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CORRELATION OF ANTHROPOMETRIC MEASUREMENTS WITH CARPAL TUNNEL SYNDROME IN FENCING AND HOCKEY

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ABSTRACT

Carpal tunnel syndrome (CTS) may develop with repetitive and forced movements of wrist and hand. In this study we aimed at evaluating the correlation of CTS with respect to hand anthropometry in fencing and hockey. A total of 98 athletes (49 each of fencing and hockey) above 18 years of age responded to questionnaire using Boston Carpal Tunnel assessment. Symptom (SSS) and functional (FSS) scores showed a positive correlation in fencing (R2= 0.373) as well as in hockey (R2= 0.509). In this study, it was found that in Fencing there was no significant correlation between anthropometry and SSS and FSS; but athletes involved in hockey showed statistically significant ($p<0.05$) correlation between wrist ratio (WR) and SSS; and between wrist palm ratio (WPR) and FSS.
***Keywords:** Carpal tunnel syndrome, fencing, hockey, wrist ratio, wrist palm ratio, symptom score, functional scale.*

1. INTRODUCTION

The prevalence of Carpal Tunnel Syndrome (CTS) in the general population is 2.7% (Atroshi et al., 1999). CTS is characterized by symptoms such as pain, numbness and tingling in the hands that worsen at night or at dawn, known as nocturnal paraesthesia other signs and symptoms like thenar atrophy, muscle weakness and altered sensitivity may occur along the course of CTS in the hands (Akbar et al., 2014; Dawson, 1993; Keith et al., 2009; Ali, & Mohammad, 2012).

The hand is an organ that can be injured by repetitive movements. Some anthropologists have stated that the human hand is instrumental in the human brain's current state and over development (Dere, 2010; Tubiana, Thomine, & Mackin, 1996; Mohammad, 2015a; 2015b). It can be said whether the individual is prone to CTS by looking at some ratios in the hand and wrist. Wrist ratio and wrist palm ratio are above certain values poses a risk for CTS (Chiotis, Dimisianos, Rigopoulou, Chrysanthopoulou, & Chroni, 2013; Tejashree, Gandhi, Dabholkar, Yardi, 2015; Kamolz et al., 2004; Hlebs, Majhenic, & Vidmar, 2014; Kouyoumdjian et al., 2000).

CTS is a very common upper extremity entrapment neuropathy. Most cases of CTS are idiopathic. In some cases, CTS may occur due to obesity, pregnancy, osteoarthritis, wrist fractures, thyroid dysfunction and rheumatoid arthritis (Turkmen, Goker, & Bozkir, 2020).

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Research reports indicate that CTS is associated with hand anthropometry, so the present study was done to investigate the CTS incidence in the fencing and hockey athletes with respect to hand anthropometry.

2. METHODS AND MATERIALS

2.1 Participants and Sampling

The study included total of 98 athletes (49 each of fencing and hockey) above 18 years of age after approval from institutional human ethics committee. A prior consent from all the subjects was taken. Athletes with a history of diabetes mellitus, amyloidosis, hypothyroidism, previous wrist fracture, ganglion cysts, chondrocalcinosis, osteoarthritis or previous median nerve surgery were excluded. Athletes with positive signs/symptoms of CTS were included. The study was conducted after approval from institutional human ethical committee (EC/03-2017/010), Punjabi University Patiala, Punjab, India.

2.2 Anthropometric Measurements

Athletes with positive signs/symptoms of CTS were evaluated for anthropometric parameters. All the measurements were taken using standard weight machine, anthropometric rod and engineering callipers (Farmer & Davis, 2008). During measurements the athletes were sitting with the elbow joint in 90° flexion.
Based on the measured values, the following parameters were calculated:

- Shape index- Hand width x 100/ Hand length
- Digit index- 3rd digit length x 100/ hand length
- Wrist ratio (WR)- Wrist depth/ wrist width
- Hand length/ height ratio
- Palmer length/ width ratio
- Wrist palmar ratio (WPR)= wrist depth/palm length
- Measurements of height (m) and weight (kg) were also be taken for each athlete, to calculate the BMI (weight/height^2).

For wrist depth, width and palm length measurements, the forearm and hand were supported on the hard surface table and fingers were in a relaxed extended position.

The Boston Carpal Tunnel Syndrome Questionnaire were used to assess CTS, consists of two-part assessment of (i) symptom severity scale (SSS, 11 questions) and (ii) Functional status scale (FSS, 8 questions) (Levine et al, 1993). Only the athletes who had consented to participate were included for analysis.

2.3 Statistical Analysis

The mean ± SE of each parameter was computed considering the data of athletes (n = 49 for each sport) and the data was analysed using statistical package for social sciences (SPSS) IBM, 17 and judged significant if $P < 0.05$.

3. RESULTS

A total of 98 athletes (49 each of fencing and hockey) above 18 years of age completed both the parts (SSS and FSS) of Boston Carpal Tunnel Questionnaire. The data thus obtained was subjected to statistical analysis. Pearson's bivariate correlation was used to check the correlation between anthropometric measurements and CTS.

Table 1: Mean value of anthropometry of right hand and left hand in Fencing and hockey

Variables	Fencing		Hockey	
	Right hand	Left hand	Right hand	Left hand
Hand Length	17.76±1.41	17.76±1.41	17.02±1.83	17.02±1.80
Palm width	8.20±0.67	8.12±0.66	8.64±0.78	8.58±0.76
Wrist diameter	5.38±0.34	5.28±0.33	5.50±0.41	5.46±0.40
Wrist depth	3.80±0.29	3.77±0.30	3.85±0.29	3.83±0.29
Palm length	10.23±0.89	10.30±0.81	10.34±1.06	10.42±0.98
Hand Index	46.23±3.25	45.84±3.10	51.20±6.71	50.90±6.55
Digit index	41.91±3.89	42.01±4.31	38.48±5.60	38.60±6.01
PL/PW ratio	1.26±0.08	1.28±0.11	1.21±0.12	1.24±0.15
Hand Length/ Ht. ratio	0.11±0.00	0.11±0.01	0.14±0.17	0.14±0.17
WR	0.71±0.04	0.71±0.04	0.70±0.04	0.70±0.04
WPR	0.37±0.03	0.37±0.03	0.37±0.04	0.37±0.03

It was found that for athletes involved in sports fencing (Table 2) SSS was positively correlated with hand length of right hand (r= 0.382, p<0.01); FSS was positively correlated to hand length (r= 0.439, p<0.01), palm width (r= 0.306, p<0.05), but negatively correlated to WPR (r= -0.289, p<0.05). For left hand also SSS (r= 0.377, p<0.01) and FSS (r= 0.431, p< 0.01) was positively correlated with hand length.

Table 2: Correlation of hand anthropometry with SSS and FSS in Fencing

Variables	Correlation coefficient (r)			
	Right Hand		Left Hand	
	SSS	FSS	SSS	FSS
Hand Length	0.382**	0.439**	0.377**	0.431**
Palm width	0.275	0.306*	0.234	0.258
Wrist diameter	0.008	0.093	0.043	0.054
Wrist depth	0.118	0.020	0.206	0.144
Palm length	0.153	0.194	0.176	0.265
Hand Index	-0.126	-0.141	-0.196	-0.214
Digit index	0.242	0.229	0.202	0.159
PL/PW ratio	-0.083	-0.048	-0.189	-0.141
Hand Length/ Ht. ratio	0.251	0.248	0.245	0.227
WR	0.156	-0.070	0.234	0.134
WPR	-0.178	-0.289*	-0.047	-0.153

PL: Palm Length, PW: Palm Width, WR: Wrist Ratio, WPR: Wrist palm ratio
** Statistically significant p< 0.01 level
* Statistically significant p< 0.05 level

It was found that for athletes involved in sports hockey (Table 3) their SSS was positively correlated with hand length (r= 0.663, p<0.0001), digit index (r= 0.633, p<0.0001) and WR (r= 0.347, p<0.05); but it was negatively correlated with hand index (r= -0.632, p< 0.0001). FSS was positively correlated with hand length (r= 0.538, p<0.0001), digit index (r= 0.308, p<0.05) and PL/PW ratio (r= 0.345, p<0.05); but it was negatively correlated with hand index (r= -0.502, p< 0.0001) and WPR (r= -0.330, p<0.05). For left hand also SSS was positively correlated with hand length (r= 0.660, p<0.0001), digit index (r= 0.584, p<0.0001) and WR (r= 0.422, p<0.01); but it was negatively correlated with hand index (r= -0.679, p< 0.0001). FSS was positively correlated with hand length (r= 0.541, p<0.0001) and palm length (r= 0.308, p<0.05); but it was negatively correlated with hand index (r= -0.551, p< 0.0001) and WPR (r= -0.300, p<0.05). There was no significant correlation between WR and FSS.

Table 3: Correlation of hand anthropometry with SSS and FSS in Hockey

Variables	Correlation coefficient (r)			
	Right Hand		Left Hand	
	SSS	FSS	SSS	FSS
Hand Length	0.663***	0.538***	0.660***	0.541***
Palm width	-0.120	-0.085	-0.189	-0.147
Wrist diameter	-0.132	-0.016	-0.191	-0.039
Wrist depth	0.139	0.072	0.163	0.095
Palm length	0.103	0.234	0.125	0.308*
Hand Index	-0.632***	-0.502***	-0.679***	-0.551***
Digit index	0.633***	0.308*	0.584***	0.258
PL/PW ratio	0.243	0.345*	0.097	0.142
Hand Length/ Ht. ratio	-0.011	-0.075	-0.012	-0.076
WR	0.347*	0.121	0.422**	0.166
WPR	-0.117	-0.330*	-0.059	-0.300*

PL: Palm Length, PW: Palm Width, WR: Wrist Ratio, WPR: Wrist palm ratio
*** Statistically significant p< 0.0001 level
** Statistically significant p< 0.01 level
* Statistically significant p< 0.05 level

There was a significant positive correlation between SSS and FSS both in fencing (r= 0.611, $p<0.0001$, R^2= 0.373) and hockey (r= 0.714, $p<0.0001$, R^2= 0.509) as depicted in figure 1 and 2. The correlative between SSS and FSS was stronger in athletes involved in Hockey than those involved in Fencing.

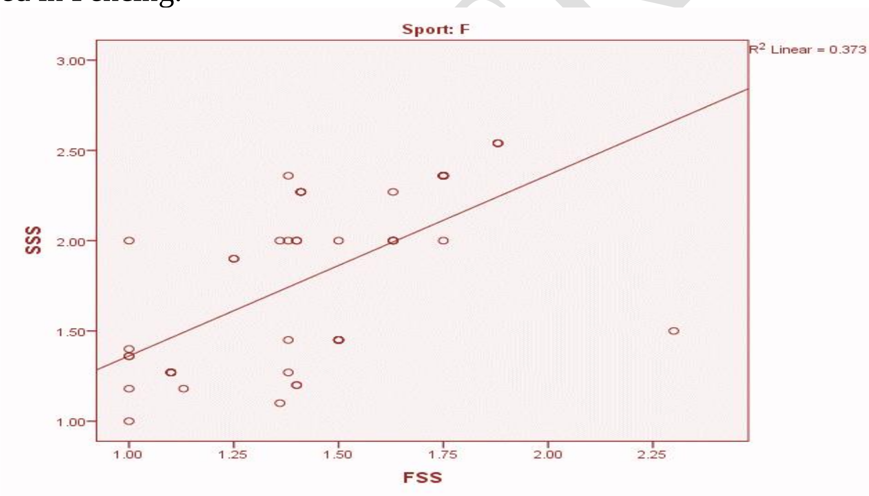

Figure 1: Scatterplot showing correlation between SSS and FSS in Fencing

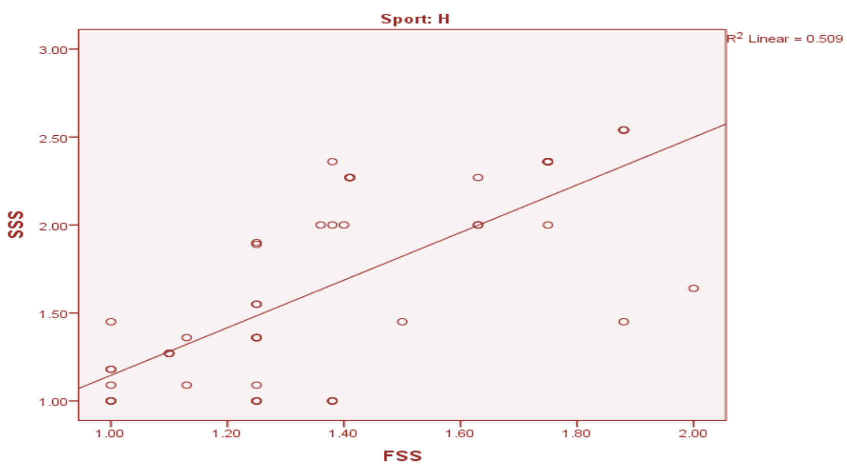

Figure 2: Scatterplot showing correlation between SSS and FSS in Hockey

4. DISCUSSION

Hlebs, Majhenic and Vidmar (2014), attempted to find an explanation that BMI and stature are risk factors, and they reported that the cross-sectional area of the carpal tunnel and even wrist dimensions are important factors in the development of CTS. It is also well known that nerve conduction parameters are affected by age, weight, and height. Our study aimed at assessing the relation of hand and wrist anthropometric measurements to prevalence of CTS in athletes of fencing and hockey. It was observed that many individuals with CTS have square wrists. This observation led to correlating wrist dimensions with median sensory latencies (Hlebs, Majhenic, & Vidmar, 2014).

The present study showed statistically significant results in CTS patients regarding hand measurements. Patients had more square-shaped wrist and shorter hand configuration. In addition, some of the wrist and hand anthropometric measurements showed a clear association with CTS. In athletes involved in sports fencing SSS was not correlated with WR for both hands but FSS was negatively ($p<0.05$) correlated to WPR of right hand. In the athletes involved in sports hockey SSS was positively ($p<0.05$) correlated with WR for both hands and FSS was negatively ($p<0.05$) correlated with WPR.

These findings matched with the work of Mondelli et al. (2015; 2016), who suggest that square-shaped wrists and short-hand anatomy are associated with slower conduction of impulses along median nerve sensory and motor fibers through the carpal tunnel. This indicates that certain hand and wrist configurations predispose to the development of CTS and that these anatomical hand measurements could, to a certain degree, predict median nerve conduction across the carpal tunnel (Mondelli et al., 2015). In agreement with the current study, Johnson *et al*. were the first to study WR in relation to CTS and demonstrated that patients with a more square-shaped wrist could have a greater tendency to develop CTS. These results were supported by many investigators (Johnson, Gatens, Poindexter, & Bowers, 1983).

In addition, Chiotis et al. (2013) found that the wider and shorter hand shape and square-shaped wrist are associated with slower impulse traveled along the sensory and motor fibers of the median nerve through the carpal tunnel. In the present study, patients had statistically significant low HR and significantly high WR. These findings were compatible with the results of previous studies. This indicates that anatomic differences appeared to be an important factor in the occurrence of CTS in individuals under the same occupational settings and stresses (Chiotis et al., 2013).

In various studies (Kouyoumdjian et al., 2000; Lim, Tan, & Ahmad, 2008; Çirakli, Ulusoy, & Ekinci, 2017), it was reported that the wrist ratio above 0.7 and the wrist palm ratio above 0.342 are a risk factor for CTS. Komurcu, Kilic and Anlar (2014) noted that the body mass index had a positive correlation between age and waist circumference and a weak positive correlation was found between body mass index and wrist ratio and a moderately positive correlation between body mass index and wrist palm ratio.

In a study conducted in Saudi Arabia on 100 individuals (50 patients of CTS and 50 as control group), it was found that wrist ratio of body mass index significantly correlated with CTS (Palve, & Palve, 2019). In this study, there was a positive correlation between body mass index and wrist ratio and wrist palm ratio, which are risk factors of CTS.

Bland (2005), in his study of 2005, stated that body mass index was a risk factor for CTS in individuals under 63 years of age. He suggested that there might be other underlying mechanisms in the formation of CTS in individuals older than 63 years. In 2010, Zambelis, Tsivgoulis and Karandreas those who worked on 260 individuals (130 right-handed CTS, 130 left-handed CTS) in the study of the left hand is dominant and the possibility of the development of body mass index in the left hand is dominant in the right hand is significantly higher. In addition, it was reported that body mass index in right hand was more frequent in young individuals and women. In our study, no correlation was found between body mass index and dominant hand. This difference may be the result of the unbalanced distribution of right- and left-hand dominance of the individuals included in our study.

In 2001, Chroni et al. in a study of 100 people (50 healthy women, 50 CTS women), it was found that the palm length in the patient group was significantly shorter than the control group. In our study, significant correlation was found between palm length and FSS.

5. CONCLUSION

Anthropometric characteristics of the wrist and hand are important in the development of CTS. These measurements can be used in athletes to screen the individuals who have increased liability to develop CTS.

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