



The role of ergonomics training and posture exercises in surgeons' musculoskeletal system disorders

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ABSTRACT

Objective: The surgeon needs to understand the risks involved in performing surgery with ergonomic errors. Although there are many barriers to ergonomic effectiveness, success begins with the surgeon's awareness, recognition of existing obstacles, and education. The main purpose of the study is to evaluate the effect of ergonomic training and posture exercises on the surgeon's pain, physical workload, psychological state, and quality of life to prevent musculoskeletal system disorders and extend career life.

Material and Methods: Surgeons who had completed at least one year in their profession, worked an average of 40 hours a week, had musculoskeletal pain in at least one area, and volunteered to participate in the study, regardless of gender and age, were included in the study. Researchers carried out the ergonomics training and exercise program individually by giving face-to-face training. Surgeons were asked to complete the physical workload questionnaire (PWQ), Beck depression index (BDI), and short form health survey (SF-36) before and one month after the study. Changes in visual analogue scale (VAS) and activities of daily living were recorded.

Results: Surgeons who received ergonomic training and exercise programs showed significant improvements in pain, physical workload, depression, and quality of life measurements.

Conclusion: To prevent fatigue and pain resulting from the accumulation of ergonomic flaws, surgeons should be trained and guided on proper posture and endurance, and encouraged to maintain a comfortable and natural posture.

Keywords: Surgeon, exercise, pain, posture, ergonomic, musculoskeletal system disorders

INTRODUCTION

Worldwide, 23-100% of surgeons in a range of subspecialties report musculoskeletal disorders (MSDs) brought on by poor workplace ergonomics (1,2). Regardless of expertise, this truth applies to all sorts of operations. In addition to mental acuity, attention, and precise movement application, the surgical procedures that surgeons do on a daily basis require them to maintain posture for minutes to hours with extended static effort (1,3). Because the surgical field is fundamentally dynamic and situations may change quickly, surgeons often choose suboptimal, ergonomically constrained postural positions to provide the best possible exposure and access to the surgical field. It is believed that these ergonomic issues result in pain, discomfort, and psychological issues (4,5). Surgeons also indicate that, off the job, MSD brought on by their jobs significantly impacts quality of life, interferes with social and sleep patterns, and makes them want to retire early (6,7). It is critical for the surgeon to realize the hazards of doing surgery with ergonomic mistakes, and although there are several barriers to ergonomic effectiveness, success starts with the surgeon's awareness, knowledge of existing barriers, and training (8). According to reports, as few as 9% of surgeons are aware of official ergonomic guidelines, and only 3% follow them on a regular basis (9). Despite the extensive literature on ergonomic issues, few research has proposed remedies to this problem (2,10,11).

The primary purpose of this study was to evaluate the effects of ergonomics training and posture exercises given to surgeons to prevent MSD and extend their career life on pain, physical workload, psychological state, and quality of life.

MATERIAL and METHODS

This prospective, cross-sectional study was conducted at İstinye University between 01/12/2023-01/02/2024, with the approval received from the Human

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Research Ethics Committee of İstinye University. All procedures were performed in accordance with the principles of the World Medical Association Declaration of Helsinki. Thirty-seven surgeons, regardless of sex and age, who had at least one year of experience, worked an average of forty hours a week, and had musculoskeletal complaints in at least one area, were included in the study. After informing the surgeons who met the inclusion criteria about the study and its purpose, an informed consent form was obtained from those who agreed to participate in the study. Data were collected using survey forms developed based on previously published literature on postural ergonomics in the surgical field. Demographic information, areas where pain is felt, causes of pain, whether pain affects daily life, ergonomics awareness and training status, and visual analog scale (VAS) values in the region where they feel the pain most severely were questioned. The surgeons were asked to complete the physical workload questionnaire (PWQ), Beck depression index (BDI), and quality of life short form 36 (SF-36). Validation of the PWQ Turkish form used in our research was conducted by Kahraman et al. and, to our knowledge, it is the only self-report questionnaire used to evaluate physical workload in Türkiye. In addition to analyzing increased workload due to poor posture and intense effort in the workplace, it can also be used to prevent high-risk work-related tasks. PWQ contains nineteen items describing different work situations (12,13). Five items include trunk posture, three items include arm posture, five items include leg posture, and six items include weightlifting. Scoring is accomplished by summing the responses to each item to create a raw score. Final scores are calculated by dividing the raw score by the maximum possible score on the subscale and multiplying by one hundred.

The BDI, developed by Beck et al., was used to evaluate the psychological states of surgeons (14). The scale, which is used to determine the risk and susceptibility of depression in adults and to measure the severity of depression symptoms, does not diagnose the person with depression, but determines the person's depression level with a numerical data. The Turkish adaptation of the scale consisting of twenty-one items was made by Hisli (15). Each item in the scale is rated between zero and three points. The highest score is sixty-three, and the higher the score, the higher the person's depression level. The severity of depression is interpreted as 0-9= minimal, 10-16= mild, 17-29= moderate, and 30-63= severe.

We used the SF-36 short form survey to collect information about the patient's quality of life and health status (16). This survey evaluates eight sub-parameters: physical functioning (PF), physical role functioning (PRF), emotional role functioning (ERF), energy/vitality (VT), mental health (MH), social functionality (SF), bodily pain (BP) and general health (GH)

perception. Each domain has a score ranging from 0 to 100%. Higher scores indicate higher levels of function and well-being. We evaluated the survey results by comparing them with Turkish norms (17).

Ergonomics training and an exercise program were given one-on-one by the physician in the form of face-to-face training. Simple and standardized ergonomic principles were taken from the literature and integrated into existing posture and strengthening exercise guides. The training procedure established regarding ideal working posture, correct monitor and table position, design of hand tools, and placement of equipment was applied to all surgeons. A standard exercise program was created, including neck (extensors, flexors, and rotators), shoulder (flexors, extensors), and upper and lower back (flexors, extensors, and rotators) muscle groups. Exercise training was given by explaining the parts of this program that could be done during surgery and outside of surgery in the work or home environment. Compliance with the program was checked, with checks made once a week. A brochure with images and descriptions was created and distributed to enable the surgeon to independently manage the program after training. After one month, they were asked to fill out the PWQ, BDI, and SF-36 questionnaires again, and the changes were recorded. It was questioned whether there were any changes in VAS and activities of daily living. Thirteen surgeons who did not comply with the procedure were excluded from the study.

Statistical Analysis

In calculating the sample size of this study, the power was determined to be at least 80%, and type-1 error was 5% for each variable. Shapiro-Wilk and Skewness-Kurtosis tests were used to check whether the continuous measurements in the study were distributed normally, and since the measurements were normally distributed, parametric tests were applied. Descriptive statistics for continuous variables in the study were expressed as mean, standard deviation, mean difference, number (n), and percentage (%). "Paired t-test" was used to compare the changes between "before and after" measurements. The McNemar test was calculated to determine the relationships between (before-after) ratios measured at various times in the same patients. In the calculations, the statistical significance level was taken as $p < 0.05$, and the SPSS (IBM SPSS for Windows, ver. 26) statistical package program was used for analyses.

RESULTS

Twenty-four surgeons from different surgical departments completed the study. Demographic characteristics are shown in Table 1, and the distribution of risk factors for MSD is shown in Table 2. Seventy percent of the surgeons stated that they had difficulty in daily life activities due to MSD, and 87.5% stated that ergonomic improvements needed to be made in the

Table 1. Demographic characteristics of the surgeons

		n	%
Sex	Female	6	25.0%
	Male	18	75.0%
		Mean	SD
	Age	49.17	8.83
	Height (cm)	173.25	6.77
	Weight (kg)	77.54	13.86

SD: Standard deviation, cm: Centimeter, kg: Kilogram.

Table 2. Risk factors of musculoskeletal symptoms among the study participants

	n	%
Bad position	21	87.5%
Bad posture	18	75.0%
Lean forward too much	14	58.3%
Standing for a long time	12	50.0%
Stand still	9	37.5%
Stress	7	29.2%
Temperature of the operating room environment	7	29.2%
Table height	7	29.2%
Used materials	7	25.0%
Insufficient equipment	6	20.8%
Monitor position	5	20.8%

operating room. Of the surgeons, 95.8% had not received any ergonomics training. The distribution of the regions with MSD before and after the study is shown in Table 3. After the program, the decrease in pain in the neck, back, and waist, which are the most frequently painful areas, was found to be statistically significant. Despite that, no statistically significant relationship was observed between the ratios of the patients' shoulder, leg, and hand variables measured at two separate times. Since the classifications of the patients' elbow, knee, hip, and foot variables, which were measured at two separate times, were not determined in some periods, the relationships between these variables could not be calculated. The changes in VAS, PWQ, BDI, and SF-36 values of the surgeons before and one month after the program are statistically significant and are shown in Table 4.

DISCUSSION

In our study, we evaluated the effects of ergonomic training and posture exercises on pain, physical workload, psychological state, and quality of life. Consistent with the literature, we found that MSDs are most commonly seen in the neck, upper back, and waist, and the most blamed factors are poor posture, inappropriate body positions, and working leaning forward for

extended periods of time (1,2,10,11,18). The prevalence of MSD in surgeons also highlights the need for prevention. Ergonomics training is essential to protect surgeons from preventable, potentially career-changing, or even career-ending injuries. Although many surgeons seek medical treatment for MSD and modify their practices based on pain, they are not adequately trained. In studies, the rate of surgeons receiving ergonomics training varies between 1.5% and 16% (19-21). In our study, this rate was found to be 4.1%. Additionally, it has been reported that most surgeons receiving ergonomics training do not comply with these guidelines (9). In our study, it was determined that only half of the surgeons complied with the instructions. Forgetting and lack of time are the main reasons for not being able to adapt to the training program and exercises, which suggests that ergonomics and postural awareness should be the focus of surgical training from an early age. Poor posture can lead to muscle imbalances over time. It can cause one muscle group to repeatedly shorten and another muscle group to lengthen. In addition, no matter how many surgeons focus on ergonomics, posture problems will continue to occur in the operating room due to the nature of their work. In this context, exercises performed in and outside the operating room are thought to make a critical contribution to ergonomics to

Table 3. Distribution of pain regions

	n	%	*p
Neck 1	22	91.7%	.001
Neck 2	10	41.7%	
Upper back 1	21	87.5%	.016
Upper back 2	14	58.3%	
Back 1	10	41.7%	.008
Back 2	2	8.3%	
Shoulder 1	8	33.3%	.125
Shoulder 2	4	16.7%	
Leg 1	5	20.8%	.125
Leg 2	1	4.2%	
Hand 1	4	16.7%	.510
Hand 2	2	8.3%	
Elbow 1	2	8.3%	
Elbow 2			
Knee 1	1	4.2%	
Knee 2			
Hip 1	2	8.3%	
Hip 2			
Foot 1			
Foot 2			

prevent and reverse musculoskeletal problems. The exercises are aimed at improving postural imbalances, reducing musculoskeletal pain, and eliminating the negative impact of the operating room. Strength training and stretching exercise protocols have been proven to be effective in reducing neck, back, and waist pain (22-25). Training regimens have been shown to be effective in forward positioning of the head and straightening of the shoulders, which are common in surgeons (26-28,29). There are publications in the literature that reach the common conclusion that regular exercise reduces musculoskeletal pain (23-25,30,31). This claim is also supported in our study.

MSD is the leading cause of workforce loss (32,33). According to the current literature, the main risk factors are heavy lifting, bending the back or working with arms raised, repetitive movements, and vibration (34,35). Studies have shown that surgeons experience physical symptoms due to ergonomic problems, tilting their heads up or down more than 50° for half of the average surgery time, and working in awkward postures due to the nature of the operation (36,37). For these reasons, it is important to evaluate the physical workload in the workplace. In our study, we used PWQ to assess physical workload. To the best of our knowledge, PWQ is the only valid and reliable questionnaire available in Turkish to assess physical workload

resulting from body posture and overexertion. Moreover, as far as we know, this is the first time it has been used in a study on the physical workload of surgeons. A significant improvement was detected in surgeons' PWQ scores before and after the training and exercise program, and this result is important in terms of drawing attention to the importance of ergonomics training and exercise programs to reduce the physical workload of surgeons.

It has long been known that doctors are at risk of developing several psychological conditions, such as burnout, stress, anxiety, and depression. The unique pressures of a surgical career, including long, unpredictable hours, the expectation of significant personal sacrifice, and dealing with life-or-death decisions daily, place surgeons at risk for psychological distress (38-40). Accumulated evidence from both observational studies and randomized controlled trials suggests that exercise reduces depressive symptoms and anxiety. In our study, the average Beck depression scale value before the program was 7.8, and the symptoms were found to be compatible with minimal depression. After the program, the mean value of the scale decreased significantly, and it was determined that mild depressive symptoms continued in only one surgeon, and the results were consistent with the literature (40-43).

Table 4. Comparison results of “before-after” values of measurements

	Mean	SD	Difference	t	*p
VAS 1	6.50	1.41	3.36	10.632	.001
VAS 2	3.10	1.48			
Beck 1	7.80	3.84	3.21	8.326	.001
Beck 2	4.60	2.75			
PWQ 1	16.60	6.34	5.51	6.412	.001
PWQ 2	11.10	4.37			
SF PF	73.75	19.46	-9.17	-4.011	.001
SF PF 2	82.90	14.06			
SF PRF	35.80	31.13	-26.74	-7.948	.001
SF PRF 2	62.50	27.58			
SF ERF	40.25	40.48	-18.01	-4.520	.001
SF ERF 2	58.25	31.46			
SF Energy	43.10	20.95	-13.29	-4.655	.001
SF Energy 2	57.25	17.94			
SF MH	55.00	18.57	-8.17	-3.099	.004
SF MH 2	63.20	13.62			
SF SF	49.50	22.87	-15.60	-5.704	.001
SF SF 2	65.10	20.49			
SF Pain	53.23	15.85	-16.48	-6.993	.001
SF Pain 2	69.70	17.11			
SF GS	52.80	20.03	-11.17	-5.376	.001
SF GS 2	63.40	16.68			

VAS: Visual analog scale, PWQ: Physical workload questionnaire, PF: Physical functioning, FRG: Physical role functioning, ERF: Emotional role functioning, MH: Mental health, SF: Social functionality, GS: General health.

The SF-36 is the most frequently used standardized scale with proven validity to evaluate quality of life (16,17). At baseline evaluation, surgeons reported moderate impairment on the physical role, bodily pain, physical role functioning, emotional role functioning, social functioning, mental health, and energy/vitality subscales; however, no impairment was detected at baseline assessments of physical functioning and general health.

This result shows that surgeons experience significant problems regarding their quality of life and personal health. A statistically significant increase was obtained in all parameters in the post-program evaluation. Physical role function, pain, and energy scores also reached the population average. Although the increases were significant, emotional role function, mental health, and social functioning scores were still below the average value. This result suggests that surgeons should also be supported in terms of mental health in addition to physical support programs (exercise and ergonomics training).

Ideally, formal, specialty-specific training in ergonomics, body mechanics, and posture should be provided at the assistant

level. We predict that it is important to encourage surgeons to exercise, as well as to ensure that they continue their exercise habits for many years. It is important for surgeons to improve their working hours and make exercise a part of their lives, both for themselves and for their patients. This should be considered a public health problem; therefore, the surgeons and other members of society should be ensured to live together with sports throughout their lives. Thus, musculoskeletal pain, which has been shown to be the most common occupational disease in Europe, will decrease, and the frequency of the need to apply to health services will decrease.

The limitations of this study include the fact that the surgeons are from a single institution, the sample size is small, the follow-up period is short, the use of survey forms and the surgical sub-branches are not evaluated separately.

CONCLUSION

In conclusion, a significant improvement was shown in the pain, physical workload, depression, and quality of life measurement values of surgeons who were given ergonomics

training and exercise programs before and one month after the program. Surgeons should be encouraged to maintain a comfortable and natural body posture, trained, and directed to exercise for correct posture and endurance to avoid the fatigue and pain that accumulate from ergonomic errors. Future focus should be on specialty-specific ergonomics training, postural awareness training, and surgical expertise. We also think that ergonomic training should be accepted as a part of surgical training and that the ergonomic awareness of all individuals receiving surgical competence should be established at an early stage.

Ethics Committee Approval: The study was approved by the İstinye University Human Researches Ethics Committee (Decision no: 2023/09, Date: 06.11.2023).

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**ORİJİNAL ÇALIŞMA-ÖZET**

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Ergonomi eğitimi ve postür egzersizlerinin cerrahların kas iskelet sistemi rahatsızlıklarındaki rolüSevinç Külekçioğlu¹, Evren Dilektaşlı²¹ Mudanya Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi Bölümü, Bursa, Türkiye² İstinye Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, İstanbul, Türkiye**ÖZET**

Giriş ve Amaç: Cerrahin ergonomik hatalarla ameliyat yapmanın içerdiği riskleri anlaması gerekir. Ergonomik etkinliğin önünde pek çok engel olsa da başarı, cerrahın farkındalığı, mevcut engelleri tanınması ve eğitimi ile başlar. Çalışmanın temel amacı kas-iskelet sistemi bozukluklarının önlenmesi ve kariyer ömrünün uzatılması için ergonomik antrenman ve postür egzersizlerinin cerrahın ağrısına, fiziksel iş yüküne, psikolojik durumuna ve yaşam kalitesine etkisini değerlendirmektir.

Gereç ve Yöntem: Cinsiyet ve yaş gözetmeksizin mesleğinde en az bir yılını tamamlamış, haftada ortalama 40 saat çalışan, en az bir bölgede kas-iskelet sistemi ağrısı olan, çalışmaya katılmaya gönüllü olan cerrahlar çalışmaya dahil edildi. Araştırmacılar ergonomi eğitimi ve egzersiz programını yüz yüze eğitim vererek bireysel olarak gerçekleştirdiler. Cerrahlardan çalışmadan önce ve çalışmadan bir ay sonra fiziksel iş yükü anketini (PWQ), Beck depresyon endeksini (BDI) ve kısa form sağlık anketini (SF-36) doldurmaları istendi. Görsel analog skala (VAS) ve günlük yaşam aktivitelerindeki değişiklikler kaydedildi.

Bulgular: Ergonomi eğitimi ve egzersiz programları alan cerrahların ağrı, fiziksel iş yükü, depresyon ve yaşam kalitesi ölçümlerinde anlamlı iyileşmeler görüldü.

Sonuç: Ergonomik kusurların birikmesinden kaynaklanan yorgunluk ve ağrıyı önlemek için cerrahlar, doğru duruş ve dayanıklılık konusunda eğitilmeli, yönlendirilmeli, rahat ve doğal bir duruş sürdürmeleri teşvik edilmelidir.

Anahtar Kelimeler: Cerrah, egzersiz, ağrı, duruş, ergonomik, kas-iskelet sistemi bozuklukları

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