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RESEARCH ARTICLE

Postural Ergonomic Risk Assessment and Work-related Musculoskeletal Symptoms Among Surgeons

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ABSTRACT

Background: Work-related musculoskeletal disorders (WMSDs) develop mainly because of poor work ergonomics. Surgeons are much prone to develop the musculoskeletal symptoms due to nature of their precise work linked with prolong postures.

Objectives: To assess the level of postural ergonomic risk exposure and frequency of work-related musculoskeletal symptoms among Surgeons.

Methods: This was an observational, descriptive cross-sectional survey conducted among surgeons (n=100) working in hospitals of Rawalpindi and Islamabad, Pakistan. Convenient sampling technique was used. Structured survey questionnaire was used to collect demographic data and work details of surgeons. Pre-validated tools such as Quick Exposure Check (QEC) and Body Mapping Tool were also used. SPSS version 21 was used for data entry and analysis.

Results: More than half of the surgeons' working posture exposed them to high 49(49%) and very high ergonomic risk 15(15%). The mean of Quick Exposure Check score was 55.71±14. Majority of the surgeons 64(64%) requires urgent and immediate change of their work posture. A significant difference of QEC score (p= 0.001) between males and females was found. Statistically significant difference (p=0.002) of QEC score among Surgeons. 64(64%) of the participants have reported work-related body pain in lower back 35(35%), neck 29(29%), shoulder 16(16%), wrist 15(15%), ankle 15(15%), upper back 14(14%), hip pain 9(9%), knee 9(9%) and elbows 5(5%).

Conclusion: It is concluded that work- related posture puts surgeons at higher ergonomic risk. Most of them were experiencing work-related musculoskeletal pain in some of their body regions.

Key words: Ergonomic Assessment, Posture, Risk, Work-related disorders, Surgeons .

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Introduction:

Ergonomics is a science that deals with safe and effective interaction among workers, tools and their work-related environment.(1) It is concerned with designing and arranging workplace according to a job nature. Maintaining good ergonomics at work helps enhance physical fitness of workers. Ergonomic training reduces the incidence of work-related musculoskeletal disorders (WMSDs).(2) These are injuries or dysfunctions affecting bones, tendons, nerves, muscles, ligaments, joints, cartilages and spinal discs as a result of work - related activity.(3) A variety of risk factors associated with WMSDs has been reported in numerous published studies. They are explained as being occupational/workplace- related, personal/ individualistic and psychosocial.(4, 5)

Surgeons are a distinctive group of healthcare professionals who are at risk of developing WMSDs.(5) Their health and wellbeing is an essential factor that needs consideration.(6) Workplace-related risk factors majorly contribute in developing WMSDs like mechanical stress due to poor ergonomic adaptations of surgical instruments and operating room (OR) that may have a negative effect on surgeons' health as well as quality of life.(7, 8) Contrary to it, even in well-designed operating rooms, having availability of remote-controlled operating tables, ergonomically-designed operating chairs and patient sliding devices, frequent and repetitive activities with prolonged awkward postures while performing surgery exert mechanical load on their body.(9) Literature suggests that despite advancement in designing of surgical instruments and operating room, there are different mechanical risks attached to various types of surgical procedures like prolonged static posture and exerting excessive force while handling heavy surgical instruments. (6, 10) Besides, muscle fatigue can result from performing same surgical tasks repetitively, localized pressure on some body parts while using vibrating surgical tools and reduced degree of

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bodily movement.(5, 10)

Neck, upper back, lower back, shoulder and arm have high prevalence of musculoskeletal disorders and symptoms among surgical specialists.(5, 8, 11-13) Both psychosocial and physical factors contribute to it.(4) Most experienced surgeons performing minimally invasive surgeries are also sufferers of WMSDs.(8) Physical loading in dentistry procedures causes musculoskeletal complaints commonly in upper limb due to repetitive movements of hands. (14, 15) Rambabu T et.al reported 61% musculoskeletal disorders among dental surgeons as compared to other specialty surgeons (37%) and physicians (20%). Stressful, prolonged body postures and repetitive tasks in labor room increase ergonomic risk exposure to back and shoulder among gynecologists.(16) According to survey report of Vijendren A et. al, 47.4% ENT surgeons experienced WMSDs and 85% of them sought treatment.(9) Lower back pain and lateral epicondylitis have been reported in pediatric orthopedic surgeons of North America due to repetitive and forceful nature of their work.(17) Increasing age and long experience are associated with orthopedic trauma surgeons.(18)

Ergonomics risk assessments can be used to identify physical risk factors and which body part is at higher risk, this assessment can determine some risk monitoring and adequate preventive measures.(6) Globally, there are many studies available that have determined musculoskeletal symptomatology among surgeons. However, very limited national literature is available on level of ergonomic risks exposure based on surgical postures. On these grounds, the current study was designed with objectives to assess levels of postural ergonomic risk exposure along with frequency of work-related musculoskeletal symptoms among surgeons of Rawalpindi and Islamabad.

Methods:

This was an observational, descriptive cross-sectional survey. It was conducted from August 2017 to January 2018 in different surgical specialties of two public and three private sector hospitals of the twin cities. After receiving an approval from the research ethical committee of Riphah international university Islamabad (RIPHAH/RCRS/REC/Letter-00460) , the process of data collection was started. Prior permission for data collection was taken from hospital authorities of Capital hospital Islamabad, Islamic international Dental Hospital Islamabad, IIMCT Pakistan Railway General Hospital Rawalpindi, Quaid e Azam International Hospital Islamabad and Maryam Memorial Hospital, Rawalpindi.

The study population consisted of surgeons working in Rawalpindi and Islamabad. The "Raosoft" sample size calculator was used for sample size calculation with 95% confidence level, 5% margin of error, 80% response distribution and assumed population size of 200. The calculated sample size was 111.(19) A total of 111 surgeons were contacted, of which 100 agreed to be part of study. So, the actual sample size was n=100.

The purpose of study was well explained, and informed consent was taken from the surgeons. Non-probability, convenient sampling technique was used. Both male and female surgeons, working at least since last 6 months in same physical environment, willing to be interviewed and photo shot their most sustained posture during surgical procedure were included in the study. While those with previous 6-month history of road traffic accident/trauma, pregnant female surgeon or who refused to be part of study, were excluded.

Structured survey questionnaire was given to the surgeons (n=100), having three sections. The first section consisted of individual characteristics of surgeons and their work-related history. It included questions on age, gender, years of experience, employment status, job sector, prior ergonomic knowledge, specialty, working hours per day, average time duration during surgery and number of surgeries performed per day.

The second section consisted of pre-validated body mapping tool, with the aim of determining work-related musculoskeletal symptoms. It contained questions about body regions that experienced pain and discomfort during the last three months and seven days, affecting activities of their daily living. The above information was collected by the researchers themselves while doing structured interviewing of the surgeons outside the operating rooms.

After conducting MSK symptomatology assessment, exposure to ergonomic risks due to sustained and repeated working postures on different body parts while performing surgery, was analyzed in third section of study questionnaire through pre-validated Quick Exposure Check (QEC).(20) The QEC system focuses mainly on the assessment of workplace risk factors contributing to WMSDs.(21) It combines assessment done by both observer and worker. Direct observation of surgical tasks was done by the researcher. Photographs of most repetitive tasks and sustained postures adopted during surgery were taken using mobile camera (Samsung J2). These photographs were used later for observational postural analysis. The patient confidentiality was not breeched as

only surgeons' working posture was captured and saved with their permissions. Risk exposure scores for back, shoulder/arm, wrist/hand, and neck in relation to particular task were later calculated on QEC tool. Other workplace risk factors like job stress, vibration exposure and work pace were also scored. Based on these calculated QEC score, participants' postures were categorized on predetermined action levels as;≤40% acceptable; 41-50% investigate further; 51-70% investigate further and change soon;>70% investigate and change immediately.(20, 21)

All the data was entered and analyzed in Statistical Package for Social Sciences (SPSS) version 21. The data of QEC score was normally distributed as checked by plotting histogram and value of Shapiro-Wilk test (p=0.616). To compare mean ergonomic risk score between male and female surgeons, independent t-test was employed. To assess difference of ergonomic risk score among surgeons of different specialties and years of experience, one-way ANOVA test was used. P<0.05 was taken as statistically significant.

Results:

The mean age of participants was 33.13±11 years. Employment status was fulltime in 86(86%) and part time in 14(14%). Clinical facility in which surgeons were working was secondary care 44 (44%) and tertiary care 66(66%). Their mean working experience was 7.48±9.51 years. The working hours per day and number of surgeries performed per day, 8.34±2.64 and 3.54±2.12; respectively. Prior ergonomic knowledge was reported by 65(65%) surgeons whereas 35(35%) had no formal ergonomic information.

The mean of calculated QEC score was 55.71±14. The minimum QEC score was 25% and maximum was 93%. As per tool protocol, action levels were determined based on individual ergonomic risk exposure score. Amongst them, 17 (17%) were presented with low-risk exposure which is considered an acceptable value, 19(19%) with moderate exposure that needs further investigation of their work posture, 49(49%) with high risk exposure that requires urgent change in working postures and 15(15%) surgeons were exposed to very high risk, so immediate change of their work posture needed.

Gender wise ergonomic risk assessment was found statistically significant (p=0.001) calculated by independent sample t-test as male surgeons' QEC score was higher as compared to their female counterparts. The analysis done by ANOVA showed statistically significant difference (p=0.002) of QEC score among surgeons' belonging to different Specialties. But ANOVA analysis between QEC score and Surgeons' years of work experience showed non-significant difference (p>0.05) with almost similar QEC mean score between novice and experienced professionals. Their respective QEC scores have been mentioned in Table 1. Table 2 showed exposure level of different body regions to ergonomic risk. Neck, shoulder/arm are more exposed to risks followed by wrist/hand and back. Risk exposure to vibrating tools of surgery was low 78(78%), moderate 18(18%) and high 4(4%). Job stress risk was low 11(11%), moderate 45(45%), high 33(33%) and very high 11(11%). The surgeons 38(38%) found to be at low risk of having

Table 1: Quick Exposure Check (QEC) score among Gender, Specialty, and years of experience in surgeons

Variables	Subcategories	N (%)	QEC-Score (Mean ± S.D)	P value
Gender	Male	48(48%)	60.45±13.71	0.001
	Female	52(52%)	51.33±12.87	
Surgery Specialty	General	15(15%)	54.30±11.73	0.002
	Orthopedic	14(14%)	66.06±16.31	
	Urologist	3(3%)	72.56±.51	
	Gynecologist	23(23%)	49.35±11.25	
	ENT	10(10%)	57.63±11.77	
	Dental	32(32%)	54.81±13.45	
Experience (years)	Less than 2 Years	42(42%)	53.60±13.98	0.54
	2 to 4 Years	20(20%)	55.84±12.29	
	5 to 9 Years	19(19%)	56.89±16.81	
	10 Years and above	19(19%)	59.06±12.80	

[QEC-Quick Exposure Check, Frequency (N)]

Table No 2 shows level of risk exposure of different body regions of surgeons calculated from Quick Exposure Check (QEC)

Exposure Score	Low	Moderate	High	Very High
Back (static)	8 %	13%	12%	2%
Back (Moving)	12%	36%	14%	3%
Shoulder/Arm	32%	51%	15%	22%
Wrist/Hand	24%	50%	23%	3%
Neck	7%	32%	30%	31%

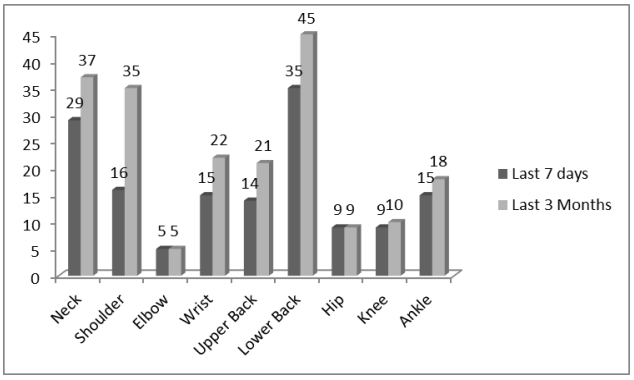

Figure 1: Work -related Musculoskeletal symptoms of surgeons during last 7 Days and last 3 Months

difficulty in keeping up with their work, 58(58%) moderate and only 4(4%) have high work pace risk. According to response of body mapping tool, 64(64%) surgeons had some sort of pain, discomfort, or ache in one or more body regions, while 36(36%) did not have such symptoms. During the last seven days' work related pain/ache/ discomfort and/or numbness among surgeons was high in lower back 35(35%), followed by neck 29 (29%), shoulder 16(16%), wrist 15(15%), ankle 15 (15%). upper back 14(14%), hip pain 9(9%), knee 9(9%) and elbows 5(5%) (Fig.1).During last three months work-related pain/ache/discomfort and/or numbness was reported in lower back 55(55%), followed by neck 37(37%), shoulder 35(35%), upper back 21(21%), ankle 18(18%), knee 10 (10%), hip 9(9%), elbow 5(5%) and wrist 5(5%) (Fig.1).

Discussion:

In the current paper, ergonomic risk exposure was evaluated by analyzing surgeons' work postures, along with investigation of work-related musculoskeletal symptoms. On average this study's participants scored moderate level of ergonomic risk, but a large proportion was exposed to high and very high risks. Neck, shoulder/arm are more exposed to risks followed by wrist/hand and back.

Previous systematic reviews conducted to evaluate evidence of biomechanical risk factors for causing work-related musculoskeletal disorders, reported non-neutral body postures, excessive repetition and heavy lifting to contribute the most. (3, 22) The postural risk exposure assessment of current study supports claim of a study done in Stanford University Medical Center, South America, which reported medium to high level exposure risk among laparoscopic, open and robotic surgeons despite using well-designed surgical instruments.(11) Batham C et al. did postural ergonomic risk exposure assessment through QEC on Indian dentists and found 93.8% were exposed to moderate and high level of postural ergonomic risk.(23) Another descriptive study found high ergonomic risk exposure score in open, laparoscopic and microscopic surgery among surgeons in Tehran hospital.(6) Results of previous literature showed congruency with findings of current study in that more than fifty percent participants(64%) are exposed to postural ergonomic risks at high and very high level (49% and 15% respectively).

A review on epidemiological evidence of WMSDs also added rapid work pace and vibration in physical ergonomic work factors.(22) Specific to surgeon population, a previous study by Park HS et al had commented that dentists were constantly exposed to weak vibration while handling dental hand piece.(24) Another study conducted on orthopedic surgeons to measure hand-arm vibration risk by using hand operated saws, they also had reported neglected risk due to vibration.(25) Although current study focused on multiple specialties but vibration and work pace risks were found to be largely low (78%) and moderate (58%) respectively among surgeons.

Excessive and awkward postural demand on neck, shoulder and arm place higher muscular and joint forces.(26) In past studies, it has been commonly reported that prevalence of musculoskeletal symptoms is high among surgeons due to prolong poor postures.(6, 8, 11, 16-18) Similar results have been reported in current study. A very recent research report by Gutierrez-Diez MC et al concluded lower back (54%), neck (51%) and shoulder (29%) as more affected body zones in

minimal invasive surgical procedures.(8)Likewise, back and shoulders pain was also frequently presented musculoskeletal problem in obstetric and gynecological surgeons.(16) Another study by Saad M et al reported low back pain to be a commonly affected area (29.3%) among orthopedic trauma surgeons.(18) Therefore , results of current study deduced by body mapping tool are found to be consistent with those of previous literature. It is reported in the current study that lower back symptoms were frequent i.e. 35%, followed by neck 29%, shoulder 16%, wrist 15%, ankle 15%, upper back 14%, hip pain 9%, knee 9% and elbows 5% among surgeons.

Some limitations of the current study need to be acknowledged. This was an observational cross-sectional study which evaluated surgeons' postural ergonomic risk exposure at a single point of time. Other important aspects of ergonomics like physical infrastructure of workstation, building and handling of surgical tools or equipment were missed. As multiple surgical specialties were chosen due to lack of sufficient number of surgeons of single specialty in twin cities of Rawalpindi and Islamabad, generalization of study's findings is rather uncertain. In surgical field, application of postural ergonomic guidelines would be a great benefit for both surgeons and patients. So, ergonomic guidelines for operating room should be revised and implemented to avoid future risks of developing musculoskeletal disorders. Ergonomic training and postural awareness programs must be introduced as regular part of training. Strengthening exercises for high-risk areas of body should be practiced, enhancing their capacity to work in pain free environment, and facilitating the delivery of quality care to patients. Further studies are recommended with proper implementation of ergonomic training along with analysis of operating room.

Conclusion:

In conclusion, majority of the surgeons were exposed to moderate and high level of postural ergonomic risks. Male surgeons were more exposed to postural ergonomic risks as they scored high in QEC. Many of them reported work-related pain or discomfort in one or more body regions. The most affected musculoskeletal zone showing both acute and chronic symptoms was upper back, followed by lower back, neck, shoulder and arm. Vibrating tool, work pace and job stress risks' scores were low, moderate, and high, respectively.

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Author Contribution:

Riaz H: Conception, Data analysis, Data interpretation, Critical Review and Final Approval.
Khan H: Data Collection, Data Analysis, Drafting of Manuscript.
Malik Q: Data Acquisition, Data Analysis, Drafting of Manuscript.