

Evaluation of Musculoskeletal Disorders in Dentists and Application of DMAIC Technique to Improve the Ergonomics at Dental Clinics and Meta-Analysis of Literature

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ABSTRACT

Introduction: Musculoskeletal disorders (MSD) result in discomfort, pain and illness that can result in disruption or impairment of dental practice.

Materials and Methods: A cross-sectional study consisting of 60 dentists was carried out to determine musculoskeletal work related pain in major cities of Northern India. The study was planned in two phases. In the first phase, the subjects were given questionnaire related to the musculoskeletal pain happened over the last twelve months. In the second phase of study, improvement was carried out by recommending the subjects to implement ergonomics at their workplace. After three months subjects were again approached and given questionnaire about the musculoskeletal disorders. DMAIC (define, measure, analyse, improve and control) methodology of

six sigma strategy was used to access the MSDs. Chi-square test was used for the analysis and a p-value of less than or equal to 0.05 was considered statistically significant.

Results: The overall prevalence of musculoskeletal problems in the present study was found to be 68.3%. After three months only 23 respondents applied ergonomics at their work place, prevalence of pain was reduced in neck from 47.8% to 21.7% out of total 23 respondents, shoulder pain 39.1% to 17.3%, pain in elbows from 26% to 21.7%, as well as in other locomotor organs. The p-value was significant with $p < 0.05$.

Conclusion: MSD represents a major occupational health issue for dentists in India as well as worldwide and result revealed necessitates the need of workshops to create awareness of ergonomics as effective measures for reducing MSD among dentists.

Keywords: Occupational health hazards, Strain injuries, Six sigma methodology

INTRODUCTION

Practicing dentistry cannot be considered as an easy job as it involves repetitive, awkward, or stressful [1] motions of hands and wrists and even working in same posture for long hours. These can result in discomfort, pain and illness leading to musculoskeletal disorders and can result in disruption or impairment of dental practice [2]. Musculoskeletal disorders (MSD) can be ascribed to numerous risk factors such as repetitive movements, prolonged static posture, inadequate lighting, improper positions, genetic predisposition, mental stress and age [3]. It is one of the major occupational health problems being faced by the nation and estimation results have shown that it contributes to about 40% of all costs towards the treatment of work related injuries [4]. Implement of proper ergonomics at workplace is important to thwart repetitive strain injuries, which can increase over the span of time and can result in long-term disabling conditions [2]. The word ergonomics is a Greek which means natural laws or systems at work. Thus, it is an applied science concerned with designing products and procedures for maximum efficiency and safety. It is also a study of the relationship among the personnel, equipment and environment in the work area. Common injuries due to poor ergonomics at dental offices usually affects back, neck and upper limb and are mainly caused by repetition and over strain at tendons and joints, unbalanced and prolonged postures, chronic inflammation and weakness [5]. This study was planned and carried out to find the prevalence of MSD among dental practitioners due to poor ergonomics at their workplaces using DMAIC technique which involves defining, measuring, analysing and then improving by implementation of methods to control the problem.

MATERIALS AND METHODS

A descriptive cross-sectional study consisting of 60 dentists who daily practices for more than 8 hours was planned and carried out to determine musculoskeletal work related pain in three major cities Amritsar, Ludhiana and Chandigarh of North India. Ethical

clearance was taken from institutional ethical committee for the commencement of the study. The study was undertaken at Ludhiana and authors visited different cities and collected the data. Informed consent was taken from all the study participants. The study was planned in two phases. In the first phase, the subjects were given questionnaire related to the musculoskeletal pain happened over last twelve months. Standardized Nordic Questionnaire (SNQ) [6] [Table/Fig-1] consisted of mainly objectives questions, requiring a simple yes or no reply [Table/Fig-1,2]. The validity of questionnaire was determined by carrying pilot study by asking the 20 subjects to refill the questioner and reliability of the questionnaire was determined by using cronbach's alpha coefficient test value degree 0.92. Thus, in the first phase musculoskeletal problem was defined, measured and analysed using first three steps of DMAIC methodology. In the second phase of study, fourth step of DMAIC methodology improving was carried out by recommending the subjects to implement ergonomics at their workplace. After three months subjects were again approached and given questionnaire about the MSD.

STATISTICAL ANALYSIS

Data so obtained was analysed using Statistical Package for Social Science (SPSS) Version-16 data analysis software. Chi-square test was used for the analysis. A 95% Confidence Level was used and a p-value of less than or equal to 0.05 was considered statistically significant.

RESULTS

The overall prevalence of musculoskeletal problems in the present study was found to be 68.3%. The mean age of total 60 respondents was 42.4 years. Among them 38 were males and 22 were females. Out of 38 male dentists 23 were suffering from MSD and among 22 females, 18 were affected by this condition. Out of 41 affected dentists, 28 were general dental practitioners and 13 were specialist.

Genetic predisposition was found in case of 13 (Male = 5, Female = 8) dentists. Thirteen reported lack of rest, 16 maintenance of same position for more than half an hour and 12 reported both the reasons for the occurrence of this disorder [Table/Fig-3]. The areas affected by musculoskeletal pain and discomfort was neck in 58% cases, shoulder 29%, hands or wrists 52%, elbows 43%, upper back 37%, low back 42%, knees 4%, hips, thighs, ankles and feet 2% each [Table/Fig-4]. Twelve percent respondents had taken self administered medicines for relief and 5% had consulted the orthopaedicians for discomfort. After three months only 23 respondents applied ergonomics at their work place, prevalence of pain was reduced in neck from 11 (47.8%) to 5 (21.7%) out of total 23 respondents, shoulder pain 9 (39.1%) to 4 (17.3%), pain in elbows from 6 (26%) to 5 (21.7%), pain in wrists or hands 8 (34.7%) to 3 (13%), upper back pain 13 (56.2%) to 4 (17.3%), low back pain 7 (30.4%) to 3 (13%), pain in one or both knees 3 (13%) to 1 (4.3%), pain in one or both ankles and feet from 2 (8.6%) to 0%. The p-value was significant with $p < 0.05$ [Table/Fig-5].

DISCUSSION

MSD consist of injuries that influence soft tissues mainly muscles, tendons, ligaments, joints, cartilage as well as nervous system and most commonly involve the arms and back. These conditions are also known as cumulative trauma disorders, repeated trauma, repetitive stress injuries, and occupational overexertion syndrome.

Have you at any time during the last 12 months had trouble (ache, pain, discomfort) in:		Have you at any time during the last 12 months received medical treatment for trouble in:	
Neck		Neck	
1 No	2 Yes	1 No	2 Yes
Shoulders		Shoulders	
1 No	2 Yes	1 No	2 Yes
Elbows		Elbows	
1 No	2 Yes	1 No	2 Yes
Wrists/ Hands		Wrists/ Hands	
1 No	2 Yes	1 No	2 Yes
Upper back		Upper back	
1 No	2 Yes	1 No	2 Yes
Low back		Low back	
1 No	2 Yes	1 No	2 Yes
One or both hips and thighs		One or both hips and thighs	
1 No	2 Yes	1 No	2 Yes
One or both knees		One or both knees	
1 No	2 Yes	1 No	2 Yes
One or both ankles/feet		One or both ankles/feet	
1 No	2 Yes	1 No	2 Yes

[Table/Fig-1]: Standardized Nordic Questionnaire (SNQ) about pain and discomfort in various locomotor organs

Questionnaire		
Name	Age	Sex
Participant suffering from musculoskeletal problems: A) Yes B) No		
Qualification: BDS MDS (branch)		
Genetic Predisposition: A) Yes B) No		
According to you, reason for your musculoskeletal problem: A) Lack of rest B) Position maintained for more than half an hour per patient C) Both		
Average duration of work per day (in hours)		
Excessive fatigue in shoulders and neck: A) Yes B) No		
Decreased grip strength: A) Yes B) No		
Reason:		
Decreased range of motion: A) Yes B) No		
Reason:		
Have you administered medicines for relief or consulted the orthopaedicians for discomfort?		

[Table/Fig-2]: Questionnaire consisting of demographic data

Variables	Number (%)	
Total study participants	60	
Demographic Data	Age (mean age)	42.4 ± 2.3years
	Male	38 (63.3%)
	Female	22 (36.7%)
Participants suffering from musculoskeletal problems		41 (68.3%)
Male		23 (56%)
Female		18 (44%)
General Dental Practitioners		28 (68.3%)
Specialist dentist		13 (31.7%)
Genetic Predisposition		13 (31.7%) (Male = 5, Female = 8)
Lack of rest		13 (31.7%)
Position maintained for more than half an hour per patient		16 (39%)
Both reasons: Lack of rest and position maintained for more than half an hour per patient		12 (29.2%)
Mean duration of work per day (in hours)		8.20 ± 1.2 hours
Excessive fatigue in shoulders and neck		18 (45%)
Decreased grip strength		12 (29.2%)
Decreased range of motion		15(36.5 %)

[Table/Fig-3]: Summary of data obtained from study participants

Musculoskeletal Conditions	Percentage within last 12 months
Neck pain	58%
Shoulder pain	29%
Pain Elbows	43%
Pain in wrists/ Hands	52%
Upper Back Pain	37%
Low Back Pain	42%
Pain in one or both hips and thighs	2%
Pain in one or both knees	4%
Pain in one or both ankles/feet	2%
Number and % of participants who at any time during the last 12 months received medical treatment	17%

[Table/Fig-4]: Data obtained from Standardized Nordic Questionnaire (SNQ) about pain and discomfort in various locomotor organs

Musculoskeletal Conditions	Percentage within last 12 months n=23	Within last 3 months after application of DMAIC
Neck pain	11 (47.8%)	5 (21.7%)
Shoulder pain	9 (39.1%)	4 (17.39)
Pain in Elbows	6 (26%)	5 (21.7%)
Pain in wrists/ Hands	8 (34.7%)	3 (13.04%)
Upper Back Pain	13 (56.2%)	4 (17.3%)
Low Back Pain	7 (30.4%)	3 (13.04%)
Pain in one or both hips and thighs	0 (%)	0 (%)
Pain in one or both knees	3(13.04%)	1 (4.3%)
Pain in one or both ankles/feet	2 (8.6%)	0(%)
p-value	0.048	

[Table/Fig-5]: Comparison of data obtained from respondents who applied ergonomics at their workplace

Such conditions generally develop gradually over weeks, months and years and are usually painful and disabling for the patient [7].

Dentists are more vulnerable to occupational health hazards, their long working hours and maintenance of same postures without microbreaks result in MSDs causing pathologies such as tendinitis, synovitis, tenosynovitis, and bursitis [8,9]. The present study was undertaken to find the prevalence of musculoskeletal conditions in dentists practicing in the major cities of North India which revealed that the overall prevalence of musculoskeletal problems was found to be 68.3%. Similarly, In Southern part of India, Muralidharan D et

al., [4] carried a study in the state of Andhra Pradesh and reported an incidence of 78% MSD. Abduljabbar TA [1] studied musculoskeletal disorders among dentists in Saudi Arabia and reported 82.9% of the responding dentists had pain or discomfort from the neck, shoulders, lower back or head. Chowanadisai S et al., [10] carried a cross-sectional study regarding the occupational health problems faced by dentists in Thailand and found that musculoskeletal pain (78%) and percutaneous injury (50%) are the most often disorders faced by the dentists. Al Ali K et al., [11] also carried a similar study among dentists in the United Arab Emirates and reported prevalence of musculoskeletal pain to be 68%. Leggat PA et al., [12] reported 87.2% prevalence; neck being the most prevalent MSD during the previous 12 months followed by lower back and shoulder (53.3 per cent). The present study also showed similar pattern of distribution of musculoskeletal disorders as reported by previous studies [Table/Fig-6].

Author	Year	Country	Prevalence of musculoskeletal disorder
Muralidharan D [4]	2013	Andhra Pradesh, India	78%
Al Ali K et al., [11]	2012	United Arab Emirates	68%
Rabiei M [3]	2012	Iran	73%
Ayer KMS et al., [13]	2009	New Zealand	60%
Chowanadisai S et al., [10]	2000	Thailand	78%
Abduljabbar TA [1]	2008	Saudi Arabia	83%
Leggat PA et al., [12]	2006	Queensland, Australia	87.2%

[Table/Fig-6]: Meta-analysis of studies of musculoskeletal disorders among dentists worldwide

The female dentists showed higher frequency of pain and discomfort than their male counterparts which was similar to studies carried by Abduljabbar TA [1] and Ayers KMS et al., [13]. Ergonomics is a discipline that includes all aspects of work from the physical stresses it places on joints, muscles, nerves, tendons, bones and the environmental factors which can effect hearing, vision, and general comfort and health of the worker [5]. Repetitive neck movements, long continuous working hours, constant hand and wrist movements affecting the neck and shoulder forms the ergonomic risk factors for dentists resulting in neck MSDs. Dental work is related with greater force and repetitive motions resulting in prolonged increased passive or active pressure in the carpal canal which makes dentist more liable to suffer from Carpal Tunnel syndrome. Discomfort and pain in low back area has been correlated with prolonged tiresome sitting and standing dental work with forward bending postures and dentists experiencing work-related MSDs have been found to be more discontented at work and are more apprehensive, agonized by poorer psychosomatic health and less assured with their future perspectives [14]. Yamalik et al., [15] provided some points to work with good posture which includes use of an adjustable chair with lumbar, thoracic and arm support, maintenance of an erect posture, placement of feet flat on the floor, working close to your body by positioning chair close to the patient, alternate work positions between sitting and standing.

In the present study, after three months only 23 respondents applied ergonomics at their work place and all agreed that ergonomics helped in reduction of musculoskeletal pain and discomfort. The DMAIC technique is a tool of six sigma method

that was used by various forums to increase their output to zero defect [16]. The DMAIC technique was taken into account to apply ergonomics in the dental offices in the present study. According to the authors this is the first study in which authors have attempted to reduce MSD among dentists by first analysing the prevalence of musculoskeletal problems among them, then motivating them for implementing ergonomics and then again evaluated the affects of implementation of ergonomics. Approaches for reduction of ergonomic problems in dentists include awareness and adaptation of postural techniques that consists of sustaining a low back curve, utilization of magnification systems, adjusting dental chair, positional and postural strategies that consist of avoiding constant postures, alternating between standing and sitting, positioning patients at the proper height, positioning feet parallel to floor, repositioning the feet, rotating shoulders backwards, usage of backrests, avoiding twisting, regular periodic breaks and stretching that includes chairside directional stretching, stretching during microbreaks, releasing trigger points, clasping hands together and turning inside-out [5,14]. Physiotherapy with a psychosomatic approach and individual ergonomic instruction can help to provide better relief from pain and discomfort [1]. Dentists should try to recognize and identify their own working postures and their way of equipment usage to avoid the risks of experiencing occupational MSD.

CONCLUSION

Within the limitations of the present cross-sectional study, the results suggested that the prevalence of musculoskeletal symptoms among dentists represents a major occupational health issue for dentists, further research is required to identify risk factors and results so revealed necessitates the need of workshops to create awareness of ergonomics as a effective measures for reducing MSD among dentists.

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