

The relationship between the ridge patterning and the frequency of minutiae on the interdigital area of palmprints

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OVERVIEW

This study investigated the relationship between ridge patterning (Level 1) and minutiae frequency (Level 2) on the volar pad IV (VP IV) of the interdigital area in palmprints (Figures 1 and 2).

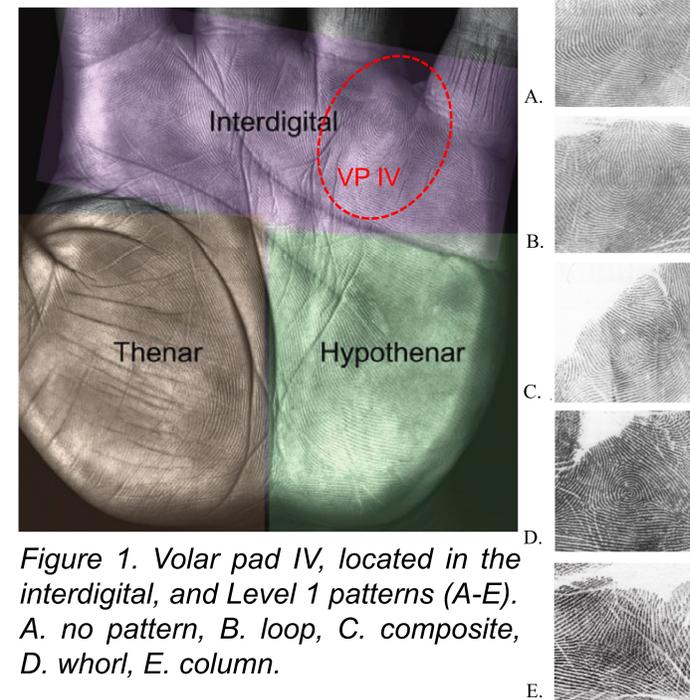


Figure 1. Volar pad IV, located in the interdigital, and Level 1 patterns (A-E). A. no pattern, B. loop, C. composite, D. whorl, E. column.

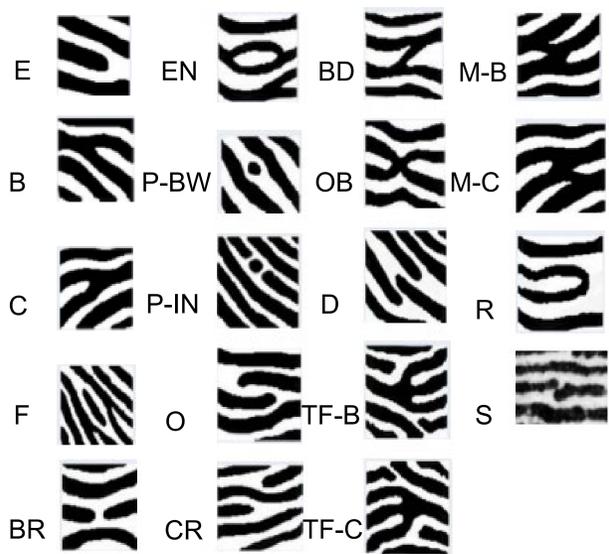


Figure 2. Minutia types considered in this study.

RESULTS & DISCUSSION

- 7,380 minutiae computed.
- Left hand presented 17.76% more minutiae than right hand.
- Ridge endings and bifurcations are the most common minutia types in both sexes (Table 1).
- Women presented 1.58% more minutiae than men in VP IV (Figure 3).
- The order from the most to the less abundant minutia is different between sexes (Figure 4).
- Minutia types associated with sex: C ($\chi^2 = 4.95$, $p \leq 0.026$), CR ($\chi^2 = 10.78$, $p \leq 0.001$), D ($\chi^2 = 8.45$, $p \leq 0.0037$) (men), and F-BG ($\chi^2 = 10.97$, $p \leq 0.0009$) (women).
- There was no association between most of the minutia types and the general patterns loop, double loop, and no pattern.

Table 1. Relative frequencies of minutia types (n = 7,380) present in the VP IV of analyzed palmprints (n = 80).

| Minutia type | B | BD | BR | C | CR | D | E | EN-BG | EN-SM | F-BG | F-SM | O | OB | P-BW | P-IN | R | S | TF-C |
|--------------|------|------|------|------|------|------|-------|-------|-------|------|------|-----|------|------|------|------|------|------|
| RF (%) | 7.56 | 0.06 | 0.98 | 5.25 | 2.26 | 0.54 | 68.29 | 0.09 | 0.23 | 1.93 | 4.87 | 2.2 | 0.04 | 3.38 | 0.08 | 0.02 | 1.47 | 0.02 |

Figure 3. Comparison of minutiae frequency between men and women. Ridge ending (E) and bifurcation (B) were suppressed from the graph to allow a better visualization of minutia types with low counting.

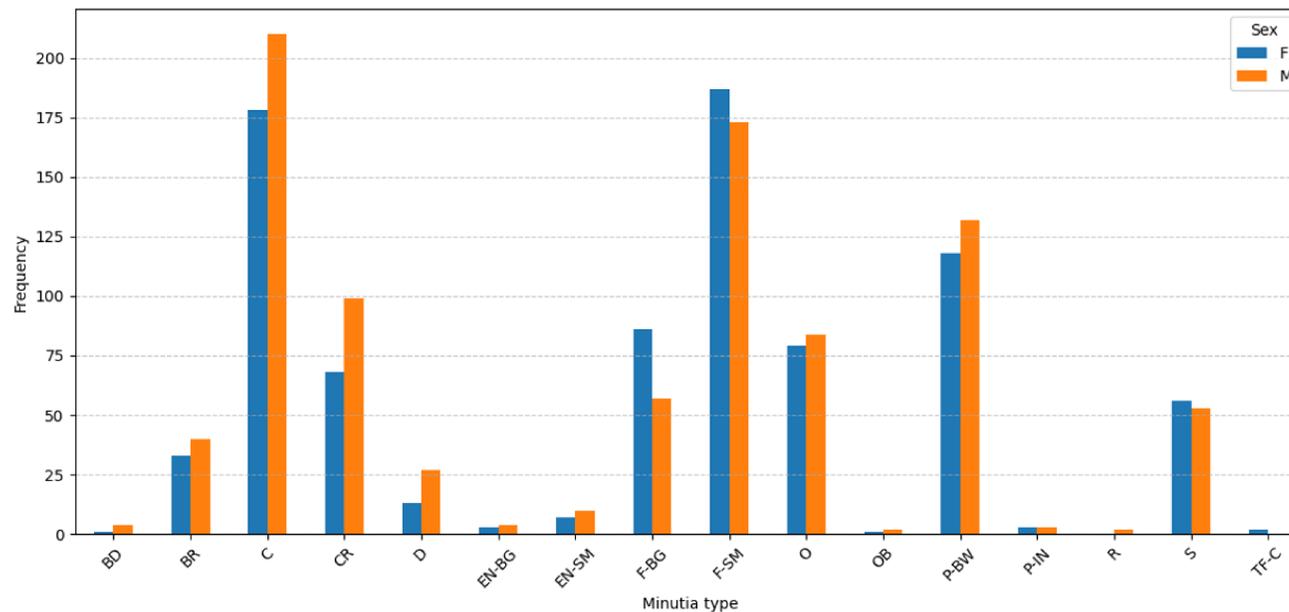


Figure 4. Highly discriminative minutia types per sex (presenting frequencies ranging from 0.9% to 0.05%).

| Men | Women |
|--|--|
| D > EN-SM > DB > EN-BG > P-IN > OB > R | BR > D > EN-SM > EN-BG > P-IN > TF-C > BD > OB |

MATERIALS & METHODS

- 20 male and 20 female - 18 and 38 y.o.
- Palmprinting by classic inking method¹ (Figure 5A).
- 21 minutia types considered^{2,3}.
- Frequencies of minutiae - for the total sample, by side, by sex, on VP IV.
- Computer Vision Annotation Tool (CVAT) software - minutia marking and computing (Figure 5B).
- Python 3.13 - data manipulation, computation of tables, Chi-square and Fisher's exact statistical tests.



Figure 5. (A) AUTOPALM Printer (SIRCHIE®, USA), (B) CVAT software.

CONCLUSIONS

Less frequent minutia types hold higher evidential value, particularly when combined with factors such as general pattern, sex, and hand (left/right).

Findings suggest that variations may depend on the specific region analyzed (other VPs, thenar, hypothenar), rather than general trends observed across the entire palmprint.

Future research needed to bridge this gap by expanding sample sizes, and improving classification methodologies.

REFERENCES

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