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AN ERGONOMIC STUDY USING SURG- TLX SCORING SYSTEM TO EVALUATE THE PHYSICAL CHALLENGE AND COGNITIVE STRESS ON THE SURGEON PERFORMING LAPAROSCOPIC SURGERY

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INTRODUCTION

Any human system interface inflicts not just a biomechanical stress on the human, but rather even cognitive stress. It has been more than two decades of the existence of the minimal access techniques. Yet an ergonomically optimal environment is yet to be fashioned. These unseen stress will surely impact on the outcome of the procedure and on the surgeon's health in long term. The effect of the highly sophisticated work environment pushes the surgeon to extreme limits of psychomotor and cognitive over load. The physical and mental abilities are surely interconnected

NASA TLX VS SURG TLX

The Official NASA Task Load Index (TLX) is a subjective workload assessment tool to allow users to perform subjective workload assessments on operator(s) working with various human-machine interface systems.

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

Originally developed as a paper and pencil questionnaire by NASA Ames Research Center's (ARC) Sandra Hart[1] in the 1980s, NASA TLX is now widely used for measuring subjective workload across a wide range of applications

NASA TLX uses a multidimensional rating procedure to arrive at a workload score based on the average ratings on the following six subscales:

- Mental Demand
- Physical Demand
- Temporal Demand
- Performance
- Effort
- Frustration

NASA TLX has been successfully used around the world to assess workload in various environments such as aircraft cockpits; command, control, and communication workstations; supervisory and process control; and simulations and laboratory tests[1]. It has also been applied to the field of surgery[2]. Though has been quite effective in getting an estimate of the overall stress the original TLX was not specific to the surgical environment and hence posed difficulty in getting clarity. This pressed for a system or assessment tool which was specific for OR. The Surg TLX was developed and validated by Wilson et al[3].

AIMS & OBJECTIVE

To identify the prevalence of physical challenges and cognitive stress of surgeons involved in performing laparoscopic surgery utilizing a self-reporting tool SURG-TLX.

METHODOLOGY

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

- Thirty-eight surgeons were enrolled in this study. Study conducted between July 2019 to Jan 2020 at Victoria hospital, Bangalore. To evaluate the stress encountered, the participants were requested to answer the SURG- TLX (Figure 1) questionnaire after every laparoscopic surgery. Assistant surgeons were also enrolled and same survey was assimilated. The data collected was analyzed.
- The surgeons were even asked on a general note to comment on the challenges posed by laparoscopic surgery in terms of the physical and mental stress.

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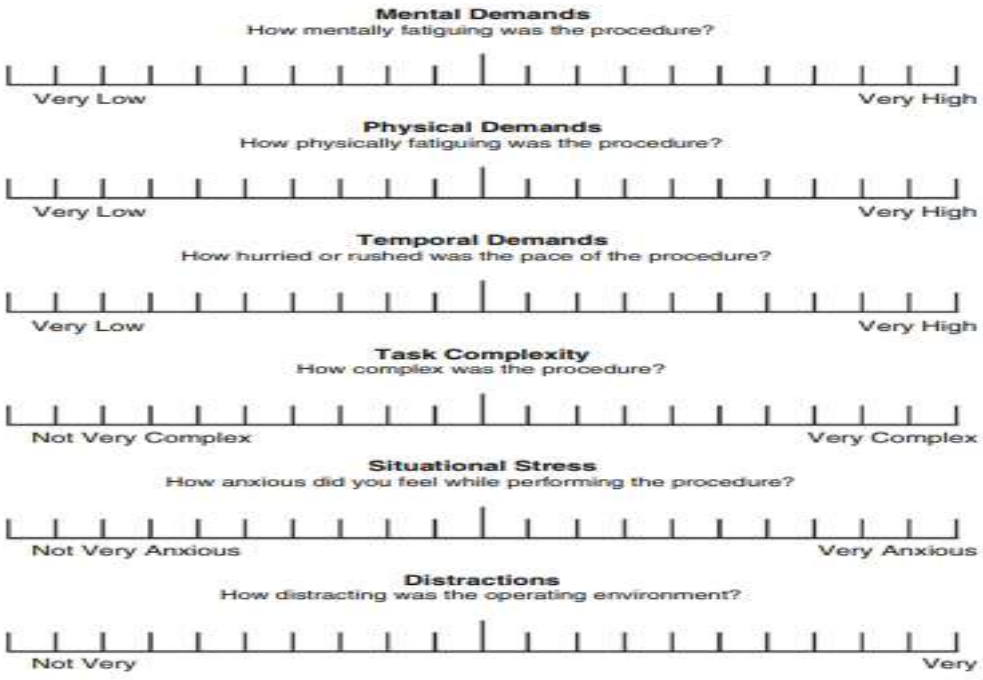

Figure 1: SURG-TLX questionnaire

RESULTS

38 participants (including 12 surgeons and 26 assistant surgeons) were included in the study and were requested to answer the SURG TLX questionnaire after surgeries. A total of 111 surveys were obtained, of which surgeons gave responses

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

to 12 (10.8%) surgeries and assistants responded to 99 surgeries (89.2%). Out of 38 participants, 26 (68.4%) were male and 12 (31.57%) were female.

The 111 surgeries included 36 (32.4%) laparoscopic appendectomies, 43 (38.7%) laparoscopic cholecystectomies, 11 (9.9%) laparoscopic ventral hernia repairs, 4 (3.6%) laparoscopic inguinal hernia repairs, 5 (4.5%) laparoscopic fundoplications and 12 (10.8%) laparoscopic sleeve gastrectomies. Of these, the surgeons answered the questionnaire for laparoscopic appendectomy, laparoscopic cholecystectomy and laparoscopic sleeve gastrectomy, while the assistant surgeons answered the questionnaire for all the above surgeries (Fig 2).

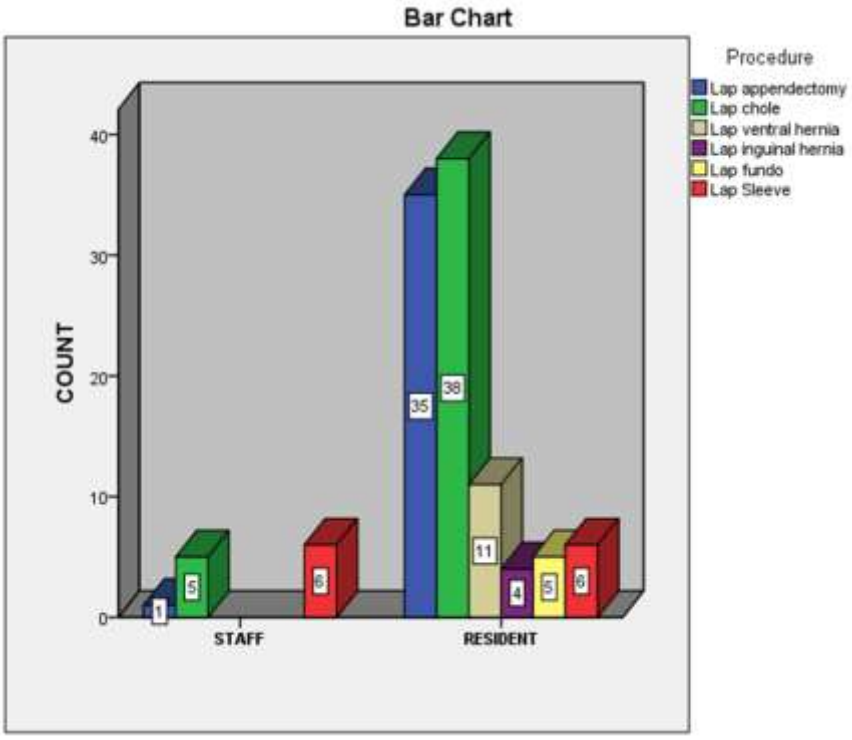

Figure 2: Distribution of responses across various procedures

Physical demand

In this study, 65 (58.6%) of the responses were ‘Very low’ (VL), which included 5 surgeons and 60 residents, and 46 (41.4%) of the responses were ‘very high’ (VH),

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

which included 7 surgeons and 39 residents. The difference between the responses by the surgeons and residents were not statistically significant in this category ($p>0.05$) (Table 1).

Mental Demand

In this study, 75 (67.6%) of the responses were very low (VL), which included 72 residents and 3 surgeons, and 36 (32.4%) of the responses were very high (VH), which included 27 residents and 9 surgeons. The difference between the responses by the surgeons and residents was statistically significant in this category ($p<0.05$) (Table 1).

Temporal demand

In this study, 94 (84.7%) of the responses were 'very low' (VL) of which 12 responses were by surgeons and 82 responses were by residents, and 15 (13.5%) of the the responses were very high (VH), all of which were given by residents. 2 of the responses in this category were missing. The difference between the responses by the surgeons and residents were not statistically significant in this category ($p>0.05$) (Table 1).

Task complexity

In this study, participants in 100 (90.1%) of the surgeries responded that the task was not very complex (NVC), which included 91 residents and 9 surgeons, while those in 11 (9.9%) surgeries responded that the task was very complex (VC), which included 3 surgeons and 8 residents. The difference betweeen the responses by the surgeons and residents were not statistically significant in this category ($p>0.05$) (Table 1).

Situational stress

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

In this study, 85 (76.6%) responses were favoring not very anxious (NVA), of which 10 were by surgeons and 75 by residents, while 26 (23.4%) responses were favoring very anxious (VA), of which 2 were by surgeons and 24 by residents. The difference betweeen the responses by the surgeons and residents were not statistically significant in this category ($p>0.05$) (Table 1).

Distraction

In this study, 96 (86.55) of the responses were 'not very' (NV), of which 86 were by residents and 10 by surgeons, and 14 (12.6%) of the responses were 'very' (V), of which 2 were by surgeons and 10 by residents. 1 response in this category was missing. The difference betweeen the responses by the surgeons and residents were not statistically significant in this category ($p>0.05$) (Table 1).

TABLE 1: Responses to the SURG-TLX questionnaire

CATEGORY	VALUES (%)	
PHYSICAL DEMAND	VL	VH
	58.6	41.4
MENTAL DEMAND	VL	VH
	67.6	32.4
TEMPORAL DEMAND	VL	VH
	84.7	13.5
TASK COMPLEXITY	NVC	VC
	90.1	9.9
SITUATIONAL	NVA	VA

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

STRESS	76.6	23.4
DISTRACTION	NV	V
	86.55	12.6

Discussion

The minimal invasive technique, though extremely advantageous to the patient, poses a great deal of mental and physical exertion on the surgeon. Even with all the developments in the minimal invasive field, an accommodating and welcoming operating room environment for the surgeon is yet to be created. Assessment of the physical and mental workload thus becomes important. An attempt to measure this was made using the NASA TLX questionnaire. NASA TLX is widely used for measuring mental workload, owing to its simplicity of application and interpretation[4]. It has been widely used for the measurement of workload in the surgical environment[5]. However, it was not developed specific to the surgical environment and hence fails to provide clarity with respect to the surgical environment. Thus, the SURG-TLX questionnaire was developed. It was based on two concurrent multidimensional workload measures developed by focused group discussion[3]. It takes into consideration the following parameters:

1) Physical demand

Minimally invasive surgery causes the surgeons and assistants to assume upright postures with a straight back for prolonged periods with minimal weight shifting. They also perform repetitive movements like looking back and forth from the monitor and repeated insertion and removal of instruments. These cause overuse injuries to the muscle and cause musculoskeletal pain and discomfort[6,7,8].

2) Mental Demand

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

The physical effort or the demand is very clear but the mental demand to the operating surgeon is still not well comprehended. Minimally invasive surgery having a steep learning curve is a highly technically demanding for the surgeon. This induces mental stress on the surgeon, which has its impact on the overall health and patient outcome. The mental demand even though is more of a subjective opinion, can be measured in terms of level of demand. The impact of this mental overload can accumulate and lead to chronic occupational stress and manifest as breakdown[9]. This will negatively affect the healthcare system.

The cause could be due to the different instruments used or the limited access which limits the surgeon's movements or the freedom of space. The vision although is magnified is not the direct vision unlike the open surgery. The different threshold of each surgeon in handling the stress or the mental demand varies and would be very difficult to quantify.

3) Temporal demand

During the surgical procedures , situations arise where the surgeon steps up the pace and completes the surgery. This is with the intention of reducing the time of general anesthesia but occasionally it might impede the outcome if the pace become more rapid. A study by K Moorthy et al reported that hurrying the pace of the procedure was considered as a stress inducing factor and increased the incidence of errors[10].

4) Task complexity

Task complexity varies from procedure to procedure and also depends upon individual patient factors. It is highly dependent on the complications faced on the table.

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

5) Situational stress

The necessity of accurate and error free performance or intricate dissection in crucial areas is highly stressful for the operating surgeon. The visual interface with lack of open haptics is very taxing to the surgeon. Ajitha Prabhu et al identified stress as one of the factors preventing the transfer of simulator acquired skill to the operating room[11]. Cordial MWetzel et al noted that undue levels of stress impaired judgement, decisions making and communication, especially among junior surgeons[12].

6) Distraction

The operating room is generally a controlled environment and ensuring that the surgeon and his team will be able to concenterate and the procedure is completed without any complications. This can be disturbed by a variety of distractions- the entry or exit of OT personnel, phone calls and even conversations.

Surgeons highly capable of multitasking, making the to handle many interruptions and distractions. But the reduction in these would surely improve the potential and outcome. Would Music be beneficial to reduce the cognitive demand is question to ponder. Wiseman's showed the Music enhanced spatial temporal reasoning which enabled and improver the physical performance. Indeed, in a recent study of the effects of stress on surgical performance, 40% of responding surgeons felt they had witnessed a surgeon commit an intraoperative error due to excessive stress. a study showed that the distraction causes a negative impact on the outcome and should be reduced[13].

Though NASA-TLX has been widely used, the use of the more surgical specific questionnaire SURG-TLX has been limited. In our study, we found 41.4% of the responses stating that laparoscopic surgery was physically demanding, 32.4% of

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 10, 2023

the responses stated that it was mentally demanding. Only 13.5% of the responses said that laparoscopic surgery was stressful due to hurrying of the procedure and only 9.9% of the responses suggested that the procedure was complex. 23.4% of the responses suggested that situational stress was present and 12.6% of the responses suggested that distractions were causing the stress.

The limitations of this study include the small sample size and also the measurement across different surgeries of varying difficulties, making it difficult to achieve standardized responses. Studies need to be conducted on a larger scale and across surgeries of similar complexities to achieve better validation of results.

Conclusion

The demands even though play a crucial role is difficult to quantify and corroborate. Further studies are suggested.

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