Original Article
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Medical Journal of the Islamic Republic of Iran (MJIRI)
Iran University of Medical Sciences

Ergonomic risk factors and musculoskeletal symptoms in surgeons with three types of surgery: Open, laparoscopic, and microsurgery

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Received: 10 October 2016 Accepted: 8 December 2016 Published: 28 December 2016

Abstract

Background: Musculoskeletal symptoms are the main cause of loss of working time, and increase in labor costs. Poor posture is the most important risk factor for work-related musculoskeletal symptoms. This study aimed at evaluating the role of ergonomic risk factors in different surgical (open surgery, laparoscopy, and microsurgery) in the frequency or resonance frequency of musculoskeletal symptoms.

Methods: This descriptive-analytic study was conducted on 81 surgeons in a hospital in Tehran. In this study, the prevalence of musculoskeletal symptoms was evaluated using the Nordic Questionnaire. Moreover, Workplace ergonomic risk assessment method (WERA) was used to evaluate ergonomic risk factors in 3 types of open surgery, laparoscopy, and microsurgery.

Results: The results revealed that the prevalence of musculoskeletal symptoms of the neck, back, shoulder, and arm is high in surgeons (over 75%). The mean final score of WERA was 40.11, representing the high risk of the 3 types of surgery for the prevalence of musculoskeletal symptoms. Results revealed that the prevalence of musculoskeletal symptoms in the neck, waist and wrists had a significant relationship with the body posture in the 3 types of open surgery, laparoscopy, and microsurgery ($p<0.05$).

Conclusion: In the present study, the prevalence of musculoskeletal symptoms was high in the neck, waist, and hands surgeries. Depending on the type of surgery, teaching correct working methods, using proper seats and ergonomic equipment are the best strategies to reduce musculoskeletal symptoms in the surgical profession.

Keywords: Ergonomic Risk Factors, Musculoskeletal Symptoms, Surgeons, Posture.

Cite this article as: Aghilinejad M, Ehsani AA, Talebi A, Koohpayehzadeh J, Dehghan N. Ergonomic risk factors and musculoskeletal symptoms in surgeons with three types of surgery: Open, laparoscopic, and microsurgery. *Med J Islam Repub Iran* 2016 (28 December). Vol. 30:467.

Introduction

Musculoskeletal disorders are one of the most common causes of occupational injuries and disability in industrialized nations and developing countries (1-3). A variety of risk factors are involved in the occurrence of the damage that can be divided by physical factors such as poor posture, ergonomics, lifting, and carrying heavy loads and working with repetitive movements (4), psychological, organizational, and individual factors (5). These disorders mainly occur in the upper extremities such as hands, wrists, arms, shoulders, neck, and waist (6). These disorders occur due to repetitive movements that led to the injury of nerves, tendons, joints, cartilage or disks between the vertebrae (7). Factors that cause these disorders are awkward posture, repetitive movements, and excessive force. The signs

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of musculoskeletal symptoms are muscle pain, discomfort, numbness down, burning, tenderness, swelling, limited range of motion, and loss of power. A long repetitive movement of the body (8) causes these pains. According to the previous studies, there is a significant relationship between musculoskeletal disorders and repetitive motion. (9). The symptoms include physical negative effects that are highly costly.

Several professionals such as surgeons and personnel of the operating rooms are at risk of these symptoms. The surgeons perform the surgery in a standing position, and the hands are generally in motion in surgery. Sometimes a fixed posture continues for hours and the pressure exerted by the musculoskeletal organs is too high (11). Over time, the continuous exposure to biomechanical and psychosocial stressors may intensify the musculoskeletal injuries in the workplace. Because surgery is often subtle, sensitive, and time-consuming, ergonomics aims at helping the surgeons to work without feeling any pain, or stress, and with less error (12). Nowadays, various surgical procedures are done such as open surgery, laparoscopy, and microsurgery (13). The body posture of the surgeons during open surgeries is described as a head-bent and back-bent posture. Surgeons maintain this posture for long periods; and as a result, they experience physical discomfort during and after the surgery (13). During laparoscopic procedures, the body movement of the surgeon is very limited, resulting in a more static upright body posture compared to open surgery (13). Due to the position and depth of the incision during open surgery, surgeons have a fixed work posture, tending to work with arms abducted and unsupported (14). There are various ergonomic risk factors in each of these surgeries. For instance, repetitive motion of the wrist in laparoscopic surgery, and neck static posture in microsurgery could cause musculoskeletal disorders (14, 15). In addition to improper posture due to ergonomics, repetitive movements of the hands and wrists, neck and shoulders, and excessive force can ultimately cause or exacerbate these effects (16). According to healthcare professionals, multiple ergonomic risk factors in the operating rooms can lead to or aggravate musculoskeletal symptoms. Moreover, no comprehensive study has been conducted to evaluate and compare the ergonomic risk factors in these 3 types of surgeries. This study aimed at evaluating the role of various ergonomic risk factors in the frequency or resonance frequency of musculoskeletal symptoms in surgeons who perform surgery (open surgery, laparoscopy, and microsurgery) in a hospital of Iran University of Medical Sciences.

Methods

In this cross-sectional study, participants were selected by census. Eighty-one male surgeons who consistently worked at Milad hospital in Tehran participated in this study. Each of these surgeons exclusively conducted one of the 3 types of open surgery, laparoscopy, and microsurgery. After interviewing the surgery team, to determine the prevalence of musculoskeletal symptoms, the Nordic Questionnaire (a questionnaire made by Kurinka et al. at the Institute of Occupational Health in 1987) was used (17). In this study, the prevalence of musculoskeletal symptoms was first examined using the Nordic questionnaire. Demographic information such as age, height, weight, work experience, and number of hours per day were added to the questionnaire. To estimate and evaluate the ergonomic risk factors in each of these three types of surgery WERA method was used. The WERA covers an extensive range of physical risk factors including posture, repetition, forceful, vibration, contact stress, and task duration, and it assesses the five main body regions (shoulder, wrists, back, neck and legs) (18). Eighty-one surgeons who performed the 3 following types of surgeries participated in this study: Open surgery (n=26), laparoscopy (n=28), and microsurgery (n=27). Each of the surgery types was observed using the WERA tool. During the surgery, observation of the

workplace was carried out by recording the surgeries using a video camera. The three types of surgery were observed and videotaped to collect data for the WERA assessment. The angle of the body segments relative to the vertical position was estimated (shoulders, wrists, back, neck and legs) using the video tapes (18). Data were analyzed using SPSS Version 22, and descriptive statistics were reported. Pearson correlation coefficient test was used to examine the relationship between the variables.

Results

The demographics of the surgeons are demonstrated in Table 1. The Mean±SD age of the participants was 45.34 ± 2.34 years. The participants were middle aged and experienced (5.4 years of work experience).

Table 2 demonstrates the prevalence of musculoskeletal disorders that the surgeons experienced during the past 12 months. The prevalence of symptoms in the neck, back, shoulder, and arm was high; and a high percentage of the participants involved in all the 3 types of surgeries (open surgery, laparoscopy, and microsurgery). No significant difference was found in the prevalence of musculoskeletal symptoms in the body of the surgeons performing these 3 types of surgeries.

Table 3 displays the evaluations of the WERA scores. The average of WERA final score is 40.11, representing an upward risk for musculoskeletal disorder in 3 types of surgeries. In this study, the WERA score of laparoscopic surgery had a significant relationship with back problems (r=0.61, p=0.02), wrist (r=0.53, p=0.03), and neck (r=0.49, p=0.02). Musculoskeletal disorder had a significant relationship with the WERA score (r=0.48, p=0.02) in open surgery, and (r=0.46, p=0.04) microsurgery.

Discussion

Table 1. The Demographic Characteristics of the Surgeons in the Study (n=81)

Demographic Characteristics	Mean	Standard Deviation	Maximum	Minimum
Age (year)	45.34	7.13	55	34
Length (cm)	171.38	7.93	194	164
Weight (kg)	67.87	11.39	97	56
Work experience (year)	5.4	4.49	16	4
Average working hours per day	6.21	1.76	7	4

Table 2. Distribution of the Prevalence of Musculoskeletal Disorders in Different Body Organs of the Surgeons during Surgery in the Last 12 Months (n=81)

Surgery Types	Open Surgery n=26		Laparoscopy n=28		Microsurgery n=27		
Organ areas	n	%	n	%	n	%	p*
Neck	21	80.7	25	89.2	23	85.1	0.627
Shoulder and arm	20	76.9	23	82.1	22	81.4	0.591
Elbow and forearm	19	73	21	75	20	74	0.723
Hand and Wrist	18	69.2	19	67.8	21	77.7	0.821
Back	24	92.3	22	78.5	19	70.3	0.625
Trunk	17	65.3	17	60.7	18	66.6	0.757
Thigh	11	42.3	15	53.5	16	59.2	0.512
Knee	10	38.4	9	32.1	11	40.7	0.673
Legs and feet	16	61.5	15	53.5	16	59.2	0.691

* Friedman Two-Way Analysis of the Variance Test

Table 3. The Scores of the 3 Types of Surgeries by WERA Method

Surgery	Vibration	Cargo	Contact Stress	Duration of Work	Number	WERA (Added scores)
Open surgery	Applicable	5-10kg	Semi-rigid	More than 4 hours per day	26	42.34
Laparoscopy	Not applicable	Less than 5 kg	Semi-rigid	More than 4 hours per day	28	37.99
Microsurgery	Not applicable	Less than 5 kg	Semi-rigid	More than 4 hours per day	27	40.01

The aim of this study was to evaluate the relation of musculoskeletal disorders and ergonomic risk factors based on WERA method in 3 types of surgery among the surgeons who were working in Tehran's hospitals.

In this study, it was found that specified ergonomic risk factors, based on evaluating by WERA, has a high impact on the prevalence of musculoskeletal symptoms. On the other hand, the type of surgery was the main cause of musculoskeletal disorders among surgeons who participated in this study. In a study on the prevalence of musculoskeletal symptoms in surgeons, it was found that the highest prevalence was in the lower back, neck, and hands due to poor postures of the surgeons during surgery (19). In another study, the most important cause of arthritis pain and disability was found to be long-term operating mode or standing back for long hours (11). Therefore, the results of this study are consistent with those of the previous studies on the prevalence of musculoskeletal symptoms in surgeons. Musculoskeletal disorder is more common in laparoscopic surgery and open surgery due to incorrect posture, such as the need to bend neck and back (20). On the other hand, the prevalence of musculoskeletal symptoms in wrist of the surgeons had a direct relationship with instruments in this study, which is consistent with the results of previous studies (21). Improper use of hand tools in the surgery caused musculoskeletal symptoms and back pain, especially in awkward postures (22). In a study conducted on surgeons, the most complaints of the surgeons were related to limbs shoulder, wrist, and waist (23). In another study, the highest prevalence was in the back, neck, and wrists, causing adverse deviation of the wrist posture from the normal posture (24).

Among the most important tools used in laparoscopic surgery is Grasper/Loop, which causes poor posture of the body. In addition, looking into a monitor for a long time increases the risk of musculoskeletal symptoms in laparoscopic surgeries in the cervical region (25). Moreover, working with the surgical microscope for a long-time, improper postures, and improper seating increase the prevalence of musculoskeletal symptoms in the back and neck muscle areas while performing microsurgery (26).

The results of this study revealed that the prevalence of musculoskeletal symptoms was high among the surgeons. Therefore, it is necessary to take action to solve this problem by using appropriate ergonomic tools, management solutions, and suitable design of surgical instruments. A standing-sitting ergonomic chair could be used to prevent back pain in open surgery. Moreover, using a suitable chair can prevent improper postures. To prevent wrist musculoskeletal symptoms, surgical tools with ergonomic design and soft rubber handle could be used to easily raise hands while working. Depending on the type of surgery training, using appropriate seats and ergonomic instruments are the best solution to reduce musculoskeletal symptoms in the surgeons.

Conclusion

The results of this study revealed that the prevalence of musculoskeletal symptoms was high in 3 types of open surgery, laparoscopy, and microsurgery among the surgeons. In addition, it was found that these symptoms were more prevalent in the neck, waist, and hands. Depending on the type of surgery, teaching appropriate methods, using equipment properly, and using proper ergonomic seats are the best strategy to reduce musculoskeletal symptoms in surgeons.

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