

Distinctive Features of Footprints of Eastern Indian Tribes — Forensic Aspects

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Abstract

In almost every criminal investigation, it is necessary to establish whether a particular person or persons may or may have not been present at the scene of a crime. In this regard, the application of forensic science plays a vital role in the criminal investigation to establish the identity of the offender. Like a fingerprint, the footprint of every person is unique and can be used to identify a person. It can help to link the suspect to a crime scene and the victim. Every individual's print contains friction ridges and other individual characteristics that are unique to that person. The present study aims to identify, analyze, and illustrate the individual characteristics of footprints of the tribal population in Jhargram District, West Bengal, India from a forensic perspective in a sample of 120 adult tribal people participants consisting of 60 males and 60 females. These tribal people live in deep forest areas and most of the people walk barefoot day by day. The footprints were collected using a footprint ink slab and white paper. Various identification characteristics feature were identified and recorded during analyses of the collected footprint from different parts of the foot, like, the number of toes, number of humps, phalanges marks, corn, pits, cracks, Crease marks, etc.

Keywords: Forensic Science, Footprint, Crime Scene Investigation, Physical Evidence, Impression Evidence, Person Identification.

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1. INTRODUCTION

Footprints are like fingerprints in their uniqueness [1]. The use of bare footprints has been considered a means of identification for many years. Both have distinct characteristics capable of providing identification. Like fingerprints, no two people have the same footprint [1]. Footprints are found at crime scenes and footprint analysis helps estimate height [2-4], gender, Weight [5, 6]. Sex [7, 8], number of people present [9], direction a person is walking, speed a person is walking, etc. Similarly, the dimensions of the length and width of the toes, the foot pad, the foot 'stem' and five toes, and the angle of inclination from the ball to its joint help distinguish one person's footprint from another person's. Dimensional or morphological similarities may occur between footprints of members of the same family, but significant morphological differences exist in one or more regions of the footprint. The present investigation aims to study toes, humps, creases, cracks, pits, etc., in the footprints of Eastern Indian Tribes to conclude individualizing characteristics.

2. MATERIALS AND METHODS

The present study was conducted on 120 adult Eastern Indian Tribe (EIT) consisting of 60 males and 60 females ranging in age from 18 to 60 years old. The present study was conducted on Bhumij people living in Jangalmahal of Jhargram district of West Bengal state, India. Bhumij is a Munda ethnic group of India. They primarily live in the Indian states of West Bengal, Odisha, Assam, and Jharkhand, mostly in the old Singhbhum district. Also, in states like Bihar and Assam. There is also a sizeable population found in Bangladesh. The Bhumij of Jhargram speaks in Bengali language. During the collection of the footprint from the subjects their name and residence was recorded and consent was obtained from all participants. A total of 120 bilateral footprints were collected from participants who were healthy and free from any apparent symptomatic deformities of the feet. Before taking footprints from the subjects, their feet were washed with soap solution and moisture using a cotton cloth. The footprints were collected using a footprint ink slab and white paper. The toes' inter-distance was measured using a digital caliper. Toes inter- distance is the measurement between the most lateral points of

adjacent toes, i.e. between the most lateral point of toe 1 and the most lateral point of toe 2, and likewise between toe 2 and toe 3, toe 3 and toe 4, and Toe 4 and Toe 5 (Fig 2). The collected data were organized, and statistically analyzed. Descriptive results for individual characteristics are presented as tables using frequencies and percentages. In the present study, various identification features of Eastern Indian Tribes' footprints, viz. Missing toes, toes inter-distance, relative lengths of the toes, humps, phalange marks, multiple phalange marks, corn marks, crease marks, pits marks and some other characteristics were analyzed statistically and their frequencies and percentages are presented in Table 1–12.

INSTRUMENTS USED

For Taking Footprint: Ink, Footprint slab, roller, white paper.

For Measurements: Rulers, Scales, T-squares, Protractor, and Divider, compass, magnifying glasses, Digital caliper and Metric grids.

Sample Selection

The author(s) were interested in studying the footprints of those people who use shoes/footwear very few times in their daily lives, or walk barefoot day by day, or do not wear footwear very long time in their lives. The tribal people of the study area live in deep forest areas and most of the people walk barefoot day by day. They make their living by cultivating, collecting, and selling forest resources. Before starting the fieldwork, the author(s) surveyed the area, interrogate the local people, observed the daily lives of the local people, and decided to collect data for analysis. The present study aims to identify, analyze, and illustrate the individual characteristics of footprints of the tribal population in Jhargram District, West Bengal, India from a forensic perspective.

3. RESULTS

3.1. Morphological/Individualizing Characteristics of Footprints

Footprints are always smaller in size than actual feet. A careful observation of the footprints reveals that, in the bare footprints, we can see only that part, the part of the sole that touches the ground or an object. The internal foot skeleton and the soft tissue covering the bone determine the size and shape of the foot. The planter surface of the foot also leaves an impression of foot size when it touches the ground. Some sections of the foot like the heel and ball regions are more forcibly pressed against the ground than are other sections of the medial side of the arch, for example. The heel and ball areas of a footprint, therefore, reflect that strong pressure. A footprint exhibits features that are not readily apparent in the fleshed foot. The flexed or extended position of the bone in the toe region and the position of weight-bearing pressure along the length of the foot structure are two features that are notably delineated in a footprint (Rabbin p. 139). So, bare footprints are not the actual size of that foot. The footprints of two individuals are not alike; even two footprints of a person are not alike. The variation in footprints is due to variations of individualizing characteristics of footprints i.e. shape, size, ball lines, inter-distances of toes, heel shape, crease marks, corn marks, accidental damage to the feet, etc. From the analysis of the collected footprints, definitive information was retrieved. Information on footprint morphology is particularly significant because it explains the uniqueness of each individual's footprint. A footprint can be normal, flat foot, broken bridge, or curved; several types of footprints can be found in different populations. During analysis of the collected footprints, many intermediate variations are seen in the present population i.e. missing toes, humps line, toes marks, crease, corn, pits marks, toes length, broken bridges, abnormal heels, etc.

Table 1: Frequency and percentage distribution of missing toes in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Missing Toes	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Toe-1								
Toe-2					2	(1.6)[.8]		
Toe-3					2	(1.6)[.8]		
Toe-4								
Toe-5	2	(1.6)[.8]	4	(3.3)[1.6]	5	(4.1)[2]	7	(5.8)[2.9]

Note: (% Male or Female footprint) [% among the total footprint]

3.2. Features of the Toes

Variations in the shape, size, and inter-toe spacing of the toes lead to variations in footprints in the toe area. The shape of the toe prints may be oval, round, pear-shaped, or asymmetrical [1]. The shape of the toe line can be straight, curved, stepped, or irregular. Any

accident marks on the toes, caused by cuts, cracks, and other damages, give uniqueness to the toe pattern [10]. Sometimes, the toe impression may be found missing. The notable feature observed in the present study is that apart from the missing 5th toe, some participants were also found to be missing the 2nd and 3rd toes (Table-1).

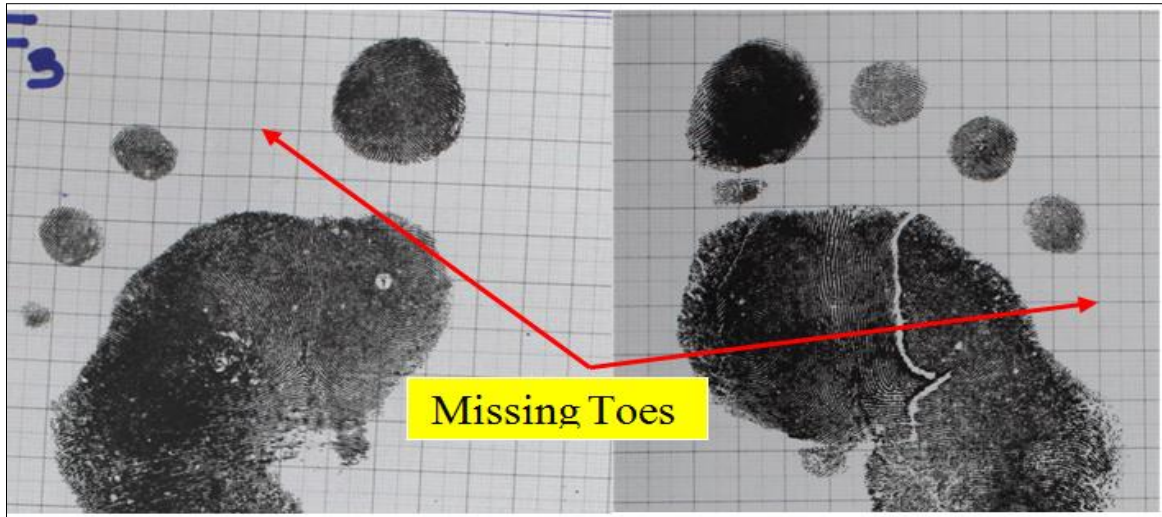


Figure 1: Illustrative examples showing missing toes in the footprint of Eastern Indian Tribes

Table 2: Percentage distribution of toes inter-distance (cm) in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N= 120).

Sex	First inter-distance (%) (between toe 1 and toe2)			Second inter-distance (%) (between toe 2 and toe 3)			Third inter-distance (%) (between toe 3 and toe 4)			Fourth inter-distance (%) (between toe 4 and toe 5)		
	Narrow	Medium	Wide	Narrow	Medium	Wide	Narrow	Medium	Wide	Narrow	Medium	Wide
Male (N=60)	(2) [1]	(82) [41]	(16)[8]	(46) [23]	(54)[27]	(0)[0]	(24)[12]	(76)[38]	(0)[0]	(12)[6]	(80)[40]	(8)[4]
Female (=60)	(5)[3]	(87) [43]	(8)[4]	(55)[27]	(44)[22]	(1)[1]	(12)[6]	(87)[43]	(1)[1]	(8)[4]	(87) [43]	(5)[3]

Note: (% Male or Female footprint) [% among the total footprint]

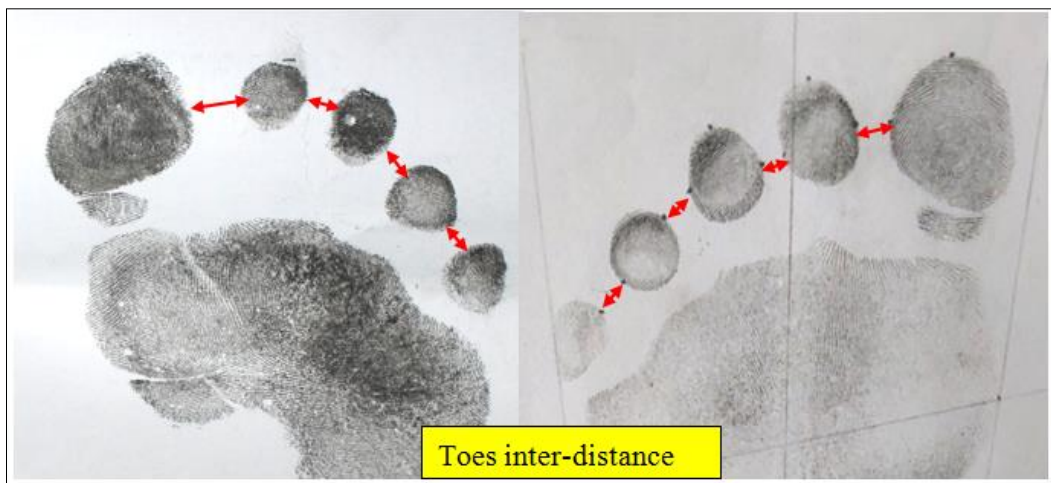


Figure 2: Illustrative examples showing toes inter-distance in the footprint of Eastern Indian Tribes

The inter-distance spacing of the toes gives a characteristic pattern of a footprint. They may be touching each other or there may be some distance between them. The inter-distance between the toes varies from footprint to footprint. The characteristic features of toes inter-distance of Bhumij tribes of Jangalmahal as shown in (Table No. 2).

No two footprints have exactly identical toes inter-distances not even between the left and right footprints of the same individual [1]. In the present population study, the toes inter-distance can be classified into three type's viz.:

- a) Narrow: when the toes inter-distance is <.50 cm.
- b) Medium: when the toes inter-distance is between 0.51 and 1.50 cm.
- c) Wide: when the toes inter-distance is > 1.51 cm.

The present study found the percentage of medium toe inter-distance to be relatively high followed by narrow toe inter-distance in both sexes. The statistical result of toes inter-distance in the footprints of Bhumij tribe of Jangalmahal is as shown in (Table 2).

Table 3: Frequency and percentage distribution of toe length in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Toes length	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
T1> T2	25	(20.8)[10.4]	25	(20.8)[10.4]	39	(32.5)[16.3]	37	(30.8)[15.4]
T2>T1	35	(29.2)[14.6]	35	(29.2)[14.6]	21	(17.5)[8.7]	23	(19.1)[9.6]
T3>T1 & T2	0		0		0		0	
T1=T2=T3	0		0		0		0	

Note: (% Male or Female footprint) [% among the total footprint]

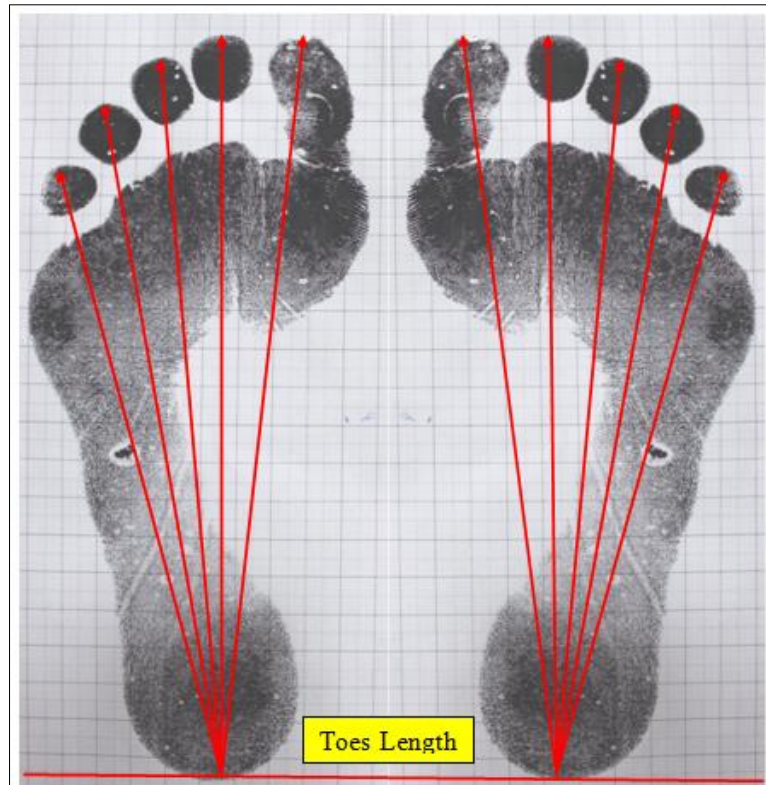


Figure 3: Illustrative examples showing toes length in the footprint of Eastern Indian Tribes

The footprints can be classified into four types based on the relative morphological lengths of the first, second, and third toes [10]. Following Philip [11], these four types have been denoted as T-type (the tibialis-type), F-type (the fibularis type), Ma-type (the midularis-type), and O-type (the intermediate-type) as shown below:

- When the $T1 > T2$ T-type (the Tibialis-type),
- When the $T2 > T1$ F-type (the Fibularis-type),
- When the $T3 > T1$ and $T2$ M-type (the Midularis-type),
- When the $T1 = T2 = T3$ O-type (the Intermediate-type).

Table 3 shows the frequency distribution of the relative toe lengths of the first, second and third toes. The present study shows that among males, the frequency of F-type is the highest (left 29.2%, right 29.2%) followed by T-type (left 20.8%, right 20.8%). Similarly, among

females, the frequency of T-type is the highest (left 32.5%, right 30.8%) followed by F-type (left 17.5%, right 19.5%). M-type and O-type are not found in the present population.

3.3. Features of Humps

Humps are very important characteristic features of the footprint. It can help to separate one footprint from another. The hump is an extended curvature in the ball line [10], and it is generally found lower portion of the phalanges and the joint position of the first phalange bone and metatarsal bone. In the footprint, the hump may be present one, two, and more than two humps or absent humps (zero humps). In the present study, one hump, two humps and more than two humps, and zero humps (no humps) were found among the footprints of the Bhumij tribes of Jangalmahal as shown in (Table No.4).

Table 4: Frequency and percentage distribution of humps in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Number of humps present	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
0	2	(2) [.9]	0		9	([7] [3.7]	9	(7)[3.7]
1	0		4	(4)[1.6]	7	(6)[2.9]	11	(9)[4.6]
2	28	(23)[11.6]	33	(27)[13.8]	19	(16)[7.9]	15	(13)[6.2]
3	30	(25)[12.5]	23	(19 [9.6]	25	(21)[10.5]	25	(21)[10.5]

Note: (% Male or Female footprint) [% among the total footprint]

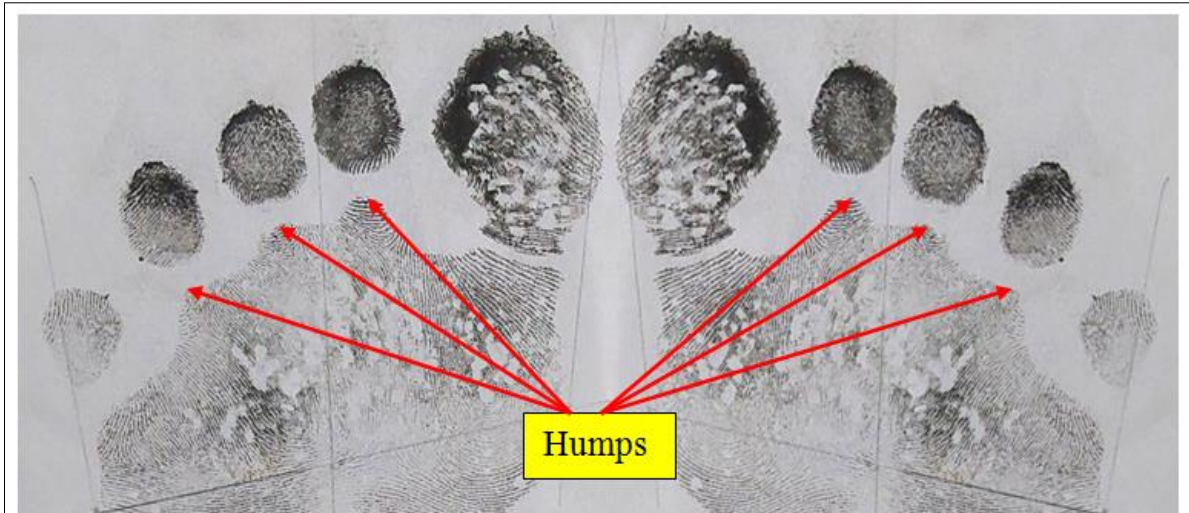


Figure 4: Illustrative examples showing Humps in the footprint of Eastern Indian Tribes

The results of male footprints showed that three humps were found more in the left footprint (left-25%), on the other hand, two humps were found more in the right footprint (right-27%). The results of three humps of male footprint are (left-25% and right-19%), followed by two humps (left-23% and right-27%), one hump (left-0% and right-4%) and zero humps (left-2% and right-0%). But in female participants, the order is different i.e. The presence of three humps found more. The presence of three humps was found to be equal in left and right footprints (left-21% and right-21%), followed by two humps (left-16% and right 13%), one humps (left-6% and right-9%), and by zero humps (left-7% and right-7%). So the values on the left and right sides of men and women indicate that the number of humps present on

both feet of an individual is not the same. Thus the present study shows bilateral variation in footprints.

3.4. Phalange Marks

Phalange marks of the toes are also play very important role to identify the footprint. The shape, size, number and position of the phalange marks are help to individualization of the toe pattern. Different types of phalanges can be seen in the footprints of different people. Some footprint specimens show phalange marks of all toes and some specimens show no phalange marks. Also some footprints have one, two, three or four phalange marks and their size, shape also varies which helps to distinguish one footprint from another footprint.

Table 5: Frequency and percentage distribution of phalanges marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Phalanges marks	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Only Toe-1	42	(35) [7.5]	51	(42.5) [21.2]	41	(34.1) [17]	48	(40)[20]
Only Toe-2	0		0		0		0	
Only Toe-3	0		0		0		0	
Only Toe-4	0		0		0		0	
Only Toe-5	2	(1.6) [.8]	2	(1.6)[.8]	2	(1.6) [.8]	0	
Zero	4	(3.3) 1.6]	7	(5.8)[2.9]	12	(10)[5]	10	(8.3) [4.1]
Multiple	12	(10)[5]	0		5	(4.1)[2]	2	(1.6) [.8]

Note: (% Male or Female footprint) [% among the total footprint]

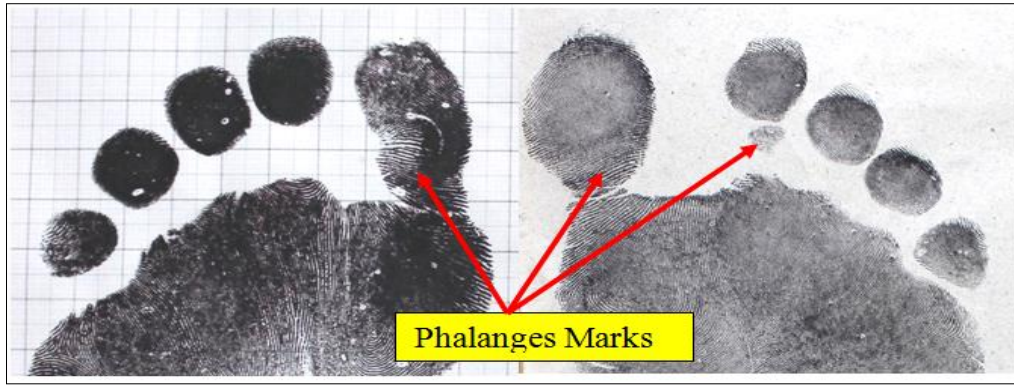


Figure 5: Illustrative examples showing Phalanges Marks in the footprint of Eastern Indian Tribes

Table -5 shows the present & absent of phalange marks in the different toes of the footprints of Eastern Indian Tribes. The present study shows that among males, the frequency of phalanges marks only one toe is the highest (left 35%, right 51%) followed by multiple phalanges marks (left 10%, right 0%), zero phalanges marks (left 3.3%, right 5.8%) and only toe five (left

1.6%, right 1.6%). Similarly, among females the frequency of phalanges marks only one toe is the highest (left 34.1%, right 40%), followed by zero phalanges marks (left 10%, right 8.3%), multiple phalanges marks (left 4.1%, right 1.6%) and only toe five (left 0%, right 1.6%).

Table 6: Frequency and percentage distribution of multiple phalanges marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Pattern of multiple phalange marks in a footprint.	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Phalange mark in one toe only (one toe stem)	44	(36.7) [18.3]	53	(35.8) [17.9]	43		48	(40) [20]
Phalange marks in two toes (two toe stems)	12	(10)[5]	0		3		2	(1.6) [.8]
Phalange marks in three toes (three toe stems)	0		0		0		0	
Phalange marks in four toes (four toe stems)	0		0		2	(1.6) [.8]	0	
Phalange marks in all five toes (five toe stems)	0		0		0		0	
Absence of phalange marks (no or zero toe stem)	4	(3.3) 1.6]	7	(6)[2.9]	12	(10)[5]	10	(8.3) [4.1]

Note: (% Male or Female footprint) [% among the total footprint]

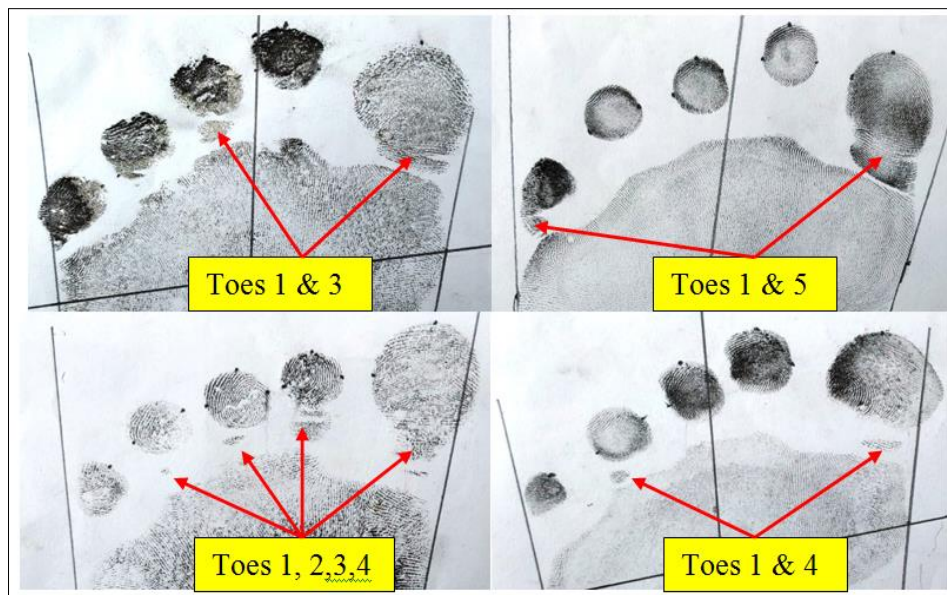


Figure 6: Illustrative examples showing Multiple Phalanges Marks in the footprint of Eastern Indian Tribes

Table-6 shows the multiple phalange marks made in footprints of Eastern Indian Tribes. Interesting

feature come to light that most phalange marks are found in one toe and multiple phalange marks are very rare.

This finding is forensically important to include or exclude the suspects in real crime scenarios.

3.5. Corns, Pits, Crack and Cut Marks

The presence of different type's damages in the feet like- corns, pits, crack, cut marks and other deformities are very important identification

characteristics features of the footprint. Their presence and absence, shape and size and their position on the footprint distinguish one footprint from another. Although some of these signs may not be permanent at times, they are of immense importance in forensic investigations for person identification.

Table 7: Frequency and percentage distribution of corn marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Corn Marks	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Present	1	(.8)[.4]	0	0	4	(3.3) 1.6]	1	(.8)[.4]
Absent	59	(49.1)[24.5]	60	(50)[25]	56	(46.6)[23.3]	59	(49.1)[24.5]

Note: (% Male or Female footprint) [% among the total footprint]

Table -7 shows the present & absent of corn marks in the different toes of the footprints of Eastern

Indian Tribes people in Jhargram District, West Bengal, India.

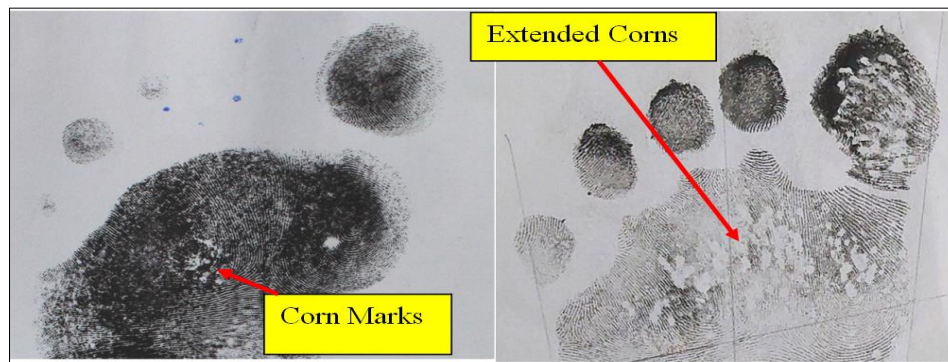


Figure 7: Illustrative examples showing Corn Marks in the footprint of Eastern Indian Tribes

Table 8: Frequency and percentage distribution of pits marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Pits Marks	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Present	56	(46.6)[23.3]	54	(45)[22.5]	58	(48.3)[24.1]	55	(48.8)[24.4]
Absent	4	(3.3) 1.6]	6	(5)[2.5]	2	(1.6) [.8]	5	(4.1)[2]

Note: (% Male or Female footprint) [% among the total footprint]

Table-8 shows the pits marks in the footprints of Eastern Indian Tribes. Interesting feature come to light that pits marks present all most every footprint of Eastern

Indian Tribes people in Jhargram District, West Bengal, India.

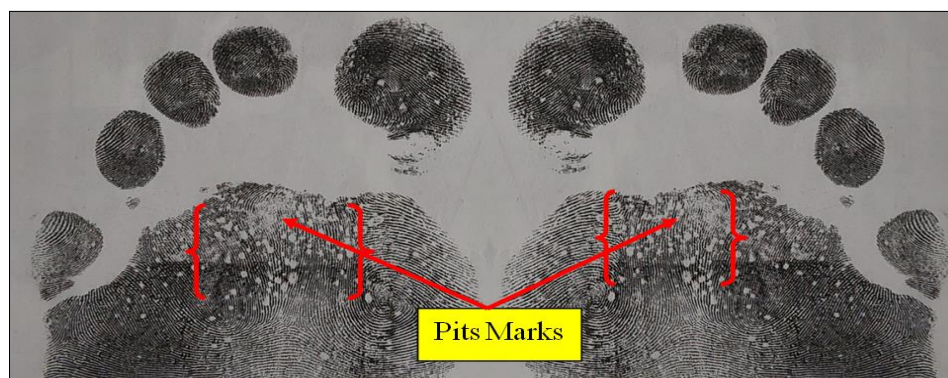


Figure 8: Illustrative examples showing Pits Marks in the footprint of Eastern Indian Tribes

Table 9: Frequency and percentage distribution of Crack marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Crack Marks	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Present	3	(2.5)[1.2]	2	(1.6) [.8]	4	(3.3) 1.6]	3	(2.5)[1.2]
Absent	57	(47.5)[23.7]	58	(48.3)[24.1]	56	(46.6)[23.3]	57	47.5)[23.7]

Note: (% Male or Female footprint) [% among the total footprint]

Table -9 shows the present & absent of crack marks in the footprints of Eastern Indian Tribes people in Jhargram District, West Bengal, India.

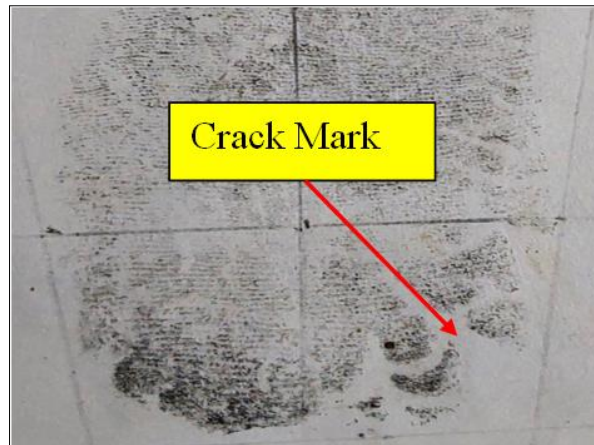


Figure 9: Illustrative examples showing Crack Marks in the footprint of Eastern Indian Tribes

3.6. Crease Marks

Crease marks or lines are formed due to skin folds on the plantar surface of the foot [1]. Different

types crease can be found in different footprints i.e horizontal, vertical or crossed which helps to distinguish one footprint from another footprint.

Table 10: Frequency and percentage distribution of crease marks in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Crease Marks	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Present	15	(12.5)[6.2]	12	(10)[5]	32	(26.6)[13.3]	35	(29.1)[14.6]
Absent	45	(37.5)[18.7]	48	(40)[20]	28	(23.3)[11.6]	25	20.8)[10.4]

Note: (% Male or Female footprint) [% among the total footprint]

Table -10 shows the presence & absence of crease marks in the different footprints of the Eastern Indian Tribes people in Jhargram District, India. The present study shows that numerous crease marks are more common in female footprints (left 26.6%, right

29.1%) than in male footprints (left 12.5%, right 10.0%). Thus the footprint crease marks used in the present study show a significant gender difference, an important identification feature forensically.

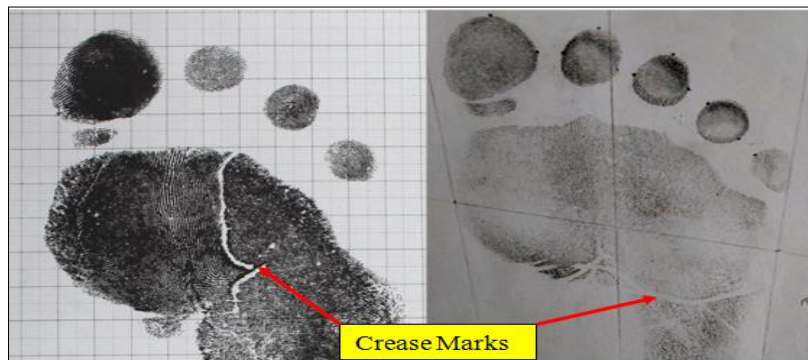


Figure 10: Illustrative examples showing Crease Marks in the footprint of Eastern Indian Tribes

3.7 The Central Axis Line

The central axis of the footprint (CA) is defined by the method of Kennedy *et al.*, (2003, 2005), i.e. identifying it with the bisector of the angle of the envelope cone created by the intersection of the tangents to the readable contour passing through the points of

maximum lateral and medial extension, i.e. the line joining the medial metatarsal tip (mmt) with the medial calcaneal tip (mct), and the line joining the lateral metatarsal tip (lmt) with the lateral calcaneal tip (lct) (Robbins, 1985).

Table 11: Frequency and percentage distribution of central axis line in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120).

Axis line	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Between T1& T2	0		0		0		2	(1.6) [8]
Between T2& T3	16	(13.3)[6.6]	16	(13.3)[6.6]	21	(17.5)[8.7]	25	(20.8)[10.4]
Touch T1	0		0		0		0	
Touch T2	14	(11.6)[5.8]	16	(13.3)[6.6]	23	(19.1)[9.5]	14	(11.6)[5.8]
Touch T3	30	(25)[12.5]	28	(23.3)[11.6]	16	(13.3)[6.6]	19	(15.8)[7.9]

Note: (% Male or Female footprint) [% among the total footprint]

Table -11 shows the position of central axis line of the footprints of Eastern Indian Tribes people in Jhargram District, India.

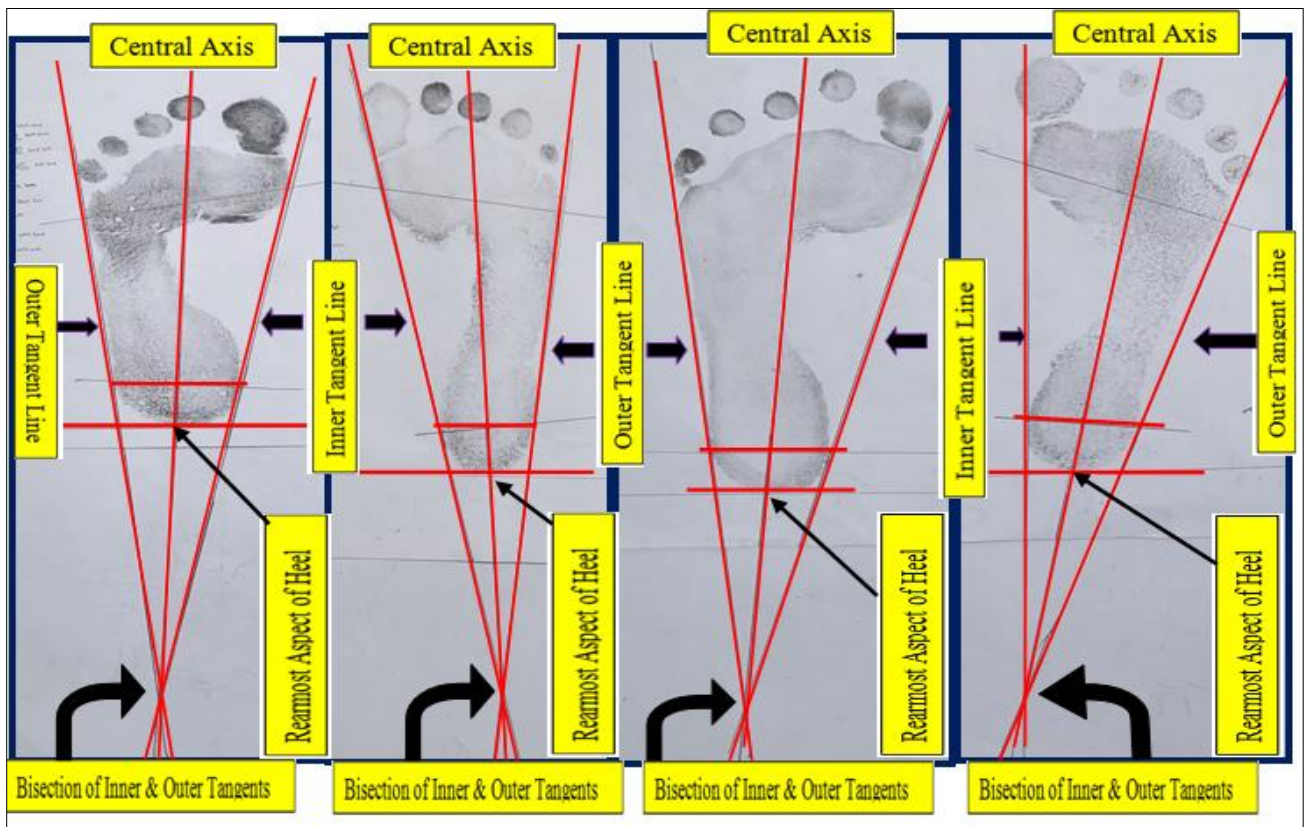


Figure 10: Illustrative examples showing different position of Central Axis in the footprint of Eastern Indian Tribes.

Table 12: Frequency and percentage distribution of heel shape in the Footprints of Eastern Indian Tribes people in Jhargram District, India (N = 120)

Heel shape	Male (N=60)				Female (N=60)			
	Left	%	Right	%	Left	%	Right	%
Round	46	(38.3)[19.1]	48	(40)[20]	32	(26.6)[13.3]	42	(35)[17.5]
Oval	12	(10)[5]	12	(10)[5]	21	(17.5)[8.7]	16	(13.3)[6.6]
Irregular	2	(1.6) [8]	0		7	(6)[2.9]	2	(1.6) [8]

Note: (% Male or Female footprint) [% among the total footprint]

Table -12 shows the heel shape of the footprints of Eastern Indian Tribes people in Jhargram District, India.

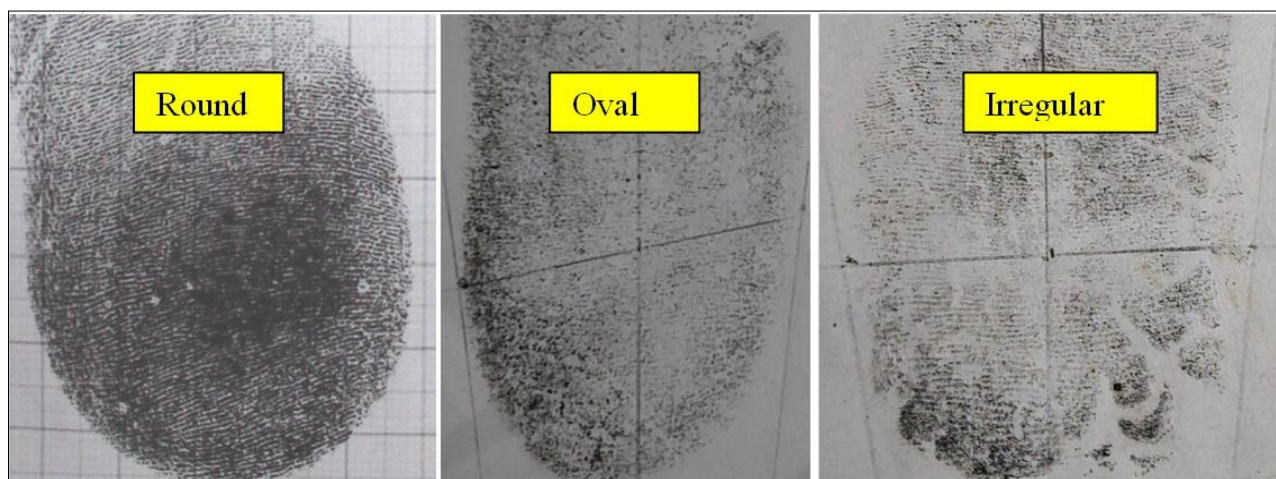


Figure 12: Illustrative examples showing Round, Oval and Irregular heel shape in the footprint of Eastern Indian Tribes

4. DISCUSSION

The present study highlights some of the individualizing characteristics of footprints in Eastern Indian Tribes people in Jhargram District, India for person identification. The detailed analysis of the characteristics like phalange marks, feature of toes, humps, crease marks, flatfoot condition, pits, corns, and crack marks can be used as valuable evidence to link the crime and the perpetrators. These characteristic features can be used for inclusion or exclusion of suspects even in the preliminary scientific investigation followed by subsequent identification.

The present study found that the frequency of the missing toe of male population only toe-5 (left 1.6% right 3.3%) and other hand among the female found multiple missing toes toe₂ (1.6%), toe₃ (1.6%) and toe₅ (4.1%) in the left foot and (5.8%) in the right foot (Table-1).

The inter-distance spacing of the toes gives a characteristic pattern of a footprint. They may be touching each other or there may be some distance between them. The inter-distance between the toes varies from footprint to footprint. In the present study, the frequency of the toes inter-distance medium range (between 0.51 and 1.50 cm.) found relatively high in both sex of all categories followed by narrows (<.50 cm.) and wide (> 1.51 cm.) (Table-2).

The present study shows that among males, the frequency of F-type is the highest (left 29.2%, right 29.2%) followed by T-type (left 20.8%, right 20.8%). Similarly, among females, the frequency of T-type is the highest (left 32.5%, right 30.8%) followed by F-type (left 17.5%, right 19.5%). M-type and O-type are not found in the present population (Table-3). Similar studies were conducted on Gujjars of the north India population [10]. The frequency of the T-type is the highest (62.50% on

left and 62.21% on right side), followed by F-type (32.88% on left and 33.07% on right side) and O-type (3.75% on left and 3.85% on right side). The M-type is the least frequent among adult male Gujjars. "In the Malaysian Malay population among males¹, the frequency of F-type is the highest (left 54.5%, right 59.5%) followed by T-type (left 23%, right 16%), O-type (left 12%, right 14%) and the least frequent M-type (left & right 10.5%). Similarly, among females the frequency of F-type is the highest (left 43%, right 46%) followed by T-type (left 36.5%, right 38.5%), O-type (left 15%, right 11%) and the least frequent M-type (left 5.5%, right 4.5%). Hence in the Malaysian Malay population, the relative frequency of these types are in the order F type > T type > O type > M type for the left and right footprints of both the genders".

The results of male footprints showed that three humps were found more in the left footprint (left-25%), on the other hand, two humps were found more in the right footprint (right-27%). The results of three humps of male footprint are (left-25% and right-19%), followed by two humps (left-23% and right-27%), one hump (left-0% and right-4%) and zero humps (left-2% and right-0%). But in female participants, the order is different i.e. The presence of three humps found more. The presence of three humps was found to be equal in left and right footprints (left-21% and right-21%), followed by two humps (left-16% and right 13%), one humps (left-6% and right-9%), and by zero humps (left-7% and right-7%). "Similar studies were conducted on Gujjars of the north India population [10]. The results show that three humps are found more often in a footprint (45.96% on left side and 43.94% on right side), followed by two humps (33.75% on left side and 34.81% on right side), four humps (10.77% on left and 12.59% on right side), then by five humps (5.86% on left side and 6.25% on right side). One hump is the least frequent (1.92% on left side and 1.34 on right side) among Gujjars". In the Malaysian

Malay population [1], two humps are found more often (right – 58% and left – 55%), followed by three humps (right – 30.5% and left – 31%), and zero hump (right – 11.5% and left – 14.0%). But in females, the sequence differs i.e. the presence of three humps is found more often (right – 47% and left – 52.5%), followed by two humps (right – 45.5% and left – 43.5%) and then by zero hump (right – 7.5% and left – 4%).

So the values on the left and right sides of men and women indicate that the number of humps present on both feet of an individual is not the same. Thus the present study shows bilateral variation in footprints (Table-4).

The present study shows that among males, the frequency of phalanges marks only one toe is the highest (left 35%, right 51%) followed by multiple phalanges marks (left 10%, right 0%), zero phalanges marks (left 3.3%, right 5.8%) and only toe five (left 1.6%, right 1.6%). Similarly, among females the frequency of phalanges marks only one toe is the highest (left 34.1%, right 40%), followed by zero phalanges marks (left 10%, right 8.3%), multiple phalanges marks (left 4.1%, right 1.6%) and only toe five (left 1.6%, right 0%). Interesting feature come to light that most phalange marks are found in one toe and multiple phalange marks are very rare. This finding is forensically important to include or exclude the suspects in real crime scenarios. (Table-5 & 6). “In Gujjars of the north India population¹⁰, in most of the footprints, the phalange mark is shown by toe 1 only, whereas, phalanges of the toes 2–5 are usually absent in a footprint impression unless the footprint is made in a very soft soil. Phalange marks of the toes 2–5 are not found in most of the footprints of the present sample”. “In Malaysian Malays population¹, the phalange marks are created not only by toe 1 but also by other four toes in varying frequencies. Another interesting feature observed is the existence of multiple phalange marks in a footprint”.

The presence of different type's damages in the feet like- corns, pits, crack, cut marks and other deformities are very important identification characteristics features of the footprint. Their presence and absence, shape and size and their position on the footprint distinguish one footprint from another. Although some of these signs may not be permanent at times, they are of immense importance in forensic investigations for person identification.

The present study shows that among males, the frequency of corn marks absent (left 49.1% Right 50 %) and present (left .8% right 0%) on the other hand among the female the frequency of corn marks absent (left 46.6% Right 49.1 %) and present (left 3.3% right .8%) (Table-7).

The frequency of pits marks among males absent (left 3.3% Right 5 %) and present (left 46.6% right

45%) on the other hand among the female, the frequency of pits marks absent (left 1.6% Right 4.1 %) and present (left 48.3% right 48.8%) (Table-8).

The frequency of crack marks among males absent (left 47.5% Right 48.3 %) and present (left 2.5% right 1.6%) on the other hand among the female, the frequency of crack marks absent (left 46.6% Right 47.5 %) and present (left 3.3% right 2.5%) (Table-9).

The present study shows that numerous crease marks are more in female footprints (left 26.6%, right 29.1%) than in male footprints (left 12.5%, right 10.0%). Thus the footprint crease marks used in the present study show a significant gender difference, an important identification feature forensically (Table-10). “In Malaysian Malays populations¹, crease marks are found more often in female footprints (left 37.0%, right 39.5%) when compared to male footprints (left 5.5%, right 7%). The male footprints mostly show just one or two or almost zero crease marks in their footprints”.

Findings Impressions of the Present Study

- i. In the present study, all the footprints have been found unilateral. No bilateral footprints have been found in the collected footprints of Eastern Indian Tribes.
- ii. No flat footprints have been found in the collected footprints.
- iii. In the present study, 77% footprint of the total collected footprints were found to contain only one phalanges mark (below the big toe).
- iv. In the present study, pit marks were found in 93% of the total footprints.
- v. In the present study, 52.5% of the footprints were found Toe-1 is longer than Toe-2 ($T1 > T2 = 52.5\%$), and 47.5% of the footprints were found Toe-2 is longer than Toe-1 ($T2 > T1 = 47.5\%$).

The soil of the study area consists of sand and small red pebbles. The Bhumi tribal people of the study area live in forest areas and most of the people walk barefoot day by day. They make their living by cultivating, collecting, and selling forest resources. Most of the people got pit marks on their feet. Probably due to walking barefoot day after day on the soil mixed with sand and small red pebbles. Since most of the people walk barefoot day after day. Therefore, probably the middle part is raised when putting more pressure on the tip of the toe to grip the soil (earth) during walking or running bare foot. Maybe for that reason, Phalanges marks on their toes are rarely found on second, third, fourth, and fifth toes other than the big toe.

5. CONCLUSION

The present study highlights some of the individualizing characteristics of footprints in Eastern Indian Tribes in Jhargram district West Bengal India for person identification. The detailed analysis of the

characteristics like phalange marks, features of toes, humps, crease marks, pits, corns, and crack marks can be used as valuable evidence to link the crime and the perpetrators. These characteristic features can be used for the inclusion or exclusion of suspects even in the preliminary scientific investigation followed by subsequent identification. Therefore the researchers are encouraged to conduct similar studies for different ethnic groups living in different parts of the India as well as the world so that the genetic and environmental effects can be investigated in forensic terms. The results of this study demand planning for government and non-government organization intervention to create suitable facilities to improve the situation. The findings of the study will be playing an important role in enhancing knowledge regarding forensic footprint and improving the services qualities in future on personal identification in the criminal justice system.

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Informed Consent: Inform consent was taken from the participants of the study.

Ethical Standards

All data/information used in this study were collected maintaining all legal formalities and the method has been used according to the guidelines mentioned in the Directorate of Forensic Science Service- India. This study did not disclose the identity of anybody by any means.

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