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ORIGINAL ARTICLE

Comparison of Forensic Value of Biometric Analysis in Face & Ear Recognition in the Punjabi Population, Pakistan

NADIR ALI[1], M. ASGHAR KHATTAK[2], SAMINA KANWAL[3], NOREEN FARID[4], SHEHRBANO BATOOL[5], MUFASSAR NISHAT[6]
[1]*MBBS, M Phil Forensic Medicine (UK) Assistant Professor/HOD Department of Forensic Medicine &Toxicology, Sargodha Medical College, Sargodha.*
[2]*Assistant professor Forensic medicine Kabir Medical College Peshawar*
[3]*Assistant professor Forensic medicine Khawaja Muhammad Safdar Medical College Sialkot*
[4]*Assistant professor Forensic medicine Foundation university medical college Islamabad*
[5]*House officer, Medical unit 1 Holy family hospital Rawalpindi*
[6]*Associate professor University medical & dental college. Faisalabad*
Correspondence to: Nadir Ali, Email: dr_nadir228@yahoo.com

ABSTRACT

Background: The use of face biometrics is very prevalent in forensic investigations for the identification of the perpetrators of crime due to the excessive use of CCTV footage that is usually available at the scene of a crime in urban settings. Ear biometric analysis of ear prints is also in vogue as a result of research advancements in the fields of biometrics. Keeping in view this scenario, it is the need of the hour to analyze the forensic value of this type of forensic evidence and compare these two tools of forensic biometrics.

Purpose: To analyze and compare the forensic value of biometric analysis of face and ear print recognitions in the Punjabi population, in Punjab, Pakistan.

Study design: This study is conducted by collecting the data from 100 samples of different people belonging to different backgrounds from different cities in Punjab, Pakistan after their informed consent and ethical approval. Their facial photographs and ear prints were collected for proceeding biometric analysis to form a database for comparison and recognition.

Method and materials: After collecting data, the comparison is done to see whether we can recognize a person by only using ear print analysis or face biometrics after running a search in our own created database. Moreover, we also calculated the forensic values of this biometric analysis separately on its own and combined these two i.e., face and ear biometrics. . Furthermore, standard deviation, F-statistics, and Chitest p-value were also applied to see the power of discrimination of these two biometric methods of identification

Results: In 100 samples, face recognition was proved to be 80 % recognition of identity as compared with only ear prints which showed 56 % accuracy in identifying the individuals who participated in this research. Furthermore, the combined result of both face recognition and ear biometrics showed 90 % recognition of the identity of the individuals. Statistical analysis proved that biometric analysis of the face for recognition of the identity of individuals was more valued as compared with ear print recognition. Also, it was found that if we combine these two methods of biometrics, the forensic value of recognition of individuals has increased and showed good results.

Conclusion: The forensic value of biometric evidence of face and ear recognition is a very important tool for the forensic identification of individuals in crime scene investigations. Biometric facial recognition is better as compared to only ear print biometric analysis. Furthermore, using face and ear biometrics enhances the forensic value of biometric analysis.

Keywords: Biometric analysis**,** Forensic value, face recognition, ear print recognition,

INTRODUCTION

Face recognition is considered as the natural way of recognizing the individuals all over the world. Face biometrics are now very extensively used in the world ranging from mobile phones are unlocked by face biometric to very advanced level of security depending upon facial recognition (1,2). This miraculous advancement of face biometrics is now being used for forensic purposes as well as it was used in the past with little development at that time (3). Digitalizations of biometric features in computer forensic and cyber security have also posed great responsibilities to the law enforcement agencies and forensic experts all over the world (4). The forensic evidence of biometric analysis has become prime concern for law enforcement agencies to solve different crime scenes occurring day to day. Due to presence of CCTV footages at urban level has imposed a great demand to recognize the perpetrators of crimes from these footages by using biometrics of face, ear, gait, and other body structure visible in these footages(5).

The main purpose of biometric analysis is to utilize the facial features to recognize a person who is involved in some criminal activity or to exclude him from the crime(6,7). This relationship is fairly important in all crime scene investigations to identify the people. This is a kind of corroborative evidence which will be used in addition with other trace evidences like latent finger prints, foot prints or other minute material left at the scene of crime by the suspected offenders(8). The forensic biometric analysis is used by two ways in solving the forensic cases. Firstly it is used for the identification purposes where we have some piece of evidence in the form of photograph or a CCTV photo and then we compare it with already existing database to see for any hit of matching(9). Secondly, it is used for verification, where someone claims an identity and we verify by comparing it with data already provided by him (10). The first purpose of biometric identifications is extensively used in forensic investigations to search perpetrators of crime while second purpose is mostly used in international airports where the biometric identity given in the passport is compared with actual ones.

Ear prints are also being used for identifications of persons as it may be present at the scene of crime especially if the perpetrators of crime touches & places his/her ear to a door for listening sounds inside the room before breaking in the house(10,11). These ear prints may also be used for many purposes in crime scene investigations such as increasing the evidence to identify and verifying a suspect or exonerate him(12,13). However, the forensic value of ear prints alone has also been challenged in many countries and thus it is also used to add on evidence with other evidentiary materials before finalizing the identity or verification(14). Admissibility of only ear print in courts of law has always in question in many trail court decision(14). The latent ear prints taken from crime scene may be missing some parts which become another difficulty to recognition problem due unequal elevations and depressions of these different parts. Therefore, ear mages are considered better evidence and explaining the almost all parts and also ear images are fairly available while examining the CCTV footages of a crime scene.

In an ear print or image, we usually see the width & length of an ear print to see the variation among people along with the different parts of ear such as helix, anti-helixes, tragus, anti-tragus , lobe , curs and fosse. In these parts, helix, anti-helixes, tragus and anti-tragus are elevated parts of ear which usually seen

prominent in ear prints while in ear images usually all parts are visible except the cases of blurry footages (15). There can be many challenging ear prints and ear images when the surveillance cameras are placed at large distance from crime scene or ear images are occluded by hair or partially hidden in mask. In these cases we receive ear images with missing information of some parts which decrease the forensic value as evidentiary material in forensic investigations. In case of ear prints there can be variation of same ear print of single person due to ear print taking techniques as there can pressed print masking some details of some parts of ear while other one can be lightly pressed (16).

The use of face biometric is very prevalent in forensic investigations for the purpose of identification of the perpetrators of crime due to excessive use of CCTV footages that are usually available at scene of crime in urban settings(17). Ear biometric analysis of ear prints are also in vogue as results of research advancements in the fields of biometrics. Keeping in view this scenario, it is need of hour to analyze the forensic value of this type of forensic evidence and compare these two tools of forensic biometrics.

METHODOLOGY

Purpose: In this study we analyzed and compared the forensic value of biometric analysis of face and ear print recognitions in Punjabi population, Punjab, Pakistan. This study would describe question of admissibility and verification of this forensic biometric method. Statically, power of discrimination by this biometric method would be explained as well.

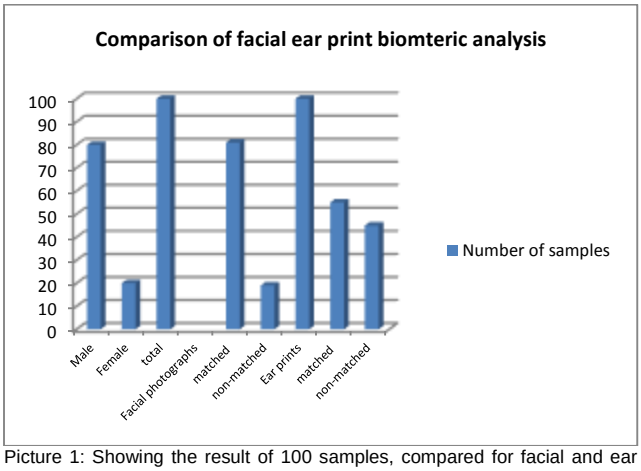
Study design: This study is conducted by collecting the data of 100 samples of different people belonging to different backgrounds from different cities of Punjab, Pakistan after their informed consent and ethical approval. Their facial photographs and ear prints were collected for proceeding biometric analysis to form a database for comparison and recognition.

Method and materials: After collecting data, the comparison is done to see whether we can recognize a person by only using ear print analysis or face biometric after running a search in our own created database. The data base used to record all the biometric data of photographs and ear prints was Automatic Biometric Identification system (ABIS) as used by many other researchers (18). Moreover, we also calculated the forensic values of this biometric analysis separately at its own and combining these two i.e., face and ear biometrics. Furthermore, standard deviation, F-statistics, and Chitest p-value were also applied to see power of discrimination of these two biometric methods of identification.

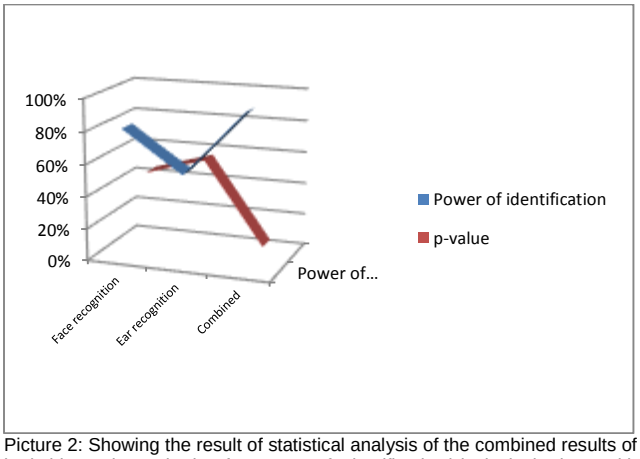
RESULTS

In 100 samples, face recognition was proved to be 80 % recognition of identity as compared with only ear prints which showed 56 % accuracy in identifying the individuals who participated in this research (See pic.1). Statistical analysis proved that biometric analysis of face recognition of the identity of individuals was more valued as compared with ear print recognition.

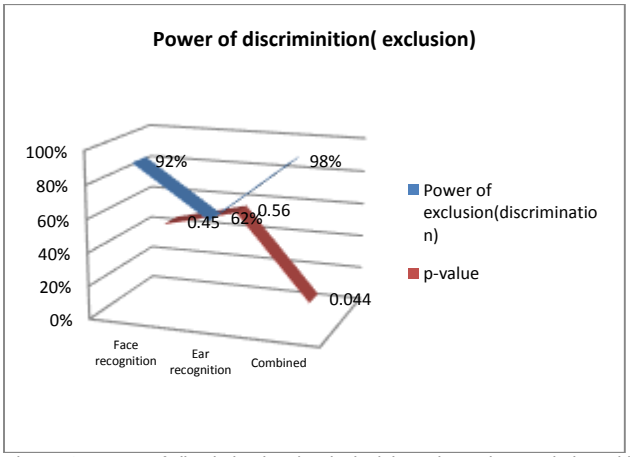
Furthermore, the combined result of both face recognition and ear biometrics showed 96 % recognition of the identity of the individuals. Hence, it was found that if we combine these two methods of biometrics, the forensic value of recognition of individuals has increased and showed good results. It is obvious from picture 2 that the forensic value of the combined result has statically more correlated with the p-value very close to 0.05 which predicts it is very near to our supposed 100 % absolute identification of a person when we search by combining these two biometrics shreds of evidence recovered from the crime scene and use ABIS (Automated Biometric Identification System) to find out the match. However, these results are for a controlled set of samples where evidence of a single match is in very good shape (a photograph or an ear print) and showed good matching while using database search with ABIS. This is used when we can identify and confirm a suspected person's biometric evidence and he is found in our existing database as well.



Picture 1: Showing the result of 100 samples, compared for facial and ear biometric analysis by using ABIS (Automatic Biometric Analysis System)



Picture 2: Showing the result of statistical analysis of the combined results of both biometric methods for power of Identification(inclusion) along with their p –value comparison.



Picture 3: Power of discrimination (exclusion) has shown in correlation with their p-values after statistical analysis.

This biometric tool by combining facial and ear print or photograph are also used to exonerate or exclude suspect being involved in the crime scene. It has also shown very statistically correlated as seen in the results of this research study in picture 3.

Power of discrimination has great agreement with p-value of 0.044 which is very much near to our supposed p-value of 0.05. Hence, this is very power tool for excluding a suspect being involved in crime scene.

DISCUSSIONS

Many biometric studies have shown many valuable biometric markers that are being utilized by law enforcement agencies all over the world in forensic investigations to solve different crime scenes all over the world (19). Sketch-to-face photo comparison, tattoo mark matching, fingerprints on documents handled by criminals, mobile locking & ant locking system, advanced devices of audio recordings of secrete messages, and matching the sound tapes are the latest biometric tools that are being used by crime protecting agencies and law enforcement departments nowadays (20). This research study has investigated on a very minute scale with 100 samples the importance of two biometric methods of facial recognition and ear print biometric examination in a limited capacity. Furthermore, their comparison by considering their forensic values was also established which can be further enhanced by using more samples and incorporating more new biometric methods in the future as well.

Facial recognition as a biometric tool was demonstrated as a better biometric tool as compared to ear print /photograph. This fact was well established by many researchers who already had worked and performed the same studies on different populations in different parts of the world (21, 22, 23). This study is unique in the sense that it has compared the forensic value of these two biometric methods and proved the validity, admissibility, verification, and confirmation of forensic evidence of biometric face & ear print recognition in the modern world. The biometric data regarding demographic description has shown interesting results as male participants were in more numbers as compared to female participants in this research. There were three times more males as compared to females who participated in this study due social dynamics of Punjab province. Females were found hesitant to give consent to include their facial photographs in this study due to religious and family constraints. Furthermore, it was very difficult to get their ear prints as there were many changes in ear structure has changed their morphology due to ear piercing and the use of earrings as ornaments. Although, the use of a special type of ear piercing and earrings can be used as another parameter for their identification in forensic investigations and it is used in many forensic investigations as additional evidence.

This fact was well established if we see in picture 1 that facial recognition has two times more matches than ear prints if we do a random search in facial recognition in ABIS software for a specific person. Moreover by combining these two parameters the value of forensic evidence shows nearly 96% of results which have determined the combined value of these powerful forensic tools(24,25). Picture 2 has remarkably demonstrated the power of identification which proved the inclusion of a person being involved in a crime scene from where the biometric evidence has been collected during crime scene investigations. This graph has shown the statistical analysis of the p-value which is very much in the direction of proving the authenticity of the results of this study (26). Furthermore, picture 3 has also demonstrated the forensic value of these two biometric methods in forensic investigations when it is used to exclude some person (suspected) being not involved in a crime scene(27). The power of exclusion has been in co-relation with a number of samples which is seen with p-values analysis in this study.

CONCLUSIONS

The forensic value of biometric evidence of face and ear recognition is great. It is a very important tool for the forensic identification of individuals in crime scene investigations. Biometric facial recognition is better as compared to only ear print biometric analysis. Furthermore, using face and ear biometrics enhances the forensic value of biometric analysis. The statistical analysis demonstrated that these biometric tools should be used in forensic investigations with confidence and they can solve the problems of validity, authenticity, and accuracy of forensic investigations by using these two biometric tools together.

Future Implications and limitation of the study: This research study has investigated although on a very minute scale (with 100 samples) the importance of two biometric methods of facial recognition and ear print biometric examination in a limited capacity. This research study has very promising future implications in forensic investigations as cyber crimes are in vogue these days. Forensic investigators and law enforcement agencies are increasing their capacity to validate and evolve new advanced methods of biometric identifications of crime scene shreds of evidence. There is a need for further research studies in the field of biometric analysis to invent new biometric gadgets to solve cyber crimes.

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