Indian J.Sci.Res. 3(2): 209-212, 2012

STUDY ON FOOT IMPRESSIONS AND BOOT MARKS AS MEANS OF IDENTIFICATION AMONG NORTH INDIAN POPULATION

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ABSTRACT

The present study was conducted among 120 subjects during 2011 in the Department of Forensic Medicine & Toxicology, Santosh Medical College, Ghaziabad. We compared the dimensions of POP cast and impression taken on white sheet of both subjects (with shoes and without shoes). Mean age of the subjects was 21.22 ± 2.847 years. Mean values of foot lengths were ranging around 24-29 cms whereas mean values of foot widths were in the range of 9-11 cms. Correlations in paired samples about foot lengths and widths between paper and POP cast were found to be positive and ranged between .922 to .992 i.e. between 92.2% to 99.2%. Highest correlation was observed in paired samples of left foot length between paper and POP cast. The foot prints on soft material and on hard material, both are having correlation of high degree so both can provide reliable evidence with fair degree of accuracy. It can also provide a fair idea about the bare foot morphology and individualistic characteristics.

KEYWORDS: Evaluation; Foot Print; Boot Mark, Identification

It is well known fact that a detailed working knowledge is a must for the use of foot impression and boot marks in solving crimes. Application of podiatric knowledge during criminal investigations requires an in depth information. Morphological features such as the shape and size of the contours of each toe, ball, ball-arch juncture, arch, arch-heel juncture, and heel, allow positive identification because of their uniqueness (Ozden *et al.*, 2005).

Examination of barefoot impressions is important especially in developing countries like India where majority of the rural population like to walk barefooted because of socio-economic and climatic reasons (Krishan *et al.*, 2008). Estimation of stature from the dimensions of foot or shoeprints has considerable forensic value in developing descriptions of suspects from evidence at the crime scene and in corroborating height estimates from witnesses (Sanli *et al.*, 2005). The partial or complete footprints can be found on rain covered surfaces, newly waxed floors, freshly cemented surfaces, moistened surfaces, in dust, mud, sand, oil, paint and can be left in blood at the murder scenes (Gordon *et al.*, 1992).

Hardly any study has been undertaken on the comparative evaluation of soft and hard material of foot impression and boot marks in our country and none in the state of Haryana thus information on the same is patchy and scanty. Therefore, it was planned to conduct a study with the objective of ascertaining the use of foot impressions and boot marks as means of identification of individuals by a scientific method of forensic podiatry. Additional objective was to compare dimensions of foot impression and boot mark on papers and POP cast.

METHODS

The present cross-sectional observational survey was carried out among 120 subjects (60 with shoes and 60 without shoes) during 2011 in the Department of Forensic Medicine & Toxicology, Santosh Medical College, Ghaziabad. Students with any abnormality of foot/lower limb were excluded from the study. Plaster of Paris of consistency of cream, Mud, Black painters ink, Paint brush, White sheet, Metal scale, Lab tray and Tissue paper were used as study tools. We compared dimensions of foot impression and boot mark on papers and POP cast.

The procedure was explained to the study subjects and then requested to participate in the study. Subjects were asked to stand on mud with both feet straight and leave the impression. Then the prepared POP of consistency of cream was gently poured over the impression. Then 10-15 minutes were given for the cast to set completely. Then POP cast was re-moved. Then the same subject was asked to give the second impression. Black painters ink was applied over the both feet uniformly. Then the subject was asked to stand on the white sheet with both feet straight to leave a clean impression. Then the same procedure was repeated with the subject wearing shoes. Then we compared the dimensions

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of POP cast and impression taken on white sheet of both subjects (with shoes and without shoes).

All interviews and examinations were conducted by single person. Ethical committee approved the study. Informed consent was obtained from the study participants. After compilation of collected data, analysis was done using Statistical Package for Social Sciences (SPSS), version 20. The results were expressed as proportions. Chi-square (χ^2) test was applied to test the difference across the groups and $p<0.05$ was considered statistically significant. Regression formulae were also derived to estimate stature for both the sexes.

RESULTS

Mean age of the subjects was 21.22 ± 2.847 years. Mean values of foot lengths were ranging around 24-29 cms whereas mean values of foot widths were in the range of 9-11 cms. Descriptive statistics of each group of subjects including minimum values and maximum values are available. Standard error of mean, standard deviation and variance for each pair are also available. (Table 1)

Correlations in paired samples about foot lengths and widths between paper and POP cast were found to be positive and ranged between .922 to .992 i.e. between 92.2% to 99.2%. Highest correlation was observed in paired samples of left foot length between paper and POP cast. (Table 2) Theoretically correlation values range between -1 to +1. +1 correlation is said to be perfect correlation.

Table 1: Descriptive Statistics of Each Group of Subjects

GROUP	DESCRIPTIVE ANALYSIS							
	N	minimum	Maximum	Statistic	Mean	Std. Error of mean	Std. Deviation	Variance
PPRFL	60	7.40	22.00	29.40	25.0967	.2426	1.87887	3.530
PPLFL	60	8.10	21.20	29.30	24.9483	.2397	1.85660	3.447
PPRFB	60	3.20	8.00	11.20	9.4917	.0981	.75986	.577
PPLFB	60	3.50	8.00	11.50	9.5800	.1039	.80503	.648
POPRFL	60	7.70	22.70	30.40	25.9617	.2405	1.86294	3.471
POPLFL	60	8.10	22.10	30.20	25.8983	.2461	1.90623	3.634
POPRFB	60	3.50	8.50	12.00	10.0983	.1034	.80074	.641
POPLFB	60	3.20	8.70	11.90	10.1167	.1019	.78916	.623
JPRFL	60	7.30	25.00	32.30	28.0967	.2178	1.68744	2.847
JPLFL	60	7.20	25.10	32.30	28.1050	.2208	1.71033	2.925
JPRFB	60	3.10	10.10	13.20	11.5467	.0974	.75430	.569
JPLFB	60	3.40	10.10	13.50	11.5950	.0956	.74023	.548
JPOPRFL	60	7.00	26.20	33.20	29.0983	.2199	1.70358	2.902
JPOPLFL	60	7.20	26.10	33.30	29.0583	.2198	1.70287	2.900
JPOPRFB	60	3.20	10.70	13.90	12.2033	.0988	.76534	.586
JPOPLFB	60	3.60	10.70	14.30	12.2283	.1005	.77876	.606

PPRFL, RIGHT FOOT LENGTH ON PAPER; PPLFL, LEFT FOOT LENGTH ON PAPER; PPRFB, RIGHT FOOT WIDTH ON PAPER; PPLFB, LEFT FOOT WIDTH ON PAPER; POPRFL , RIGHT FOOT LENGTH ON POP CAST; POPLFL, LEFT FOOT LENGTH ON POP CAST; POPRFB, RIGHT FOOT WIDTH ON POP CAST; POPLFB, LEFT FOOT WIDTH ON POP CAST; JPRFL, RIGHT BOOT LENGTH ON PAPER; JPLFL- LEFT BOOT LENGTH ON PAPER; JPRFB, RIGHT BOOT WIDTH ON PAPER; JPLFB, LEFT BOOT WIDTH ON PAPER; JPOPRFL- RIGHT BOOT LENGTH ON POP CAST; JPOPLFL, LEFT BOOT LENGTH ON POP CAST; JPOPRFB, RIGHT BOOT WIDTH ON POP CAST; JPOPLFB, LEFT BOOT WIDTH ON POP CAST.

Table 2: Paired Samples Correlations between Paper and Pop Cast

Pairs of foot		N	Correlation	P value
PAIRED SAMPLES CORRELATIONS ABOUT RIGHT FOOT LENGTH BETWEEN PAPER AND POP CAST				
Pair	PPRFL & POPRFL	60	.985*	.000**
PPRFL- RIGHT FOOT LENGTH ON PAPER; POPRFL- RIGHT FOOT LENGTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT LEFT FOOT LENGTH BETWEEN PAPER AND POP CAST				
Pair	PPLFL & POPLFL	60	.992*	.000**
PPLFL- LEFT FOOT LENGTH ON PAPER; POPLFL- LEFT FOOT LENGTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT RIGHT FOOT WIDTH BETWEEN PAPER AND POP CAST				
Pair	PPRFB & POPRFB	60	.943*	.000**
PPRFB- RIGHT FOOT WIDTH ON PAPER; POPRFB- RIGHT FOOT WIDTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT LEFT FOOT WIDTH BETWEEN PAPER AND POP CAST				
Pair	PPLFB & POPLFB	60	.941*	.000**
PPLFB- LEFT FOOT WIDTH ON PAPER; POPLFB- LEFT FOOT WIDTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT RIGHT BOOT LENGTH BETWEEN PAPER AND POP CAST				
Pair	JPRFL & JPOPRFL	60	.996*	.000**
JPRFL- RIGHT BOOT LENGTH ON PAPER; JPOPRFL- RIGHT BOOT LENGTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT LEFT BOOT LENGTH BETWEEN PAPER AND POP CAST				
Pair	JPLFL & JPOPLFL	60	.971*	.000**
JPLFL- LEFT BOOT LENGTH ON PAPER; JPOPLFL- LEFT BOOT LENGTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT RIGHT BOOT WIDTH BETWEEN PAPER AND POP CAST				
Pair 1	JPRFB & JPOPRFB	60	.973*	.000**
JPRFB- RIGHT BOOT WIDTH ON PAPER; JPOPRFB- RIGHT BOOT WIDTH ON POP CAST				
PAIRED SAMPLES CORRELATIONS ABOUT LEFT BOOT WIDTH BETWEEN PAPER AND POP CAST				
Pair 1	JPLFB & JPOPLFB	60	.922*	.000**
JPLFB- LEFT BOOT WIDTH ON PAPER; JPOPLFB- LEFT BOOT WIDTH ON POP CAST				
*Positive Correlation, ****P<0.001, statistically highly significant				

DISCUSSION

This study compared dimensions of foot impression and boot mark on papers and POP cast and to know the value of POP cast footprint among 120 subjects. In the present study, the reason for taking the adult sample ranging in age from 18 to 30 years may be attributed to the fact that the average adult length of foot is attained by the age of 16 years in males (Ilayperuma *et al.,* 2009). According to Ulijaszek, generally stature at 18 years is accepted as adult, although there are small increments in stature after this. The median age for attaining height in males is 21.2 years with growth continuing in 10% of males until 23.5 years (Ulijaszek *et al.,* 2006).

All the measurements of the footprints and the foot outlines (taken on diagonal axis) can be compared with those of Robbins presents the comparison of various footprints and foot outline measurements separately for left and right sides (Robbins *et al.,* 1986). The footprint and foot outline dimensions of the present study Gujjars (Krishan *et al.,* 2008) indicate somewhat larger values than that of the Robbins LM who presented combines data for both male and female subjects ranging in age from 14 to 50 years in a Unites States population. The length (T-1 length) and breadth of the footprint and foot outline in the present study can be compared with the studies by Philip *et al.* (1988) on South Indian subjects and Jasuja on Jat Sikhs of Punjab, India (Jasuja *et al.,* 1991). The former used the same technique to measure the maximum length of the footprint and foot outline as used in the present study and the later used somewhat different technique to measure the foot size; however, the results are comparable. Present study show somewhat smaller footprint and foot outline dimensions as compared to the South Indian subjects and

Jat Sikhs of Punjab, however, the mean stature is slightly higher in the present study.

Agnihotri developed a relationship between foot length and stature using linear and curvilinear regression models. Measurements of foot length and stature were taken from 250 medical students (125 males and 125 females) aged 18–30 years. General multiple linear regression model was highly significant ($P < 0.001$) and validated with highest values for the coefficients of determination R2 = 0.769 and multiple correlation coefficient r = 0.877. Right foot length, sex and age explained for about 77% variations in stature (Agnihotri *et al.*, 2007).

Quamra *et al.* worked on making height estimations from foot and shoe measurements by means of a statistical method (Qamra *et al.*, 1980). Singh TS saw differences in their studies on the connection between foot measurement and height in relation to ethnic group, with the correlation coefficient between foot length and height in different groups being 0.63 and 0.92, the connection between foot width and height 0.51 and 0.65, proving height estimation by foot length measurement gives better results than height estimation by foot width measurement (Singh *et al.*, 1993).

CONCLUSION

Based on careful observations of the findings of the present study, it can be concluded that examination of foot prints and boot marks on soft material and on hard material, both are having correlation of high degree so both can provide reliable evidence with fair degree of accuracy. It can also provide a fair idea about the bare foot morphology and individualistic characteristics

REFERENCES

Agnihotri A.K., Purwar B., Googoolye K., Agnihotri S., Jeebun N., 2007. Estimation of stature by foot length. Journal of Forensic and Legal Medicine, **14**(5): 279-83.

Giles E. and Vallandigham P.H., 1991. Height estimation from foot and shoeprint length. Journal of Forensic Sciences, **36**(4): 1134-51.

Gordon C.C. and Buikstra J.E., 1992. Linear models for the prediction of stature from foot and boot dimensions. J Forensic Sci., **37**(3): 771-82.

Ilayperuma I., Nanayakkara B.G. and Palahepitiya K.N., 2009. A model for reconstruction of personal stature based on the measurements of foot length. Galle Med. J., **13**(1):6.

Jasuja O.P., Singh J. and Jain M., 1991. Estimation of stature from foot and shoe measurements by multiplication factors: a revised attempt. Forensic Science International, **50**(2): 203-15.

Krishan K., 2005. Estimation of stature from footprint and foot outline dimensions in Gujjars of North India. Forensic Science International, **175**(2-3): 93-101.

Ozden H., Balci Y., Demirüstü C., Turgut A. and Ertugrul M., 2005. Stature and sex estimate using foot and shoe dimensions. Forensic Science International, **147**(2-3): 181-4.

Philip T.A., 1988. Foot size for predicting stature of males. J. Ind. Acad. Forensic Sci., **27**: 30-9.

Qamra S.R., Sharma B.P. and Kaila P., 1980. Naked foot marks-a preliminary study of identification factors. Forensic Sci. Int., **16**(2): 145-52.

Robbins L.M., 1986. Estimating height and weight from size of footprints. Journal of Forensic Sciences, **31**(1): 143-52.

Sanli S.G., Kizilkanat E.D., Boyan N., Ozsahin E.T., Bozkir M.G., Soames R., Erol H. and Oguz O., 2005. Stature estimation based on hand length and foot length. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists, **18**(8): 589-96.

Singh T.S. and Phookan M.N., 1993. Stature and footsize in four Thai communities of Assam, India. Anthropologischer Anzeiger., pp.349-55.

Ulijaszek S.J., 2006. The international growth standard for children and adolescents project: environmental influences on preadolescent and adolescent growth in weight and height. Food and Nutrition Bulletin, **27**(4_suppl5):S279-94.