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Research Report

Musculoskeletal disorder risk level evaluation of posterior maxillary tooth extraction procedures

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ABSTRACT

Background: *The professional activity of dentists involves a relatively small treatment area, namely; the oral cavity. Dental treatment requires a high level of precision with the result that dentists frequently perform their duties in a physically uncomfortable position over a relatively extended period of time. Tooth extraction is the most common form of treatment performed in a standing position, with extraction of the posterior maxillary tooth being the most challenging. 80 per cent of students and dentists working in the Faculty of Dentistry at the University of Indonesia present musculoskeletal disorders (MSD).* ***Purpose:*** *To evaluate the level of MSD risk of Oral and Maxillofacial Surgery Clinic students at the Universitas Airlangga Dental Hospital following posterior maxillary tooth extraction.* ***Methods:*** *The evaluation of MSD risk level was performed over a period of three months on 73 subjects who had experienced posterior maxillary tooth extraction, categorized as extraction under anaesthesia, extraction involving the use of an elevator and extraction using forceps. Evaluation was conducted by two observers by means of CCTV video footage using a Rapid Entire Body Assessment (REBA) worksheet.* ***Results:*** *Under anaesthetic sedation, 67.12% experienced medium risk, 31.51% high risk, and 1.37% low risk. During extraction using an elevator, 58.90% experienced high risk, 35.62% medium risk and 5.48% extremely high risk. During extraction using forceps, 57.53% ran medium risk, 39.73% high risk, and 2.74% extremely high risk.* ***Conclusion:*** *Students who performed posterior maxillary tooth extraction could be categorized as running a high risk of MSD during extraction using an elevator, but medium risk when administering anaesthesia and performing extraction with forceps.*

Keywords: *ergonomics; musculoskeletal disorders; rapid entire body assessment; tooth extraction*

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INTRODUCTION

The daily professional activity of dentists involves a relatively small treatment area, namely; the oral cavity, access to which requires a high degree of precision. As a result, dentists frequently execute their duties in physically uncomfortable positions over comparatively lengthy periods of time. Moreover, it is not uncommon for dentists to maintain static hand and shoulder posture during treatment,[1] prioritizing the comfort of their patients while devoting far less attention to their own. Dentists consider it more appropriate to approach the patient, rather than adjust seated position of the latter in the dental chair.[2] This, compounded by insufficient breaks, can increase their risk of musculoskeletal disorders (MSD).[3] According to Brown *et al*. (2010), MSD was the most common cause of retirement on the grounds of ill health amongst dentists (55%), followed by mental and behavioural disorders (28%).[4]

Tooth extraction is one frequently performed procedure that is sufficiently difficult to necessitate dentists unconsciously adopting an uncomfortable posture that leads to difficulties requiring the application of specific appropriate techniques and strategies.[5] MSD constitutes a disorder of the muscles, tendons, joints, vertebrae, peripheral nerves and vascular system that can occur suddenly and acutely or, alternatively, slowly and chronically. These disorders can be induced or exacerbated

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by various factors including work-related ones such as poor posture, maintaining a static position for excessive periods and repetitive movements.[6] MSD can be assessed by a variety of methods, one of which is Rapid Entire Body Assessment (REBA).

REBA was devised by Hignett and McAtamney at the University of Nottingham to analyze body postures associated with the risk of work-related MSD. The REBA method can be used in a range of contexts where the entire body is being employed, for example: static, dynamic or rapidly-changing (where posture is unstable, weights are lifted and modifications are made to the workplace, equipment, training or working practices). REBA evaluation is carried out in several stages. First, work attitude and behaviour is observed. Second, the posture to be studied is selected, including repetitive postures, prolonged unchanging postures, postures requiring high levels of energy expenditure or muscle activity, uncomfortable postures, awkward, extreme and unstable postures, or ones that can be corrected by intervention, control or other changes. Lastly, posture is assessed and posture scores calculated using the REBA worksheet.[7]

According to a study by Hasibuan (2011), 80% of students and dentists who studied or practiced at the Faculty of Dentistry at Universitas Indonesia had experienced MSD, especially that affecting the neck, shoulders, lower arms, hands and back. It was concluded that the most common procedure undertaken in a standing position was that of tooth extraction, with the posterior maxillary tooth being the most challenging to manipulate.[8]

This study aims to determine and evaluate the ergonomic aspects and risk level of MSD affecting students of the Universitas Airlangga Dental Hospital during the extraction of posterior maxillary teeth using the REBA method. Hopefully, the results may raise awareness among students and dentists alike concerning the risks of developing MSD during dental practice.

MATERIALS AND METHODS

A descriptive observational study with a cross-sectional approach was conducted at the Oral and Maxillofacial Surgery Clinic of Universitas Airlangga Dental Hospital between September and November 2017. This study received ethical clearance by the Universitas Airlangga Faculty of Dental Medicine Health Research Ethical Clearance Commission with Certificate Number: 099/HRECC.FODM/VII/2017. The research samples were students of the Faculty of Dental Medicine, Universitas Airlangga. Simple random sampling was employed to determine the minimum sample size for this study.

Given the 302 cases of posterior maxillary tooth extraction, a minimum of 73 samples were employed to ensure that sampling error remained within 10%. Following a study by Domingo *et al*. (2015), observation of the most difficult and most frequently performed tasks was conducted.[9] After determining the most common procedure and the most difficult tooth to manipulate, it was decided that subjects included in this study should comprise Faculty of Dental Medicine, Universitas Airlangga students experienced in extracting maxillary premolars and molars. Samples excluded from this study were ones that provided incomplete information when observed by means of CCTV video recordings and/or performed tooth extraction procedures without resort to anaesthesia, extraction using an elevator, and/or extraction employing forceps.

$$n = \frac{(Z_{(1-\alpha/2)})^2 p(1-p)N}{d^2(N-1) + (Z_{(1-\alpha/2)})^2 p(1-p)}$$

Where:

n = minimum sample size

N = population size

d = tolerated margin of error used in this study

$Z_{(1-\alpha/2)}$ = 1,96

p = proportion of incidence or prevalence rate, if unknown then 50% (0.5) was used

A total of four CCTV cameras were installed at strategic locations in the Oral and Maxillofacial Surgery Clinic of Universitas Airlangga Dental Hospital to record students performing tooth extraction procedures consisting of anaesthesia, extraction using an elevator and extraction utilising forceps. Video recordings were monitored by two observers with the MSD risk level being evaluated according to the REBA method[7] within which they assigned a score for each of the following body regions: neck, back, upper and lower arms, wrists, and legs. The scores were subsequently entered on an REBA worksheet divided into two main sections, labelled A and B. Section A contained analysis of the neck, trunk and legs, as presented in Figure 1.

Section B contained analysis of the arm and wrist, as shown in Figure 2. When using REBA, only one side of the body (left or right) is assessed at a time. Section A postures (trunk, neck and legs) are scored first, with whichever section B postures are dominant for the operator (either left or right upper arms, lower arms and wrists) being subsequently scored.

For each region, as shown in Figure 3, a posture scoring scale and additional adjustments needed to be considered and accounted for in the score. The postures to be assessed should be based on the following criteria: the most challenging posture and work task, the posture sustained over a protracted period, or the posture involving the highest force loads. After the data for each region had been collated and scored, the tables contained in the worksheet (Figure 4) were then used to compile the risk factor variables, generating a single score that represents the level of MSD risk as presented in Table 1.

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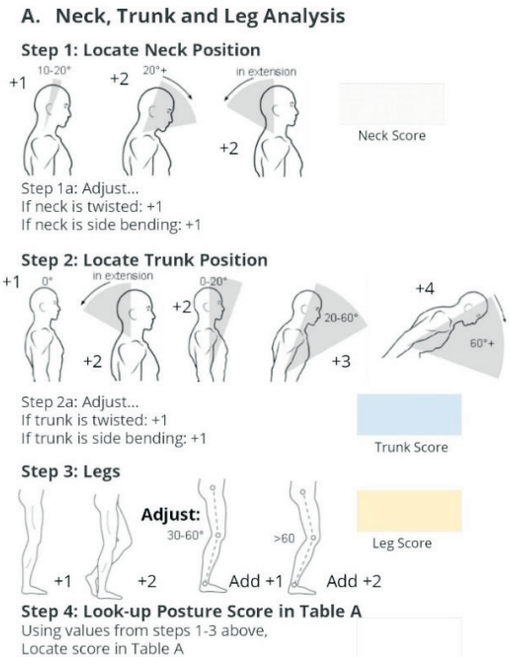

Figure 1. Section A of REBA worksheet.[7]

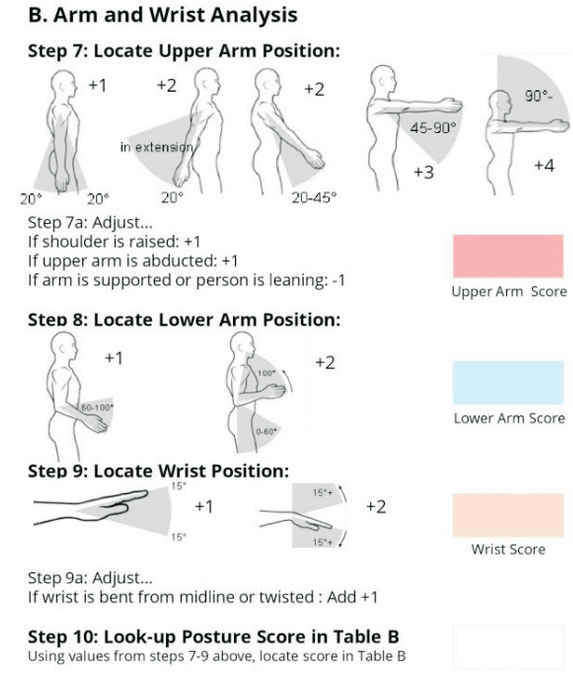

Figure 2. Section B of the REBA worksheet.[7]

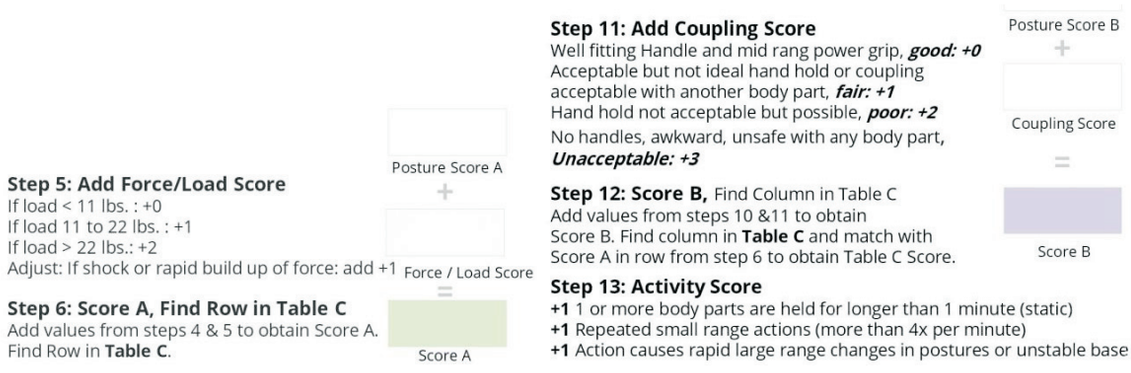

Figure 3. Additional adjustment in the REBA worksheet.[7]

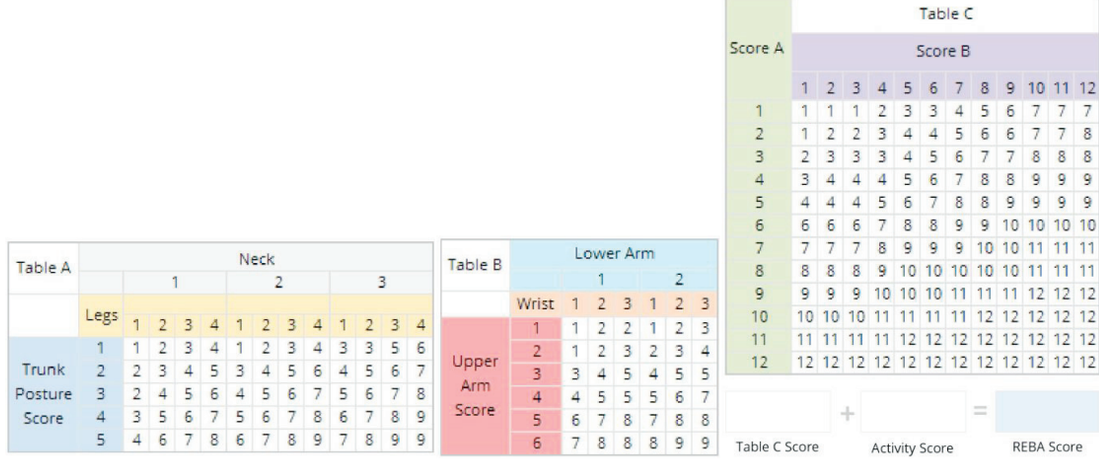

Table A

Trunk Posture Score	Legs	Neck 1				Neck 2				Neck 3			
		1	2	3	4	1	2	3	4	1	2	3	4
1		1	2	3	4	1	2	3	4	3	3	5	6
2		2	3	4	5	3	4	5	6	4	5	6	7
3		2	4	5	6	4	5	6	7	5	6	7	8
4		3	5	6	7	5	6	7	8	6	7	8	9
5		4	6	7	8	6	7	8	9	7	8	9	9

Table B

Upper Arm Score	Wrist	Lower Arm 1			Lower Arm 2		
		1	2	3	1	2	3
1		1	2	2	1	2	3
2		1	2	3	2	3	4
3		3	4	5	4	5	5
4		4	5	5	5	6	7
5		6	7	8	7	8	8
6		7	8	8	8	9	9

Table C

Score A	Score B 1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

Figure 4. Compiling table in the REBA worksheet.[7]

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RESULTS

The study was conducted on 73 samples, consisting of 14 males and 59 females. As a result, 67.12% students were categorized as of medium MSD risk level for undertaking anaesthetic procedures and 57.53% for performing extraction using forceps. While high risk students were most often found performing extractions involving the use of elevator procedures (81.13%), their low-risk counterparts were found to only implement anaesthetic procedures with the lowest amount (1.37%) compared to other levels of risk, as presented in Figure 5.

Students who performed anaesthesia and extraction using forceps can be categorized as being at medium risk of MSD as can be seen from the mean, mode and median values. In cases of extraction involving the use of elevators, the mean, mode, and median values are all categorized as involving a high risk of MSD, as shown in Figure 6.

Data from two observers was examined using the Wilcoxon Signed Ranks test to eliminate the possibility of bias. The test showed there to be no significant difference between the two observers in all procedures (p š 0.05), as indicated by the contents of Table 2.

Table 1. Interpretation of risk levels according to REBA[7]

Score	Risk level
1	Negligible risk, no action required
2-3	Low risk, change may be needed
4-7	Medium risk, further investigation, change is required
7-10	High risk, investigate and implement change as soon as possible
š 11	Very high risk, implement change immediately

Table 2. Test result of Wilcoxon signed ranks test

	Anaesthesia	Extraction using elevator	Extraction using forceps
Asymp. Sig. Value	1.000	0.157	0.317

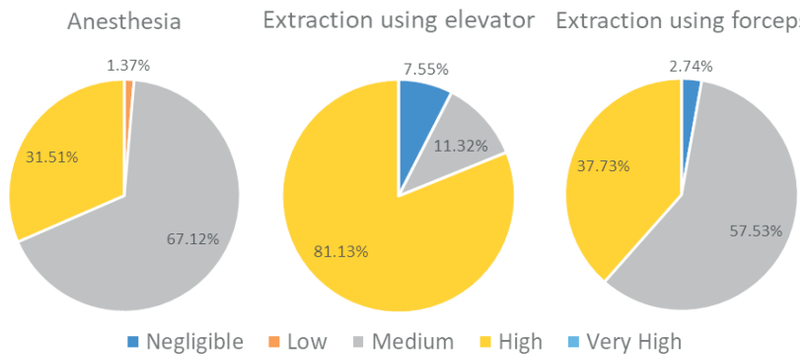

Figure 5. Distribution of students' risk level of MSD during extraction procedure of the posterior maxillary tooth.

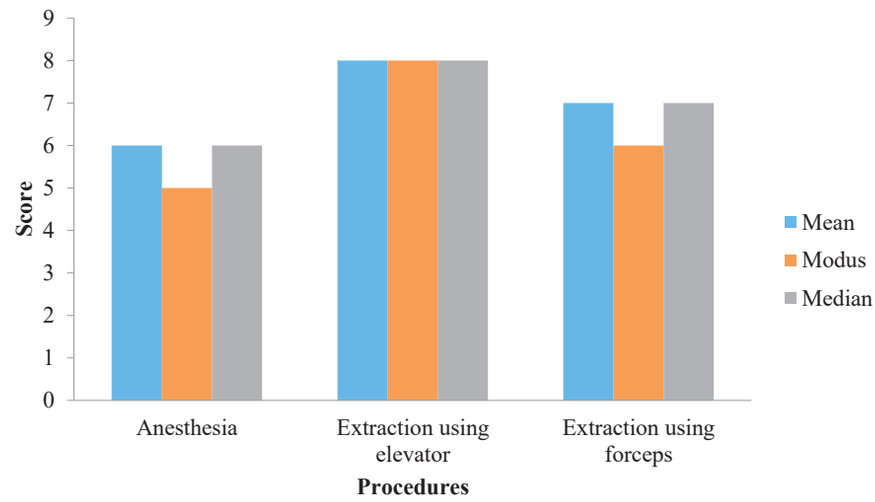

Figure 6. Descriptive data of students' REBA score during extraction procedure relating to the posterior maxillary teeth.

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DISCUSSION

The results of the study showed that those students who performed anaesthesia and extraction using forceps could be categorized as having a medium risk of MSD, whereas in cases of extraction involving elevators the risk run by students was categorized as high. One salient factor influencing the results was the static position maintained by the students for more than one minute when performing tooth extraction procedures. The higher the effort expended in maintaining a static position, the lower the blood supply to the muscles. Blood supply obstruction can cause the by-products of muscle contraction, for example lactic acid accumulating in the muscles and causing acute pain in the area of the contracting muscle. When this static position is frequently maintained for a protracted period, the pain can extend to the joints, tendons and other tissues. This condition is also referred to as MSD.[10,11]

Another factor that influenced the high level of risk of MSD was the relatively inclined posture widely adopted by the students. According to Dul and Weerdmeester (2008), the need to lean in this manner results from the height of work site being too low in relation to the elbow,[11] with students compensating for this problem by bending further in order to change their posture. An inclined posture can cause compression in the area of the cervix, spine and surrounding muscles which, in turn, may inhibit the blood supply leading to intervertebral disc malnutrition and potential compromising of the integrity of the musculoskeletal system.[12] Another factor that needs to be considered is the condition of the facilities and infrastructure used while the students carry out extraction procedures. Possible defects in these can affect the posture of the dentist, especially in the case of bending.[11] Malfunctioning dental chairs which cannot be set at the optimal height and angle can affect his/her posture, obliging him/her to bend or lift the arms to a position higher than that recommended. It is this factor that increases the level of risk of MSD in the students and which can be exacerbated by the possibility of complicating factors in the extraction cases carried out. According to Riawan (2009), this is because such factors necessitate greater effort, more complicated techniques and more protracted treatment[5] This scenario produces an awkward or unstable posture, with the pressure to which the muscles is subjected also being greater and the risk of MSD in the operator increased.[13]

The evaluation results suggest that the REBA scores produced by the students during anaesthetic procedures constitute the lowest among the three tooth extraction procedures. According to Gupta *et al.* (2014), this is due to extraction, either by means of elevators or forceps, being carried out by operators with repetitive movements.[14] The musculoskeletal system can be damaged by a series of repetitive movements, a condition termed microtrauma. Such movements can take the form of gripping, twisting, pushing and pulling, among others. When carried out continuously for a protracted period, they can lead to excessive energy expenditure resulting in fatigue and injury to the muscles in question. It is this process that increases the incidence of MSD.[13]

A lower REBA score during anaesthesia was also influenced by a relatively short process of extraction compared to that using elevators and forceps because, in general, a longer procedure is more likely to cause fatigue than one involving a shorter working time.[3,11] Moreover, rest periods play an important role in muscle fatigue which represents a reversible physiological process if balanced by an optimal rest period which, in the opinion of Chakrabarty *et al.*(2016), should be approximately 15% of the total working time.[3] The relaxation period referred to here is the time required to stretch the muscles or simply change the posture previously adopted. However, when forced to continue working pathological changes will gradually occur in the muscles which also affect the surrounding tissue. This situation can cause pain or MSD that does not dissipate immediately, even after rest.[3,11,12] Therefore, a balanced and adjusted working time setting should be able to prevent excessive exposure to the source of injury.[10,11]

Extraction using elevators was the primary procedure that placed students at high risk of MSD. Elevators are employed in tooth extraction procedures to separate the tooth from the surrounding soft tissue.[15] This statement is supported by Mamoun (2017), who argued that this procedure serves to expand the alveolar bone around the teeth and facilitate removal of the tooth from its socket by the use of forceps.[16] Therefore, it can be concluded that, in general, extraction using elevators requires greater effort and energy than that using forceps.

According to research conducted by Sholihah *et al.* (2016), providing knowledge of ergonomic concepts can reduce the number of complaints regarding MSD.[17] In the field of dentistry, understanding the concept of ergonomics and its application is very important in preventing MSD and the occurrence of early retirement,[4] thereby improving overall quality of life.[18]

The REBA evaluation results support the conclusion that, from an ergonomic perspective, students who extracted posterior maxillary teeth at the Oral and Maxillofacial Surgery Clinic of Universitas Airlangga Dental Hospital ran a high risk of MSD, especially when using elevators. In contrast, with regard to anaesthesia and extraction involving the use of forceps, the students are considered to have experienced a medium level of risk.

Limitations on the study include the fact that observation was conducted indirectly via a CCTV camera feed. This meant that several variables such as differences in the right and left regions of the extracted teeth, complicating factors in tooth extraction, anthropometry, age, and gender were inadequately considered. It is anticipated that further research could conduct analytic studies which take these variables into account.

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