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Musculoskeletal disorders in dental workplace: A comprehensive review

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Abstract
Musculoskeletal disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back. With the ever-increasing precision and complexity involved in dentistry along with an increase in patient expectation, procedures are taking longer time. Over time muscle imbalances also can develop between the muscles that stabilize and those that move, and the stressed shortened muscle becomes ischemic and painful. The combination of these proliferative and infiltrative processes can lead to tissue changes over time. Awkward Postures, forceful exertions, repetitive motions, duration, contact stresses, vibration and psychosocial factors are important risk factors for musculoskeletal disorders among dental professionals, especially when occurring at high levels and in combination. Hence, the aim of this comprehensive review is to provide a lead-in, definitions, basic structure of the musculoskeletal system, epidemiology and classification, mechanism of injury, signs and symptoms, diagnosis, risk factors, and management and prevention of work-related musculoskeletal disorders in the dental workplace.

Keywords: Musculoskeletal disorders, dentists, ergonomics

Introduction
The dental profession is responsible for the prevention, diagnosis, and treatment of diseases and disorders of the oral cavity and related structures [1]. Dentistry is a visually dependent occupation where the visual demands may require adoption of fixed postures for extended periods of time [2]. The job profile of dentists exposes them during their work to many burdensome and harmful factors. The irrational posture adopted by dentists during their work causes discomfort and disorders of the musculoskeletal system and the peripheral nervous system.
Musculoskeletal disorders (MSD) are significant occupational health problems that affect muscles, tendons, ligaments, cartilage, joints, nerves and blood vessels [3]. These are caused by sudden or sustained exposure to repetitive motion, force, vibration, and awkward positions.
This review provides a lead-in, epidemiology and classification, mechanism of injury, signs and symptoms, diagnosis, risk factors, and management and prevention of work-related musculoskeletal disorders among dental professionals.

Structure of the Musculoskeletal System
The musculoskeletal system (MSS) is composed of bones, muscles, tendons, ligaments, cartilage, nerves and blood vessels. This dynamic system absorbs and distributes loads and supports the body [4]. The integrated action of joints, bones, and skeletal muscles produces obvious movements such as walking and running. Skeletal muscles also produce more subtle movements that result in various facial expressions, eye movements, and respiration [5]. In addition to movement, muscle contraction also fulfils some other important functions in the body, such as posture, joint stability, and heat production. Posture is maintained as a result of muscle contraction.
In standing postures, the spine has four natural curves (figure 1) when viewed from the side: cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis [6]. The curves are interdependent; a change in one curve will result in a change in the curve above or below it [7]. Since the sacral curve is composed of five fused vertebrae, its movement is extremely limited. However, the remaining curves, especially the lumbar and cervical curves, are more mobile

and can be influenced more easily. When the curves of the spine are present and balanced against the center of gravity, the spine is supported mostly by the bony structures of the vertebrae resting on top of one another [8]. When these curves become either exaggerated or flattened, the spine increasingly depends on muscles, ligaments and soft tissue to maintain erect. The bony infrastructure provides little support to the spine, which now is hanging on the muscles, ligaments and connective tissue at the back of the spine, causing tension in these structures. Ischemia can ensue, leading to low back strain and trigger points. This flattening of the lumbar curve also causes the nucleus in the spinal disk to migrate posteriorly toward the spinal cord. Over time, the posterior wall of the disk becomes weak, and disk herniation can occur [8].

The trapezius and Latissimus dorsi connect the upper extremity to the vertebrae column and are of relevance. The angles of the trapezius fibers provide pull in three different directions: up, down, and in toward the center line of the body. The descending rises part of the right and left trapezius muscle and the latissimus dorsi rises no higher in point of origin than the first lumbar spine [9].

Definitions of MSD

A disorder of the muscles, tendons, peripheral nerves or vascular system not directly resulting from an acute or instantaneous event (e.g., slips or falls). These disorders are considered to be work-related when the work environment and the performance of work contribute significantly but are only one of a number of factors contributing to the causation of a multifactorial disease.

-The World Health Organization (2007) [10]

Work-related musculoskeletal disorders (WMSDs) are conditions in which the work environment and performance of work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work conditions

-Centers for Disease Control and Prevention (2016) [11]

MSDs, or musculoskeletal disorders, are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system.

-Occupational Safety and Health Administration (2000) [12]

Classification of MSDS

As per International statistical Classification of Diseases and related health problems (ICD-10) in occupational health MSDs are classified as follows [10]

Diseases caused by mechanical vibration affecting the hands and arms

Vascular effects

I73.0 Raynaud´s syndrome

Neuropathies

G56.0 Carpal tunnel syndrome
G56.1 other lesions of median nerve
G56.2 Lesion of ulnar nerve
G56.3 Lesion of radial nerve
G56.9 Mononeuropathy of upper limb, unspecified

Diseases of the musculoskeletal system and connective tissue

M65. Synovitis and tenosynovitis
M70. Soft tissue disorders related to use, overuse and pressure
M77. Other enteropathies

Epidemiology

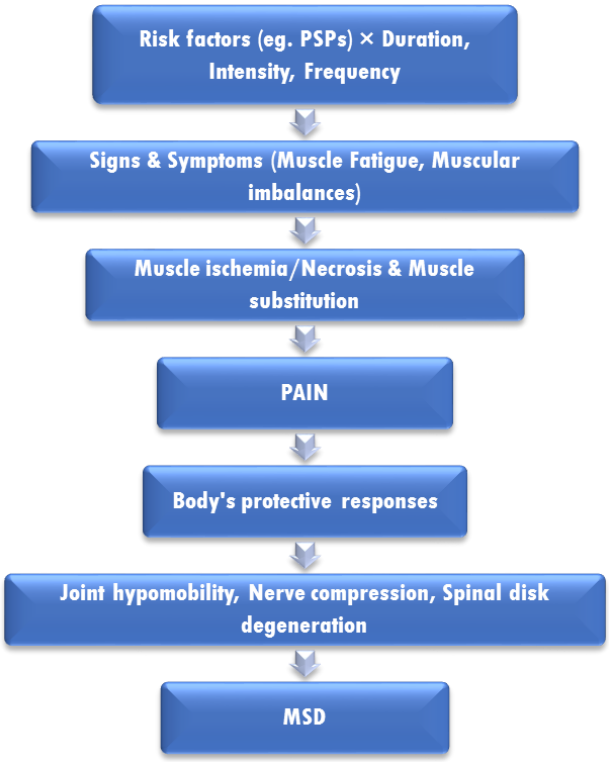
The prevalence of MSD among dentists is about 49% [13]-92% [14], Women report a higher frequency of pain and discomfort than men [15-17]. Among the regions, neck was most affected (26%-83.8%) [13, 18], followed by shoulder (18.9%-72.4%) [19, 20] and wrist (26%-49.7%) [20, 21]. Back pain was reported in 22.2%-91% [16, 22] of dentists predominantly in upper back (20%-61.8%) [13, 23] than lower back (34%-69.8%) [13, 20].

Risk Factors

Work in dentistry is characterized by some body postures with different degrees of distortion. There are many types of factors responsible for MSD: occupational factors, medical factors (physical disorders, genetic predisposition, and age) and life style factors. Usually two or more factors trigger MSD [24]. Occupational factors include prolonged static postures [25], repetitive movements [26-31], inadequate lighting [32], the excessive exertion of the small muscles, and the instrument tight grip, raised arms, static exertion of the muscles on long term, fine-tuned actions [27] and vibrations [26, 27]. A study of the working postures of dentists found that they spent 86% of their working time with a neck flexion of at least 30% and 53% of their work time with a trunk flexion of at least 30%. [33]

Mechanism of Injury

Dental practitioners frequently assume static postures, which results in the contraction of more than 50 percent of the body's muscles and hold the body motionless while resisting gravity. These prolonged static postures (PSP) initiate a series of events that may result in pain, injury or a career-ending MSD. These static forces resulting from these postures have been shown to be much more taxing than dynamic (moving) forces [34].



Etiopathogenesis of MSD

In modern clinical dentistry, dental practitioners should strive to maintain a neutral, balanced posture but still they find themselves in sustained awkward postures. In seated posture,

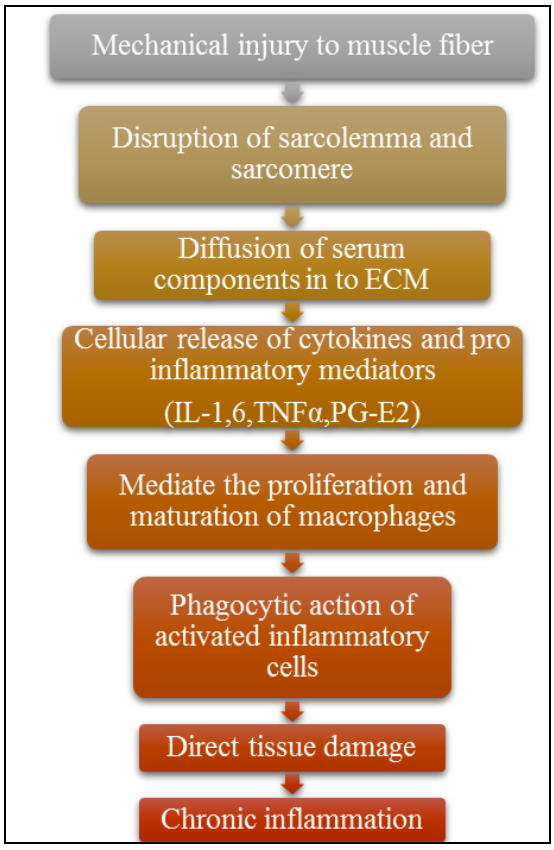
static prolonged contractions of the low back extensor muscles significantly decrease oxygenation levels in the muscle. Even when using the best working postures, dental practitioners still maintain static contractions of the trunk muscles. As their postures deviate from neutral, their muscles must contract harder to maintain a working posture. As muscles become fatigued, this prolonged contraction can cause muscle ischemia [35]. These areas are especially susceptible to the development of trigger points, which are groups of muscle fibers that are in a constant state of contraction inside a tight band of muscle.

Human muscles are not adapted for continuous long-lasting contractions and require rest periods to recover from even very low-level exertion [36]. During a sustained, static muscle contraction, the tendon stretches and compresses the vascular supply to the muscle and surrounding tissues, thereby depleting nutrient and oxygen supply [37]. Accumulation of lactic acid and other metabolites in the muscle tissue results in their damage and leads to painful sensation.

In dentistry, because of insufficient rest periods, the damage often exceeds the rate of repair and leads to muscle necrosis. To protect the stressed area from further injury, the body uses another part of the damaged muscle to maintain the body position. Over long periods, entire muscles become compromised, so the body recruits different muscle groups to perform the needed task. This is known as muscle substitution, and muscles are required to perform a task for which they are not ideally designed [38] The descending part of the right and left trapezius muscle and the latissimus dorsi are a common site of symptomatic pain in dentists.

During periods of PSPs or when joints are restricted due to muscle contractions, synovial fluid production is reduced dramatically, and joint hypomobility may result. The loss of mobility can lead to early degenerative changes in the joint and put the operator at risk of experiencing further injury [6].

Cellular Indicators of Injury



Signs and Symptoms [39]

Signs	Symptoms
• decreased range of motion • decreased grip strength • deformity • loss of muscle function.	• Tingling and burning • Pain and numbness • cramping, • stiffness.

Diagnosis of MSD

Subjective and objective assessment

The experience of pain is inherently subjective. Current techniques for assessing exposure to risk factors associated with WMSDs include self-reports, observational methods, and direct measurement.

Observational methods include questionnaires such as Nordic Musculoskeletal Questionnaire (NMQ) [40], Quick Exposure Check (QEC), Rapid Upper Limb Assessment (RULA) [41] and Rapid Entire Body Assessment (REBA) [42]. NMQ developed by the Nordic Council of Ministers allows comparison of low back, neck, shoulder and general complaints for use in epidemiological studies. QEC is designed to assess the changes in exposure to musculoskeletal risk factors of the back, shoulders and arms, hands and wrists, and neck before and after an ergonomic intervention. RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. REBA tool uses a systematic process to evaluate whole body postural MSD and risks associated with job tasks.

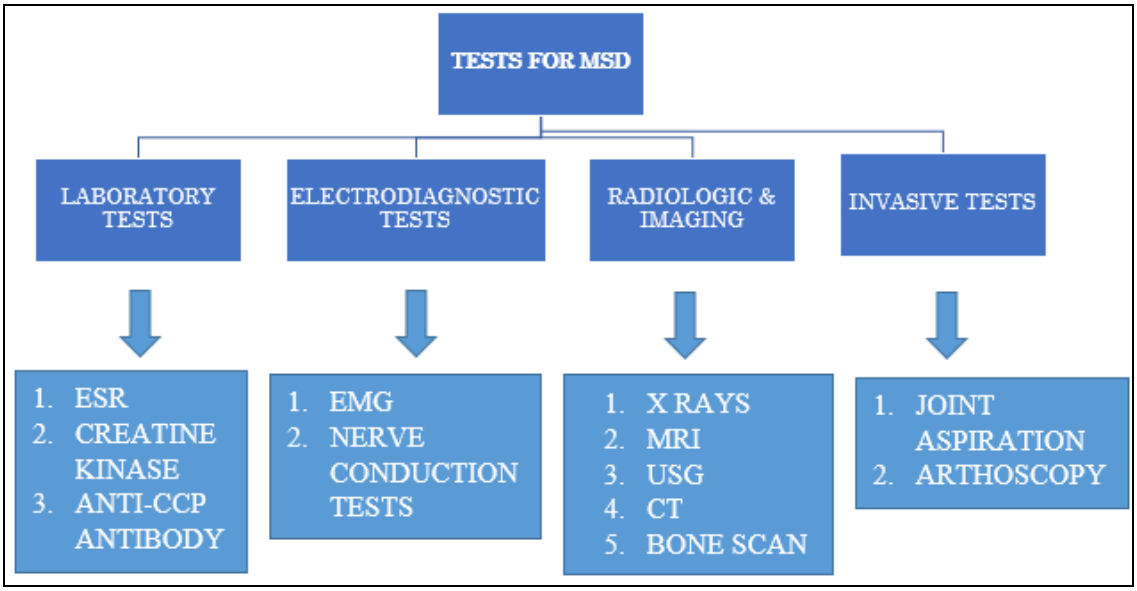
Other observational methods for the evaluation of body postures

- Video Technique for Analysing Postures and Movements-VIRA,
- Method for the Identification of Musculoskeletal Stress Factors-PLIBEL,
- Portable ergonomic observation-PEO,
- Postural and Repetitive Risk-Factors Index-PRRI,
- Ovako Working Posture Analysing System-OWAS,
- Occupational Repetitive Action Index-OCRA.

Complete history and medical examination

A comprehensive, thorough medical examination protocol needs to be employed for assessing MSDs. A systematic medical evaluation protocol produces a specific list of symptoms and coordinated physical findings. Detailed diagnosis-specific provocative tests are performed (Tinel's, Phalen's, Hawkins and Neer tests, etc.) [6]

Evaluation protocols have been developed. The UPPER (Upper extremity protocol evaluation in rehabilitation) Program elements include a pre-evaluation questionnaire, individual team member assessments and a team meeting. It is followed by a patient appointment with the team physician to review the results and recommendations. An upper quarter evaluation from the neck to the fingertips includes detailed exam of muscles, joints, nerves, and the vascular system. Muscle assessment includes swelling, atrophy, lengthening or contracture, range of motion assessment, strength testing, and pain on palpation [43].



Management and Prevention [44]

The main elements for the prevention and management of MSDs in the workplace are

- Training
- Risk assessment and Safe Systems of Work plans
- Policy on prevention and management of MSDs
- Injury management (Retention Rehabilitation and return to work)

Prevention [44]

Safety and health at work is a realistic target and prevention is the best option. Simple and cost-effective programmes may reduce the risks, exposure to workplace hazards and the incidence and severity of MSDs. Thus, it is important to address both the symptoms and the cause. Systematic evaluation and a clear understanding of both the aetiology and the clinical course of WMSDs is required at all stages (primary, secondary, tertiary) of prevention.

The important factors for prevention are optimised work engineering, administrative controls, adequate machinery and tool designs, substitution/modification of equipment and processes, correct operation and maintenance of processes, good working practices, better work organisation, appropriate information and training, modification of individual factors, recognition of employee's own interests in occupational health and safety, compliance with the relevant regulations and standards, creation of a low-stress social atmosphere, and improvement of ergonomics.

Primary prevention occurs when the intervention is undertaken before members of the population at risk have acquired a condition of concern, for example, educational programs. Secondary prevention occurs when the intervention is undertaken after individuals have experienced the condition of concern, for example, introduction of job redesign for workers with symptoms. Tertiary prevention strategies are designed for individuals with chronically disabling MSDs; the goal is to achieve maximal functional capacity within the limitations of the individual impairments'.

Recommendations for preventive measures also include the balance between activity and recovery, periods of relaxation, avoiding overload and recognition of differences in individual favourable load, and applying ergonomic and organisational measures.

Specific strengthening exercises for the trunk and shoulder girdle to enhances the health and integrity of the spinal column, maintains good working posture, optimizes the function of the arms and hands and prevents injuries. Combination of strengthening and stretching addresses a unique pattern of muscle imbalances that can develop among dental professionals.

Aerobic exercise when performed three to four times a week for at least 20 minutes, increases blood flow to all of the tissues in the body and improves their ability to use oxygen.

A variety of stress-reduction techniques decreases stress-related muscular tension. They include breathing techniques, progressive relaxation, visualization, massage, aerobic exercise, meditation or yoga.

Educational interventions are key in preventing and managing MSDs and should ideally start from under graduation so that dental students receive constant practical training and their improper postures are brought to their notice and corrected before habituation sets in and causes serious consequences later on in their career.

Conclusion

Preventing chronic pain as a result of MSD in dentistry may require a paradigm shift within the profession regarding clinical work habits, including proper use of ergonomic equipment, frequent short stretch breaks and regular strengthening exercise. Clinicians should have a thorough understanding of the mechanisms of MSDs so that they are able to make informed choices regarding ergonomic equipment and lifestyle and are able to self -recognise signs of high-risk ergonomic profiles. Thus, applying ergonomics to the practice of dentistry not only could provide safety benefits but a practice may also improve performance objectives through greater productivity.

References

1. Gambhir RS. Primary care in dentistry - An untapped potential. J Family Med Prim Care. 2015; 4(1):13-8.
2. Marshall ED, Duncombe LM, Robinson RQ, Kilbreath SL. Musculoskeletal symptoms in New South Wales dentists. Aust Dent J. 1997; 42:240-6.
3. Bozkurt S, Demirsoy N, Günendi Z. Risk factors associated with work-related musculoskeletal disorders in dentistry. Clinical & Investigative Medicine. 2016; 39(6):192-6.
4. Fitting the Job to the Worker. An Ergonomics Program Guideline. Source: State of Washington Department of

Labor, Division of Labor and Industries, Division of Consultation and Compliance Services, Workplace Consultation Program. [Available on www. ergoweb.com/resources/.reference/guidelines/fittingjob.cfm. Last accessed on 15/12/17 19:00 HRS]
5. Sambrook P, Taylor T, Schrieber L, Ellis A. The musculoskeletal system. 2nd ed. Edinburgh: Churchill Livingstone, 2013.
6. Saunders HD, Saunders R. Evaluations, treatment and prevention of musculoskeletal disorders. Spine, 3rd ed. Chaska, Minn. Educational Opportunities. 1995; 1:106.
7. Norkin C, Levangie P. Joint structure and function: A comprehensive analysis. 2nd ed. Philadelphia: F.A. Davis, 1992.
8. The Benefits of Ergonomically Correct Workstations. Chiropractic Economics. [Available on www.chiroeco.com/article/1999/1999.php3?article =0699f2&menu=0699. Last accessed on 12/12/17 18:30 HRS]
9. Standring S, Gray H. Gray's anatomy. 38th ed. [Edinburgh]: Churchill Livingstone/Elsevier; 2008.
10. Karjalainen A. International statistical classification of diseases and related health problems (ICD-10) in occupational health. Geneva: World Health Organization, Sustainable Development and Healthy Environments, Protection of the Human Environment, 1999.
11. Bernard BP, editor. U.S. Department of Health and Human Services, Centers for Disease control and Prevention, National Institute of Occupational Safety and Health. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and lower back. July 1997. DHHS (NIOSH) Publication No. 97-141. [Available from: https://www.cdc.gov/niosh/docs/97-141/ Last accessed on 20/05/2018 at 1800 HRS]
12. Ergonomics: the study of work. U.S Department of Labor. Occupational Safety and Health Administration. OSHA 3125, 2000 Revised.
13. Kursun S, Evirgen S, Akbulut N, Oztas B, Vaizoglu BA. Work characteristics and musculoskeletal disorders among postgraduate dental students: A pilot study. J Musculoskelet Pain. 2014; 22(1):62-7.
14. Kierklo A, Kobus A, Jaworska M, Botuliński B. Work-related musculoskeletal disorders among dentists-a questionnaire survey. Ann Agric Environ Med. 2011; 18(1):79-84.
15. Coury HJ, Porcatti IA, Alem ME, Oishi J. Influence of gender on work-related musculoskeletal disorders in repetitive tasks. Int J Ind Ergon. 2002; 29(1):33-9.
16. Alexandre PCB, da Silva ICM, de Souza LMG. Musculoskeletal disorders among Brazilian dentists. Arch Environ Occup Health. 2011; 66(4):231-5.
17. Harutunian K, Gargallo Albiol J. Barbosa de Figueiredo RP, Gay Escoda C. Ergonomics and musculoskeletal pain among postgraduate students and faculty members of the School of Dentistry of the University of Barcelona (Spain). A cross-sectional study. Med Oral Patol Oral Cir Bucal. 2011; 16(3):425-9.
18. Feng B, Liang Q, Wang Y, Andersen LL, Szeto G. Prevalence of work-related musculoskeletal symptoms of the neck and upper extremity among dentists in China. BMJ open. 2014; 4(12):e006451.
19. Gopinadh A, Devi KNN, Chiramana S, Manne P, Sampath A, Babu MS. Ergonomics and musculoskeletal disorder: as an occupational hazard in dentistry. J Contemp Dent Pract. 2013; 14(2):299-303.
20. Botha P, Chikte U, Esterhuizen T. Self-reported musculoskeletal pain among dentists in South Africa: A 12-month prevalence study. SADJ. 2014; 69(5):208-13.
21. Barghout NH, Al-Habashneh R, Al-Omiri MK. Risk factors and prevalence of musculoskeletal disorders among Jordanian dentists. Jordan Med J. 2011; 45(2):195-204.
22. Puriene A, Aleksejuniene J, Petrauskiene J, Balciuniene I, Janulyte V. Self-reported occupational health issues among Lithuanian dentists. Ind Health. 2008; 46(4):369-74.
23. Hayes MJ, Smith DR, Taylor JA. Musculoskeletal disorders and symptom severity among Australian dental hygienists. BMC Research Notes. 2013; 6(1):250.
24. Anghel M, Argesanu V, Talpos-Niculescu C, Lungeanu D. Musculoskeletal disorders (MSDs)-consequences of prolonged static postures. Journal of Experimental Medical & Surgical Research. 2007; 4:167-72.
25. Lalumandier J, McPhee S, Parrott CM, Vendemia. Musculoskeletal pain: Prevalence, prevention, and differences among dental office personnel. Gen Dent. 2001; 49(2):160-6.
26. Lake J. Musculoskeletal dysfunction associated with the practice of dentistry – proposed mechanisms and management: literature review. Univ Tor Dent J. 1995; 9:7-11.
27. Morse TF, Michalak-Turcotte C, Atwood-Sanders M, Warren N, Peterson DR, Bruneau H *et al*. A pilot study of hand and arm musculoskeletal disorders in dental hygiene students. J Dent Hyg. 2003; 77:173-9.
28. Lindfors P, von Thiele U, Lundberg U. Work characteristics and upper extremity disorders in female dental health workers. J Occup Health. 2006; 48:192-197.
29. Anton D, Rosecrance J, Merlino L, Cook T. Prevalence of musculoskeletal symptoms and carpal tunnel syndrome among dental hygienists. Am J Ind Med. 2002; 42:248-57.
30. Ylipaa V, Arnetz BB, Benko SS, Ryden H. Physical and psychosocial work environments among Swedish dental hygienists: risk indicators for musculoskeletal complaints. Swed Dent J. 1997; 21:111-20.
31. Dong H, Loomer P, Barr A, Laroche C, Young E, Rempel D. The effect of tool handle shape on hand muscle load and pinch force in a simulated dental scaling task. Appl Ergon. 2007; 38:525-31.
32. Yamalik N. Musculoskeletal disorders (MSDs) and dental practice Part 2. Risk factors for dentistry, magnitude of the problem, prevention, and dental ergonomics. Int Dent J. 2007; 57(1):45-54.
33. Marklin RW, Cherney K. Working postures of dentists and dental hygienists. J Can Dent Assoc. 2005; 33:133-6.
34. Ratzon NH, Yaros T, Mizlik A, Kanner T. Musculoskeletal symptoms among dentists in relation to work posture. Work. 2000; 15(3):153-8.
35. Cailliet R. Soft tissue pain and disability. 3rd ed. Philadelphia: F.A. Davis, 1996, 489-501.
36. Sjogaard G. Intramuscular changes during long-term contraction. In: The ergonomics of working postures: Models, methods and cases—The Proceedings of the First International Occupational Ergonomics Symposium, Zadar, Yugoslavia, 15-17 April, 1985. Philadelphia: Taylor & Francis, 1986, 136-43.
37. Kumar S. Biomechanics in ergonomics. Philadelphia:

Taylor & Francis; 1999, 250-4.
38. Valachi B, Valachi K. Mechanisms leading to musculoskeletal disorders in dentistry. J Am Dent Assoc. 2003; 134(10):1344-50.
39. Gupta A, Manohar Bhat TM, Bansal N, Gupta G. Ergonomics in dentistry. Int J Clin Pediatr Dent. 2014; 7(1):30.
40. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G *et al*. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987; 18(3):233-7.
41. McAtamney L, Corlett EN. RULA: a survey method for the investigation of work-related upper limb disorders. Appl Ergon. 1993; 24:91-9.
42. Hignett S, Mcatamney I. Technical note Rapid Entire Body Assessment (REBA). Appl Ergon. 2000; 31:201-5.
43. Tong HC, Haig AJ, Theisen ME, Smith C, Miller Q. Multidisciplinary team evaluation of upper extremity injuries in a single visit: the UPPER Program. Occup Med. 2001; 51(4):278-86.
44. Guidance on the Prevention and Management of Musculoskeletal Disorders (MSDs) in the Workplace. [Available on http://www.hsa.ie/eng/Publications_and_Forms/ Publications/Manual_Handling_and_Musculoskeletal_Disorders/Guide_on_Prevention_and_Management_of_Musculoskeletal_Disorders_MSDs_.pdf. Last accessed on 14/1/18 22:30 HRS].