

Rapid upper limb assessment (RULA) and Rodgers muscle fatigue analysis (RMFA) of dentists using optical microscope, loupes or no magnification during endodontic access. A pilot study.

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1. Introduction

Musculoskeletal disorders (MSD) are considered to be work-related when the environment and performance of work contribute significantly to the condition; the condition is made worse or persists longer due to work conditions, or both. MSDs represent a significant occupational health problem among dental practitioners and have been attributed to deteriorating quality of life and often resulting in premature retirement and stress related illnesses (Burke et al., 1997).

MSDs occurring among dental workers are: chronic low back pain, tension neck syndrome, trapezius myalgia and rotator cuff impingement (B. Valachi & Valachi, 2003). The prevalence of general musculoskeletal pain in dental professionals (dentists and dental hygienists) ranges between 64% and 93% according to a systematic review (Hayes et al., 2009). Common MSDs affecting dental workers were neck, shoulder and lower back (Gupta et al., 2013).

Some studies have suggested that MSDs develop over time as a result of an incorrect working posture, and that being aware of these disorders and preventive practices early in professional life can minimize the risk of onset of MSDs (Sakzewski & Naser-ud-Din, 2014). Indeed, a correct posture promotes more energy, less stress and strain, less distraction from pain, and less errors; an incorrect posture results in pain, fatigue, poor work quality, negative attitudes, and aging (American Dental Association, 2004).

Dental work processes are mostly predetermined, and these circumstances result in awkward body postures, which then require the dentist to work in constrained postures (Ohlendorf et al., 2017). Dentists' work includes several well-known risk factors for musculoskeletal symptoms in general and specifically for low back pain. The following widespread postures among dentists are considered risk factors: Forward bent sitting posture, accompanied with bending and twisting, and the relative static work. Additionally, not only sitting and twisting postures have an effect on back pain, the time spent in these postures greatly impact musculoskeletal pain (Ohlendorf et al., 2016; Ratzon et al., 2000).

Neck pain has in fact been shown to be associated with any job where forward head posture is 20° or more for 70 % of working time. On average, dentist and hygienists work with forward head postures of at least 30° for 85% of their time in the operatory. Poor posture, movement or imbalances in the neck or shoulder can result in the three most prevalent pain syndromes seen in dentistry: tension neck syndrome, rotator cuff impingement or trapezius myalgia, pain, stiffness, movement difficulties and tenderness are some of the symptoms related to this syndrome (D. B. Valachi, 2008).

The rapid upper limb assessment (RULA) is a survey method originally developed for ergonomic studies to assess working posture in workplaces where work-related upper limb disorders are reported (McAtamney & Nigel Corlett, 1993). The method uses diagrams of body postures and three scoring tables to provide evaluation of exposure to risk factors. The Muscle Fatigue Analysis was proposed by Rodgers as a means to assess the amount of fatigue that accumulates in muscles during various work patterns within 5 minutes of work (Rodgers, 1992). Based on the premise that a rapidly fatiguing muscle is more susceptible to injury and inflammation, if fatigue can be minimized, so should injuries and illnesses of the active muscles. The purpose of the present pilot study was to evaluate the working position adopted during a standard endodontic procedure (endodontic access) with the Rapid Upper Limb Assessment (RULA) and Rodgers Muscle Fatigue Analysis (RMFA) tools.

2. Methodology

In this preliminary study, endodontic access was performed in tooth number 4.7 (31 American system) using round and troncoconical burs attached to a highspeed handpiece. A dental operating microscope (Newton SRL, Buenos Aires, Argentina), 2.5x Galilean loupes or no magnification, i. e. the naked eye, were used on three different patients. All procedures were performed using an ergonomic chair (Dynamic model, Back Quality Ergonomics, The Hague, Netherlands) with telescopic and revolving arm rests by the same operator, with 14 years' experience, 8 years of which were using the microscope. The operator reported no vision issues and no recent history of MSD. Each endodontic access procedure took between 8 – 10 min. A video camera was used to record the procedures from 3 different angles (2 lateral views (right and left) and a front view) in three different patients following the National Institute for Occupational Safety and Health (NIOSH) protocol for video recording jobs for risk factors. The position of the camera standardized for all the recordings. The working posture adopted during the procedures was recorded by a video camera (Model STK-LX3, HUAWEI Technologies Co. Ltd., China) and evaluated using Rapid Upper Limb Assessment (RULA) and Rodgers Muscle Fatigue Analysis (RMFA).

3. Results & Discussion

Table 1 shows the detailed RULA scores of the working posture adopted during endodontic access of tooth 4.7 (31 American system) using microscope, loupes or no magnification.

Table 1. Detailed RULA scores of the working posture adopted during endodontic access of tooth 4.7 (31 American system) using microscope, loupes or no magnification in three different patients.

RULA item score		Microscope	2.5x Loupes	No magnification
Arm and wrist Analysis	Upper arm	1	1	1
	Lower arm	2	2	2
	Wrist twist	1	1	1
	Wrist	2	3	3
	Posture A	2	3	3
	Muscle use	1	1	1
	Force/load	0	0	0
	Wrist and Arm	3	4	4
Neck, trunk and leg analysis	Neck	1	5	5
	Trunk	1	4	4
	Leg	1	1	1
	Posture B	1	8	8
	Muscle use	1	1	1
	Force/load	0	0	0
	Neck, Trunk, Leg	2	9	9
	RULA Score	3 (Low risk, change may be required)	6 (Very high risk, implement change now)	6 (Very high risk, implement change now)

Very little difference in scores was observed during the arm and wrist analysis (Table 1). An operator ergonomic stool was used during the procedures and may have influenced the wrist and arm scores. During the three working conditions, the upper arm was positioned between 20-45 degrees forward from the shoulder, without abduction and supported by the operator stool. The lower arm was positioned 60-100 degrees upward, where the most dynamic movement were in the wrists scores due to the continuous work with the handpiece in the right hand and holding the mirror in the left hand, both with bending and

twisting. The use of arm supports has been reported to reduce static and median neck/shoulder activity, but not affect peak muscle activity (Bolderman, F.W. et al., 2017).

The largest difference was observed during the neck, trunk and leg analysis, in particular in the neck and trunk scores, which was lower for the working posture adopted during microscope use than for loupes and no magnification (Table 1). When using the microscope, the neck, trunk and legs position remained steady during the complete task cycle with low scores in their positions, without any bending or twisting. This is because the microscope allows the operator to adopt an upright sitting position whilst the focusing range of 200–415 mm can be continuously adapted to the requirements of the task (Bolderman, F.W. et al., 2017). However, the use of loupes or no magnification both resulted in the 20 degrees forward head posture neck position, with twisting and side bending. A cohort study that there was an increased risk of neck pain for people working with the neck at a minimum of 20° of flexion for more than 70% of the working time (Ariëns et al., 2001). The trunk was observed to be forward bending up to 20 degrees with twisting and side bending and the legs well supported on the floor. A prolonged static posture was observed for all working conditions.

The use of loupes and no magnification achieved similar scores. Thus, the overall RULA score was lowest for microscopes. The RULA provides a method of screening a working population to assess exposure to significant risk of work-related upper extremity disorders. By identifying the muscular effort which is associated with working postures and excessive forces while performing static or repetitive work, and which may contribute to muscle fatigue. In these 3 cases, shows that during the endodontic access the operator required less postural load to do the same procedure, especially in the neck and back, were dentist suffers most of pain, discomfort, and injuries.

Concerning the RMFA, table 2 shows the change priority at each region according to the use of microscope, loupes or no magnification. The underlying hypothesis of Rodgers MFA is that a rapidly fatiguing muscle is more susceptible to injury and inflammation. There are three factors that used in the assessment; effort level, continuous effort duration, and effort frequency. According to this study, the biggest risk factor in all the working conditions was the continuous effort duration. This means that a posture was held continuously for at least 20 s and many for more than 30 s. However, the effort level and frequency in all the muscle groups was light to moderate. The loupes are an additional weight attached to the operator's forehead that already has to position his/her head at a 20° forward. This should be considered when evaluating these results.

Table 2. Rodgers muscle fatigue analysis overall priority scores of each region according to the use of microscope, loupes or no magnification.

Region	Microscope	2.5× Loupes	No magnification
Neck	Very High	Very High	Very High
Shoulders	Very High	Very High	Very High
Back	Very High	Very High	Very High
Arms/Elbow	Low	Very High	Low
Wrists/Hands/Fingers	Moderate	Very High	Low
Legs/Knee	Very High	Very High	Very High
Ankles/Feet/Toes	Very High	Very High	Very High

Access cavity preparation is the first step in a series of procedures in endodontic treatment because it can affect all subsequent procedures and also the outcome (Krapež & Fidler, 2013). Clinically, this procedure can last approximately 5 - 10 min. However, the duration of root canal treatment is variable but usually is between 60 to 90 min per session. Endodontic work involves performing high precision tasks with a limited range of motion (constrained postures) resulting in isometric muscle contractions, difficulties in direct visualization (which causes awkward posture), visual demands requiring static postures, repetitive tasks for long periods and high precision where the use of magnification is strongly recommended, sometimes in combination with the exertion of high forces and psychosocial stress (Morse et al., 2010).

By using both ergonomic assessment tools to evaluate the same videos, extensive data could be obtained. Both methods evaluate risk factors for development of musculoskeletal disorders in static activities such as dentistry, one (RULA) with a tendency for postural analysis such as and the other (RMFA) with a tendency to muscle fatigue risk by zones according to the task being performed.

4. Conclusions

These preliminary results suggest that the working positions adopted, especially by the neck and trunk, and muscle fatigue risk of the arms, elbow, wrists, hands and fingers during an endodontic procedure (access cavity preparation) to be affected by the type of magnification being used. Additionally, there the RMFA suggests a very high priority of change for the three working conditions due to the prolonged static posture. The preliminary data gained in the present pilot study will guide the design of larger scale studies performed in dentists and dental students.

5. References

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