Original article

Three-Jaw Chuck Pinch Strength and Its Correlation with Hand Breadth in Electronic Technicians

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Abstract

Context: The three jaw chuck pinch refers to an act where placing the object between the pad of the distal phalanx of the thumb opposing the pads of the distal phalanges of both the index finger and the middle finger. Pinch strength is generally influenced by the health status and level of physical activity of a person. ***Objectives:*** The present study was planned to measure the correlation of three-jaw chuck pinch strength with hand breadth in electronics technicians working in Dhaka Metropolitan City. The data obtained from the study used as a base line for other professions as well as for research in our country. ***Methods:*** A cross-sectional, analytical study was carried out in the department of Anatomy, Dhaka Medical College, Dhaka during the period of July' 2015 to June' 2016 with 100 adult male electronics technicians and 100 adult sedentary workers. Collection was done by convenient purposive sampling technique. Hand breadth was measured by digital slide calipers and pinch gauge was used to measure the three-jaw chuck pinch strength. ***Results:*** The mean three-jaw chuck pinch strength was significantly higher ($P<0.05$) in case group than in the control group. Significant difference also observed between case group and control group in the mean hand breadth ($P<0.05$). Mean hand breadth was greater in case group than that of control group. Three-jaw chuck pinch strength showed significant positive correlation with hand breadth in case group. Case group was further subdivided according to their working experiences, the mean three-jaw chuck pinch strength and hand breadth was significantly higher ($P<0.05$) in more working experience group than in less working experience group. ***Conclusion:*** Three-jaw chuck pinch strength showed significant positive correlation with hand breadth.

Keywords: Three-jaw chuck pinch, Pinch, pinch gauge, hand breadth

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Introduction

The human hand is a prehensile part of upper limb endowed with grasping and precision movements for skill works. Prehensile movements of the hand have been described as three basic forms of grip, namely precision, power and hook grips. In precision grip, an object is held by the pulp surface of the thumb and the fingers which place themselves opposite to each other and small movements of the digits are carried out skillfully. Pinch grip is an example of precision

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grip.[1] Despite the technological advancements in many manufacturing industries, hands and fingers are still primary tools for high precision manufacturing work.[2] The human hand is one of the most sophisticated and complex anatomical structures in the body.[3] It is not a fixed, static structure but a dynamic sensory motor organ.[4]To perform such sophisticated functions the human hand has been equipped with both mechanical and sensory capabilities.[3] Non powered hand tool operation and manual assembly are the typical activities, in which pinching is usually applied.[5] The human hand is capable of pinching, moving and placing objects without rough impact because of the softness of human finger tips.[6] Pinch strength is categorized as isometric strength. [7] Pinch strength is the backbone of pinch grip. The majority of the inward force is generated by the long flexor tendon of forearm. This force is balanced by one or more fingers of the same hand applying a force back towards the thumb. Strength of the fingers is greatly influenced by the flexion and extension of the wrist. [8]

Pinch strength depends on factors such as occupation, grip span, position of the thumb, position of the elbow and position of the arm, torque directions, contact surface orientations, object shape and size. Manual labourers exert stronger three-jaw chuck pinch compared to sedentary and skill labourers.[9] There are four types of pinch techniques such as three-jaw chuck pinch, pulp pinch, tip pinch and lateral pinch.[6] In three-jaw chuck pinch the palm faced down, force was exerted between the pad of the index and middle fingers together and the pad of the thumb, through the centre of the opposing pads .[10] The muscles that contribute to pinch grips include both the intrinsic and extrinsic musculatures of hand and forearm. [11] Activities of daily living tasks require constant pinch strength. Workers in various occupations such as electronics technicians, rock climbers, musicians, dentists, carpenters use pinch techniques for their daily work.[12]According to Ager, cited by Ertem, et al, pinch strength increases from early childhood towards adolescence and with increasing age pinch strength decreases.[13] Pinch strength exertions by males on dominant hand was found to be significantly higher.[3]

Electronics service technicians are responsible for installing and repairing home electronics equipment. They use pinch grip for high precision tasks, such as connecting or disconnecting wires, assembling small electronics parts.

The present study aims to see the correlation of pinch strength and hand breadth between the electronics technicians of Dhaka Metropolitan City and sedentary workers of the same region.

Materials and Methods

A cross-sectional, analytical study, was carried out in the department of Anatomy, Dhaka Medical College, Dhaka during the period of July' 2015 to June' 2016 with 100 adult male electronics technicians (case group) and 100 adult male sedentary workers (control group), age ranging from 25-45 years both the groups residing in Dhaka Metropolitan City. 100 participants of case group was further divided into two subgroups according to their working experience. Among them 53 were in less working experience (5-10 years) group and 47 were in more working experience (11-15 years) group. Electronics technicians should have minimum 5 years working experience were selected from different electronics repair shops of Dhaka, and they used tools like screwdrivers, impact drivers, tweezers etc for their work handling them using three-jaw chuck pinch. Sedentary worker had no prior experience in jobs which involve the use of tools requiring the use of three-jaw chuck pinch. After obtaining informed written consent from all the study subjects data were documented in a pre-designed data sheet. Prior to consent they were explained the aim and purpose of the research. The subjects were assured of the confidentiality of the study.

Exclusion criteria:

1. Congenital deformity of hand such as syndactyly, polydactyly etc.

2. Acquired hand deformity due to burn contracture, fracture or any surgical procedure of hand.

After collection of data, statistical analysis was done by the software, SPSS (Statistical Package for Social Sciences) for Windows, Version 22.0. All data were expressed as mean ± SD (standard Deviation) as appropriate. Mean values of different parameters were compared to see the differences between two groups by using Student's unpaired 't' test. Correlation was done by Pearson's Correlation Coefficient Test.

The pinch strength measurements were recorded by a pinch gauge, which is inexpensive, easy to administer, and are considered to provide

repeatable measurements, with the subject sitting on a chair with the elbow flexed at 90° and wrist in neutral position. Subjects were asked to exert his maximal voluntary contraction (MVC) on the pinch gauge and to hold that force for three second. To overcome the fatigue, subject was given one minute resting period between each exertion (figure: 1). Mean value of three exertion was taken into account. Hand breadth was measured by slide calipers as a straight distance from the radial side of the second metacarpophalangeal joint to the ulnar side of the fifth metacarpophalangeal joint (figure:2).

Fig: 1 photograph showing measurement of Three-jaw chuck pinch strength by using pinch gauge

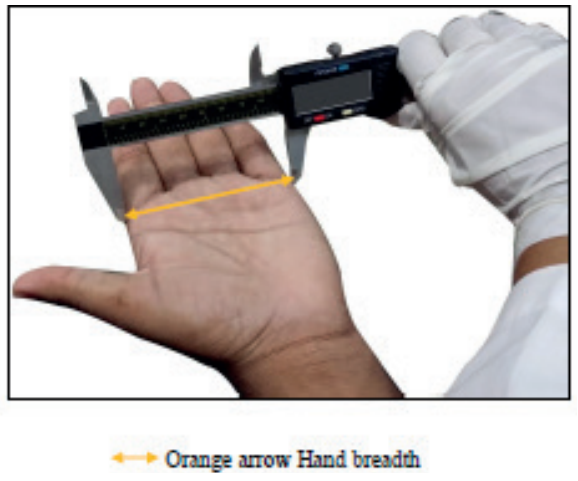

Fig. 2. Photograph showing measurement of hand breadth

Results

Mean three-jaw chuck pinch strength was 7.80±0.77 kg and 13.96±1.46 kg and mean hand breadth was 80.01±1.55 mm and 86.38±2.32 mm in control group and case group respectively (Table 1). Significant difference was observed between control group and case group in the mean three-jaw chuck pinch strength and hand breadth (P<0.001) where mean three-jaw chuck pinch strength and hand breadth was greater in case group than that of control group.

Mean three-jaw chuck pinch strength of less working experience group (5-10 years) and more working experience group (11-15 years) was 12.75±0.85kg and 15.32±0.47kg and mean hand breadth was 85.07±1.72mm and 87.86±2.01mm respectively (Table 2). Statistically significant difference was observed between less working experience group and more working experience group in the mean three-jaw chuck pinch strength and in hand breadth (P<0.001), where mean three-jaw chuck pinch strength and hand breadth was lower in less working experience group than that of more working experience group (Table 3).

Table 1: Comparison of three- jaw chuck pinch strength and hand breadth between control group and case group

Variable	Control Group (n=100) (Mean ± SD)	Case Group (n=100) (Mean ± SD)	*P value*
Three- jaw chuck pinch Strength In kg	7.80 ± 0.77 (5.90 – 9.20)	13.96 ± 1.46 (11.10 – 16.50)	0.001*
Hand breadth In mm	80.01 ± 1.55 (74.23 – 84.10)	86.38 ± 2.32 (80.00 – 90.75)	0.001*

Figure in parentheses indicate range.SD=Standard Deviation, Comparison between control and case was done by Unpaired Student's 't' test, ns= not significant, *=significant, Control group = sedentary worker, Case group = electronics technicians

Table: 2 Comparison of three- jaw chuck pinch strength and hand breadth between different sub group of case group

Variable	Less working experience group (n=53) (Mean ± SD)	More working experience group (n=47) (Mean ± SD)	*P value*
Three- jaw chuck pinch Strength In kg	12.75 ± 0.85 (11.10 – 14.30)	15.32 ± 0.47 (14.50 – 16.50)	0.001*
Hand breadth In mm	85.07 ± 1.72 (80.00 – 88.20)	87.86 ± 2.01 (81.50 – 90.75)	0.001*

Figure in parentheses indicate range, SD=Standard Deviation, Comparison between different subgroup of cases was done by Unpaired Student's 't' test,

ns=not significant, *=significant, Sub group of case group was done depending on working experience in year, Less working experience group = 5 – 10 years, More working experience group = 11 – 15 years.

Table 3: Correlation of three –jaw chuck pinch strength with hand breadth in control group and case group

Variable	Control Group		Case Group	
	r value	*p value*	r value	*p value*
Hand breadth	+0.122	$P=0.226^{ns}$	+0.629	P<0.001*

Statistical analysis done by Pearson's correlation coefficient (r) test, * = Significant, ^{ns} = not significant.

Discussion

Pinch has been identified as a basic yet crucial skill for daily task performance, and is used to assess general strength in order to determine work capacity. Pinch strength is one of the most important parameters of hand function. Regular exercise improves pinch strength. Any deterioration in pinching ability can impair activities of daily living.

In this study, correlation of three-jaw chuck pinch strength with hand breadth was discussed. Electronics technicians were selected for the present study on the basis of the observation that they regularly and repeatedly use pinch grip hundreds and thousands of times a day to get firm hold of the instrument to disassemble and reassemble equipment parts. Sedentary workers do not use the three-jaw-chuck pinch in their work.

The results of the present study were compared with the studies carried out by Imrhan and Rahman, Didomenico and Nussbaum, Dempsey and Ayoub, Mohammadian et al., and Kaushik and Patra,P.,

In the present study, the mean three-jaw chuck pinch strength of control group and case group was 7.80±0.78 kg and 13.96±1.47 kg respectively. The mean three-jaw chuck pinch strength was significantly higher (P<0.0001) in case group than in control group.

Dempsey and Ayoub found 6.6±2.19 kg mean three-jaw chuck pinch strength.[14] Mohammadian, et al. found 10.3±2.7 kg mean three-jaw chuck pinch strength.[15] The mean three-jaw chuck pinch strength of case group in this study was significantly higher (P<0.0001) than the findings of Dempsey and Ayoub and Mohammadian et al.

In the present study, the mean three-jaw chuck pinch strength was recorded 12.75±0.85 kg in less working experience group (5-10 years) and 15.32±0.47 kg in more working experience (11-15 years)group. The mean three-jaw chuck pinch strength was significantly higher (P<0.0001) in the more working experience group than in the less working experience group.

Kaushik and Patra reported 16.23±2.10 kg mean three-jaw chuck pinch strength in the group with 6-9 years working experience, [16] which was significantly higher (P<0.0001) than that for less working experience group of the present study, and the researcher also recorded 13.42±2.43 kg mean three-jaw chuck pinch strength in the group with 10-14 years working experience which was significantly lower (P<0.0001) than that of the more working experience group of the present study.

The mean hand breadth was 80.01±1.55 mm and 86.38±2.32 mm in control group and case group respectively. There was significant difference observed between control group and case group in the mean hand breadth (P<0.001). Mean hand breadth was greater in case group than that of control group. In the present study three-jaw chuck pinch strength showed significant positive correlation with hand breadth in case group (r=+0.629, P<0.001).

In contrary, Imrhan and Rahman recorded 80.0±4.0 mm and Didomenico and Nussbaum reported 88.0±5.0 mm mean hand breadth.[17,10] The mean hand breadth of Didomenico and Nussbaum was significantly higher (P<0.0001) and mean hand breadth of Imrhan and Rahman was significantly lower(p<000.1) than the findings of the present study.

Dempsey and Ayoub found 83.7±6.4 mm and Mohammadian, et al. recorded 89.9±4.4 mm mean hand breadth.[14,15] The mean hand breadth of Mohammadian, et al. was significantly higher (P<0.0001) and the mean hand breadth of Dempsey and Ayoub was significantly lower (p<000.1) than the findings of the present study. The researchers also found nonsignificant positive correlation between the three-jaw chuck pinch strength and hand breadth (r= +0.493, P<0.05) and significant positive correlation between the three-jaw chuck

pinch strength and hand breadth (r= +0.16, P<0.05) respectively.

Conclusion

In this study, the three-jaw chuck pinch strength was significantly higher in electronics technicians. Significant positive correlation between three-jaw chuck pinch strength and hand breadth in electronics technicians was found. In case group, the more experienced subgroup had significantly higher three-jaw chuck pinch strength than the less experienced subgroup. Besides, significant difference in hand breadth was observed between the sub-group. The study findings suggest the repetitive work increases three-jaw chuck pinch strength. The cause of increase hand breadth needed to be evaluated by further study.

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