparoscopic shoulder), finger joint pains, burning eyes, stress exhaustion, and hand muscle injury among laparoscopic surgeons are also reported[5].

These can be minimised by certain critical ergonomic adjustments during laparoscopic surgeries, such as alteration of the height of the operating table, position of the visual display, location of the foot pedal, selection of hand instruments. The angle between lower and upper arm should ideally be between 90 and 120 degrees. Foot pedals should be placed near the surgeon's foot, aligned in the same direction as the instruments. Monitors should

be placed in front of the surgeon 15-40 degrees below the eye level for maximum comfort [9].

Despite awareness of ergonomic guidelines among surgeons, its practice is lower than expected [10]. Better application of the knowledge of principles of ergonomics will provide better surgeon comfort and thus better patient results. This study aims to determine the ideal height of the operating table at which a laparoscopic surgeon should work, for maximum comfort and least strain.

## MATERIALS AND METHODS

*Study Design:* Descriptive study

*Place of study:* Victoria Hospital, Bangalore, Karnataka

*Duration of study:* August-September 2019

*Sample size:* 30

*Participants:* 14 trained surgeons, 16 trainees

### Materials and methods

30 surgeons were included in the study after obtaining oral consent for inclusion into the study and photography. 14 of them were trained in laparoscopic surgery and 16 were trainees. The height of the operating table was noted while the trained surgeons performed laparoscopic procedures. This was the height to which the operating surgeon adjusted the table after placement of ports, according to his/her comfort level, and the measurement was taken at the level of port placement in the region where the surgeon operated.

The height of the table at which the trainees were comfortable using the endotainers was noted. These were tabulated along with the surgeons' heights in Microsoft Excel, and the ratio of OT table height to the surgeon's height was calculated.

### Inclusion criteria

- Surgeons trained in laparoscopy willing to participate in the study
- Trainee surgeons willing to participate in the study

### Exclusion Criteria

- Surgeons not giving consent for participation in the study

**Statistical Analysis**

The data was transferred to spss 25 software and analysed by descriptive statistics such as mean, standard deviation, and tables. Pearson coefficient was used to determine the relationship between OT table height and surgeons’ height. Linear regression was used to predict the OT table height using surgeon height. P value <0.05 was considered statistically significant.

**RESULTS**

Among the 30 surgeons included in the study, 22 were males (73%) and 8 were females (27%). 16 of the 30 surgeons were trainees (53%) and 14 were trained surgeons (47%).

**Height Distribution of Surgeons**

The maximum height of the surgeon was 185cm and the least was 154 cm, with a mean of 169.47cm and a standard deviation of 8.41. (Table 1)

**TABLE 1: Descriptive statistics**

|                 | MEAN (CM) | STANDARD DEVIATION (SD) |
|-----------------|-----------|-------------------------|
| HEIGHT          | 169.47    | 8.41                    |
| OT TABLE HEIGHT | 75.57     | 5.91                    |

**Distribution of OT Table Height**

The maximum height of the OT table used was 88 cm and the least was 67cm, with a mean of 75.57 cm and a standard deviation of 5.91. (Table 1)

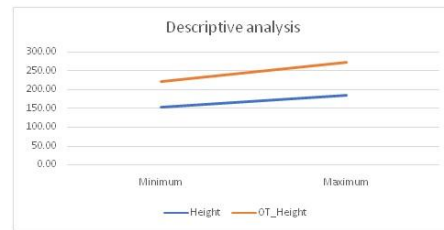
With the above data, a linear correlation was noted between surgeons’ heights and OT table height (Fig I); with one unit change in surgeon’s height altering the OT table height by 0.45 times.

Thus, OT table height can be predicted with the surgeon’s height by using the formula:

OT table height = -0.199+ 0.45 x surgeon’s height

**Discussion**

The height of the table has an effect on the upper joint movements of the shoulders, arms and wrist during laparoscopy. The fixed position of the trocars and the scope in the abdominal wall requires the surgeon to move the upper extremities into making longer external arc of movements with long awkward positions manipulating the tissues at different angles inside the abdomen [11].



**Figure I: Linear Correlation between surgeons’ height and OT table height.**

In our study we compared the surgeon’s height with the height of the operating table. The maximum height of the OT table used was 88 cm and the least was 67cm, with a mean of 75.57 cm and a standard deviation of 5.91.

This is in close agreement with the guidelines set by Avinash supe et al in their study ergonomics in laparoscopic surgery, where they have stated that the ideal height of the OT table for laparoscopic surgery should be between 64 and 77 cm [5]. MA van Veelen et al in their study ‘assessment of then ergonomically optimal operating surface height for laparoscopic surgery found that the ideal height of the table should be 0.7-0.8 times the elbow height [12]. To eliminate the inconvenience of measuring the elbow height for every surgeon during practice, the optimum operating surface height was suggested to be at pubic level, where a neutral posture could be maintained, with minimal joint and arm strain.

All the surgeons in our study preferred to adjust the height of the operating table to below their umbilical level, as evidenced by the photographs (Figures II and III). This is in contrast to the study by Madhu Shankar KC et al where 61.5% of the surgeons included in

the study preferred to adjust the height to the level of the umbilicus [13].



**Figure II: Trained surgeon operating at a comfortable level of OT Table Height**

In our study we derived the following formula to predict the OT table height from the surgeon's height.

OT table height =  $-0.199 + 0.45 \times \text{surgeon's height}$

In the study 'Role of OT Table Height on the Task Performance of Minimal Access Surgery', Gurvinder Kaur et al concluded that the optimal height of the operating table during laparoscopic surgeries should be 0.49 times the surgeon's height [14].

The limitations of the study include the fact that the operating tables used by trained surgeons were designed for open surgeries and have a limitation of the minimal height to which it can be adjusted. This is reiterated by Sang Choi in his article 'A review of the ergonomic issues in laparoscopic operating room' where it's mentioned that most operating tables are designed for open surgeries and may be too high for laparoscopic surgeries[15]. Ulrich Matern et al stated that new operating tables with lower adjustability are needed to meet the ergonomic demands to maximise surgeon comfort [16]. Another limitation is that the only factor considered was the height of the operating table, and the other ergonomic factors were not considered in the study.

## Conclusion

OT table height is an important ergonomic factor in laparoscopic surgeries. 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.



**Figure III: Trainee operating the endotrainer at a comfortable height**

## LEARNING POINTS

OT Table height during laparoscopic surgery can be calculated and applied to reduce the strain on surgeons.

Ideally, the OT table should be below the level of the surgeon's umbilicus.

## LIST OF ABBREVIATIONS USED

OT – Operating theatre

## AUTHOR'S CONTRIBUTIONS

Dr.Prem Kumar A participated in the study design and edited the final manuscript. Dr. Sindhu collected the data, interpreted the results and prepared the first draft. Dr. Meenakshi Yeola conceived and designed the study. All authors have read and approved the final manuscript for submission.

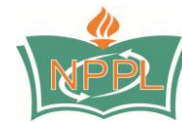
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