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Original Research Article

Hand Index - A Forensic Tool for Sexual Dimorphism

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ABSTRACT:

Introduction: Amongst the various parameters of identification, sex is one of the most important elements. Figuring out hand index from measurement of hand dimensions is a convenient way to determine sexual dimorphism. This study aims to find out sexual dimorphism from hand dimensions, obtain cut off points for male and female and check percentage accuracy of sex determination from hand dimensions in Nepalese population. **Methods:** The data was collected from 400 asymptomatic, healthy working staff (229 males and 171 females) above 23 years in the department of Forensic Medicine and Toxicology of a tertiary care center of Western Nepal. Measurements of hand length and hand breadth were taken using standard instruments and hand index was calculated therefrom. **Results:** The mean (±SD) right hand lengths for male and female were found to be 17.87 cm (±0.87) and 16.93cm (±0.58) respectively. The mean (±SD) left hand lengths for male and female were 17.85 cm (±0.86)and 16.97 cm (±0.56) respectively. The average hand breadth for male was 1.00 cm greater for right hand and 0.96 cm greater for left hand as compared to female hand breadth. Differences in length and breadth of hands for both sexes were statistically significant ($p<0.001$) with no statistically significant difference of hand dimensions in the same sex. Cut off point for right hand index was found to be 42.32 cm and for left hand, 42.30 cm. **Conclusion:** Hand dimensions and hand index can be reliably used to determine sex in medicolegal cases, especially where isolated hand is obtained.

Keywords: Anthropometry, Hand Index, Sex Determination

INTRODUCTION:

Determination of sex is considered a major element among the "big four" in forensic anthropology including determination of race, age and stature.[1,2] Trends are changing in the field of forensic anthropology, as earlier anthropologists had to depend exclusively upon pelvic and skull bones to determine the sex whereas now, they are able to determine sex from long bones as well.[3,4,5] It is not much difficult to determine sex when complete body parts are available as external and internal genitalia can directly give the clue; however it will be challenging when only dismembered parts are available.[6] It is common to find peripheral body parts such as hands in case of mass disasters , natural calamities, aircraft accidents and bombings. In many situations a criminal dismembers the body parts to conceal identification of victim. [7] Hands are more expedient and suitable part of the body for forensic experts to examine upon. Figuring out hand index from measurement of hand dimensions is a convenient way to determine sexual dimorphism.[8] Considerable anthropometric works have been carried out to assess the stature from hand dimension, foot dimension, nasal length and craniometric analysis in Nepalese population. [9-12] This study mainly focuses to find out sexual dimorphism from hand index, to obtain cut off points for male and female and to check percentage accuracy of sex determination from hand index of Nepalese population.

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METHODS:

The present cross sectional descriptive study was carried out in the Department of Forensic Medicine and Toxicology, Lumbini Medical College and Teaching Hospital. The sample size was calculated using Slovin's formula as:

Sample size (n)=N/(1+Ne2).

For N=800 and e=0.05, n=266.

A total of 400 right handed subjects (229 males and 171 females) aged more than 23 years were selected by non-probability convenient sampling among the Nepalese staff working in tertiary center. Age more than 23 years was taken as the maximum growth of bone is already attained by this age. Right handed subjects were taken to avoid effects of handedness. The study was carried out after obtaining ethical approval from the Institutional Review Committee (IRC-LMC 14-E/018).

An informed consent was taken prior to examination from all participants. Females were examined in the presence of a female attendant. All the measurements were carried out by the same observer and the same instruments to avoid errors. Subjects with deformities, injuries and amputation of the hand, deformities of vertebral column or limbs and with chronic illness were excluded.

Fig. 1: Sliding Calliper

PROCEDURE FOR EXAMINATION:

Subjects were asked to place hand on flat surface in such a way that forearm was aligned in a line with mid-finger.

Hand length: A distance from tip of mid-finger to the distal crease of wrist joint measured by sliding caliper (Fig. 1) was taken as the hand length (Fig. 2).

Fig. 2: Measurement of hand length

Hand breadth: Distance between the lateral most part of the head of second metacarpal bone and the medial most part of the fifth metacarpal bone at full stretch of hand was taken as the hand breadth(Fig. 3).

Fig. 3: Measurement of hand breadth

Hand Index: Hand index was calculated by applying the following formula;
Hand Index= (Hand breadth / Hand length) X 100

STATISTICAL ANALYSIS:

The collected data were entered to Microsoft Excel spreadsheet and imported to Statistical Package for Social Sciences (SPSS™) software version 21 for analysis. Student's independent t-test and paired t-test were applied to compare the hand length, hand breadth and hand index and bilateral variations respectively. P value less than 0.05 was considered statistically significant.
Sectioning point or cut off point was derived as;
Sectioning point=
(Mean male value + mean female value)/2
Receiver operating characteristic (ROC) curve analysis was applied to determine the discriminating potentials of hand index for right and left hands.

RESULTS:

A total of 400 participants were enrolled into the study. Among them, 229(57.25%) were males and 171(42.75%) were females with the male: female ratio of the study population being 1.34:1.
Table 1 presents the descriptive statistics for hand length and breadth of both male and female participants.

There existed statistically significant difference in length of male and female hands ($p<0.001$). However, difference between right and left hand was not significant statistically.
There was no statistical significant bilateral difference in hand breadth but sex wise difference was significant ($p<0.001$).

The mean right hand index (±SD) for males and females were 43.97(±2.22) and 40.68 (±2.61) respectively. The difference in means was tested with t test and found to be statistically significant ($t=13.571$, $df=398$, $N=400$, $p<0.001$). Similarly, the difference in means of left hand index for males and females was also found to be statistically significant ($t=14.813$, $df=398$, $N=400$, $p<0.001$). Cut off points derived was 42.32 for right hand and 42.30 for left hand. With this observation, in 77.30 % of cases it determines sex of male and in 75 % of cases it determines sex of females for right hand. Similarly for left hand its accuracy in determining the sex was 79.90% and 72.5 % for male and female respectively. Figures 4 to 7 show receiver operating characteristics (ROC) curve for right hand and left hand for both sexes.

From the ROC curve, areas under curve were 0.839 with standard error 0.020 and 0.839 with standard error of 0.020 for right hand index of

Table 1. Comparison of hand dimensions for male and female participants

Characteristics			Mean ± SD	Statistics
Right hand	Breadth (cm)	Male	7.87±0.54	t (df=398, N=400)=19.265, p<0.001
		Female	6.87±0.47	
	Length (cm)	Male	17.87±0.87	t (df=398, N=400)=12.292, p<0.001
		Female	16.93 ±0.58	
Left hand	Breadth (cm)	Male	7.85±0.52	t (df=398, N=400)=6.301, p<0.001
		Female	6.89±0.45	
	Length (cm)	Male	17.85 ±0.86	t (df=398, N=400)=11.505, p<0.001
		Female	16.97 ±0.56	

Table 2. Comparison of hand index for male and female participants.

Characteristics		Mean ±SD	Statistics
Right hand index	Male	43.97 ±2.22	t (df=398, N=400)=13.571, p<0.001
	Female	40.68 ±2.61	
Left hand index	Male	43.99 ±2.10	t (df=398, N=400)=14.813, p<0.001
	Female	40.61 ±2.44	

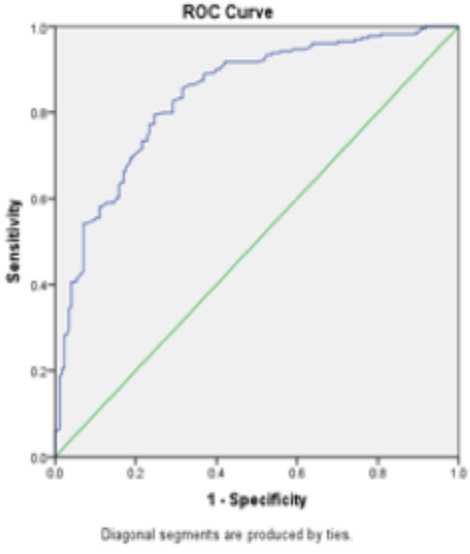

Fig. 4: ROC curve for right hand index of male

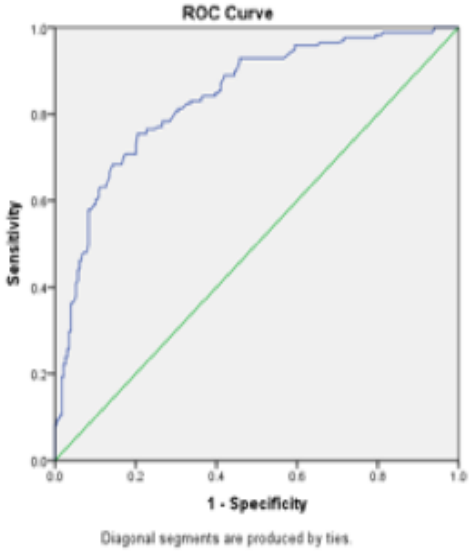

Fig. 5: ROC curve for right hand index of female

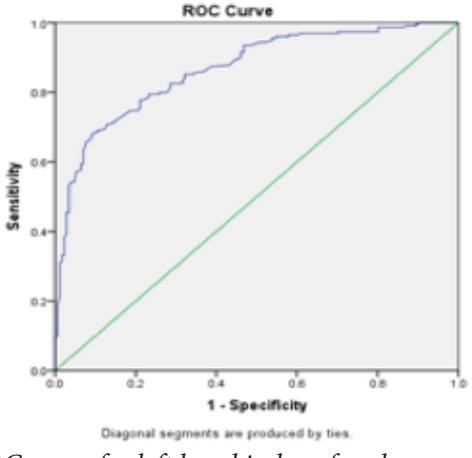

Fig. 6: ROC curve for left hand index of male.

male and female respectively. For left hand, areas under curve were 0.865 with standard error of 0.018 and 0.865 with standard error of 0.018 for male and female respectively. This result signifies higher potential of sexual discrimination by hand index.

DISCUSSION:

The advent of DNA technology has made the issue of identification much simpler and easier. However, in low income countries like Nepal, due to the cost of diagnosis and lack of skilled human resources, anthropometric studies can be applied for medicolegal purpose as the study of bones is less costly.

In this study, male hand length and breadth were found to be larger as compared to the female hand length and breadth. But the length and breadth of the right and left hands showed no statistical significant differences. This result is in accordance with study conducted by Ibrahim MA et al. in north

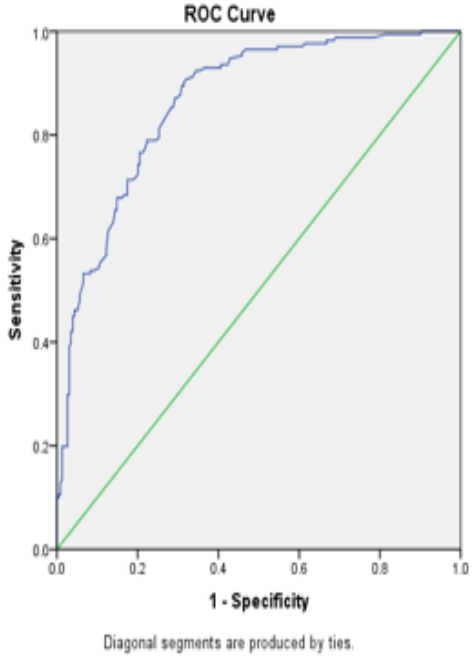

Fig. 7: ROC curve for left hand index of female

Saudi population,[8] Dey S and Kapoor AK in North Indian population,[13] Pandeya A and Atreya A in students of Medical college in Nepal.[9]

This may be due to smaller bone dimension in females as a result of earlier fusion of bones.

In the present study, value of hand index for male is greater than the value of hand index for female, both for right and left sides. This is in accordance with the findings observed by various studies.[15,16] Value of cut off point obtained by this study is greater than that obtained by Kanchan T et al. in North Indian and South Indian population[16], Aboul-Hagag et al. in Egyptian population[14] and lesser than that obtained by Varu PR et al.[6], and Jaynath SH in South Indian population.[17] Influence of race and ethnicity results in variation of hand dimensions that might have led to different values of hand index for male and female.

There are some limitations of this study. It was conducted on population working in the institute only. Since hand dimension differs in different population residing in different geographical locations, results from our study can be generalized to the Nepalese population around the study region only.

CONCLUSION:

Hand dimensions and hand index can be reliably used to determine the sex in medico-legal cases where isolated hand is obtained. The values of cut off points for right hand index and left hand

index are 42.32 and 42.30 respectively. Hand index value more than 42.30 is suggestive of male hand and less than 42.30 is suggestive of female hand.

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Conflict of interest:

The authors declare that no competing interests exist.

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