

Approach to prevention of musculoskeletal symptoms in dental students: an interventional study

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PAROLE CHIAVE: Studenti di odontoiatria; sintomi muscoloscheletrici; occupazione; ergonomia

SUMMARY

Background: *Work-related musculoskeletal (MS) disorders are very common among dentists due to abnormal positions maintained during their work. There is the need to teach undergraduate students ergonomic procedures to prevent MS pain and disorders.* **Methods:** *All the students of the School of Dentistry at the University of Trieste were enrolled for the study (No. 55). A self-administered questionnaire was used to collect anthropometric information, previous or current diseases, MS pain and disorders and work tasks performed. All students attended a training course. Three months after the training they completed a follow-up questionnaire.* **Results:** *All students reported MS pain: higher at cervical level (91%), lower at lumbosacral level (64.2%), shoulders (43.6%), and wrist/hand level (41.8%). Forty-nine percent of students reported an improvement in pain symptoms ($p < 0.05$) 3 months after the training.* **Conclusions:** *The prevalence of pain symptoms was high but the training course helped reduce symptoms. Theory and practice of ergonomics should be incorporated into dental undergraduate curricula.*

RIASSUNTO

«**Approccio alla prevenzione dei sintomi muscoloscheletrici negli studenti di odontoiatria: uno studio interventivo**». **Introduzione:** *I disturbi muscoloscheletrici (MS) sono molto comuni nei dentisti per le posizioni che devono mantenere durante il lavoro e per i movimenti ripetuti in tali condizioni. Molti studi hanno messo in associazione le posture inadeguate durante il lavoro di dentista e la comparsa di dolore o tensione muscolare e articolare. L'adozione di norme di buona pratica e di ergonomia sul posto di lavoro, la mobilitazione frequente e lo stretching, l'uso di attrezzature che permettano un miglioramento della postura, possono essere validi strumenti per prevenire o ridurre i sintomi nei lavoratori. Molto importante in questo ambito è l'attività educativa che può essere fatta nei corsi di laurea, per insegnare agli studenti le posture corrette e le modalità di prevenzione dei sintomi osteoarticolari. Scopo del nostro lavoro è stato quello di verificare i sintomi osteoarticolari negli studenti del Corso di Laurea in Odontoiatria, prima e dopo un intervento di formazione mirata all'insegnamento delle pratiche di lavoro ergonomico corrette.* **Metodi:** *Il nostro studio ha coinvolto tutti gli studenti del corso di laurea in Odontoiatria dell'Università di Trieste (n. 55). L'attività svolta comprendeva attività pratica per 22 ± 2 ore alla settimana e lezioni e studio per 17 ± 11 ore*

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alla settimana. Tutti hanno compilato un questionario standardizzato contenente domande sulle posture assunte durante l'attività pratica, sulle condizioni di salute, sull'eventuale assunzione di farmaci. La percezione del dolore muscoloscheletrico nei 3 mesi precedenti è stata valutata con la scala verbale numerica a 11 punti, dove 0 equivale a "nessun dolore" e 10 al "dolore peggiore possibile". L'87.3 % dei soggetti ha compilato il medesimo questionario 3 mesi dopo l'intervento educativo. Il training è stato condotto seguendo le linee guida suggerite dall' European Society of Dental Ergonomics e dallo standard ISO 11126. Fisioterapisti con esperienza in ergonomia hanno valutato sul campo gli studenti, facendo foto e video sulle posture corrette e scorrette. Questo materiale è stato usato per realizzare le lezioni in cui sono state fornite informazioni sull'ergonomia e sulla prevenzione delle patologie muscoloscheletriche.

Risultati: Tutti gli studenti hanno riportato sintomi MS, maggiormente a livello cervicale (91%), minore a livello lombosacrale (64.2%), alle spalle (43.6%), ai polsi/mani (41.8%). Il 49% degli studenti ha riportato un miglioramento dei sintomi ($p < 0.05$) 3 mesi dopo il training e l'educazione. Il sesso femminile (Coeff 6.97; 95% CI 2.30; 11.5), lo stress percepito (Coeff 0.90; 95% CI 0.002; 1.79), la terapia per sintomi MS negli ultimi 3 mesi (Coeff 0.62; 95% CI 0.23; 1.01) sono risultati statisticamente associati al dolore MS. Durante il follow-up le donne (OR 0.48; 95% CI 0.22-1.04), gli studenti più giovani (OR 0.93; 95% CI 0.83-1.03) e chi riportava minor dolore al primo controllo (OR 0.94; 95% CI 0.89-0.99) hanno avuto un minor miglioramento della sintomatologia, valutata con le Equazioni Generalizzate di Stima. **Discussione:** La prevalenza del dolore muscoloscheletrico risulta elevata negli studenti, ma il training seguito ha permesso una riduzione significativa dei sintomi. La teoria e la pratica dell'ergonomia deve essere inclusa nel curriculum degli studenti di odontoiatria, al fine di evitare impostazioni sbagliate nei primi anni della pratica, che possono determinare sintomi MS durante il lavoro professionale.

Abbreviations

MS: musculoskeletal

MSDs: musculoskeletal disorders

WMSDs: work related musculoskeletal disorders

BACKGROUND

Dentistry is a profession that can cause painful disorders of muscles, tendons, and nerves. Work-related musculoskeletal disorders (WMSDs) are intensified by work. When practicing, dentists sometimes are forced to adopt unhealthy postures, which depend mainly on factors related to the working conditions. The prevalence of WMSDs among dentists and other dental professionals is manifested mainly as neck, shoulder, hand, and wrist pain (also classified as upper extremity musculoskeletal disorder) and low back pain. These disorders are usually caused by postural distortion, prolonged static postures, and also repetitive movements while working. Several studies have addressed the relationship between inadequate postures while practicing dentistry and the appearance of pain or muscular lesions. A systematic review on this topic found that the prevalence of MSDs ranged between 64% and 93% (8). Valachi et al. in 2003 (19) also found a posi-

tive association between the presence of pain and specific forced postures: torsion of the trunk, moving the shoulders towards the side, elevating the elbows, operating light too far away from the line of vision, when working on the maxillary arch, working with the hands close to the patient's face and working for long periods of time. The risk of developing WMSDs can be reduced by adjusting the patient's chair, when accessing different quadrants of the mouth, placing instruments and materials easy to reach, working with elbows lower than shoulders (4). Morse et al. (14) state that "Applying ergonomics in dental equipment and instrument design can reduce or prevent WMSD". Another study showed that WMSDs pain was higher in workers with fewer years of experience (12). Therefore, this suggests that even dental students can manifest early signs of WMSDs during their years of training.

These findings were supported by research that revealed that more than 70% of dental students experienced neck, shoulder and lower back pain as early as the third year of their dental training (16).

WMSDs prevalence amongst dental students has not been thoroughly addressed in literature. Early education for students in ergonomic dentist working posture is relevant to prevent unhealthy working

postures in their prospective professional career and also to decrease the risk of MSDs in the future.

The aim of our research was to study musculoskeletal (MS) symptoms in dental students, to train them on good ergonomic practices to be applied during work and everyday life and to verify the effectiveness of the training performed.

METHODS

The literature review was initially carried out using online databases starting from MEDLINE, without adopting language restrictions, using the key words: dental ergonomics, prevalence of musculoskeletal disorders in dentists, ergonomic risk factors.

To identify additional material we used Google Scholar and we consulted the following websites: Ministry of Health, World Health Organization and conference proceedings, European Society of Dental Ergonomics, Italian Society of Dental Ergonomics.

The study was conducted on dental students studying and training at University of Trieste: 11 sixth-year students, 13 fifth-year students, 17 fourth-year students and 14 third-year students were involved (100% of the student population in this course). Students attended the training for 22±2 hours per week and lessons and study for 17±11 hours per week. All completed a questionnaire containing questions on socio-demographic characteristics, MS pain perception, pain medications intake; postures description and interest for further study. MS pain intensity in the previous 3 months was rated on an 11-point scale, where 0 is 'no pain at all' and 10 is 'pain as bad as it could be' according to the Verbal Numerical Scale (VNS) method which is a reliable tool to detect the intensity of pain (20). Eighty-seven point three percent of the initial sample returned the questionnaire three months after the follow-up study.

The program was organized by the University of Trieste to prevent occupational illness and injuries for students in accord with the School of Dentistry and in collaboration with the Physiotherapy Degree Course at the University of Trieste. For ethical reason all students underwent the training.

The training was designed following the guidelines suggested by the European Society of Dental Ergonomics and the ISO 11126 requirements (9). Physiotherapists trained in ergonomics analyzed different work tasks performed by the students, made a series of photos with correct and incorrect postures (avoid cervical flexion more than 20°; avoid trunk flexion more than 60°; maintain lumbar lordosis and avoid rotation; stay at least 40 cm away from the mouth of the patient; avoid ankles abduction more than 45°; knee and ankles flexion of 90°; use a stable seat position; etc.) that were used to perform the training in classroom, where basic knowledge on postures and MSDs were presented together with suggestions to prevent symptoms.

Training sessions (60 minutes) were held for students from each of the four years in the dental course at the University of Trieste.

The basic training aspects addressed were: identification of the work practice related to musculoskeletal disorders and related risk factors, principles of self-assessment, biomechanics of movement, work scheduling, selection of tools and equipment, and proper lighting of the workplace.

Moreover, the following aspects were highlighted as crucial to prevent musculoskeletal disorders:

- manage the patient chair as necessary to be able to meet ergonomic principles
- adjust the working stool
- use the rubber dam if you have to work without the help of a colleague
- ask colleagues for help in case of need
- energize often (about every 20 minutes)
- run-of-motion exercises and stretching proposed during rest breaks available during working hours
- use magnifying systems if necessary

Before the training, students completed the initial questionnaire, then they were shown a slide show explaining the correct work postures according to European ergonomic requirements, as well as mobilization and stretching exercises that can help to prevent musculoskeletal symptoms both during work tasks and in everyday life. At the end of training, students were given the opportunity to ask questions and clarify doubts about the topics discussed during the presentation. Each student com-

pleted a satisfaction questionnaire to verify the usefulness of the meeting. After the classroom section physiotherapist supervised students' postures during their practical training.

After 3 months, students completed by email a final questionnaire to evaluate MS pain perception and educational effectiveness of the training received.

All students signed an informed consent. No ethical approval was needed because the prevention programs for exposed workers and students are compulsory under Italian Law 81/2008.

Data analysis was performed using excel data spreadsheet and STATA rel. 17 software (Texas Inc.). Continuous data were compared using Student t-test. Association between MS pain and related factors was analyzed using multivariate regression analysis. The comparison of symptoms between 1st and 2nd control was made by using Mann Whitney U-test.

Factors involved in the improvement of pain perception before and after the training were evaluated using the Generalized Equation Estimation (GEE). Significance was settled for $p < 0.05$, two-tailed.

RESULTS

Characteristics of the population involved in the study are reported in table 1. Out of 55 students, that represented 100% of dental students, the majority were female (58%). Mean age was 25 ± 5 years. Sixty-five point five percent of students did regular physical activity or exercise, 10.9% reported sports trauma in the past and 25% trauma not related to physical activities.

All students spent a mean time of 22 hours per week working in their internship and 17 hours of study. They used vibratory tools for 5 hours a day. Thirty-four point five percent of all students report-

Table 1 - Characteristics of dental students at the University of Trieste, Italy, 2015

	Female	Male	Total	p
N (%)	32 (58.2)	23 (41.8)	55 (100)	
Age (mean years \pm SD)	24 \pm 4	26 \pm 6	25 \pm 5	0.12
Cigarette smoking n. (%)	4 (12.5)	5 (21.7)	9 (16.4)	
Physical activity n. (%)	20 (62.5)	16 (69.6)	36 (65.5)	0.58
BMI (mean \pm SD)	21 \pm 3	23 \pm 2	22 \pm 2	0.05
Trauma related to physical activity n. (%)	4 (12.5)	2 (8.7)	6 (10.9)	0.65
Trauma not related to physical activity n. (%)	9 (28.1)	5 (21.7)	14 (25.5)	0.59
Hours of study per week (mean \pm SD)	20 \pm 11	11 \pm 8	17 \pm 11	0.02
Hours of internship per week (mean \pm SD)	22 \pm 4	22 \pm 4	22 \pm 4	0.90
Hours of work before the break (mean \pm SD)	3 \pm 1	2 \pm 0.1	3 \pm 1	0.58
Daily use of vibrating tools (mean \pm SD)	6 \pm 1.7	4 \pm 2	5 \pm 1.8	0.48
Mean days of drug intake in the last 12 months (% of subjects)	8.2 \pm 12	4.2 \pm 17	7.2 \pm 14 (34.5)	0.01
Days absence over the past 12 months for musculoskeletal disorders (% of subjects)	2.0 \pm 6.1	0.5 \pm 2.0	1.2 \pm 4.0 (18.2)	0.04
Stress perception score 0-10 (% of subjects)	7.2 \pm 2.6	6.2 \pm 2.4	6.2 \pm 2.5 (98.2)	0.04
Postures reported for more than 50% of the training n. (%)				
- Head flexed more than 25°	31 (96.8)	23 (100)	54 (98.2)	-
- Trunk rotation	26 (81.2)	22 (95.6)	48 (87.3)	0.23
- Arms ahead more than 10°	27 (84.4)	19 (82.6)	46 (83.6)	0.84
- Shoulder abduction more than 60°	24 (75)	12 (52.2)	36 (65.4)	0.14
- Elbow flexed more than 115°	20 (62.5)	13 (56.5)	33 (60)	0.86

BMI=Body Mass Index, SD=standard deviation * $p < 0.05$

ed medication intake for MS pain in the previous 12 months: women for an average of 8.2 ± 12 days and men for 4.2 ± 17 days ($p < 0.05$). Eighteen point two percent of students reported sick leave for MS pain, significantly longer for women ($p < 0.05$). Almost all students reported stress perception (98.2%) with a mean score of 6.2 ± 2.5 , not significantly higher for women. The majority of students maintained wrong postures during the training for more than 50% of time: 85.7% of students said they are aware of the correct posture to be taken during clinical practice, 89% believed that the dental equipment used in the dental practice can be adjusted ergonomically for individual use, and 9.6% had a distance between the working field and eyes or used glasses for distances less than 40 cm. In a sitting posture during clinical practice, 49.1% had their head at an angle of more than 25° and 25.4% kept it down for more than 70% during the clinical practice.

Fifty-eight point nine percent of students maintained the lumbar region in kyphosis, for more than

half of the clinical practice; 76.4% flexed the trunk more than 20° and 87.3% rotated the trunk; 72.7% used the backrest with lumbar support for relaxing, but 50.9% did not keep the buttocks in contact with the back of the working stool; 64.3% of students abducted the shoulders for more than 60° for more than half the time during the clinical practice and 21.4% had difficulty in operating the tools. Finally, 58.9% of students kept their elbows flexed more than 115 degrees for more than the half of clinical practice.

Table 2 reports pain perception symptoms in the last 3 months and score (0 to 10) in different body sites before and after the training in both sexes. All students referred MS pain in one or more regions of the body. The highest percentages of symptoms were reported at cervical level (91% with average intensity of 3.6 ± 2.4), dorsal level (65.4% with average intensity of 2.5 ± 2.8), lumbosacral level (64.2% with average intensity of 2.6 ± 2.7), shoulders (43.6% with average intensity of 1.7 ± 2.0), wrist/hand level

Table 2 - Pain perception score (mean \pm SD), % of symptomatics in different districts and drug intake before and after the training, in dental students at the University of Trieste, Italy, 2015

Site of pain	I control	I control	I control	II control	II control	II control
	Female N=32	Male N=23	Total N=55	Female N=29	Male N=19	Total N=48
Cervical	4.1 \pm 2.2** (100)	2.9 \pm 2.6 (81.7)	3.6 \pm 2.4 (91)	3.7 \pm 2.5** (90)	2.3 \pm 2.6 (77.3)	3.0 \pm 2.5 (85.4)*
Dorsal	2.8 \pm 3.0 (71.8)	2.1 \pm 2.5 (56.5)	2.5 \pm 2.8 (65.4)	2.4 \pm 1.8 (73.3)	1.9 \pm 2.1 (68.2)	2.2 \pm 2.1 (77)
Low back	3.5 \pm 3.0** (86.7)	1.6 \pm 2.0 (47.6)	2.6 \pm 2.7 (64.2)	3.5 \pm 2.5** (71.9)	1.3 \pm 1.9 (52.2)	2.6 \pm 2.5 (68.7)
Shoulder	2 \pm 2** (43.7)	1 \pm 2 (43.5)	1.7 \pm 2 (43.6)	2.0 \pm 2.1** (63.3)	1 \pm 1.7 (45.4)	1.5 \pm 1.2 (56.2)
Elbow Pain	0.5 \pm 1.7 (12.5)	0.5 \pm 0.5 (13)	0.4 \pm 1.4 (12.5)	0.7 \pm 1.4 (30)	0.3 \pm 0.5 (22.7)	0.5 \pm 1 (26.5)
Wrist/hand	1 \pm 2 (46.9)	0.5 \pm 1 (34.8)	1 \pm 1 (41.8)	1.2 \pm 1.6 (53.3)	0.7 \pm 1.6 (31.8)	1.0 \pm 1.5 (45.8)
Hip	0.6 \pm 1.3 (25)	0.1 \pm 0.3 (13)	0.4 \pm 1 (20)	0.9 \pm 1.6 (33.3)	0.5 \pm 1.2 (18.1)	0.7 \pm 1 (20.8)
Knee	1 \pm 2 (34.4)	0.5 \pm 2 (30.4)	1 \pm 2 (32.7)	1 \pm 2 (33.3)	0.5 \pm 1 (31.8)	0.7 \pm 2 (32.2)
Ankle/foot	0.5 \pm 1 (15.6)	0.1 \pm 0.5 (13)	0.3 \pm 1 (14.5)	1 \pm 1 (33.3)	0.2 \pm 0.5 (18.2)	0.7 \pm 1 (16.1)
Mean days of drugs intake in the last 3 months (%)	3 \pm 6** (31.2)	1 \pm 2 (28.9)	2 \pm 6 (30.9)	3 \pm 3** (14.2)	1 \pm 2 (12.8)	2 \pm 3 (13.4*)
Mean days absence in the past 3 months for musculoskeletal disorders (%)	1 \pm 4 (12.5)	0	1 \pm 4 (7.3)	1 \pm 2 (6.9)	0	1 \pm 2 (4.1*)

* $P < 0.05$ between I e II control ** $p < 0.05$ between sexes

(41.8% with average intensity of 1.0±1.0). Lower percentages were reported at knees (32.7%), hips (20% with an average intensity of 0.4±1.0), at ankles (14.5%) and elbows (12.5%).

Score symptoms were very low for all body sites but significantly higher for women in low back (3.5±3.0 vs 1.6±2.0; p<0.05). Symptoms score for cervical and dorsal and elbow pain in both sexes decreased after the training, reaching a statistical significance for cervical pain. Despite that, 49% of students reported an improvement of symptoms after the training (p<0.05), but 17% reported a worsening of symptoms. Pain medication intake and sick leave reduced significantly from the 1st to the 2nd control (30.9% vs 13.4%, p<0.05 and 12.5% vs 4.1%, p<0.05, respectively).

Factors associated to MS pain were evaluated using multivariate regression analysis (table 3) showing an increased risk for women (Coeff 6.97; 95% CI 2.39; 11.5), and an association with perceived stress (Coeff 0.90; 95% CI 0.002;1.79), days of pain medication intake in the last 3 months (Coeff. 0.62; 95% CI 0.23;1.01) and in the last 12 months (Coeff. 0.22; 95% CI 0.07; 0.37).

Factors involved in the improvement of symptoms during the follow up were evaluated using the GEE technique (table 4) applying 3 models. Women, younger students and those who reported less pain at the first control reported less improvement of symptoms (OR 0.48; 95% CI 0.22-1.04; OR 0.93; 95% CI 0.83-1.03; OR 0.94; 95% CI 0.89-0.99, respectively). Eighty-seven point seven

Table 3 - Factors associated with MS total pain score, in dental students at the University of Trieste, Italy, 2015, evaluated using multivariate regression analysis. Data are reported as Coefficient (Coeff) and 95% Confidence Intervals (CI). In bold significant associations

Factors	1 st control Coeff (95% CI)	2 nd control Coeff (95% CI)
Sex female	6.97 (2.39; 11.5)	8.16 (3.5; 12.8)
Age (years)	-0.30 (-0.75; 0.14)	-0.19 (-0.72; 0.33)
BMI	-0.12 (-0.91; 0.66)	0.16 (-0.8; 1.19)
Smoking habit	-0.73 (-2.4; 0.95)	-1.4 (-3.4; 0.57)
Physical activity in the past	7.12 (-1.5; 15.7)	3.0 (-2.7; 6.7)
Physical activity now	-0.06 (-0.48; 4.78)	0.64 (-4.2; 5.5)
Days of drug intake in the last 3 months	0.62 (0.23; 1.01)	0.50 (0.22; 1.0)
Days of drug intake in the last 12 months	0.22 (0.07; 0.37)	-
Stress score	0.90 (0.002; 1.79)	-
Head flexed ahead more than 25°	-1.39 (-18.8; 15)	-
Trunk rotation	-2.35 (-8.9; 4.2)	-
Arms ahead more than 10°	1.88 (-4.1; 7.8)	-
Shoulder adduction more than 60°	-1.0 (-5.9; 3.9)	-
Elbow flexed more than 115°	-0.5 (-5.2; 4.1)	-

Table 4 - Factors associated with MSD, in dental students at the University of Trieste, Italy, 2015, improvement during the follow-up was assessed using the generalized estimating equations (GEE). Data are reported as Odds Ratio (OR) and 95% Confidence Interval (CI). In bold significant results

Factors of improvement	Model 1	Model 2	Model 3
Female	0.48 (0.22-1.04)	0.69 (0.31-1.5)	0.69 (0.30-1.59)
Age	0.93 (0.83-1.03)	0.90 (0.88-1.02)	0.97 (0.79-1.03)
Pain reported		0.94 (0.89-0.99)	0.94 (0.86-0.99)
BMI			0.97 (0.85-1.17)

BMI Body Mass Index

percent of students changed their way of working following suggestions (i.e position of the head, torso, shoulders, avoidance of extreme positions, improvement of stretching exercises, etc.); 43.6% of students didn't change position frequently during clinical practice, and of these 25.6% often reported more dynamic posture at the follow-up; 82.1% of students initially didn't perform stretching exercises before, during and after the clinical practice, of these 23.2% reported run-of-motion and stretching exercises at follow-up.

DISCUSSION

Our study demonstrated that MS symptoms are very common in dental students, higher for cervical pain (92.7%) and lower for other districts. Similar data were obtained from Khan and Yee Chew (10) in a cross-sectional study on 410 dental students: 93% reported MS pain in one or more parts of the body with a higher prevalence of pain at cervical level (82%) and lumbar level (64%). Also in this study, students who had already begun the practice had a higher prevalence of MS pain than students who had yet to begin clinical practice. This higher prevalence of pain might therefore be attributed to the conduct of clinical practice.

Female students reported a higher incidence of MS pain than male students. In literature these results are attributed to the fact that women have on average 65% of maximum muscle strength of the male sex. Women employed in dentistry often experience a heavier domestic role and less frequent and shorter refreshment breaks than men, and are therefore more (at a ratio of 3: 1) at risk of MSD (3,7,13). Our study confirmed that women reported more symptoms at cervical and lumbosacral level (<0.05).

In addition, the study conducted by Tezel et al. (18) on 48 dental students divided into 2 groups (24 left-handers and 24 right-handers) shows that the prevalence and severity of symptoms at cervical and shoulders are higher in left-handed than right-handed students.

According to these authors left-handed students should work using working stools designed for left-handed users to decrease the prevalence of symp-

toms. No left-handed students were present in our study.

Three months after the training 49% of students reported an improvement in pain symptoms.

However, pain score improved only at cervical level ($p<0.05$) in men and at dorsal spine for both sexes, but without reaching statistical significance. After the training, pain medication intake for MSDs reduced more than half ($p<0.05$) which demonstrates an improvement of symptoms.

Observational studies regarding dental procedures have revealed a high frequency of head movements in particular inclination (1) and flexion (6), during clinical practice, which were related to the onset of cervical disorders among dentists (10).

The incorrect positioning of the patient chair, keeping the lumbar region in kyphosis, is considered one of the contributing factors for low back pain (19). In our study, students maintained a wrong posture for more than half time during the clinical practice. In literature, studies claim that the wrong maintenance of the upper limbs during clinical practice is a predisposing factor for trapezius pain and tear of the rotator cuff (19). Fifty-eight point nine percent of students kept the upper limbs flexed more than 115 degrees for more than 50% of clinical practice. While the fingers remain static on the instrument (using an isometric caliper with three fingers), the forearm muscles have to provide the correct strength in a single maneuver: to do this the wrist is constantly moving between 15 ° flexion and 35 ° of extension in radio-ulnar deviation. Eighty-seven point seven percent of the students changed their way of working, following suggestions (i.e position of the head, torso, shoulders, avoidance of extreme positions, improvement of stretching exercises, etc.) and this result, together with the improvement of symptoms, demonstrated the usefulness of the training performed.

Other studies have shown a lack of awareness among dentists regarding MS pain (2,5,11). Some authors support the importance of preventing MS by performing mobilization exercises and stretching, but a clear prescription for them is still limited (15, 17).

Our study demonstrated that MS pain is very common in dental students, and the training pro-

gram was useful to improve symptoms in some districts and to learn basic ergonomic information that will bring about, on long term follow-up, to decrease symptoms through a better knowledge of preventive techniques. Nevertheless, there is the need to improve equipment (mainly for the left-handed), to have new ergonomic stools, to use headrests for the patient, to have magnification systems, and to increase the use of rubber dam to permit easier work tasks for operators.

Our study is the first, to our knowledge, that considered dental students during training. However, it has some limitations. First of all, the number of students is limited, though the entire course population was involved in the training and followed the physiotherapist suggestions. The duration of follow-up (3 months) is too short to show improvement of symptoms in a clear way. A longer follow-up with more training sections would have increased students' knowledge and awareness of postures and actions to do in order to prevent MSDs symptoms. Given that postures are self-reported, they can be either under or over-estimated, but the use of pictures and slide presentation to explain right and wrong postures, permitted a better explanation of ergonomic requirements.

Another limitation is the absence of the control group, so we cannot be sure that the decrease in perceived pain was a real effect of training or, for example, a time-dependent effect caused by coping with work physical requirements. Nevertheless, the improvement obtained is significant were good practices were adopted.

Ergonomic intervention and classroom teaching is important for students who have to learn the right postures and the correct way to do different tasks. Therefore, theory and practice of ergonomics should be incorporated into dental undergraduate curriculum.

CONCLUSION

Our study demonstrated that MS pain is highly prevalent among dental students and that an ergonomic intervention with physiotherapist supervision of job tasks was useful to improve quality of work and life and to improve symptoms.

Such programs are best effective when they are carried out directly on the job, and periodic consolidation meetings are provided to assess and achieve practical results.

The operator's video recordings, which demonstrated good and bad postures, may represent a good opportunity to stimulate debates for educational purposes. Finally, in the assessment and treatment of MS pain it is essential to pay attention to the entire daily activities of participants, since the onset of these symptoms can be the result of non-compliance with basic ergonomic principles during recreation or leisure activities (poor posture watching television, reading in bed, etc.), hobbies (gardening, embroidery, etc.) or from participating in heavy-action sports (eg. tennis), that put stress on the upper limbs and trunk.

NO POTENTIAL CONFLICT OF INTEREST RELEVANT TO THIS ARTICLE WAS REPORTED BY THE AUTHORS

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Authors' contribution:

- A. Koni collected data, participated to intervention and students' training and wrote the paper
 M. Kufersin participated to the study design and to the intervention
 F. Ronchese, participated to the intervention and participated to the writing of the paper
 M. Travan participated to the study design and to the intervention
 M. Cadenaro participated to the design of the study and revised the paper
 F. Larese Filon designed the study, did the statistical analysis and revised the paper

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