Prevalence of work-related musculoskeletal symptoms among young orthopedics during the surgical practice: an intervention study

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Keywords: Ergonomics; prevention; physiotherapy

Abstract

Background: *Work-related muscle-skeletal symptoms (WRMS) represent a substantial social and economic impact on the way of work and have a high incidence in surgeons. In the literature, several studies address the impact of WRMS in surgeons performing gynecological, laparoscopic, and robotic surgery, but there are no studies in the field of orthopedic surgery. This pilot study aims to assess the effectiveness of a preventive program to reduce pain.* **Methods:** *All workers filled in a standardized questionnaire, and postoperative pain in the operating room was quantified using a numeric scale (NAS). The intervention group followed ergonomic principles in the operating room supervised by a physiotherapist and specific physical exercises before and after surgery. Data were analyzed using the statistical program STATA rel. 14.0.* **Results:** *Twenty-one surgeons were assigned to intervention groups and thirty-three to controls. At baseline, the two groups were homogeneous for anthropometric factors, and controls were older and with higher work seniority. Pain perception resulted in high in both groups in many body districts. At follow-up, after three months, the intervention group significantly reduced pain perception in all body districts for the lumbar back, knees, ankles and feet (p<0.05). In the control group, pain perception increased in all body districts investigated.* **Conclusions:** *We found a high prevalence of WRMS in young orthopedic surgeons, and we demonstrated the effectiveness of a preventive program through targeted ergonomic education and exercises for the most affected body districts.*

1. Introduction

Nowadays, work-related muscle-skeletal symptoms (WRMS) represent a growing problem as a cause of absenteeism from work, reduction of activity, transfer to another job and disability [1]. In the Netherlands, Germany and the United Kingdom, WRMS account for 28% of lost days worked by health workers [2]. In Italy, the National Institute for Occupational Accident Insurance [3] reports that in 2017 there were about 58,000 complaints of occupational diseases, 65% affect the muscle-skeletal system [3].

Healthcare professionals are exposed to the risk of developing WRMS up to three times higher than the general population [4], depending on the type of activity carried out by the professional, the workload and the position taken during work. For

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example, a Portuguese study has shown a correlation between the symptoms perceived by nurses in prolonged standing activities and the maintenance of incongruous positions [5]. Ergonomists have assessed surgeons' environments and working conditions as equal to or even worse than some industrial workers [6].

The presence of WMSDs in surgeons seems to be underestimated [7]. Several studies and literature reviews emerge [8] that deal with the detection of the existence and prevalence of WRMS symptoms in surgeons performing gynecological surgery [9, 10], microsurgery [11], general surgery [12], plastic surgery [8], neurosurgery [13] and assisted robots [14]. These studies recommend special attention to the ergonomic education of surgeons [15] by including this education already during the training course. Few clinical studies propose symptom reduction interventions with exercises during surgery [16] or before and after surgery [17], but orthopedic surgeons are not considered.

The purpose of this intervention study is to propose an ergonomic educational intervention combined with stretching exercises to prevent WRMS in orthopedic surgeons.

2. Materials and Methods

The study had a prospective design comparing results obtained before and after an intervention to evaluate its effectiveness. The same design was applied in a control group continuing the activity requested by the job as usual. Fifty-four orthopedic surgeons from two different Italian hospitals in the Friuli Venezia Giulia region were recruited and agreed to participate in the study. Twenty-one orthopedic surgeons from Cattinara Hospital were recruited into the intervention group. In contrast, thirty-three orthopedic surgeons from Santa Maria della Misericordia Hospital in Udine were selected as a control group.

In July 2019, during the first assessment, the Italian version of the Nordic questionnaire [18], SF 12 [19] and numeric analogic score (NAS) [20] were administered twice: before and after the surgery in the operating theatre; detecting the present pain in the different body districts. A further questionnaire based on previous studies [21] was proposed to investigate the postural structure and the knowledge and application of ergonomic measures in the operating theatre. The questionnaire on joint pain investigated anthropometric information, job, presence of pathologies, use of drugs for musculoskeletal pathologies, physical activity, and the presence of joint pain in the various body districts (cervical spine, upper limbs, dorsal spine, lumbar spine, lower limbs) in the last month according to the Numerical Rating Scale (1 no pain, 10 unbearable pain) [20]. The SF 12 questionnaire (Short Form) investigated the health status perceived by the subjects in the last four weeks. [19]. The SF 12 is the reduced version of SF 36 covering physical activity, role and physical health, role and emotional state, and mental health. The remaining scales, covering physical pain, general health, vitality and social activities, are presented here in a reduced form with only one question each. Some studies on European populations show that the synthetic indices of SF 12 correlate with the corresponding SF 36 with a range of values between 0.93 and 0.97 [22]. The calculation of the scores was performed by referring to the cited manual.

In addition, an *ad-hoc* questionnaire based on previous studies [21] was prepared, including questions on postural set-up in the operating theatre and awareness and application of ergonomic prevention measures. All participants filled the four questionnaires at the baseline and after a three-month follow-up. At the three-month follow-up, the questionnaire was supplemented with questions regarding compliance with the program of self-treatment exercises.

During the three months, a physiotherapist went to the operating theatre of the study group to record video and photos of surgeons' positions during the interventions; both first and second operators (if present) were followed. These data were included in a table to detect incongruous postures taken during a shift.

The intervention group underwent an educational program based on ergonomic guidelines in the operating room and simple self-treatment exercises; these exercises should be performed before and after surgical sessions or twice a day if not in the operating room. Inclusion criteria were an agreement to participate, be an orthopedic surgeon, and work in Trieste and Udine's orthopedic facilities. Exclusion criteria: previous surgery at osteoarticular level, history of trauma, orthopedic or rheumatological diagnoses, and neurological pathologies.

The statistical package STATA 14.0 (Stata Corporation, Texas, TX) was used to analyze the data. Continuous data were summarized as median (25-75° percentiles) due to non-normal distribution assessed using the Shapiro-Wilk test and compared with the Mann-Whitney test. Symptom scores before and after treatment were investigated with the Wilcoxon test. Categorical data were compared using the Chi-square test. Factors associated with pain in different body districts were examined during the follow-up using the Generalized Equations Estimation (GEE) and reported as OR (Odds Ratios) and 95% Confidence Intervals. Statistical significance was placed at p<0.05.

3. Results

Twenty-one surgeons participated in the intervention group (IG) and thirty-three in the control group (CG), and the majority were men in both groups (66.7% and 84.9%, respectively), as shown in Table 1.

There were no differences between the two groups considering the anthropometric features, but IG resulted in older and higher work seniority. Almost all surgeons performed open surgery, while arthroscopic interventions were more common in CG (p=0.01). Surgeries performed daily, and weekly were similar. Drug intake for MS was reported by 23.8% and 31.2% in IG and CG, respectively; no one said to use opioids. A surgeon reported work absence due to MS. Musculoskeletal symptoms in the previous twelve months were declared by the majority of subjects with a higher prevalence of low back pain (66.7% in IG and 42.4% in CG), neck pain (57% in IG and 24.2% in CG, p<0.01) and dorsal pain (42.9% in IG and 15.1% in CG, p=0.02).

Table 2 reported MS symptoms in IG and CG after surgery before and after the intervention: 47.6% and 24.2% in IG and CG, respectively, reported dorsal pain, 42.9% and 45.1% in IG and CG, respectively, reported low back pain and 39.1% and 27.3% in IG and CG, respectively, reported neck pain. After the three months of follow-up, we have

Table 1. Characteristics of the population studied.

Variable	Intervention Group (IG) n=21	Control Group (CG) n=33	p
Age, years median (25°-75° percentiles)	30 (29-33)	33 (30-37)	0.020
Women n. (%)	7 (33.3)	5 (15.1)	0.117
Weight kg median (25°-75° percentiles)	73 (68-82)	72 (65-84)	0.703
Height cm median (25°-75° percentiles)	178 (169-182)	177 (171-183)	0.696
BMI median (25°-75° percentiles)	23.7 (21.8-25.3)	21.9 (22-25.8)	0.894
Residents n. (%)	20 (95.2)	26 (78.8)	0.040
Work seniority years Median (25°-75° percentiles)	3 (2-4)	7 (5-12)	0.020
Surgery performed n. (%)			
Open	21 (100)	32 (97)	
Arthroscopic	9 (42.9)	25 (78.8)	0.421
Robotic	0	3 (9.4)	0.010
Endovascular	0	0	0.149

Variable	Intervention Group (IG) n=21	Control Group (CG) n=33	p
Surgery per day median (25°-75° percentiles)	2 (2-3)	3 (2-3)	0.09
Surgery per week median (25°-75° percentiles)	9 (6-10)	10 (6-15)	0.353
Surgery duration minutes median (25°-75° percentiles)	60 (60-90)	70 (102-120)	0.003
Drugs intake n. (%)	5 (23.8)	10 (31.2)	0.604
NSAID	5 (23.8)	10 (31.2)	0.604
Opioids	0	0	0.206
Muscle relaxant	1 (4.8)	0	
For days median (25°-75° percentiles)	2.5 (1.5-4.5)	5 (4-7)	0.060
Leaded gown	21 (100%)	29 (97.9%)	0.097
Absence from work due to WRMSD	1 (4.8%)	0	0.206
Sport hours weekly median (25°-75° percentiles)	3 (1-4)	4 (2-6)	0.098
Orthopedic diseases n. (%)	0	1 (3.1)	0.421
Pain n. (%)			
Neck	12 (57.1)	8 (24.2)	0.010
Shoulders	7 (33.3)	7 (21.2)	0.321
Elbow	2 (9.5)	1 (3.0)	0.312
Wrists-Hands	6 (28.6)	5 (15.5)	0.230
Dorsal back	9 (42.9)	5 (15.5)	0.020
Lumbar back	14 (66.7)	14 (42.4)	0.083
Leg	1 (5.9)	3 (9.7)	0.642
Knees	3 (14.3)	7 (1.2)	0.524
Ankles-Feet	2 (11.8)	4 (12.9)	0.902

Table 2. Musculoskeletal symptoms in the previous seven days reported after the surgery at the baseline and follow-up.

Pain	Groups	Baseline	Three-month follow up
Neck	Intervention	8 (39.1%)	7 (33.3%)
	Controls	9 (27.3%)	15 (45.4%)
	P-value	0.404	0.377
Shoulders	Intervention	8 (38.1%)	6 (28.6%)
	Controls	11 (33.3%)	15 (45.4%)
	P-value	0.120	0.132
Elbows	Intervention	2 (9.52%)	1 (5.88%)
	Controls	1 (3.03%)	4 (12.90%)
	P-value	0.311	0.440
Wrist	Intervention	4 (19%)	5 (23.1)
	Controls	3 (9.1%)	14 (42.4)
	P-value	0.298	0.163
Hands	Intervention	6 (28.57%)	4 (19.5%)
	Controls	5 (15.15%)	11 (33.3%)
	P-value	0.232	0.232

Pain	Groups	Baseline	Three-month follow up
Dorsal back	Intervention	10 (47.62%)	8 (38.1%)
	Controls	8 (24.2%)	15 (45.4%)
	P-value	0.083	0.594
Lumbar back	Intervention	9 (42.9%)	8 (38.1%)
	Controls	15 (45.4%)	17 (51.5%)
	P-value	0.052	0.270
Knees	Intervention	4 (19.5%)	2 (9.5%)
	Controls	11 (33.3%)	19 (57.6%)
	P-value	0.254	0.010
Ankle	Intervention	4 (12.1%)	2 (9.5%)
	Controls	1 (4.6%)	10 (30.9%)
	P-value	0.072	0.072
Feet	Intervention	2 (9.5%)	5 (23.8%)
	Controls	5 (15.5%)	10 (30.3%)
	P-value	0.548	0.269

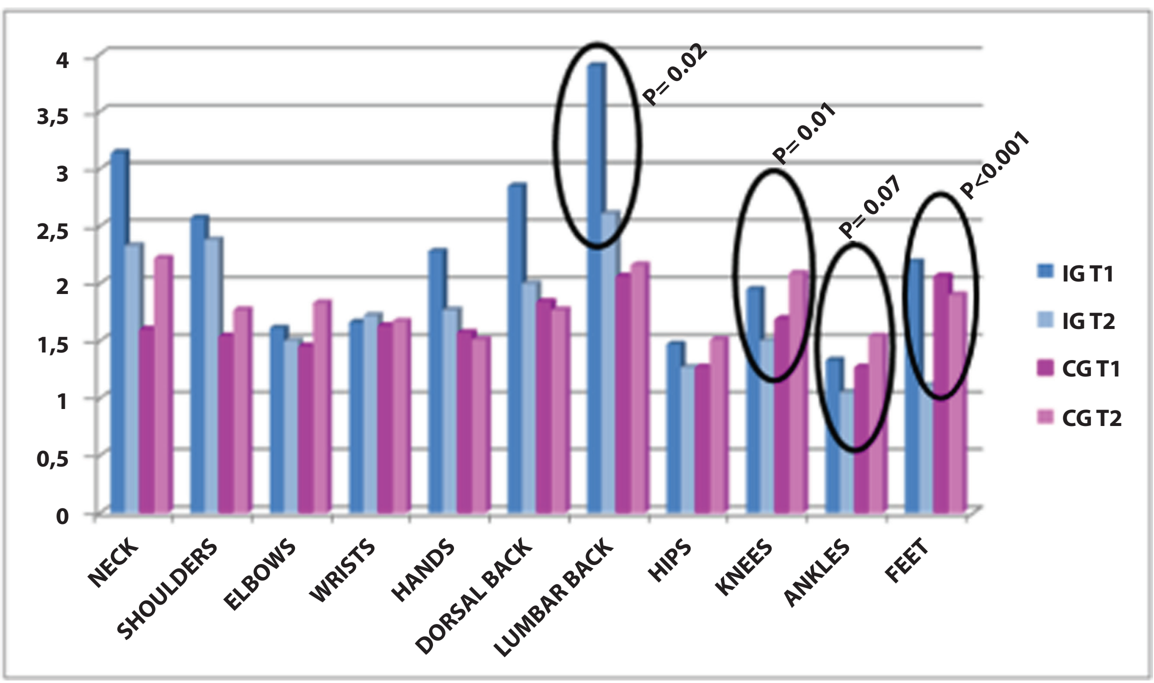

Figure 1. Postoperative NAS values of the two groups at T1 (baseline) and T2 (after three months) in the intervention group (IG) and control group (CG). Wilcoxon signed rank test between lumbar back and feet pain before and after intervention in IG (P=0.02 and <0.001, respectively). Mann-Whitney test between knees and ankles pain after intervention between IG and CG P=0.01 and P=0.07, respectively.

a reduction in the number of workers that reported symptoms in all body districts except in wrist in IG, while in CG, we found an increase in subjects that reported symptoms.

Figure 1 shows symptoms score (NAS) after surgery in the two groups before and after the follow-up in body districts. At follow-up, after three months, the intervention group significantly

Table 3. Factors associated with musculoskeletal symptoms investigated using the GEE (Generalized Equations Estimation) during the follow-up. Data are reported as OR (Odds ratio) and CI (confidence intervals) at 95%.

	OR	95%CI	P
Intervention vs Controls	0.37	0.1-1.6	0.190
Age	1.04	0.99-1.2	0.577
Women	3.2	0.9-33.0	0.328
Surgeries/week	1.03	0.9-1.2	0.671

reduced pain perception in all body districts for the lumbar back, knees, and ankles ($p<0.05$). In the control group, pain perception increased in all body districts investigated.

We evaluated factors associated with WRMD during the follow-up using the Generalized Equations Estimation (GEE) statistics (Table 3), finding a non-significant reduction of symptoms in IG and higher symptoms in women, probably due to the small number of subjects involved in the study.

4. Discussion

WRMS are significant health problems in various areas of work, including surgery. The first aim of this study was to quantify the extent of musculoskeletal disorders afflicts young orthopedic surgeons during their work performance. The surgical activity involves postural habits known to be risk factors for WRMS, including the maintenance of incorrect postures, frequently repeated movements of the upper limbs and prolonged static postures (postures maintained for more than 4 seconds).

Despite the limited numbers of our population, our study confirmed the higher prevalence of WRMS in orthopedic surgeons, mainly in younger subjects, in accord with other studies that correlate more WRMS to fewer years of experience [23]. The lumbar spine (66.7%), neck (57.1%), dorsal spine (42.9%) and shoulders (33.3%) are the most affected areas, as found by other studies [16, 24].

At the baseline, IG reported a higher prevalence of neck and dorsal back pain compared to CG and a NAS higher in all body sites. However, the CG was older than IG. Moreover, our study reported a prevalence of WRMS lower than that of a randomized controlled trial in Italy involving surgeons [17].

At three months follow-ups, we noted symptom scores in all body sites except wrists in IG and increased CG significantly for lumbar back and feet (pre-post IG), knees and ankles (post-intervention between IG and CG), and feet.

The importance of knowledge of ergonomics and how this can affect the onset of WRMS is also highlighted in studies, in which it is noted that already during the training as residents, it is necessary to implement ergonomic knowledge to prevent musculoskeletal disorders [25]. In the analysis of inappropriate positions taken during surgery, the most involved operators are the second and third, as the role of the first surgeon is played by the most experienced doctor, who adjusts the surgical field according to his needs. Instead, available guidelines suggest adjusting the operating table according to the height of the tallest operator and not the oldest [10, 26].

This study presents some limitations: the limited number of the sample, the variability in the execution of the operations (often unforeseeable, for example, in the traumatic field), and the time frame of only three months that has allowed for short-term improvements. It is necessary to continue the follow-up the verify the effectiveness of mid- and long-term prevention and adherence to the suggested preventive protocol.

Another limitation could be the older age of CG. However, the prevalence of symptoms and NAS was higher in IG than in CG despite the young but different ages (median age of 30 *vs* 33, respectively). The high prevalence of symptoms was not expected in young subjects.

5. Conclusion

This study has highlighted the high prevalence of WRMS in young orthopedic surgeons and that a preventive intervention, in collaboration with the physiotherapist, can reduce postoperative pain symptoms, especially in the lumbar spine and lower limbs. These results indicate the importance of increasing the knowledge and the application of ergonomics among orthopedic surgeons.

Institutional Review Board Statement: The approval of the Ethics Committee was not requested for the study as the assessments carried out are included in the health surveillance procedures.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Declaration of Interest: The authors declare no conflict of interest.

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