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## Examination and evaluation of foot print for individualization

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### Abstract

Foot print analysis is an important technique in forensic investigation which can be used for personal identification in the cases such as homicide and sexual offence. This study was carried out at the department of Forensic Science, Sam Higginbottom University of Agriculture Technology and Sciences (Deemed-to-be-University), Allahabad. Total 50 samples of right foot containing 25 foot prints of males and 25 foot prints of females were collected and were analyzed for the purpose of individualization.

The present study was done by physical analysis of foot prints was carried out to identify the individual and class characteristics and also to determine the foot length, foot breadth and foot index which can be useful to find out the result for the personal identification and comparison of individual.

The foot print can be successfully examined through the foot length, breadth and foot index measurement which helps to differentiate the foot print between male and female since on an average the foot size of males was found to be greater than that of the females. The footprints can also be individualized on the basis of class and special characteristics. The observation hence found concludes that the identification and comparison of footprint can be properly done on the basis of the method prescribed in this dissertation which may help in the forensic investigation.

**Keywords:** foot print, individualization, foot index, special mark, fraternity

### Introduction

Foot print analysis is a simple and cost effective method to identify a person in forensic context. Foot print is one of the valuable physical evidences left by the criminals in the crime scene [7]. Offenders tend to remove their foot wears to avoid noise while committing crimes and to gain better grip while climbing walls and fast escaping. Useful information can be obtained from foot impression evidence. Foot prints are of great value in establishing the identity of the criminals in forensic investigation [9]. Footprints or footmarks are the impressions or images left behind a person walking or running. Hoof prints and Paw prints are those left by animals with hooves or paws rather than feet. Gayer was probably the first person to conduct a detailed study of footprint while working in the United Province of India and published his results in form of a book. The partial or complete foot prints can be found on rain wetted surfaces, newly waxed floors, freshly cemented surfaces, moistened surfaces, in dust, mud, sand, oil, paint and left in blood at the murder scenes.

A study on the footprints of human being has been made with the footprint parameter such as footprint pattern, footprint class and individual characteristics such as delta, dot, bifurcation, trifurcation, wear and tear mark etc. Individual characteristics are unique patterns or features. Class characteristics are a defined pattern or feature that belongs to a group [2]. Wear patterns are individual characteristic based on the use of an item. Foot prints and foot outlines reveal that the human foot, its bones and its impressions can successfully be used in estimation of stature in forensic and legal examination. The forensic examination is based on a comparison of the contours, shapes and placements of parts of the foot and the conclusion depends on the fact that the bare feet of individuals show a high degree of individuality [10, 4, 5]. The foot prints are unique i.e. two prints, even from the same individual, will be exactly identical. Various other studies have been conducted on individualization and estimation of stature from foot and foot prints. All these studies suggested different ways of utilization of footprints in forensic examination. A study on the footprint parameter such as footprint length, inter metatarsal distances and flat index can be useful for forensic application. Study of footprints, length between heel to 1st toe and heel to 2nd toe also helps in discrimination. Footprint having set of

ridges that make up a print unmatched by any other human being [6]. As with fingerprints, the footprint's pattern is a unique characteristic that can pinpoint any one particular person [8]. An actual footprint can be checked and matched to an existing print on record, such as one from a birth certificate.

The method used in the present work which was earlier prescribed [12]. That is for the purpose of person identification of human foot print, through tool and techniques to measure and compare foot impression. And the method prescribed [11], that is for the comparison of footprints through parameter such as footprint length and flat index to individualize the footprint of two individual. Foot prints are of immense value in establishing personal identity of the criminals in forensic examination Possibility of footprint recovery at the scene of sexual offences and homicides is relatively more. Analysis of footprints helps in estimation of an individual's stature because of existence of strong positive correlation between one's stature and foot size [2, 3]. Foot prints are also considered as indicators of skeletal and body structure of a person. Therefore, the present study entitled "Examination and Evaluation of Foot Print for Individualization" has been carried out for proper and effective analysis of foot with objective to study the characteristics features of foot prints and to individualize a person through foot prints.

## Materials and Method

### Collection of samples

Total of 50 samples of right footprint from 25 males and 25 females having no deformities or fractures were collected. To obtain a clear footprint of right foot, the foot of each volunteer was first cleansed properly with water so as to remove all the dust and dirt from it. Then the feet were dried with a clean cloth to remove grease if present. Ink was then applied evenly on volunteer's right foot with footprint roller. Care was taken to ensure the contact surface of the foot was evenly covered with ink. The volunteers were then asked to step onto a white A-4 size sheet spread on an even surface and thus clear footprints were obtained from all the volunteers for the analysis.

### Procedure for analysis

Foot prints were analyzed for their foot index as per the method prescribed [11, 1].

### 1. Calculation of Foot Index

After collection of samples for the analysis, the samples were numbered. The male samples were numbered from 1 to 25 and female samples were numbered from 26 to 50 the length and breadth of each footprint was measured with the help of scale.

The foot index was calculated for both males and females separately for right footprint samples hence obtained. The foot index of males and females were then compared.

## 2. Visual Analysis for Ridge and Individual Characteristics

$$\text{FOOT INDEX} = \frac{\text{FOOT BREADTH}}{\text{FOOT LENGTH}} \times 100$$

After the calculation of foot index, each footprint was divided into two quadrants A and B. The ridge characteristics were then studied with magnifying lens separately for both the quadrants as per the method prescribed [12]. A keen study was done individually for each quadrant of volunteer's right footprint for the presence of loop, arch and whorl patterns. Also the special characteristic features such as delta, bifurcation, island etc were identified for the individualization of the person on the basis of footprint patterns.

The average foot length, foot breadth and foot index of males and females helps to differentiate a give population into males and females. The class and special characteristics helps to individualize a person through footprint. The results are reported in table 1 to table 6.

### Result

For the present work, 50 samples (from 25 males and 25 females) of right foot were collected for the analysis. The footprints were then numbered as sample no. 1, 2, 3, 4 up to 50. Each footprint sample was then individually measured with a scale and marked with pencil. Table no. 1 and table no. 2 shows the foot length and breadth of the footprints of males and females respectively. And also the foot index hence calculated from it.

**Table 1:** Foot index of right footprint samples of males

Sample no.	Foot length (in cm)	Foot breadth (in cm)	Foot index
1.	22.8	8.4	36.84
2.	24.8	10.1	40.72
3.	20.7	8.8	42.51
4.	22.6	9	39.82
5.	25.7	10.5	40.85
6.	22.4	9.3	41.54
7.	21.8	8	36.69
8.	23.2	8.5	36.63
9.	23.1	8.6	37.22
10.	26.2	9.5	36.26
11.	24.5	10	40.81
12.	21.8	8.2	37.61
13.	24.5	8.8	35.91
14.	24.7	10.2	41.29
15.	24.6	8.4	34.14
16.	25.7	10.2	39.68
17.	21.8	8.9	40.82
18.	22.1	8.5	38.46
19.	24.2	9.1	37.60
20.	22.8	8.1	35.52
21.	23.8	9.4	39.49
22.	22.6	8.3	36.72
23.	23.1	9.3	40.26
24.	25.6	10.2	39.84
25.	22.8	8.5	37.28

**Table 2:** Foot index of right footprint samples of females

Sample No.	Foot length (in cm)	Foot breadth (in cm)	Foot index
26.	22.6	8.6	38.05
27.	22.4	9.3	41.51
28.	22.8	8.4	36.84
29.	20.7	8.8	42.51
30.	21.8	8.2	37.61
31.	22	8.1	36.81
32.	21.8	8.2	37.61
33.	23.2	8.5	36.63
34.	22.1	8.6	38.91

35.	21.9	8.9	40.63
36.	23.3	8.5	36.48
37.	22.2	8.1	36.48
38.	21.7	8.7	40.09
39.	23.1	8.5	36.79
40.	22.7	8.9	39.20
41.	23.3	9.1	39.05
42.	22.1	7.9	35.74
43.	23	8.8	38.26
44.	21.4	8.1	37.85
45.	22	8.3	37.72
46.	23.5	9.1	38.72
47.	22.1	8.3	37.55
48.	22.7	8.6	37.88
49.	22.9	8.1	35.37
50.	23.1	8.9	38.52

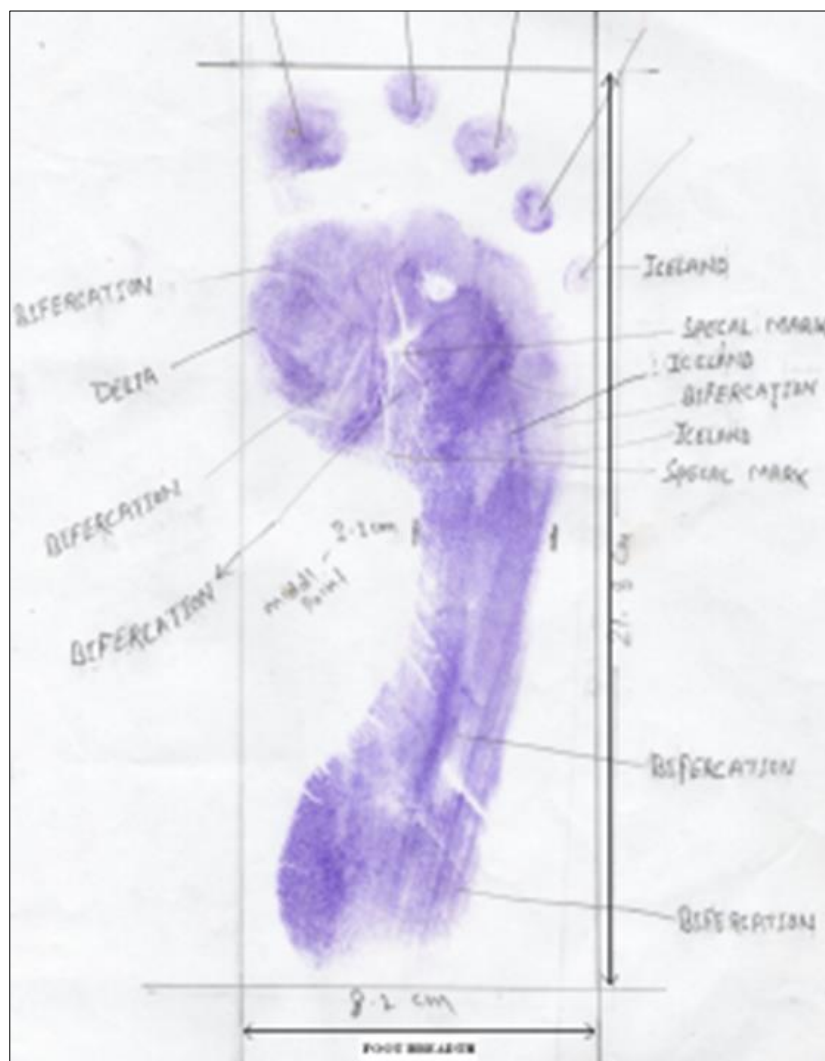


Fig 1: Foot print for the measurement of foot length and breadth.

After the calculation of foot index of both males and females were performed a comparison was done between the males and females overall on the basis of foot length, breadth and foot index. Table no. 3 shows the average foot length, breadth and foot index of both males and females. The comparison

hence shows that the average length, breadth and foot index of males are greater than those of females. Therefore, the measurements and calculations performed shows that the size of footprint of males is greater than that of the foot size of females in general.

Table 3: Comparison between foot index of right footprint samples of males and females

Sex	Average foot length (in cm)	Average foot breadth (in cm)	Average foot index
Males	23.51	9.06	38.58
Females	22.41	8.54	38.10

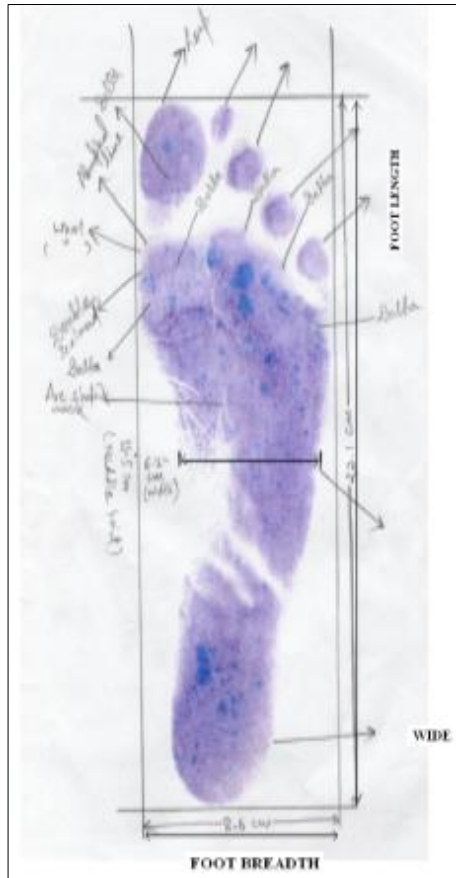


Fig 2: Foot print of a male.



Fig 3: Foot print of a female.

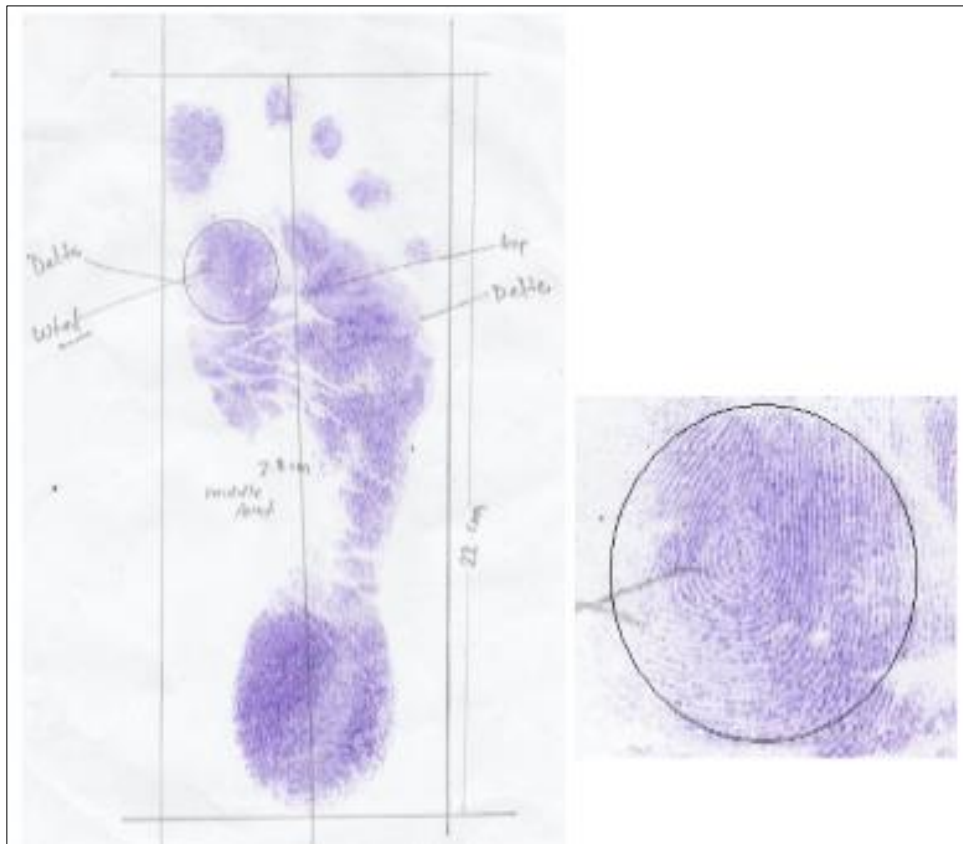


Fig 4: Foot print showing whorl pattern as class characteristic

Footprint plays an important role in forensic science due to the fact that no two footprints can be exactly same even of the same individual. Hence a keen study of the footprints reveals the presence of different class and special characteristics. The

class characteristics consist of loop, whorl and arch. Table no. 4 shows the class characteristics found in each quadrant A and B of males and females.

**Table 4:** Class characteristics found in right footprint samples of males and females

Sample No.	Quadrant	Class Characteristics
1.	A	Whorl, Tented Arch
	B	Loop
2.	A	Whorl
	B	Loop
3.	A	Whorl, Loop
	B	Loop
4.	A	Loop
	B	Tented Arch
5.	A	Loop
	B	Loop
6.	A	Whorl, Plain Arch
	B	Loop
7.	A	Whorl
	B	Loop
8.	A	Whorl
	B	Plain Arch
9.	A	Whorl, Plain Arch
	B	Loop
10.	A	Whorl, Loop
	B	Loop
11.	A	Loop
	B	Loop
12.	A	Whorl
	B	Whorl
13.	A	Loop, Plain Arch
	B	Loop
14.	A	Loop, Whorl
	B	Plain Arch
15.	A	Whorl
	B	Loop
16.	A	Loop, Whorl
	B	Loop
17.	A	WHORL
	B	Loop
18.	A	Whorl, Loop
	B	Loop
19.	A	Loop
	B	Loop
20.	A	Whorl, Plain Arch
	B	Loop
21.	A	Whorl, Loop
	B	Loop
22.	A	Loop, Tented Arch
	B	Loop
23.	A	Whorl
	B	Loop
24.	A	Whorl
	B	Loop
25.	A	Whorl
	B	Loop
26.	A	Whorl, Loop
	B	Loop
27.	A	Loop, Tented Arch
	B	Loop
28.	A	Whorl
	B	Loop
29.	A	Whorl
	B	Loop
30.	A	Whorl, Tented Arch
	B	Loop
31.	A	Whorl
	B	Whorl
32.	A	Loop
	B	Loop
33.	A	Whorl, Loop
	B	Plain Arch
34.	A	Whorl
	B	Loop
35.	A	Loop
	B	Whorl

36.	A	Whorl, Twined Loop
	B	Loop
37.	A	Whorl, Plain Arch
	B	Loop
38.	A	Loop
	B	Loop
39.	A	WHORL, TWINED LOOP
	B	Loop
40.	A	Loop, Loop, Loop
	B	-
41.	A	Whorl, Tented Arch
	B	Loop
42.	A	Whorl
	B	Loop
43.	A	Whorl, Loop
	B	-
44.	A	Loop, Tented Arch
	B	-
45.	A	Whorl
	B	Plain Arch
46.	A	Loop, Loop
	B	Whorl
47.	A	Whorl
	B	Loop
48.	A	Whorl, Arch
	B	-
49.	A	Whorl
	B	-
50.	A	Whorl, Plain Arch
	B	Whorl

The footprints were studied for the presence of loop, whorl and arch and then the possibility of finding these class characteristics were calculated. Table no. 5 shows the

possibility of finding class characteristics in a footprint in terms of percentage.

**Table 5:** Percentage of class characteristics found in right footprint of all samples

Class characteristics	Loop	Whorl	Arch
Percentage	50%	40%	10%

Special characteristics present in footprints helps in individualization of a person. The special characteristics studied in the present work are delta, bifurcation, trifurcation,

island and special mark with the help of magnifying lens. Each of these characteristics was searched in quadrant A and B of footprints separately and is showed in Table no. 6.

**Table 6:** Special characteristics found in right footprint samples of males and females

Sample no.	Quadrant	Delta	Bifur-cation	Trifur-cation	Island	Special mark
1.	A	2	Present	Absent	Present	Present
	B	1	Absent	Present	Absent	Absent
2.	A	2	Present	Absent	Present	Present
	B	-	Absent	Absent	Present	Absent
3.	A	1	Present	Present	Present	Present
	B	1	Present	Present	Present	Present
4.	A	2	Present	Absent	Present	Present
	B	1	Absent	Present	Absent	Present
5.	A	1	Present	Present	Present	Present
	B	-	Absent	Present	Present	Present
6.	A	1	Present	Present	Absent	Absent
	B	1	Present	Absent	Present	Present
7.	A	1	Present	Present	Present	Present
	B	2	Absent	Present	Present	Present
8.	A	1	Present	Present	Present	Absent
	B	-	Present	Absent	Present	Present
9.	A	1	Absent	Present	Present	Absent
	B	2	Present	Present	Absent	Present
10.	A	2	Present	Absent	Absent	Absent
	B	2	Present	Absent	Present	Present
11.	A	1	Absent	Present	Present	Absent
	B	1	Present	Present	Present	Present
12.	A	1	Present	Absent	Present	Present
	B	-	Present	Present	Present	Absent
13.	A	2	Present	Present	Present	Present
	B	1	Present	Absent	Present	Absent
14.	A	1	Present	Present	Absent	Present

	B	1	Present	Absent	Present	Absent
15.	A	1	Present	Absent	Present	Present
	B	-	Present	Present	Absent	Absent
16.	A	1	Absent	Present	Present	Absent
	B	-	Present	Absent	Absent	Present
17.	A	1	Present	Present	Present	Present
	B	1	Absent	Absent	Present	Absent
18.	A	2	Absent	Absent	Present	Absent
	B	-	Present	Absent	Absent	Present
19.	A	1	Present	Present	Absent	Present
	B	-	Present	Absent	Present	Absent
20.	A	2	Absent	Absent	Absent	Absent
	B	-	Present	Present	Absent	Present
21.	A	1	Present	Absent	Present	Absent
	B	1	Present	Absent	Absent	Absent
22.	A	1	Present	Present	Present	Absent
	B	-	Present	Absent	Absent	Present
23.	A	2	Present	Absent	Present	Absent
	B	1	Present	Present	Absent	Present
24.	A	2	Present	Absent	Present	Present
	B	-	Present	Present	Absent	Present
25.	A	2	Present	Present	Present	Present
	B	1	Absent	Present	Absent	Absent
26.	A	1	Present	Present	Absent	Present
	B	-	Present	Absent	Present	Absent
27.	A	2	Absent	Present	Present	Present
	B	-	Present	Present	Absent	Absent
28.	A	2	Present	Present	Present	Present
	B	-	Present	Absent	Present	Absent
29.	A	2	Present	Absent	Present	Present
	B	1	Absent	Present	Absent	Absent
30.	A	2	Present	Present	Present	Present
	B	1	Present	Absent	Present	Absent
31.	A	1	Present	Absent	Absent	Present
	B	2	Absent	Present	Present	Absent
32.	A	2	Present	Absent	Absent	Absent
	B	-	Present	Present	Present	Absent
33.	A	1	Present	Absent	Present	Absent
	B	2	Present	Present	Absent	Present
34.	A	2	Present	Present	Present	Present
	B	-	Present	Absent	Present	Absent
35.	A	2	Present	Present	Present	Present
	B	2	Absent	Present	Present	Absent
36.	A	1	Present	Present	Absent	Present
	B	1	Present	Absent	Present	Absent
37.	A	1	Present	Present	Present	Absent
	B	2	Absent	Present	Absent	Present
38.	A	2	Present	Present	Present	Present
	B	2	Absent	Present	Present	Absent
39.	A	2	Present	Present	Absent	Present
	B	2	Present	Absent	Present	Absent
40.	A	2	Present	Present	Present	Present
	B	1	Absent	Present	Present	Absent
41.	A	2	Present	Present	Present	Present
	B	-	Absent	Absent	Absent	Present
42.	A	2	Present	Present	Present	Present
	B	-	Present	Absent	Present	Absent
43.	A	2	Present	Present	Present	Present
	B	-	Absent	Absent	Present	Absent
44.	A	2	Present	Absent	Present	Absent
	B	2	Present	Present	Present	Present
45.	A	1	Present	Absent	Present	Absent
	B	1	Absent	Absent	Present	Present
46.	A	2	Present	Present	Absent	Absent
	B	-	Absent	Absent	Present	Absent
47.	A	2	Present	Absent	Absent	Absent
	B	2	Present	Present	Present	Present
48.	A	2	Present	Absent	Absent	Absent
	B	1	Present	Absent	Present	Absent
49.	A	2	Present	Present	Present	Present
	B	1	Absent	Present	Absent	Absent
50.	A	1	Present	Present	Absent	Present
	B	2	Present	Absent	Present	Present

## Discussion

In the present work foot impression from 50 individual was collected and study thoroughly for the study of present type of pattern in it. The foot length and breadth was measured from each sample and foot index was calculated by as per the method prescribed <sup>[12]</sup> and it was found that foot size of male was greater than that of the female. This criteria found was very helpful in discussing foot print male and female with great scientist technique as discovered <sup>[4, 5]</sup> and the foot print was further study for the presence of special characteristics such as loop, arch, whorl and for individual characteristic such as delta, bifurcation, trifurcation, island etc. and the result found to be as same as that discover <sup>[9]</sup>. This parameter was also very helpful in identification of individual with maximum surety.

There are also few characteristics which are study individually in identification of person using the method <sup>[11]</sup> after analysis it was found that this criteria such as length, inter metatarsal distance and foot index give a well information of an individual for personal identification. The technique and tool which are used here to compare and examine gait pattern of foot print was as same as that used by <sup>[12, 8]</sup>. For comparison of two foot print.

## Summary

In this study, the right footprints of 25 males and 25 females were collected and analyzed for the individualization of person through footprints. The foot length and breadth of each foot print was measured and foot index was calculated for individual samples. Then the average foot length, breadth and foot index of males and females were separately calculated and compared. The comparison revealed that the foot size of males was greater than females on an average.

Then the foot prints were divided into two quadrants and studied separately with magnifying lens for the presence of class characteristics such as loop, whorl and arch. In 40% of the right foot print samples whorl was seen where as only 50% of the samples showed the presence of loop and 10% foot print samples showed arch pattern. Then the footprints were further studied for the presence of special characteristics such as delta, bifurcation, trifurcation, island and special marks. The foot prints plays an important role in cases of homicide and sexual offences due to the fact that every footprint is unique and no two foot prints even from feet of same individual can be exactly same. And this individualization is possible on the basis of presence of class and special ridge characteristics as well as foot length and breadth of the footprint.

## Conclusion

The result incorporated together and after such analysis it was concluded that foot print can be successfully examined through the foot length, breadth and foot index measurement which helps to differentiate the foot print between male and female since on an average the foot size of males was found to be greater than that of the females. The footprints can also be individualized on the basis of class and special characteristics. The observation hence found concludes that the identification and comparison of footprint can be properly done on the basis of the method prescribed in this dissertation which may helps in the forensic investigation.

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