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Research Paper

Dermal digital ridge density of a penal population: Analysis of association and individualization

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ABSTRACT

The present study is an attempt to analyze an association between dermal digital ridge density and explosive personality based on the study of 100 male prisoners and 50 controls. The control group had higher ridge density than the prisoners. Bilateral differences revealed higher ridge density on left hand than right hand in both the groups, but differences between two groups for directional asymmetry were not significant. Surface area is not correlated with ridge density in all the digits. About 50% of the variation in ridge density may be explained by a single factor which in all probability is the genetic component of variation. Ridge density cannot be used as a marker for assessing individual's height. Individuals having ridge density less than 12 ridges and higher than 15 ridges, i.e. placed on the two extremes were more likely than not to have more explosive personality.

1. Introduction

Epidermal ridges and their arrangement exhibit a number of properties that reflect the biology of an individual. Ridge breadth is one such character that has been used as an indicator of age and sex of an individual, not only in the present day human populations but also in paleodermatoglyphic studies.[1] The above application has been possible because breadth of ridges and furrows influence the number of ridges present at a specified dermatoglyphic area, and this is called ridge density. The number of ridges has been reported to vary with an increase in age and body size/surface area.[2,3] Ridge breadth correlates with hand length and breadth.[4] Epidermal ridge characters have been used to study i) population variability as well as affinity among different populations[5–7] ii) their association with different diseases.[8–10] Sexual dimorphism in ridge density has been found in many Indian populations.[11–14] Inter-population and bimanual differences in dermal ridge density have been reported.[15]

Prevalence of explosive personality in any population is very low and it comes in many types and variations. A study conducted by Malhotra et al.[16] observed dermatoglyphic variations among prison populations involved in sex abuse and other crimes and compared the results with 10 endogamous and 11 penal populations. They found dermatoglyphic characters of sex crime offenders clustered together and these characteristics also differed from other endogamous and penal populations showing strong association between sex related crime and dermatoglyphics. Reviewing studies on the relationship of papillary pattern with criminal conduct of humans, Yarovenko[17] has demonstrated need for such studies to search unknown offenders for improving preventive measures. Any attempt to associate physical biometric attributes with criminal tendencies is out rightly rejected by social scientists ignoring physiological aspects, but such researches on behavioral criminology have been taken up in the recent times with rebirth of biological theories,[18,19] and growing studies on interaction between genes and environment including epigenetics.[20,21]

Till date, no work has been carried out for understanding the association of ridge density with explosive personality. So the present study is an attempt to highlight this aspect. The reduction factor is to find out specificity or rarity of the concordant characteristics for total ridge density observed between controls and prisoners. The conclusion of identification is considered to be an opinion based on a statement of probability expressing the probability of persons from other group (having no history of committing crime) having the same characteristic. The interpretation of this method of providing a probabilistic statement with reference to ridge density comparing controls and prisoners relies on Bayes theorem which has become more accepted in the field of forensic sciences.[22]

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The present study was done with the following major objectives: i) to find out whether variations in ridge density can help in the process of individualization of a person with tendencies of explosive personality so as to identify higher risk group of individuals; ii) association of the ridge density with stature, because ridge density has been found to be significantly associated with variations in body size. No association would entail that ridge density is independent of height. In that case height differences are eliminated as mediating factor for determining ridge density. iii) Comparison of ridge density variation among different adjacent fingertips, because these digits differ in surface area; iv) to find out bimanual differences in ridge density.

2. Material and method

The current cross sectional study consist of a sample of 100 convicted prisoners and 50 controls. Finger prints of 100 male convicts were taken from the district Kaithal jail (Haryana, North India) after taking required permission from the concerned authorities. The various types of offences for which the prisoners were convicted are: 32% convicted for murder and attempt to murder, 24% for assault (simple and grievous), 6% for offences against women, 7% for socio-economic offences, 9% for narcotics drugs and psychotropic substances and 22% for other miscellaneous offences. The control group included the students of Panjab University, Chandigarh with no history of crime. Their finger prints were taken starting from thumb, index finger, middle finger, ring finger and little finger for both the hands by simple inking method following Cummins and Midlo.[23] The digits of right and left hand were denoted as R1, R2, R3, R4, R5 and L1, L2, L3, L4, L5 respectively. All the participants were free from any deformity of fingers. Directional asymmetry of each finger's ridge density was calculated by subtracting ridge density of a left hand's fingertip from that of right hand's fingertip (R1-L1 and so on).

Ridge density value for both the prisoners and controls was gauged by counting epidermal ridges in 5 mm × 5 mm square placed diagonally on the radial side from the central core region of each finger as per method described by Acree.[24] The placement of well defined area of 5 mm × 5 mm square on the fingerprints is demonstrated in Fig. 1.

2.1. Statistical analysis

Descriptive statistics including means, standard deviations was determined for each finger using Statistical Package for Social Sciences (SPSS) version 20. The Kruskal Wallis test is One-way ANOVA on ranks for testing whether samples originated from the same distribution or not. This test was used to compare ridge density among various penal populations and also among adjacent fingertips. Bilateral differences in control and penal groups were calculated by the Wilcoxon Signed Rank test. The Mann Whitney *U* test was employed to find statistical significant differences between prisoner and control groups. The Karl Pearson's correlation coefficient (r) test was used to find the relationship between two variables. Epidermal ridge count of all the fingers of right and left hand is followed by ascertaining mean ridge count of each individual. Mean directional asymmetry in ridge density of each finger was compared between controls and penal population by *t*-test. Factor analysis of the ridge density of the ten fingers was done to find out which are the most important functions for the observed variation. Canonical discriminant function analysis was done to summarize between class variation for ridge density in control and penal populations. Probability inferences based on ridge density values for control and prisoner groups was determined by ascertaining a likelihood ratio (LR). This is expressed as Probability of given fingerprint originating from control contributor (C)/probability of given fingerprint originating from prisoners (C′).

Fig. 1. Illustration of area (5 mm × 5 mm square) used for assessing digital ridge density.

3. Results

Table 1 shows results of analysis of ridge density variations among different groups of prisoners with reference to the crime for which they were convicted. The analysis showed no significant differences (Chi square = 0.78) in the ridge density of the various categories and hence the data were pooled and analyzed as one cohort.

Table 2 presents the descriptive statistics of digital ridge density of different digits of right and left hand of prisoners and controls. In right hand maximum average ridge density was noted at R3 in both prisoners (14.03) and controls (14.38) and L4 of left hand (prisoners = 14.36; controls = 14.57), whereas minimum average ridge density was noted for R1 in prisoners (12.79) and controls (12.84/) and L1 (prisoners = 13.14; controls = 13.02) of right and left hand respectively. Ridge density in both criminals and controls from lowest to highest was in the order of: R1< R2<R5<R4<R3 for right hand and L1<L2<L5<L3<L4 for left hand. Results of nonparametric Kruskal Wallis test displayed significant differences in ridge density of different fingers in both the prisoners (Chi square: R = 32.98**; L = 27.47**) and controls (Chi square: R = 29.63**; L = 28.41**). Comparison of means between penal and control groups although demonstrated relatively higher ridge density in controls than the prisoners group (except for L1), but Mann-Whitney U- test revealed statistically non significant differences between the two groups for ridge density of different digits.

Results of bimanual differences in ridge density of different digits are presented in Table 3. Left hand digits had higher ridge density than that of right hand in both prisoners and controls. Statistically significant differences were witnessed for digits 2, 4 and 5 of the prisoners group and only for digit 2 of the control group. Results of comparison of directional asymmetry (R-L) between penal and control groups are given in Table 4 and differences between the two groups were not significant. Table 5 depicted correlation coefficient (r) of ridge density of right and left hand of prisoners with height. It is evident from the table that height had insignificant correlation with ridge density. Bimanual difference in this trend of ridge density was witnessed only in 3rd and 4th digits.

The ridge density of all 10 finger digits of each individual was summed and the mean ($\bar{x}$) ridge density was calculated for both controls and prisoners. Table 6 demonstrated probability of densities, likelihood ratio and favored odds of control and penal groups. The results revealed that when ridge density was either lower than 11 ridges or higher than 15 ridges, then it were more likely to that of individuals with explosive personality; as most of the normal