

Correlation between thumb length on handgrip strength, hand dexterity and musculoskeletal problem among dental professional

Correlação entre comprimento do polegar sobre a força de preensão manual, destreza manual e problemas musculoesqueléticos entre profissionais da Odontologia

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ABSTRACT

Objective: The key factor for potency of the teeth is their muscular strength. The dominant hand plays an important role in most of the daily muscular activities involving dental procedure. There are many factors, which may affect the grip strength, and very few studies especially in India have shown their correlation with grip strength. Work related musculoskeletal disorders (WRMSD) are an important occupational health problem affecting dental practitioners. This study assessed the prevalence of WRMSD in dental interns in relation to the thumb length and hand grip strength. **Material and Methods:** Thumb length template, jammer dynamometer, nine-hole peg board, and RULA assessment. **Methods:** Thumb length was measured by thumb length template. Grip strength was measured by jammer dynamometer, unilateral hand finger dexterity was measured by nine-hole pegboard, and work related musculoskeletal disorder was assessed by RULA. **Results:** Thumb length was positively correlated with grip strength and work related musculoskeletal disorder. Thumb length was negatively correlated with unilateral hand finger dexterity among dental professionals. **Conclusion:** Thumb length is a better predictor for measuring hand grip strength and work related musculoskeletal disorder, than unilateral hand finger dexterity.

KEYWORDS

Dental professional; Hand grip strength; Thumb length; Unilateral hand finger dexterity; Work related musculoskeletal disorder.

RESUMO

Objetivo: O fator chave para a potência do dentes é a força muscular dos mesmos. A mão dominante tem um papel importante nas atividades musculares diárias envolvendo procedimentos odontológicos. Há vários fatores que influenciam a força de preensão e poucos estudos, especialmente na Índia, mostra as correlações com a força de preensão. Desordens musculoesqueléticas relacionadas a trabalho (DMRT) são um importante problema ocupacional de saúde entre profissionais da Odontologia. Este trabalho verificou a prevalência de DMRTs em residentes de Odontologia e sua relação com o comprimento do polegar e a força de preensão manual. **Material e Métodos:** Materiais utilizados foram o gabarito de comprimento do polegar, um dinamômetro Jamar, um tabuleiro de 9 perfurações e o instrumento RULA. **Métodos:** O comprimento polegar foi medido pelo gabarito; a força de preensão foi medida no dinamômetro Jamar; a destreza manual unilateral foi verificada utilizando-se o tabuleiro perfurado e as desordens musculoesqueléticas associadas ao trabalhos foram determinadas pelo instrumento RULA. **Resultados:** O comprimento polegar apresentou correlação positiva com a força de preensão e com a presença de desordens musculoesqueléticas relacionadas ao trabalho. O comprimento polegar foi negativamente correlacionado com a destreza manual unilateral entre os profissionais da Odontologia. **Conclusão:** O comprimento polegar é melhor preditor para a força de preensão manual e presença de desordens musculoesqueléticas relacionadas ao trabalho, do que a destreza manual unilateral.

PALAVRAS-CHAVE

Profissionais da Odontologia; Força de preensão manual; Comprimento polegar; Destreza unilateral manual; Desordem musculoesquelética relacionada ao trabalho.

INTRODUCTION

Dental professionals work in a static awkward position performing procedures in a 2" x 2 1/2" work space, that is, patient's mouth [1]. Over the years, this practice has changed from a standing to a sitting task, raising the pain in the neck and shoulder region. Human body is not maneuvered to long hour positioning. Silverstein, defined a repetitive task that involves same fundamental movements for more than 50% of the work cycle [2]. Periodontal instrumentation demands an extensive upper body mobility with muscles and tendons of forearm, hand and fingers. [3]

Strenuous work posture of dentists, with much movement of neck flexion and rotation with arms abducted on the shoulders with repetitive precise movements of the intrinsic hand muscles leads to increased levels of shoulder and neck problems [4].

A survey conducted by Mc Gill, showed that 81% of dentists surveyed have neck, shoulder, wrist and back pain [5].

An EMG study conducted by Milerand, et al, identifies the shoulder, neck and arm muscles under stress, trapezius muscles had the highest mean amplitude of 9% on the right and 7.6 % on the left [6]

Morse et al. [7] reported a 37% prevalence of neck pain and 11% prevalence of shoulder pain in dental students. Hand, wrist and arm pain are much more prevalent among dental professionals than the general public, due to the sustained grips and prolonged awkward postures dentist must employ throughout the day [8]. Repetitive forceful pinching on gripping, a sustained non-neutral position, use of vibrating tools are among the major risk factors of developing musculoskeletal disorder of hand and wrist. [2,9-11]

Musculoskeletal disorders in dentistry across the globe differ from 63% to 93%. Upper limb muscles and bones are stressed more during

dental surgeries than others. [12,13]

Basic surgical posture is an important threat for dental surgeons due to work demands and repetitive tasks as in scaling, root planning and uncomfortable physical body positioning leading to musculoskeletal disorders [14].

A power grip is formed with the thumb, all four fingers, and the palm of the hand achieving full hand function or even minimal grasping capability requires a working thumb in combination with the index finger. The human thumbs oppose ability and strength is fundamental to the hands interaction and manipulation of objects, [15,16] hence clinicians commonly consider the thumb responsible for at least 50% of overall function. The characteristic structure of the hand is related to its function as a grasping tool. Grasping ability is made possible by the fingers. The thumb is one of the most stressfully used joints in the entire human body. As we grip onto an object, the thumb by itself will oppose the other four fingers. So in essence, the thumb must absorb nearly four times the effort than any other.

Daily functional activity requires high activity levels of flexors of forearm and hand grasping. During grasping activities, the flexor muscles of the forearm and hand create grip strength while the wrist is stabilized by extensors of the same.

Jammer dynamometer is a common tool to assess grip strength. Muscle force is measured using a hand held grip strength dynamometer. Waldo.B said grip as a force not a pressure, and is measured in pounds or kilograms. Hence hydraulic dynamometer is the best available accurate option. [17] Dexterity has been defined as the fine, voluntary used to manipulate small objects during a specific task, as measured by the time to complete the task [18] One of the most commonly used tools for assessing dexterity is the ninehole peg test. This test was originally introduced in 1971 as part of a study on strength

and dexterity [19]. In 1985, Mathiowetz, stated the instructions for construction of the nine hole peg test, however none has ever been produced commercially, using these specifications. [20]

AIM

To determine the correlation between thumb length on handgrip strength, hand dexterity and musculoskeletal work related disorder among dental professional.

Null Hypothesis

There is no significant relationship between thumb length on grip strength, dominant hand finger dexterity and musculoskeletal work related disorder among dental professionals.

MATERIALS USED

Thumb length Template, Jammer dynamometer, Nine – hole peg board, RULA assessment.

METHODOLOGY

The study is an observational study. Sample size followed the random sampling and was comprised of 70 dentists, being 60 female dentists and 10 male dentists. The inclusion criteria were: dental professionals (Interns), age group 21 – 25 years, and subjects willing to participate in the study. Exclusion criteria were: subjects with any kind of wrist or hand injuries in the past 1 year, subjects not willing to participate in the study, subjects with previous history of fracture on upper limb, and subjects with any kind of musculoskeletal and neurological deformity in the upper limb.

Thumb – length

Thumb length is measured using template (Figure 1). Make a right angle with the thumb and pointer (index) finger. Lay the index finger against the vertical line. Extend

the thumb on the ruler near to 5 cm. Round to the nearest 5 cm.

Hand Grip Strength

Hand grip strength is measured using a hand – held dynamometer. Participant is asked to sit in a chair with the elbow flexed to 90 degrees and the forearm in mid prone on an armrest (Figure 2). Participants are then squeezes the dynamometer. An average of 3 readings is taken [21].

Dexterity

The Nine-hole peg test is conducted on the dominant hand. One practice trial is allowed. A stopwatch records the timing in seconds (Figure 3).

Practice Trial

The pegs are picked using the right hand one at a time and put in the holes until they are filled (Figure 3). The pegs are then removed, one at a time again. The pegboard is stabilized with the left hand. This is a practice test.

Actual Test

The instructions are the same as the practice trial . The stopwatch starts when the patient touches the first peg. While the patient is performing the test say “Faster” when the patient places the last peg on the board instruct the patient, out again - faster” Stop the stop watch when the last peg hits the container [20].

RULA

RULA consists of three sections. The first is to recording the working posture, the second is scaring system, and the third is action level of risk and need for action to be conducted to gather assessment that is more detailed. A coding system, categorized into four levels indicates the level of intervention required to reduce the risk of injury. Activities

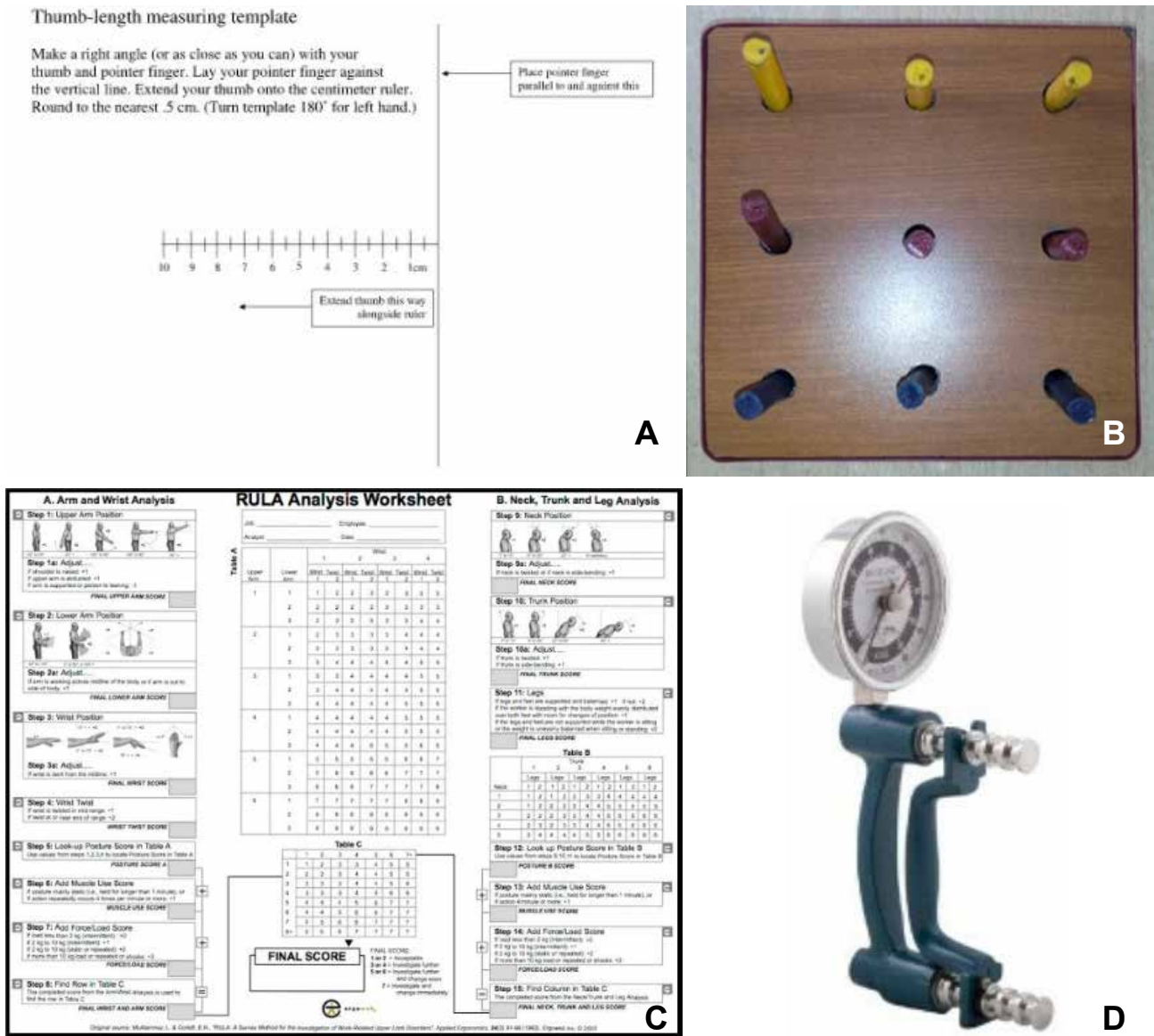


Figure 1 - A) Thumb length Template; B) Nine – hole peg board; C) RULA assessment; D) Jammer dynamometer.



Figure 2 - Thumb length measurement.



Figure 3 - Measurement of grip strength using jammer dynamometer.

using this ergonomic evaluation approach result in a risk score between one and seven where higher score signifies greater levels of apparent risk. RULA is a tool used without the need of any special equipment or investigator. It just requires a clipboard and pen and done in a simple workplace, without hindrance to the force [22].

Statistical Methods

Data is analyzed by SAS system. Regression procedure can be performed to evaluate correlation between thumb length and hand grip strength; hand dexterity and musculoskeletal among Dental professionals. Odds ratio with 95% confidence intervals calculated as a measure of association. $P < 0.05$ is considered statistically significant.

Regression Procedure

FORMULA: $Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$,
whereas:



Figure 4 - Measurement as dominant hand dexterity using nine hole pegboard.

Y = thumb length; α = intercept; β_1 = grip strength parameter estimate; X_1 = grip strength value; β_2 = dexterity parameter estimate; X_2 = dexterity score; β_3 = RULA parameter estimate; X_3 = RULA score

Data Analysis

Table 1 - Analysis of variance

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	31.76148	10.58716	23.38	<.0001
Error	66	29.88495	0.45280		
Corrected Total	69	61.64643			

Table 2 - Mean dependent variable: thumb length the regression procedure

Root MSE	0.67291	R-Square	0.5152
Dependent Mean	9.09286	Adj R-Sq	0.4932
CoeffVar	7.40038		

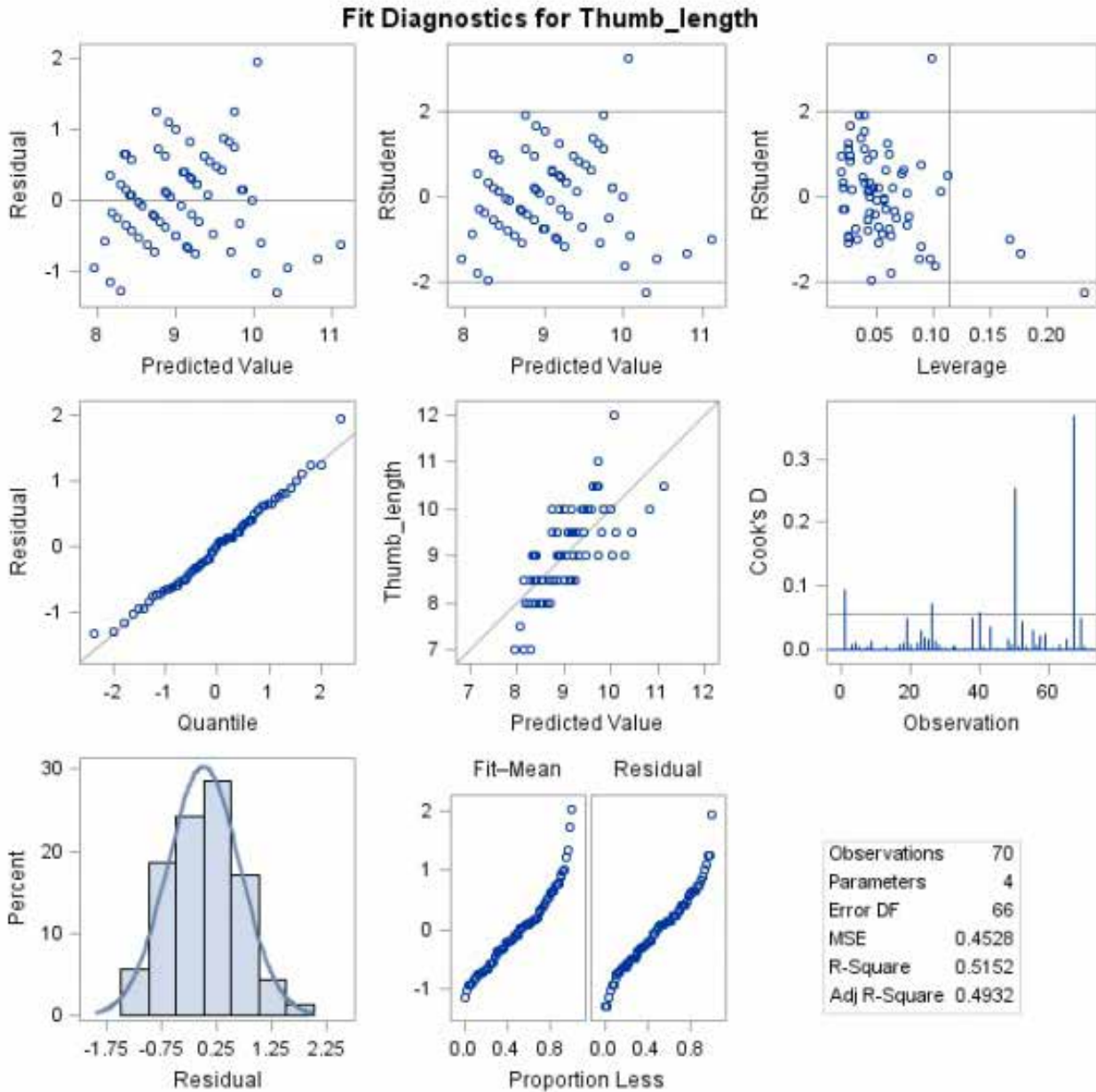


Figure 5 - Diagnostic graphs to find thumb length

Parameters Estimate:

Table 3 - Parameter estimate using regression procedure

	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t	95% Confidence Limits	
Intercept	Intercept	1	9.24166	0.85021	10.87	<.0001	7.54416	10.93916
Grip strength	Grip strength	1	0.06859	0.01231	5.57	<.0001	0.04401	0.09316
Dexterity	Dexterity	1	-0.03266	0.03330	-0.98	0.3304	-0.09915	0.03384
RULA	RULA	1	-0.27334	0.08067	-3.39	0.0012	-0.43440	-0.11228

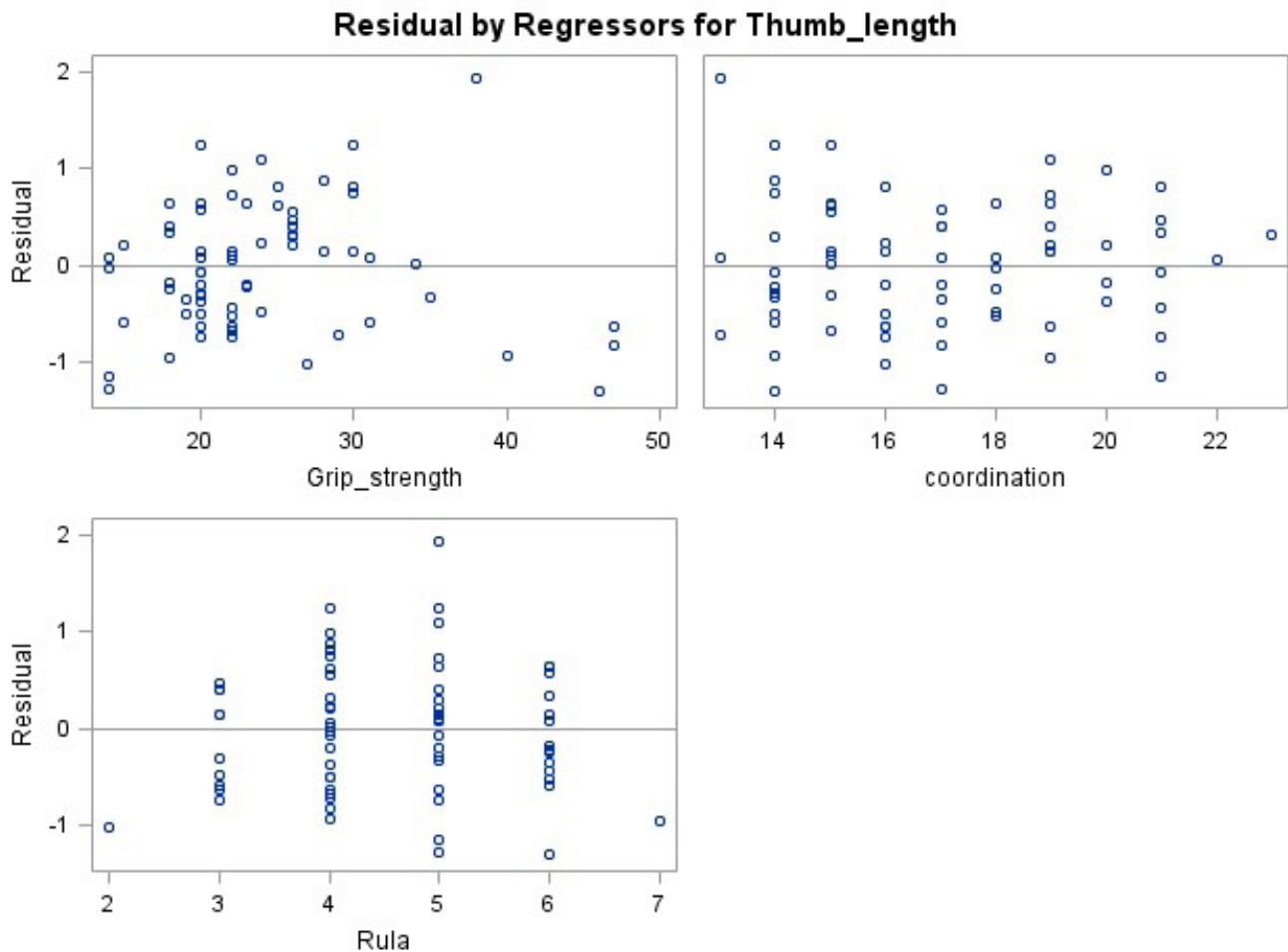


Figure 6 - Regression procedures to find thumb length

RESULTS

Thumb length and hand grip strength:

There was a statistically significant difference in thumb length and handgrip strength. The value of $Pr > [t]$ is < 0001 (Tables 1 and 2, Figure 4). There was a positive correlation between thumb length and handgrip strength. 95% confidence interval of this difference from 0.04401 to 0.09316 (Table 3, Figure 5).

Thumb length and hand dexterity

There was no statistical significant difference in thumb length and hand dexterity. The value of $Pr > [t]$ is 0.3304. There was a negative correlation between thumb length and

hand dexterity. 95% confidence interval of this difference from -0.09915 to 0.03384 (Table 3, Figure 5).

Thumb length and rula

There was a statistically significant difference in thumb length and RULA. The value of $Pr > [t]$ is 0.0012. There was a positive correlation between thumb length and RULA. 95% confidence interval of this difference from -0.43440 to 0.11228 (Table 3, Figure 5).

DISCUSSION

Static forces because of constant abnormal posture is more demanding to muscles than dynamic forces, repetitive static posture

trigger a cascade of events leading to pain in musculoskeletal disorders. Dentists work in a static posture requiring the use of more than 50% of the body muscles to contract, in order to resist gravity [23].

Factors such as repetitive movements, prolonged static posture and poor positioning contribute to musculoskeletal disorder [24]

Individuals with longer fingers and large hand surfaces have stronger grip power [21]. Previous research studies have shown a number of factors and anthropometric variables causing these outcomes. Lee Valkov et al. [25] states that “the good functional dexterity test score in the dominant hand was predicted of a good score in the dominant hand but pinch and grip strength is poorly correlated with functional dexterity”.

The objective of the present study was to evaluate the relationship between hand grip strength and thumb length, to measure unilateral finger dexterity and the extent of fine motor impairment among dentists experiencing difficulties with functional performance and to investigate the musculoskeletal work related disorders by standard questionnaire.

There were significant correlation of thumb length with hand grip strength and musculoskeletal disorders but we did not find any correlations of thumb length with hand dexterity.

The results are expected to generalize well to both genders. The findings of this study signifies the importance of the grip function, hand dexterity of unilateral hand and the musculoskeletal work related disorder during dental procedures. Because of the high prevalence of musculoskeletal disorders among dental professionals, dentist often have to consciously limit or modify grip strength and unilateral hand dexterity activities involving dental procedures.

LIMITATIONS

- Study is done with the small sample size (n = 70).

- Short duration of the study period, involving one time observation without follow up.

SUGGESTIONS

- Further studies can be done with other anthropometric measurements.

- Further studies can be done with specific work task of the dental procedures.

- It can be done with larger sample size.

CONCLUSION

In the above summary, based on statistical analysis it was found that thumb length is positively correlated with handgrip strength, and the musculoskeletal disorders among dental professionals. The thumb length is poorly correlated with dominant hand dexterity.

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