literature, besides the ethnicity, age[7] and gender[8] can influence the variations in the root canal configurations.

Thus, because the Brazilian population presents a heterogeneous characteristic and seeking to know the internal dental anatomy of a tooth with reports of expressive anatomical variations such as MPs, it is suggested to conduct further studies on the internal anatomy of the root canals, with a larger sample size, and in different Brazilian regions.

Conclusions

In the present study, the CBCT enabled a non-invasive and effective analysis of the morphology of the MPs and indicated that type I was the most frequent in both genders and in the first and second premolars. In addition, it was possible to verify that the number of roots and canals differs significantly, both between the genders and between types of teeth. However, the classification of the canals according to Vertucci was not associated with men or women.

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Analysis of osteomuscular disorders symptoms in endodontists, related to root canals instrumentation technique

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ABSTRACT

Introduction: The practice of endodontics involves of long sessions and repetitive movements during the execution of maneuvers that require considerable effort often in an uncomfortable position. Such factors exert a significant influence on the emergence of symptoms related to musculoskeletal disorders. **Methods:** Two questionnaires were administered to 25 endodontists in the city of Maringá, Brazil. Data analysis involved Fisher's exact test with the aid of Statistica 8.0. **Results:** Pain was more frequent in the lower back, neck, arms and shoulders. Endodontists who used rotary equipment did not report pain in the arms, elbows, wrist/fingers/hand or hips, but all participants reported low back and neck pain. Those who only used manual instruments reported pain in all sites, especially the back. **Conclusion:** The present findings suggest that endodontists are exposed to risk factors for the development of work-related musculoskeletal disorders, which are directly associated with the professional activity and the use of manual instruments. The most affected anatomic regions are related to the rotation of the body during the procedure and inadequate posture.

Keywords: Endodontics. Cumulative Trauma Disorders. Human Engineering.

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Introduction

Repetitive strain injuries, which have currently been renamed work-related musculoskeletal disorders (WMSDs), are, by definition, a phenomenon related to labor activities[1] stemming from excessive strain on the musculoskeletal system and a lack of time for recovery. WMSDs are a prevalent health problem throughout the world, affecting different categories of workers due to the imposition of modern technologies, such as the mechanization and automation of work processes, combined with a lack of worker training and adaptation. While workers expend less effort in the execution of their tasks, their movements are repetitive and often performed in a static position, which places strain on the same muscle group due to the maintenance of an inadequate posture for long periods per day. When combined with predisposing factors, this behavior can lead to the development of WMSDs.[2]

Many adverse health conditions that affect dentists and oral health assistants are directly related to the work environment. WSMDs affect muscles, muscular fascia, blood vessels, tendons, ligaments, nerves and joints.[3] The result is chronic pain, especially in the neck, scapular girdle and upper limbs. Besides pain, the affected anatomic site can also exhibit diminished strength, fatigue, tension, muscle contracture and altered mobility.[2]

The most common musculoskeletal disorders that affect dentists are radiculopathy, scoliosis, hyperlordosis, hyperkyphosis and carpal tunnel syndrome.[4] Among dental specialties, endodontics, periodontics and oral-maxillofacial surgery are reported to have the highest incidence of musculoskeletal disorders due to the repetitive movements associated with these professions.[4,5]

Endodontics is the study of morphology, physiology and pathologies related to the dental pulp and its focus is the prevention, diagnosis and treatment of pulp diseases. Endodontic therapy, which is commonly known as root canal treatment, is indicated when dental tissues are altered due to the occurrence of trauma, caries or other factors. The maximal decontamination of root canals is an extremely important aspect of endodontic therapy so that the tissues have the possibility of returning to a normal state.[1] This involves several steps that require expertise, tactile sensitivity,[2] patience and dexterity. However, the long treatment sessions, repetitive movements and uncomfortable positions place endodontists at risk for the development of WMSDs, which can progress to a complete inability to continue exercising the profession.[3]

The chemical-mechanical preparation of root canals is the most grueling aspect of endodontic therapy, as it normally involves the use of manual files held between the tip of the index finger and thumb. However, there has been an increase in use of motor-driven instruments, which enable the faster preparation of the canal, leading to less time required to conclude treatment. It is therefore valid to investigate the possible relation between the use of rotary instruments and musculoskeletal disorders. Thus, the aim of the present study was to investigate the occurrence of musculoskeletal disorders in endodontists and relate the findings to the use of manual and motor-driven instruments.

Materials and methods

Twenty-five endodontists registered with the Regional Council of Dentistry in the state of Paraná, Brazil participated in the present study. Professionals who worked exclusively in the field of endodontics in the public and/or private sector in the city of Maringá (state of Paraná) were included. Endodontists not currently practicing their profession (on leave for medical or other reasons) were excluded from the study.

Data collection involved the use of the Nordic Musculoskeletal Questionnaire, which has been translated and adapted to Portuguese.[6] This questionnaire is divided into two parts. The first part consists of a human figure divided into nine anatomic regions representing a body map of the individual (Fig. 1). The participant was instructed to identify regions of pain, discomfort or numbness in the previous 12 months, attributing a score based on frequency: 0 – never; 1 – rarely; 2 – often; 3 – always. The second part consists of a set of questions addressing demographic data and the use of man-

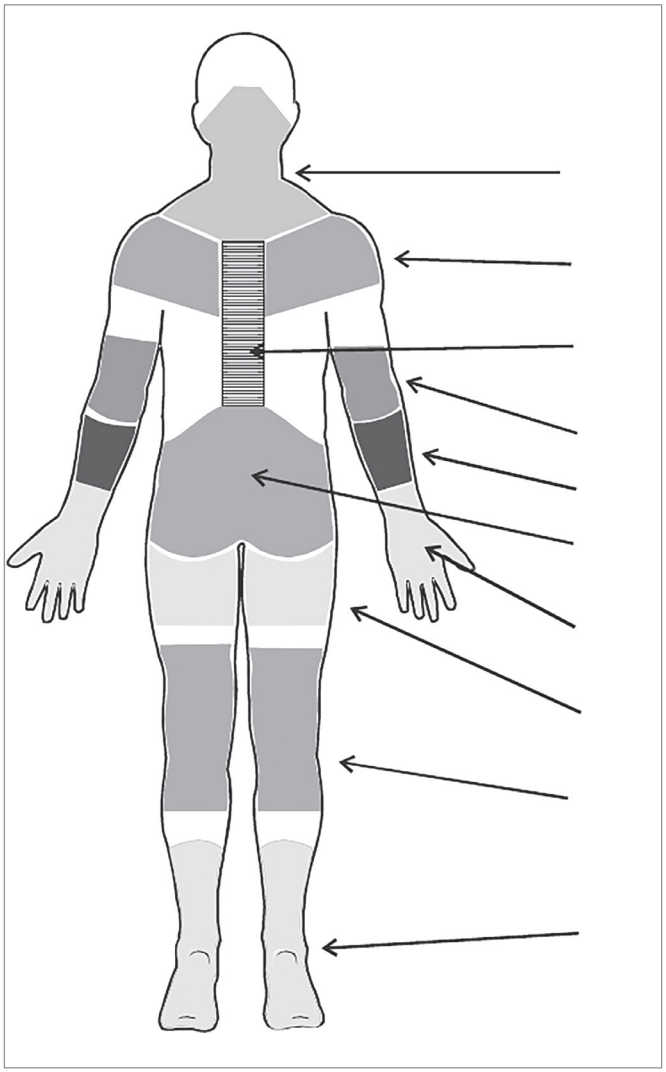

Figure 1. Illustration of body indicating different regions with musculoskeletal symptoms based on Nordic Musculoskeletal Questionnaire.

ual and motor-driven instruments, considering only the previous five years. As the second part does not address problems specific to endodontics, another questionnaire was administered, which addressed general and occupational data of the endodontists to complete characterization of the sample.

The questionnaires were administered by the researcher at the offices of the endodontists, who were instructed to answer all questions. This study received approval from the local human research ethics committee (certificate number: 11533912.0.0000.5539).

The results were expressed as absolute and relative frequencies. Associations between variables were tested using Fisher's exact, with a p-value < 0.05 considered indicative of statistical significance. Statistical analysis was performed with the aid of the Statistica 8.0 software.

Results

Table 1 lists the frequencies of pain, discomfort and numbness (musculoskeletal symptoms) indicated by the endodontists for the different regions of the body.

The regions most cited as having frequent and continual discomfort (Scores 2 and 3) were the lower back (60% of participants), neck (52%), shoulders (44%) and wrists/hands/fingers (36%). The least cited regions were the arms (4%), elbows (8%) and forearms (0%).

Table 1. Musculoskeletal symptoms in different regions of body indicated by endodontists

Scores	Symptoms							
	Neck		Shoulders		Arms		Elbows	
	n	%	n	%	n	%	n	%
0	6	24,0	8	32,0	14	56,0	20	80,0
1	6	24,0	8	32,0	10	40,0	3	12,0
2	10	40,0	6	24,0	0	0	2	8,0
3	3	12,0	3	12,0	1	4,0	0	0
Scores	**Symptoms**							
	Forearms		**Wrists/Hands/Fingers**		**Upper back**		**Lower back**	
	n	%	n	%	n	%	n	%
0	19	76,0	12	48,0	6	24,0	6	24,0
1	6	24,0	4	16,0	8	32,0	4	16,0
2	0	0	6	24,0	8	32,0	12	48,0
3	0	0	3	12,0	3	12,0	3	12,0

Never; (1) Rarely; (2) Often; (3) Always

Table 2 displays the number of endodontists who used manual and rotary files, manual files alone and rotary files alone. Table 3 displays the associations between file type and musculoskeletal symptoms. Table 4 displays the associations between upper limb symptoms and age, sex, duration in specialty and daily workload in hours.

Table 2. Number of endodontists who used manual and rotary files, manual files alone and rotary files alone.

Files	n	%
Manual and rotary	10	40.0
Manual alone	11	44.0
Rotary alone	4	16.0
Total	25	100

Table 3. Musculoskeletal symptoms in different parts of body according to use of manual and rotary files, manual files alone and rotary files alone

Variables	Files						p
	Manual and rotary		Manual		Rotatory		
	n	%	n	%	n	%	
Neck							
Yes	7	28,0	8	32,0	4	16,0	0,46647
No	3	12,0	3	12,0	0	0,0	
Shoulders							
Yes	7	28,0	8	32,0	2	8,0	0,69526
No	3	12,0	3	12,0	2	8,0	
Arms							
Yes	3	12,0	8	32,0	0	0,0	0,02212*
No	7	28,0	3	12,0	4	16,0	
Elbows							
Yes	3	12,0	2	8,0	0	0,0	0,43874
No	7	28,0	9	36,0	4	16,0	
Forearms							
Yes	2	8,0	2	8,0	2	8,0	0,41183
No	8	32,0	9	36,0	2	8,0	
Wrists/Hands/Fingers							
Yes	6	24,0	7	28,0	0	0,0	0,07478
No	4	16,0	4	16,0	4	16,0	
Upper back							
Yes	7	28,0	9	36,0	3	12,0	0,81721
No	3	12,0	2	8,0	1	4,0	
Lower back							
Yes	6	24,0	9	36,0	4	16,0	0,23802
No	4	16,0	2	8,0	0	0,0	

* Significant at 5% level, Fisher's exact test.

Table 4. Musculoskeletal symptoms in upper limbs of endodontists according to demographic and work-related characteristics.

Variables	Arms				Elbows				Forearms				Wrists/Hands/Fingers			
	No		Yes		No		Yes		No		Yes		No		Yes	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Age group																
28 to 37 years	6	24,0	5	20,0	10	40,0	1	4,0	8	32,0	3	12,0	5	20,0	6	24,0
38 to 47 years	4	16,0	3	12,0	6	24,0	1	4,0	6	24,0	1	4,0	4	16,0	3	12,0
48 to 57 years	4	16,0	3	12,0	4	16,0	3	12,0	5	20,0	2	8,0	3	12,0	4	16,0
p	0,99161				0,19724				0,77611				0,84486			
Sex																
Female	7	28,0	10	40,0	13	52,0	4	16,0	13	52,0	4	16,0	6	24,0	11	44,0
Male	7	28,0	1	4,0	7	28,0	1	4,0	6	24,0	2	8,0	6	24,0	2	8,0
p	0,02951*				0,52015				0,93599				0,06379			
Professional experience with endodontics																
Up to 15 years	9	36,0	6	24,0	14	56,0	1	4,0	11	44,0	4	16,0	7	28,0	8	32,0
15 or more years	5	20,0	5	20,0	6	24,0	4	16,0	8	32,0	2	8,0	5	20,0	5	20,0
p	0,62169				0,04123*				0,70221				0,87018			
Daily workload																
Up to 8 hours	5	20,0	3	12,0	8	32,0	0	0,0	7	28,0	1	4,0	4	16,0	4	16,0
More than 8 hours	9	36,0	8	32,0	12	48,0	5	20,0	12	48,0	5	20,0	8	32,0	9	36,0
p	0,64333				0,08635				0,35571				0,890			

* Significant at 5% level, Fisher's exact test.

Discussion

The first cases of repetitive strain injury in Brazil began to be diagnosed around 1980 and were related to the profession of data processing. On April 28, 2004, the Health Ministry issued Ordinance n° 777/04, making mandatory the reporting of work-related injuries, including WMSDs.[7] These disorders are becoming more frequent in different fields, where workers often exert less effort to perform their functions, but do so in a repetitive manner, placing excessive load on the same muscle group. Added to this is the maintenance of an inadequate posture for long periods and a lack of physical fitness.[8]

In 2004, PEREIRA et al.[9] reported WMSDs in both general dentists and specialists and the specialty with the greatest number of affected professionals was endodontics. The work position most often used by the interviewees was "11 o'clock" and the endodontist remained seated more often than other specialists. The most affected region of the body was the lower back, followed by the shoulders and neck. Moreover, dentists with the most WMSDs worked 40 hours or more per week.

A combination of different factors favors the emergence of WMSDs, such as occupational, ergonomic, biomechanical, environmental, non-occupational, psychological and precipitating factors. The signs and symptoms of WMSDs can emerge gradually or suddenly. Depending on the degree of injury, WMSDs may first appear in the form of mild pain that increases over time, with the occurrence of tingling, numbness, fatigue of the affected anatomic site, the loss of strength, cramps and muscle atrophy, becoming chronic and leading to disability or functional limitations regarding the execution of daily activities.[2]

The "9 o'clock" position is recommended by scholars of ergonomics and is the most adopted by Brazilian dentists, as it enables working with a better

view of the operating field, even in regions of difficult access.[10] Although the "9 o'clock" and "11 o'clock" positions are ergonomically acceptable, nothing impedes dentists from assuming inadequate postures on certain occasions during the exercise of their profession to achieve a better view of the tooth being treated. However, this is a risk factor for the development of WMSDs and dentists should avoid ergonomically incorrect positions as a form of prevention. In the present study, 76% of the endodontists reported neck, back and low back pain independently of the type of instruments used (motor-driven or manual).

Low back pain can occur during rotation of the trunk while maintaining the same posture for a long period of time. Neck pain can occur due to the position of the dentist during treatment, with the forward lean of the head to gain a better view of the operating field.[11] In endodontics, the use of manual or rotary instruments is another factor that can aggravate the professional's predisposition toward WMSDs due to the need for small, short, repetitive movements. In the present study, 16% of the endodontists only used rotary instruments, whereas 44% only used manual instruments; those who used rotary instruments reported not having pain in the wrists, hands, fingers, elbows or arms.

According to Michelin and Loureiro,[4] WMSDs are more frequent among professionals in the specialties of endodontics, restorative dentistry, traumatology and periodontics, who are more exposed to upper limb vibrations with or without equipment.[5]

In the present study, the majority of endodontists who used manual instruments reported pain in the neck, shoulders, wrists, hands, fingers and, especially, the upper and lower back. These findings are in agreement with data described by Regis Filho,[12] who found that endodontists maintain an inadequate posture during treatment, which generates excessive load on the muscles of the upper limbs and back. The authors also found considerable activity of the thumb muscles due to the pinching movement to secure manual instruments, with an increase in muscle activity in the wrist region. During the use of manual instruments, the rotation of the file in the canal causes greater activation of the short abductor of the thumb as well as the anterior and medial deltoid muscle due to movements involving fine coordination, which generates adaptations throughout the entire arm and forearm.[13]

Endodontists have a high incidence of pain and discomfort in the upper limbs related to the use of instruments in root canals, which requires repetitive muscle contractions of the fingers and wrist, especially when manual instruments are employed.[14] In the present study, a direct association was found between elbow pain and experience in the profession, as endodontists with less than 15 years on the job had less elbow pain. It should be pointed out that the minimum period of experience was five years. Moreover, an association with sex was found – women had more arm symptoms than men. According to Michelotto,[14] endodontic work should not be performed without the help of an assistant, as incorrect working postures were found more among endodontists who worked alone, and the practice of endodontics can exert an influence on the muscles of the shoulder, scapular gridle and elbow, leading to postural changes.[14]

The fact that endodontists who only used motor-driven instruments had no pain in the arms, elbows, wrists, hands, fingers and hips may be related to the lower stress during chemical-mechanical preparation of the root canals. Indeed, Miyamoto (1999) found a direct relation between stress/physical pain and irregular ergonomic aspects, which are expressed as inadequate posture, physical and mental fatigue as well as pathological conditions, such as WMSDs and diseases acquired during the state of stress.[15]

The use of rotary equipment causes vibratory energy in the human body. Due to this vibration, endodontists have a greater need to stabilize the upper limbs, with greater activation of the shoulder muscles. Indeed, rotary systems exert an influence on the activity of the elbow, shoulder and back muscles.[13]

Dental professionals need to be aware of their own bodies and adopt preventive measures, such as an ergonomically correct posture, which can contribute to the sensation of wellbeing. It is also important to perform regular muscle strengthening exercises, which could assist in the avoidance of poor posture during the daily practice of dentistry, and allow time to rest between appointments. Such measures should be taken to prevent musculoskeletal problems stemming from the profession.[16] Thus, ergonomics is an important strategy to prevent and improve symptoms of WMSDs, as this practice seeks to create an adequate environment for professional activities.[17]