

Review Article

Prevalence of work-related musculoskeletal symptoms in surgeons performing minimally invasive surgery: a review of literature

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ABSTRACT

Work-related musculoskeletal disorders (WRMSDs) are a group of disorders that are caused by occupational risk factors. The introduction of minimal invasive surgical techniques has led to increased complexities in the surgical environment and practice. To find out the prevalence of WRMSDs in surgeons performing minimally invasive procedures we reviewed papers on online databases, published till 2015 and also materials available in the internet. This review shows that there is a high prevalence of WRMSDs in surgeons. The commonly areas reported were low back, neck, shoulder, wrist, hand, knee and elbow. The awareness of ergonomic practice was relatively low. Poor posture, age, gender, higher surgical volume, equipment design, OR table height, OR layout have been identified as risk factors for development of work related discomfort. In order to better understand the pathophysiological risk and injuries associated with surgery (particularly minimally invasive surgery), comprehensive objective assessment of the surgeons in the operating room setting is the need of the hour.

Keywords: Surgical ergonomics, WRMSDs, Minimal invasive surgery

INTRODUCTION

Work-related musculoskeletal disorders (WRMSDs) are increasingly being reported and studied in various professions worldwide. Work-related musculoskeletal disorders (WMSD or WRMSDs) are injuries or disorders of the muscles, nerves, tendons, joints, cartilage and spinal discs in which the work environment and performance of work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work conditions.¹ Ergonomic organizations are emphasizing the need of a safe and healthy workplace environment in several occupations. The principal aim of these safeguard measures is optimization of work productivity.

Work-related musculoskeletal disorders have been extensively studied in populations where the risk is determined to be high. These include factory workers, farm labourers and those performing heavy manual loading on one hand and those engaged in repetitive work in a sedentary desk job on the other. Amongst health professionals, dentists^{2,3} nurses^{4,5} sonologists^{6,7} and recently surgeons^{8,9} have received substantial attention.

Advances in imaging, equipment, operative navigation systems etc have been incorporated in modern surgical care leading to significant change in the work setting of surgeons in operating rooms. One such advance in surgical technology is minimally invasive surgery (MIS). Some well-established MIS advantages for the patient are reduced blood loss, lower rates of surgical site infection, lesser postoperative pain, shorter hospital stays, quicker

return to productivity, and a better cosmetic result.^{10,11} Hence, more and more surgeries are being done by MIS technique. Minimal access surgery is practiced by several surgical disciplines such as general surgery, urology, gynaecology, thoracic surgery, otolaryngology, orthopaedics and ophthalmology.

Several studies, which have analyzed the ergonomic problems associated with laparoscopic surgery as compared to open surgery, have revealed that the laparoscopic technique is more taxing for the surgeon.¹²⁻¹⁴ While performing a MIS, a surgeon comes across an altered operating environment. There is a loss of tactile feedback due to substitution of instruments for the surgeon's hands. Indirect visualization of the operating field by means of monitors leads to dissociation of the visual and motor axes, loss of depth perception and loss of peripheral vision. All these factors pose mental and physical challenges to the surgeon. Compared with open surgery, laparoscopic surgery presents manipulation difficulties because the instruments are cumbersome, uncomfortable, and offer reduced degree of freedom. The largely static posture required, dictated by port placement and the site of the monitor, is known to cause eye strain and discomfort to arm, shoulder, and spine. In addition, manoeuvring instruments, passing through fixed ports

into the abdomen, increase muscle activity and require adoption of awkward positions of the upper limbs. As a result of these constraints, the physical workload in laparoscopic surgery is significantly increased over that required for an equivalent open procedure.

METHODS

An extensive review of the published literature was conducted in PubMed database for articles published between 1998 and 2015 using keywords such as: work-related musculoskeletal disorders, work-related musculoskeletal symptoms, work-related musculoskeletal pain, WRMSDs, surgical ergonomics, minimally invasive surgery, laparoscopic surgery and various other combinations.

DISCUSSION

There is a high prevalence of musculoskeletal symptoms in surgeons performing minimal access surgery as evidenced by a number of studies published till date. Relatively more prevalence reports are available in laparoscopic surgery, whereas research in the other surgical disciplines is now gaining attention. The findings of these prevalence reports are discussed in the Table 1.

Table 1: Prevalence of work related musculoskeletal symptoms in general surgeons and endoscopists.

Authors	Population studied	%Prevalence musculoskeletal symptoms
Berguer R, Forkey DL et al ¹²	149 surgeons	8% to 12%.
Wauben LS, Van Veelen MA, et al ¹⁵	Surgeons and residents laparoscopists	80%
Byun YH, Lee JH et al ¹⁶	55 GI endoscopists in Korea.	67.3% -pain at rest. 89.1% -more than one site
Hansel SL, Crowell MD et al ¹⁷	Gastroenterologists (GI). Internal medicine specialists and subspecialists (non-GI).	74% in the GI group vs. 35% in the non-GI group (P<0.001).
Grace P. Y. Szeto Pei Ho et al. ⁸	General surgeons in public hospitals of Hong Kong.	80%
Stomberg MW, Tronstad SE et al. ¹⁸	378 laparoscopists	>70% (most frequent sites lower back, neck and shoulders)
Sari V, Nieboer TE, et al ¹⁹	55 University hospital laparoscopic surgeons	73%
Takayasu Kuwabara, Yuji Urabe, et al ²⁰	Surgeons: 190 endoscopists and 120 non-endoscopists.	43% in endoscopists 41% in non-endoscopists
FA Desai, TJ Ellapen, et al ²¹	76 general surgeons	69.74%
Y Modi, Manoranjan R. et al ²²	GI, urological, gynecological and thoracic Surgeons	66% (arm and shoulder pain) 32% (neck pain)
T Dabholkar, S Yardi, et al ²³	75 general surgeons performing MIS	86% 65 % more than one site pain.

Table 2: Prevalence of work related musculoskeletal symptoms in urologists and gynaecologists.

Authors	Population studied	% Prevalence musculoskeletal symptoms
Shunaha Kim Fine, Sandra M. Woolley et al ²⁴	International Uro-gynecological association and American Uro-gynecological society.	86.7% (436/503)
Jason Franasiak, Emily M. Ko, et al ²⁵	260 members of Society of Gynecologic Oncology North America.	88% - Physical discomfort related to MIS 52% - Persistent pain.
Ofer N. Gofrit, Albert A. Mikahail, et al ²⁶	73 urologists	30% - Neuromuscular pain, 18% - Finger paresthesia, 45% - Numbness 37% - Pain in hand and wrist

Table 3: Prevalence of work related musculoskeletal symptoms in otolaryngologists.

Authors	Population studied	%Prevalence musculoskeletal symptoms
Barbar-Craig H, Banfield G et al ²⁷	325 ENT consultants in UK	72%-neck & back pain (53% attributed symptoms to surgical practice)
Cavanagh J, Brake M et al ²⁸	Paediatric otolaryngologists	62%
M. Amin, J. Rimmer et al ²⁹	78 members of the British Rhinological Society	58% (pain) and 59% (stiffness)

Table 4: Prevalence of work related musculoskeletal symptoms in ophthalmologists.

Authors	Population studied	%Prevalence musculoskeletal symptoms
Dabholkar T, Yardi S, et al ³⁰	75 ophthalmologists	49%
Sivak-Callcott Jennifer A. et al ³¹	130 ophthalmologic plastic surgeons	72.5%
Kenneth C. Dhimitri, McGwin et al ³²	697 ophthalmologists in US	51.8%

Table 5: Prevalence of work related musculoskeletal symptoms in minimally invasive surgical team.

Authors	Population studied	%Prevalence musculoskeletal symptoms
Van Veelen MA, Nederlof EA, et al ³³	Medical teams in minimally invasive surgery.	Physical discomfort 63% and perception problems 50%

Common anatomical sites

Most researchers have reported surgeons experiencing discomfort in the neck, back and shoulders, wrist and hand as can be seen in Table 6.

The neck pain has been attributed to the inappropriate height and viewing angles of the monitors. Higher monitors not placed directly in the line of vision can lead

to a persistent awkward neck posture of extension coupled with rotation. The role of prolonged repetitive upper limb task cannot be ignored in causation of neck pain.

The back pain has been attributed to the prolonged standing, bent and twisted postures adopted while performing repetitive work with precision in surgeries. Other contributing causes for both neck & back pain may be inadequate assistance, unorganised OR environment and inadequate breaks.

Shoulder pain is more likely if the arms are kept elevated or abducted for a prolonged time the result of which is increased demand on the shoulder stabilisers. Use of instruments with uncomfortable handles, reduced degree of freedom, long extracorporeal lengths and performing repetitive upper limb movement and were considered highly associated with elbow, wrist and hand pain.

Table 6: Prevalence of work related musculoskeletal symptoms as per anatomical site-wise.

Authors	Neck	Back	Upper limb	Lower limb
Y Modi, Manoranjan R. et al ²²	32%	-	66%	-
FA Desai, TJ Ellapen et al ²¹	33.9 %	60.3%-lower 26.4% upper back	32% Glenohumeral 24.5% Elbow/Forearm/ hand	22.64% -Lower limb/ankle/foot -
T Dabholkar, S Yardi et al ²³	26.6%	49.3%	Shoulder -14.6% Wrist hand - 25.3% Elbow - 14.6%	22.6%
T Dabholkar, S Yardi et al ²⁸	51%	46% (low back)	18% (Shoulder pain)	11% (leg fatigue and numbness)
Grace P. Y. Szeto, Pei Ho, et al ⁸	82.9%	68.1% lower 52.6% Upper	57.8%	-
T Kuwabara, Y Urabe, et al [Endoscopists] ²⁰	9%	26% Lower back	9% Right shoulder- 8% left thumb - 17% hand and wrist	-
B Liang, L Qi. et al 241 laparoscopic urologists ³⁴	58.1%	53.1%	30.3% Hand, 32.8% Wrist, 33.6% Shoulder	21.6% Leg ,
Dhimitri KC, McGwin et al ³² [Ophthalmologists]	32.6%	39% Low back	32.9%	-

Risk Factors of WRMSDs

Studies have identified static and awkward postures, female gender, OR table height, OR layout, higher surgical volume, instrument design, age, inexperience and poor monitor position as risk factors for development of work related musculoskeletal pain (Table 7).

It can be seen from the above table that many studies have identified age as risk factor for WRMSDs (due to higher job stress and lower fitness levels with increasing age). However in surgeons, as in any population, younger workers may also be at increased risk of musculoskeletal problems due to their lack of experience resulting in poorer skills and insufficient practice.³⁷ The “healthy worker effect” also suggests that those who are healthy are more likely to remain at work.³⁸

The confounding influence of age, general health, stress, fatigue, sleep disturbance, anxiety, emotional distress, cognitive dysfunction, poor quality of life and pain threshold makes it challenging to assess the prevalence in this population.

To prevent and minimize WRMSD in this group, the surgeons performing minimally invasive surgeries have to be made aware of simple ergonomic practices like adopting acceptable posture during surgery and adequate breaks between procedures. Spinal postures with greater than 20 degrees of flexion, lateral flexion or rotation and more than 5 degrees of extension pose a risk for spinal pain if adopted for longer durations. The monitors should be mounted in a manner that viewing angle is in the surgeon's line of vision. Adjustable ceiling mounted monitors would be preferable to monitors mounted on

fixed height TV towers in the OT. The optimal monitor position is at least 1 m from the surgeon's eyes and at a declination that ranges from 0° to-15° from the surgeon's neutral gaze.³⁹⁻⁴¹

Ergonomic awareness in surgeons

In spite of the increase in the prevalence of work related musculoskeletal symptoms, there is both limited ergonomic awareness and inadequate practice of ergonomic guidelines by surgeons as reported in literature. These statistics show that more surgeons should be made aware of ergonomic practices like ensuring optimum operating surface height and monitor height, appropriate lighting and temperature OR layout and other safety related ergonomic issues like floor clearance (Table 8).

Suggestions

In view of the high prevalence in this group we recommend fitness training for surgeons in general and those performing minimal access surgeries in particular. Lower extremity fatigue can be reduced with the help of anti-fatigue mats and ergonomic surgeon chairs. There is an urgent need for ergonomic attention to design of OR and its equipment. This should be taken into consideration by manufacturers and hospital administrators.

With increasing number of surgical procedures being done by the minimally invasive technique, it is likely that surgeons in future will be at even greater risk of developing WRMSDs, if prompt and timely measures are not initiated. Due consideration also needs to be given to

time management to avoid overload and fatigue in surgeons. A strong relationship has been observed between surgeon distress/fatigue and perceived medical errors.^{42,43} Looking to the future and the important issue

of patient safety, we believe that ergonomics in the operation theatre focusing not only on the surgeon but the entire operating team will translate into better surgical outcome & improvements in the patient safety culture.

Table 7: Risk factors of work related musculoskeletal pain in surgeons.

Authors	Population studied	Risk factors
Lucas-Hernández M, Pagador JB et al. ³⁵	Laparoscopic surgeons of the Spanish Health System	Instruments' design, operating tables, posture of the surgeons.
A.K. Hemal, M. Srinivas, and A.R. Charles ³⁶	Laparoscopic surgeons versus surgeons performing conventional surgeries	Laparoscopic more associated with WRMSDs over conventional. Inexperience
Ofer N. Gofrit, Albert A. Mikahail, et al ²⁶	73 urologists	Total number of laparoscopic procedures performed
Sari V, Nieboer TE, et al ¹⁹	Laparoscopic surgeons	Table height, monitor position, design of instrument handles
Stomberg MW, Tronstad SE et al ¹⁸	Gynaecologists and Surgeons performing laparoscopic surgery	Longer work time, ageing, gender (F>M)
Van Veelen MA, Nederlof EA, et al ³³		OR layout, limited reach of instruments, work clothing
Byun YH, Lee JH et al ¹⁶	Gastrointestinal endoscopists	Posture or habit, gender (F>M)
Twinkle Dabholkar, Sujata Yardi et al ²³	General surgeons performing MIS procedures	Wrong posture, work place ergonomics, prolonged standing, long working hours
Dabholkar T, Yardi S, et al ³⁰	Ophthalmologists	Poor posture, long surgery hours, uncomfortable seating, use of microscope
Grace P. Y. Szeto, Pei Ho, et al ⁸	General surgeons in Hong Kong	Sustained static/awkward posture Work style score
Takayasu K, Yuji U, et al ²⁰	Japanese GI endoscopists	Age of the endoscopists, procedures per week
Franasiak J, Ko EM, Kidd J et al ²⁵	Gynaecological oncologists performing MIS	Surgeon's height, age, glove size and gender (F>M), patient's BMI

Table 8: Ergonomic awareness and practice in surgeons.

Authors	Awareness of ergonomic guidelines	Practice/training of ergonomics
Wauben LS, Van Veelen MA, et al ¹⁵	89% unaware	-
Y. Modi, Manoranjan R. et al ²²	64% aware	54% - following guideline in operating surface height and 4% for monitor height
T. Dabholkar, S. Yardi et al ²³	45% aware	Not reported
T. Dabholkar, S. Yardi et al ³⁰	38% ophthalmologists aware	Not reported
Liang, B., Qi, L., et al ³⁴	98.8% laparoscopic urologists stated that ergonomic guidelines in the OR are important.	94.6% never received any training or education on ergonomic guidelines
Cavanagh J., Brake M. et al ²⁸	31.0% aware	83.9% of those aware had implemented ergonomic principles

CONCLUSION

The prevalence of WRMSDs in surgeons performing minimal invasive surgery is higher than those performing open surgery. In view of this high prevalence we

recommend urgent ergonomic attention to the work setup and better training in ergonomic practices in surgeons performing minimally invasive surgeries.

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