JOURNAL OF FORENSIC SCIENCES

J Forensic Sci, March 2012, Vol. 57, No. 2
doi: 10.1111/j.1556-4029.2012.02058.x
Available online at: onlinelibrary.wiley.com

TECHNICAL NOTE

ANTHROPOLOGY

Dasa S. Preethi,[1] *M.B.B.S.; Mandya D. Nithin,*[1] *M.B.B.S., M.D.; Basappa Manjunatha,*[1] *M.B.B.S., M.D.; and Bheemasamudra M. Balaraj,*[1] *M.B.B.S., M.D., D.F.M.*

Study of Poroscopy Among South Indian Population*

ABSTRACT: Poroscopy is the term applied to a specialized study of pore structure found on papillary ridges of skin as a means of identification. It comes under level 3 detail of identification and hence is more reliable and accurate. The goal of this study is to estimate the importance of poroscopy for identification of individuals and to determine the gender based on frequency, type, and shape of pores. Left plain thumb prints of 200 individuals (100 men and 100 women) aged between 18 and 60 belonging to South Indian population were observed. The results have shown that women tend to have a significantly higher frequency of pores than men. Number of pores ≤ 8 pores/25 mm^2 is more likely to be of male origin and ≥9 pores/25 mm^2 is more likely to be of female origin. There was no significant sex difference based on type and shape of pores.

KEYWORDS: forensic science, poroscopy, fingerprint, sex, personal identification, likelihood ratio, South Indian population

Personal identification through fingerprints is absolute and is regarded to be of great contribution to law enforcement (1), as they are the most important evidence found at the crime scene (2). Fingerprints are impressions produced by raised lines of skin known as friction ridges. Along each of these ridges is a series of pores, which are connected by ducts to sweat glands in the dermis or under layer of the skin. These pores continuously exude small amount of perspiration (3). Sweat mixed with other body oils and dirt produces fingerprints on smooth surfaces (4). Identification of fingerprints is carried out at three levels (5,6). Level 1 detail is representative of ridge flow or pattern. Level 2 includes ridge placement or path and minutiae or Galton points. Level 3 includes fine ridge details (6) such as ridge shape, pores, breaks, scars, and other permanent details (7).

Poroscopy is the term applied to a specialized study of pore structure found on papillary ridges of skin as a means of identification (8,9). The science of poroscopy was established by Dr. Edmond Locard in 1912 (8–10).

It has been claimed that pores are permanent, unique, immutable (5,11), and individual, and these are useful to establish the identity or otherwise of individuals when available ridges do not provide sufficient ridge characteristics (8). Locard observed that 20–40 pores should be sufficient to determine the identity of a person (5,10,11). Poroscopy is destined to become a vital factor in law enforcement because of its positive identification value (9).

In the present study, an attempt has been made to study the characteristics of pores among the South Indian population. There has not been much research published in this field, which prompted us to research on this topic. The goal of this study is to estimate the importance of poroscopy for identification of individuals, to show accuracy and reliability of poroscopy, and to determine the gender based on frequency, type, and shape of pores.

Materials and Methods

The study was conducted in the Department of Forensic Medicine and Toxicology, J.S.S. Medical College, Mysore, India, using 200 subjects (100 men and 100 women). In this study, subjects were chosen randomly in age group of 18–60 years belonging to South Indian Population. Subjects from East, West, North of India and nonresident Indians were excluded. It also excluded cases where there was any evidence of diseases and injury to finger tips that was likely to cause change in fingerprint pattern and alter the shape of the pores in cases of leprosy, scars, and lacerations.

The materials used in this study were Durester Printake strips measuring 250 × 75 mm (provided by Mysore Fingerprint Bureau, Karnataka State Police, Karnataka, India), micro slides measuring 75 × 25 mm, micrometer (12), and Labomed CXR3 microscope (Indian Scientific Instruments Factory, Haryana, India) with resolution power of plan achro 4 × /0.1∞.

Informed written consent was obtained prior to taking the prints. The subjects were asked to wash and dry their hands to remove dirt and grease. For collection of fingerprints, the Durester Printake strip was kept at the edge of the table, the subject was asked to keep his/her arm relaxed and try not to help in taking the fingerprint, as it may cause smearing of the fingerprint. The subject was made to stand in such a way that their forearm was in line with the table. Then, the examiner held the left thumb of the subject and touched the ink on the Printake strip with minimum pressure (13). The touch had to be so light that the ink touches only the superficial ridges and does not enter the pores or furrows. Then, the plain (13,14) impression of the left thumb was obtained on clean glass

[1]Department of Forensic Medicine and Toxicology, J.S.S. Medical College, J.S.S. University, Sri Shivarathreeshwara Nagar, Bannimantap, Mysore 570015, Karnataka, India.

*Presented as a short-term research project (Studentship) to Indian Council of Medical Research, New Delhi, India, in 2009.

Received 9 July 2011; and in revised form 30 Nov. 2011; accepted 18 Dec. 2011.

slide. The glass slide was numbered and the age and sex of the person was noted. In this way, for each and every individual, left thumb prints were obtained on glass slides. Only plain prints were taken (no roll prints) (13,14).

These impressions were observed under a microscope fitted with an ocular micrometer (12) under 4× magnification. Two ocular micrometer scales were perpendicular to each other; each ocular micrometer scale used was 10 mm long and was marked with 100 divisions. Each division is equal to 0.1 mm, that is, 100 μm. Hence, one ocular division is equal to 250 μm at 4× magnification (Fig. 1).

The pores of both male and female prints were observed carefully within a square of 5 mm × 5 mm (15,16) area. Counting of pores started from one corner of square to diagonally opposite corner (16) in a zigzag pattern. The number of pores from fingerprint samples of both men and women were counted within the chosen area of 25 mm^2. This value represents the number of pores/25 mm^2 and would reflect the frequency of pores. Some other features such as type (open or closed) and shape (round, elliptical, square, rhomboid, rectangular, or miscellaneous) of the pores were also observed and noted. The procedure was repeated for impressions of each individual (Figs 2 and 3).

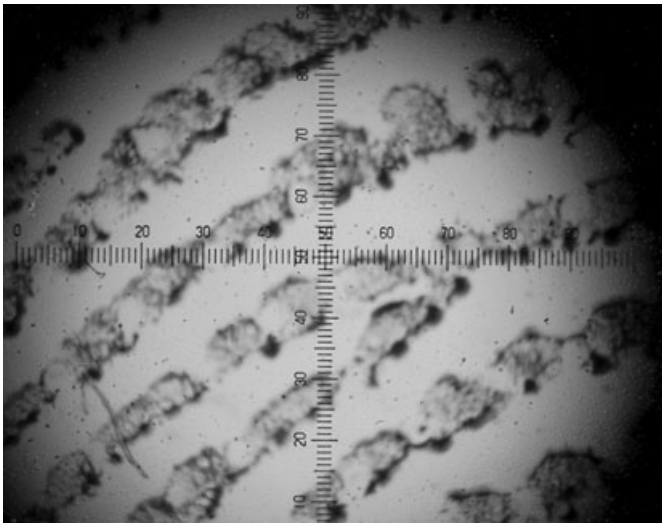

FIG. 1—*Pores under 4× magnification with ocular micrometer scales.*

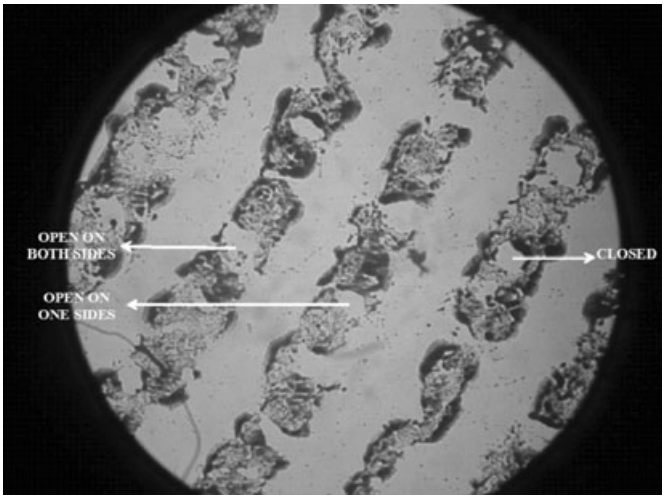

FIG. 2—*Various types of pores.*

Statistical Analysis

The data were analyzed statistically using SPSS (Statistical Programme for Social Sciences; SPSS Inc., Chicago, IL) version 14.0, computer software package. *t*-Test was performed to test the significance, and *p*-value <0.05 was considered as significant. Specific comparisons of means were made, and calculations were performed. The likelihood ratio was calculated and is based on Bayes' theorem (17–19).

Likelihood ratio (LR) = probability of given fingerprint originating from male contributor (C)/probability of given fingerprint originating from female contributor (C') (15,16).

Results

Table 2 shows the probability density for men (C) and women (C'), and using these values, the likelihood ratio LR (C/C') and (C'/C) were calculated. It is found that the LR (C/C') values tend to decrease and the LR (C'/C) values tend to increase with the increase in the number of pores (Figs 4–6; Tables 1 and 2).

Discussion

It has been claimed that the pore structure on papillary ridges of skin is unique and immutable (5,8,11) for an individual. This is useful as means of identification. The comparison of pores is based

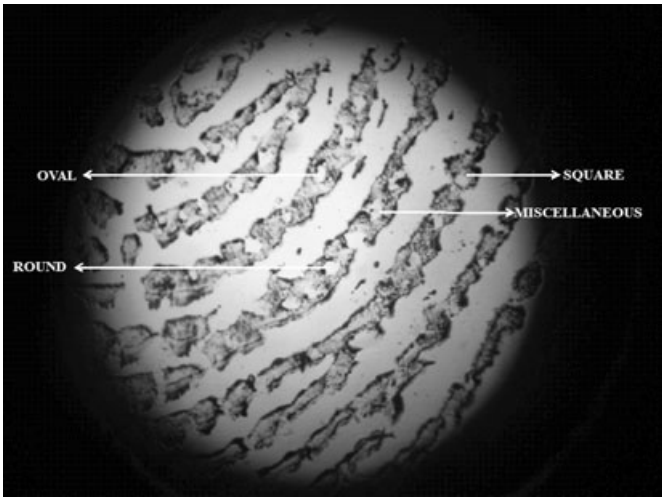

FIG. 3—*Various shapes of pores.*

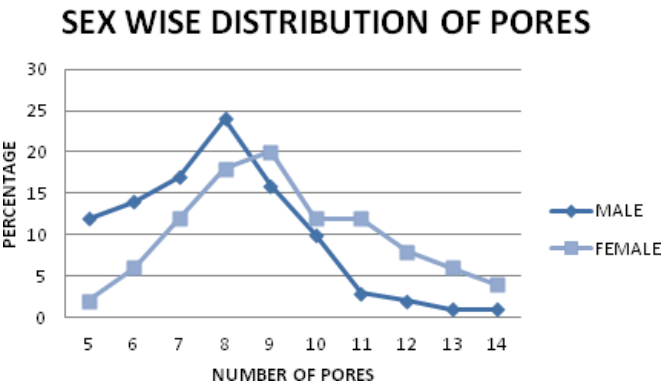

FIG. 4—*Sex wise distribution of pores, which shows that men tend to have lesser number of pores when compared with women.*

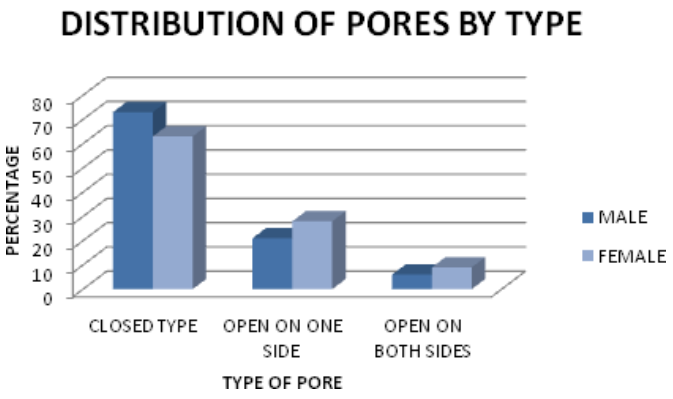

FIG. 5—*Distribution of pores in men and women according to type.*

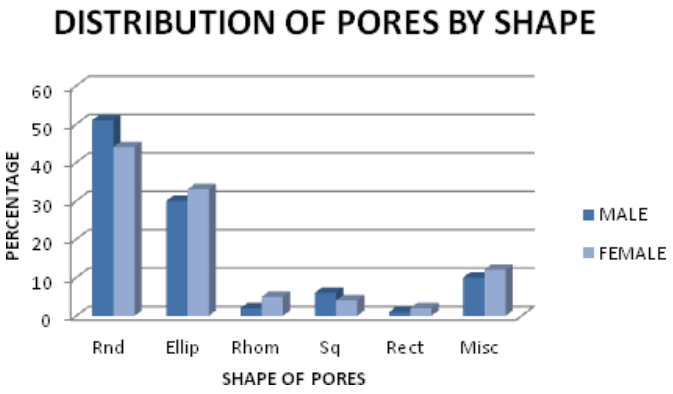

FIG. 6—*Distribution of pores in men and women according to shape. Rnd, round; Ellip, elliptical; Rhom, rhomboid; Sq, square; Rect, rectangle; Misc, miscellaneous.*

TABLE 1—*Descriptive statistics of frequency of pores in both sexes.*

Descriptives	Male	Female
Mean	7.8300	9.3600
Std. error of mean	0.18913	0.21720
Median	8.0000	9.0000
Mode	8.00	9.00
Std. deviation	1.89126	2.17200
Variance	3.577	4.718
Range	9.00	9.00
Minimum	5.00	5.00
Maximum	14.00	14.00
Sum	783.00	936.00
Percentiles		
25	6.0000	8.0000
75	9.0000	11.0000

on frequency, type, shape, size, distance from each other, and distance from edges (9). In this study, an effort has been made to study the frequency, type, and shape of pores of left thumb prints in South Indian population using 200 subjects (100 men and 100 women).

Frequency of Pores

This study shows that women of South Indian population do have significantly higher frequency of pores as compared to men. An LR > 1.0 increases the posttest probability; the greater the LR, the more information a positive test result provides. An LR < 1.0 decreases the posttest probability; the smaller the LR, the more information a negative test result provides (18). Aa a result, the larger LR, the stronger is the evidence (19). Hence, the statistical analysis of LR (C/C') shows that the number of pores of ≤8 pores/25 mm^2 area is "more likely than not" of male origin as the LR is 1.33. Similarly, number of pores of ≥ 9 pores/25 mm^2 area is "more likely than not" of female origin as the LR is 1.25. This could be interpreted as a threshold of gender differentiation.

TABLE 2—*Probability densities and likelihood ratios derived from observed number of pores.*

	Probability Density		Likelihood Ratio	
No. of Pores	Male (C)	Female (C')	LR (C/C')	LR (C'/C)
5	0.12	0.02	6.00	0.16
6	0.14	0.06	2.33	0.42
7	0.17	0.12	1.41	0.70
8	0.24	0.18	1.33	0.75
9	0.16	0.20	0.80	1.25
10	0.10	0.12	0.83	1.20
11	0.03	0.12	0.25	4.00
12	0.02	0.08	0.25	4.00
13	0.01	0.06	0.16	6.00
14	0.01	0.04	0.25	4.00

The results of LR analysis also showed that as the frequency of pores reduces to 5 pores/25 mm^2, the LR is greater (LR = 6) and hence the fingerprint has a larger probability of being from a male. Similarly, as the frequency of pores increases to 13 pores/25 mm^2, the LR also increases (LR = 6) and hence the fingerprint has a larger probability of originating from a female.

Additional research is needed to further substantiate these observations as these outcomes are only inferences based on current population in the study.

In the past, a few studies (8,11,20,21) have been conducted on poroscopy with an idea of proving a gender difference based on various features including number, shape, and type, but they fail to determine whether this difference is statistically significant. In this study, average number of pores in men was 7.83, and average number of pores in women was 9.36.

According to the study by Locard (21), the number of pores varies from 3–20/cm in men and 20/cm in women. In a study by Bindra et al. (8), it varied from 8–25/cm. Ashbaugh (10) proved that the frequency was about 20.8 pores/cm of ridge. Czarnecki (9), Locard (21), and Jain et al. (5) stated that roughly there are 9–18 pores per centimeter of ridge.

Type of Pores

This study also shows that among men, the majority of the pores were of closed type (73%), followed by open on one side (21%), and least common being open on both sides (6%). Similar findings were found in women where the majority of the pores were of closed type (63%), followed by open on one side (28%), and least common being open on both sides of the ridge (9%). Hence, there was no significant sex difference. Similar findings were found in the study by Bindra et al. (8).

Shape of Pores

This study also demonstrates that there is no significant sex difference in shape of pores in South Indian population. Commonly seen shape of pores in descending order of frequency includes round

(51%), elliptical (30%), miscellaneous (10%), square (6%), rhomboid (2%), and rectangular (1%) in men, whereas in women, the shape of pores in descending order of frequency was round (44%), elliptical (33%), miscellaneous (12%), rhomboid (5%), square (4%), and rectangular (2%). The most common shape was found to be round, while least common was rectangular in both sexes.

In the study by Bindra et al. (8), contradictory findings were found where rhomboid was most common followed by circular, elliptical, and rectangular.

Conclusion

The present study has been successful for supporting the hypothesis that women tend to have a statistically greater frequency of pores than men. Results have shown that the number of pores $\leq 8/25$ mm^2 is more likely to be of male origin and that the number of pores $\geq 9/25$ mm^2 is likely to be of female origin. Results also show that there is no significant sex difference based on type and shape of pores.

The outcome of this study is that women have higher frequency of pores than men, and there is no sex difference in type and shape of pores.

This would be universally accepted when these types of studies would be carried out on larger sample in other parts of the world including American and European countries. This study was based only on left thumb prints. More research is required to be carried out on other fingers and palmer areas as well.

References

1. Nath S. Fingerprint identification. 1st edn. New Delhi, India: C.G.O. Pvt Ltd, 1991;7–8.
2. Vij K. Textbook of forensic medicine, principles and practice. 1st edn. New Delhi, India: Churchill Livingstone Pvt, 2001;62.
3. Cunliffe F, Piazza PB. Criminalistics and scientific investigation. 1st edn. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1980;266.
4. Nadar DS. Forensic science in crime investigation. 3rd edn. Hyderabad, India: Asia Law House, 2002.
5. Jain AK, Chen Y, Demirkus M. Pores and ridges: high resolution fingerprint matching using level 3 features. IEEE Trans Pattern Anal Mach Intell 2007;29(1):15–26.
6. Bob HA. Statistical investigation of fingerprint patterns. Crawley, Australia: The University of Western Australia, http://www.csse.uwa.edu.au/~bobh/.../fingerprints/Yanchep2006_bobh.pdf (accessed August 20, 2008).
7. Houck MM, Siegel JA. Fundamentals of forensic science. 1st edn. Amsterdam, New York: Elsevier Academic Press, 2006;528–9.
8. Bindra B, Jasuja OP, Singla AK. Poroscopy: a method of personal identification. Anil Aggarwal's Int J Forensic Med Toxicol, 2000;1(1), http://www.geradts.com/anil/ij/vol_001_no_001/paper003.html (accessed May 13, 2008).
9. Czarnecki E. Poroscopy: an overview, http://www.scafo.org/library/110401.html (accessed June 14, 2008).
10. Ashbaugh DR. Ridgeology—modern evaluative friction ridge identification. Royal Canadian Mounted Police, Canada, http://onin.com/fp/ridgeology.pdf (accessed on May 13, 2008).
11. Roddy AR, Stosz JD. Fingerprint features-statistical analysis and system performance estimates. Proc IEEE 1997;85(9):1390–421.
12. Caprette DR. Measurement with the light microscope, http://www.ruf.rice.edu/~bioslabs/methods/microscopy/measuring.html (accessed June 14, 2008).
13. Feng J, Soweon S, Jain AK. Latent fingerprint matching: fusion of rolled and plain fingerprints, http://biometrics.cse.msu.edu/Publications/Fingerprint/FengYoon/Jain_FuseRollPlain (accessed January 6, 2009).
14. Kentucky State Police. Inked fingerprinting techniques as presented by the Federal Bureau of Investigation, http://www.kyjailers.com/userfiles/inked_fingerprinting_techniques.pdf (accessed January 6, 2009).
15. Acree MA. Is there a gender difference in fingerprint ridge density? Forensic Sci Int 1999;102:35–44.
16. Gungadin S. Sex determination from fingerprint ridge density. Int J Med Update, 2007;Jul–Dec:2(2), http://www.geocities.com/agnihotrimed/paper01_jul-dec2007.htm (accessed June 28, 2008).
17. Grieve MC, Dunlop J. A practical aspect of Bayesian interpretation of fibre evidence. J Forensic Sci Soc 1992;42:225–8.
18. McGee DL. Bayes' theorem, http://www.merckmanuals.com/professional/special_subjects/clinical_decision_making/testing.html#v1124370 (accessed August 27, 2008).
19. Templeman H. Fingerprint identification based on likelihood ratio, match probability & relevant fingerprint population, http://www.henrytempleman.com (accessed July 5, 2009).
20. Ashbaugh DR. Poroscopy, http://www.scafo.org/library/110601.html (accessed June 14, 2008).
21. Locard E. Les pores et I'identification des criminals. Biologica 1912;2:357–65.

Additional information and reprint requests:
Dasa S. Preethi, M.B.B.S.
J.S.S. Medical College
J.S.S. University
Sri Shivarathreeshwara Nagar
Bannimantap
Mysore 570015, Karnataka
India
E-mail: springweed_21@yahoo.co.in