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An anatomical and photographic technique for forensic facial identification

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Abstract

The increase in the use of photographs on individual identification credentials such as driving licences, credit cards, security passes and passports has led, for the purpose of criminal activities, to the falsification of genuine documents bearing photographs of the perpetrating criminal. These photographs may be used as valuable physical evidence when compared with known photographs of a suspect as they form somewhat of a *signature* of the suspect that is left behind on the evidence. The comparison of ID photographs requires the cooperation of two predominantly visual disciplines; forensic photography and morphological anatomy. This paper describes a photographic technique which allows accurate anatomical measurement and tracing of facial features, which allows direct physical comparison of ID document images.

Keywords: Anatomy; Photography; Facial identification

1. Introduction

The use of photographs to determine people's identity has been used by authorities since the middle of the nineteenth century and included in individual's criminal and prison records [1–3]. Prisoners appearing before the courts were identified by such records. One can imagine that photographing unwilling and uncooperative prisoners at that time, was fraught with difficulty when using low light-sensitive emulsions. However, with the development and establishment of fingerprint technology, fingerprints became more widely used than the early photographs and proved to be a more reliable method of identification.

Today, throughout the world, photographs are still used and are included as part of prisoners' records. Law agencies universally, routinely use fingerprints and photographs for prisoner records. These images have become commonly referred to as 'mug shots' and are characterised by two photographs, one facing directly into the camera and the other a profile. This begs the question, why are photographs used so commonly when fingerprints are a more reliable source of identification? The answer is quite simple; photographs are used so that a lay person, including customs officials, can make cursory identification by comparing the suspect in question with his/her photograph. Fingerprint identification on the other hand, requires a trained and qualified eye; a fingerprint expert.

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With the refinement of imaging technology, and the need to produce credentials that are more difficult to counterfeit, ID photographs have been incorporated into the design of many credentials, including passports, driving licences, credit cards, security passes and workplace identification.

The advantages and simplicity of visual identification by means of a photograph, and the current interface of imagery with electronic equipment, has led to the utilisation of ID photographs on many credential documents. In Australia, several state driver's licences, credit cards, workplace passes, passports, visa applications and library cards now include a photograph of the owner as a method of authenticity. For persons involved in criminal activity, creating an alias supported by known documentation requires them to use their own photograph on the document. Consequently, it has become increasingly more difficult for criminals to support their aliases without visual identification, due to the widespread use of ID photographs. This has led to the practice of applying for original credential documents under a *false name*, but using a *true photograph* of themselves. After all, a genuine credential document with someone else's photograph is not much use to the potential money launderer or drug importer.

Obtaining original but falsified credentials, by gaining genuine documents supplied by official authorities using an alias identity, offers many benefits to people involved in criminal activity. International travel and movements cannot be detected easily by authorities and the transaction of money through several accounts, established using their falsified credentials, are difficult to trace back to the criminal source when detected. These accounts successfully launder many millions of dollars worth of proceeds from illegal activity, including drug profits. Obtaining evidence towards a conviction of supplying false information for the purpose of gaining a passport (or other credentials) is often difficult for police. Handwriting analysis of the application forms may offer some physical evidence, however many forensic examinations overlook the identification photograph attached to the application and included on the credential. If the ID photograph used on the credential can be identified as the suspect by a comparison of a known photograph(s) such as a police arrest photograph, the level of detection of this type of fraud would be significantly increased. Methods employed by criminals to avoid detection would also become more difficult because they must use their own photograph for the credential to be of any value. Their ID photograph on the falsified credential is somewhat of a signature the criminal is forced to leave behind and should be exploited by forensic investigators.

Several investigations by the Australian Federal Police (AFP) and the National Crime Authority (NCA) have required the authors to identify persons whose photograph has appeared on falsified documentation. The identification of suspect ID photographs by means of a comparison with a known photograph, has two significant advantages: firstly it offers investigating police information when tracing money laundered through accounts, and secondly offers physical evidence when taking cases to a court of law [4,5]. This paper presents the photographic technique and method of anatomical comparison used by the authors on a number of cases, which resulted in successful prosecutions by the AFP and NCA.

2. Historical background

The comparison of photographs to determine a person's identity is certainly not a new concept. In 1871, physical evidence in the form of a comparison between two photographs (a daguerreotype and an albumen print) was presented and heard in an English court; the then very famous 'Tichborne Claimant' case. An extremely interesting case in which many questions remain unanswered. In 1854, a young and wealthy man, Sir Roger Tichborne from Hampshire, England, vanished on an overseas holiday, suspected drowned in a shipwreck. Lady Tichborne, Sir Roger's mother, refused to believe her son was dead and continued a vigilant search for him. Eleven years after Sir Roger's disappearance, a butcher from Wagga Wagga, Australia, claimed through the 'Missing Friends Office' to be Sir Roger. Lady Tichborne declared "This is my son..." when she first laid eyes on the man. However, many people with obvious vested interests in the estate, disputed the claim which eventually led to the court case in 1871. During the court proceedings evidence was heard with respect to the comparison of the daguerreotype photograph of a young Sir Roger, with an albumen print of the older

and heavier Claimant. Much of the scientific method of obtaining physical evidence as we now know it was yet to be born, while the comparison of two such different media would have also presented many difficulties, let alone the fact that they were created so far apart in time. The case continued until 1874 when Lord Chief Justice Cockburn finished his summing up. The latter took a month and over a quarter of a million words filling two volumes. The jury found the Claimant not to be Sir Roger Tichborne who was later charged and sentenced for perjury. After spending 10 years in prison he was released, maintaining that he was Sir Roger. He died somewhat ironically, on April Fool's Day in 1898, a pauper.

3. Materials and methods

3.1. Legal responsibility

Most photographs taken for forensic purposes are only used to support forensic findings and may be considered as secondary evidence. In the examinations reported here, the photographs themselves may be considered to be primary evidence. Like any primary evidence exhibit, handling of the exhibits must be carried out with the integrity of the evidence being maintained. The rules and procedures of local evidence must be strictly adhered and include:

- correct exhibit labelling,
- appropriate secured storage,
- appropriate use of police seals or other tamper proof methods,
- maintenance of evidence continuity,
- issuing and receiving of appropriate receipts of evidence,
- maintaining accurate notes of procedures and examination findings.

3.2. Photographic technique

The forensic examination or comparison is conducted on enlarged photographs of original ID documents and arrest photographs. Direct examination of original document photographs is often difficult due to the small size of the images which are often at different magnifications. The first stage of the method is to reproduce the original photographs as larger sized prints and at the same magnification. The equivalent image magnification is critical to the validity of the anatomical comparisons to be made. Magnification is determined by using the *interpupillary* distance of the subjects as a standard reference [6]. Enlargements with an interpupillary distance larger than 6 cm allows greater accuracy and measurement resolution (Fig. 1). Interpupillary distance is unlikely to vary on an individual if the techniques shown in Fig. 2 are used.

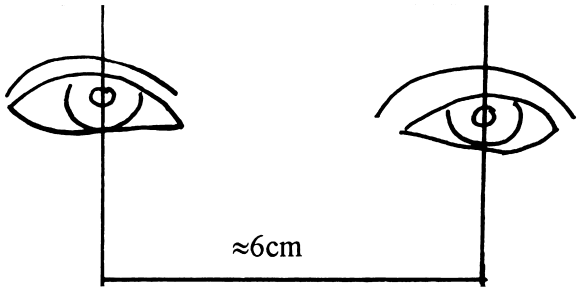

Fig. 1. Interpupillary distance.

In several cases on which the authors have worked, the supplied photographs have been stained due to previous fingerprint examination of the original credential. These can be removed by using an appropriate Kodak™ colour-compensating filter when copying the photograph.

Positive overlays of the photographs may be produced using graphic reproduction film and placing the photographs over each other on a light table. While these methods were originally tried by the authors, they were found unsuitable due to image displacement on the vertical axis. Direct visual comparison is subjective and individual, and commonly places too much responsibility on lay jurors who cannot be expected to become forensic experts in the time allowed them in court.

In this technique comparisons should only be conducted from photographs taken in *norma frontalis*. Photographs used for identification credentials characteristically display this view, rendering most ID photographs suitable. They are usually taken from a camera angle positioned directly in front of the subject, with the subject standing square to the camera. The camera height however will vary depending on the height of the subject and the photographer respectively, although most official ID document photographs are taken with fixed cameras. Two photographs taken at *different camera heights* will

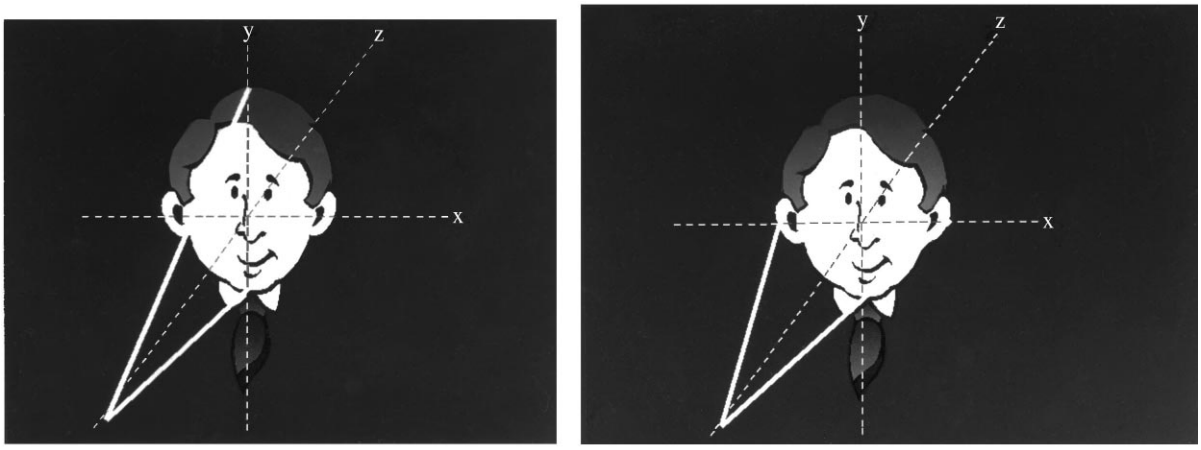

Fig. 2. Distance relationships from a camera viewpoint to two points on (a) the vertical axis (b) the horizontal axis.

exhibit differences in the *vertical axis*. In practical terms, when these two photographs at equivalent magnifications, are overlaid onto each other, a vertical misalignment of facial features occurs.

When reproducing three-dimensional photographs, subjects further away from the camera lens reproduce at a lower magnification. Distortion of the vertical axis results from the differences in distance from the camera of the furthermost and nearest vertical points (see Fig. 2). Features on the horizontal axis however, are not subject to any significant distortion, as both extreme subject points are the same distance from the camera, thus reproducing the same magnification. This only stands true if the original photographs were taken directly in front of the subject with the latter facing square to the camera.

The misalignment of facial features caused by the vertical axis distortion and the size of most ID documents, may explain why identification photographs have not been more widely used as a source of identification. With appropriate consideration paid to vertical distortion and magnification using the interpupillary distance as a standard, accurate analysis of facial features can be made on the horizontal axis.

Other factors which must be considered in relation to image distortion, are the focal length of the camera lens and subject distance. Consultation with manufacturers of ID photography cameras, concluded that most purpose built ID cameras have equivalent film format and lens focal length, which consequently required subject-distance to remain a reasonable constant.

4. Anatomical analysis

Just as the forensic photographer must have a fastidious awareness and understanding of lens optics and image distortion, the forensic anatomist must possess a sophisticated knowledge and practical skill in craniofacial anatomy. Because experienced anatomists, are not always available for this type of examination, the technique below aims at giving even a lay observer a simple basis for interpretation, which can then be confirmed by an experienced specialist.

The identification method for facial comparison has four separate components:

- individual facial characteristics (scars, moles, dimples etc),
- form, size, shape of facial features (nose, eyebrows, mouth, ears, forehead creases),
- facial symmetry,
- anthropometric measurement.

The following case study uses one of the authors as subject to explain these methods. Although the three persons depicted in Fig. 3 have different length and style of head hair and various stages of growth of facial hair, there are enough facial similarities to warrant an objective examination.

Fig. 3. Three photographs of one of the authors used as the case study to demonstrate the examination technique.

4.1. Individual characteristics

The presence of birth marks, moles, scars etc may be observed directly from the enlarged ID photographs. In cases where the suspect has attempted to alter their appearance, cosmetic changes such as moles and 'beauty spots' must be considered.

4.2. Form, size, shape of facial features

Tracings are made from each enlarged ID photograph to display the following features: overall facial outline, including jaw line, eyes including upper lid margin and extent of inner canthus, eyebrows, nose, facial contours, ear outline if not covered by hair and forehead creases. Tracings of each feature individually, or features in relation to each other on the horizontal axis are made and compared for similarity in form, size and shape.

Case study tracings A, B and C (Fig. 4) made from the photographs in Fig. 3, were examined by superimposing each tracing. In all combinations (A on B, A on C etc) the tracings displayed remarkable correlation of outline and shape. The eyes in each photograph are of the same shape, especially the curve made by the margin (eyelash line) of the upper lids and the outline of the iris. The eyebrows have the same growth pattern and outline in each photograph. The general

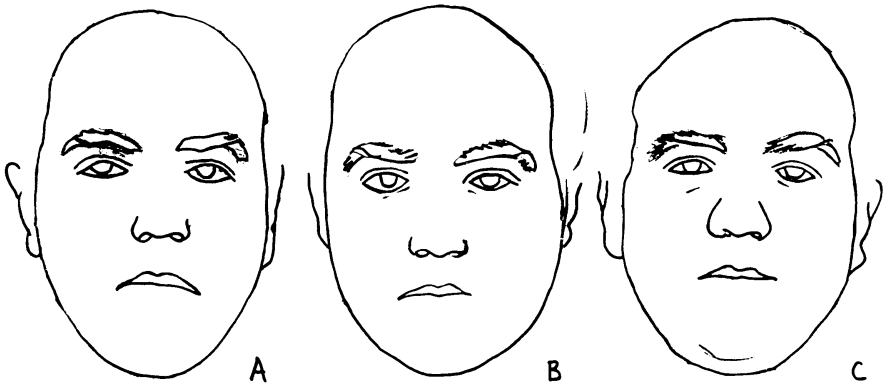

Fig. 4. Tracings made from enlarged ID photographs.

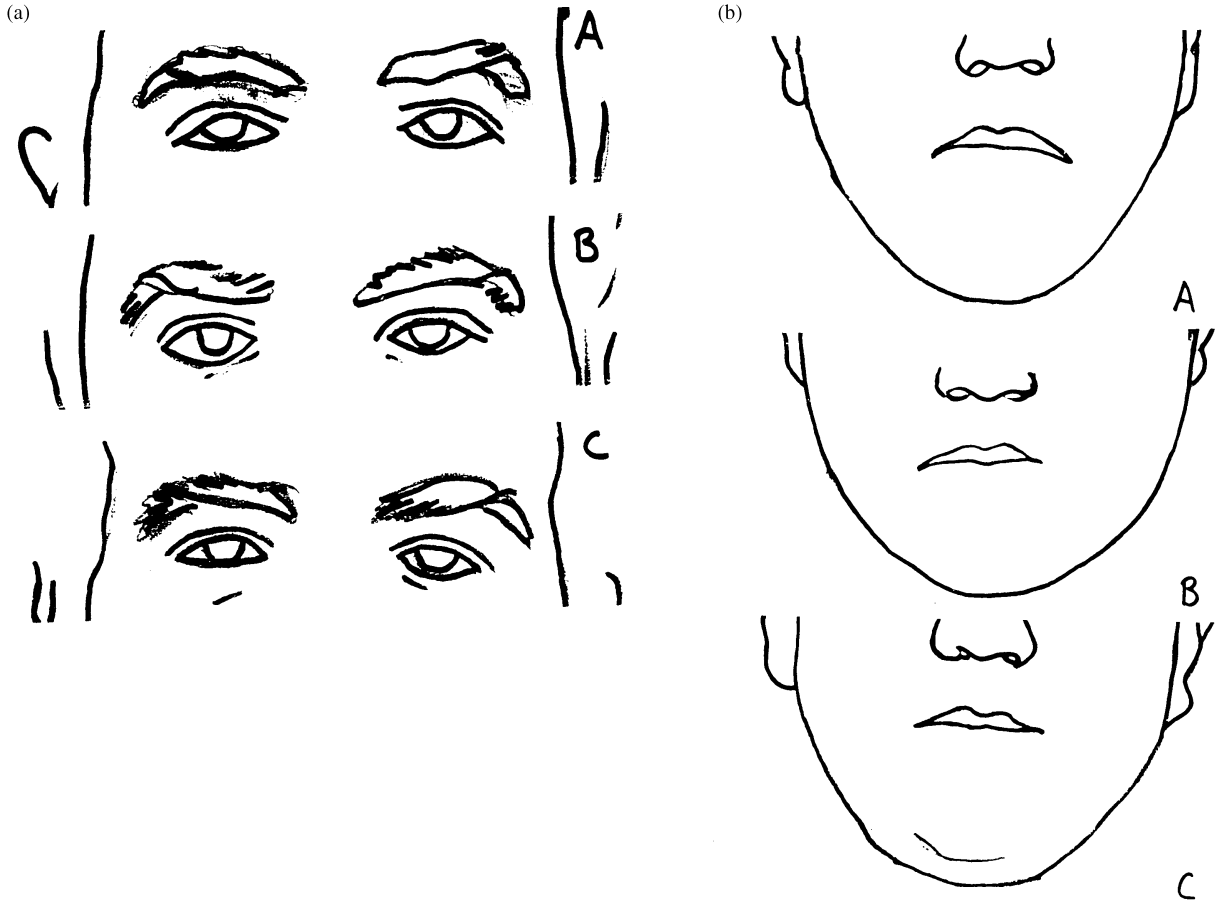

Fig. 5. (a) Enlarged tracings of the eyes and surrounding area; (b) tracing of the jaw line.

outline and shape of the nostrils is the same (Fig. 5a). The hairline, where not obscured, is likewise the same in each photograph and when combined with the overall face outline, they are virtually identical. The overall facial outline tracings correspond, particularly the jaw line from the lower border of one ear to the other (Fig. 5b).

Although changes in facial expression may vary at the time the ID document photograph is taken, subjects are usually asked to adopt a somewhat 'plain' expression.

4.3. Facial symmetry

Anatomically, human faces are rarely completely symmetrical [7]. There is often a shift of the midpoint of the chin to one side or the other of the vertical midline drawn through the nose and between the eyes. In photographs A and B (Fig. 6) there is a clear deviation of the point of the chin to the left.

4.4. Anthropometric measurement

Standard anthropometric orientation lines were drawn on all photographs (Fig. 6), including:

- horizontally, through the pupils,
- vertically, at right angles to this line at its midpoint,
- horizontally, through the oral fissure (where lips meet) parallel to the interpupillary line,
- horizontally, between the points where the mid-vertical point of the ears start at the side of the face, parallel to the interpupillary line,

Fig. 6. Photographs displaying anthropometric orientation lines.

- vertically, at the widest points of the alae (wings of nostrils) perpendicular to the point where the nasal septum meets the upper lip and
- vertically, at the widest points of the mouth on the oral fissure line.

The interpupillary distances are measured directly from the enlarged photographs to ensure correct calibration of magnification. Further measurements are then made from anatomical features on the horizontal axis only. Any measurements on the vertical axis should be strictly avoided due to the distortion consideration of this axis. Other measurements made on this case study are detailed in the table below (Table 1) and demonstrate a high degree of similarity. All measurements were made using digital callipers to the nearest 0.05 mm. Inter-observer and intra-observer error was assessed by each author making measurements on four different days. The calculated, percentage difference between the means of each day's measurements was 0.07, which is comparable to that found in other investigations [8,9].

Table 1
Anthropometric facial measurements (mm)

Area measured	Photo A	Photo B	Photo C
Interpupillary distance	44	44	44
Horizontal face width between ear roots	99	99	99
Mouth width on oral fissure line	35	33.5	33.5
Nose width on septal/lip line	25.5	25	25.5

In summary, this case study uses photographs of the same individual who has attempted to look different for each photograph. It illustrates that the anatomical form of the features traced, combined with the similarities of facial asymmetry, and the parity of the measurements recorded on the photographs are significantly similar to suggest that the three persons depicted display a 'highly likely' probability of being the same person.

4.5. Preparation of final court report

The legal requirements governing evidence vary according to Country and State. Provided local protocol, the final report involves preparing a portfolio which includes, the ID documents, the enlarged photographs, table of measurements and tracings of anatomical features examined. Overhead transparencies of the graphic material can be used in court to enable overview of the evidence which can then be confirmed by examination by all parties of the portfolio.

5. Discussion

The use of identification photographs from falsified credentials, may be considered useful as an investi-

gative tool to obtain physical evidence. The technique presented here has proven valuable for several law enforcement agencies in Australia. The authors have been successful in obtaining identifications in several cases including false passports, identifications used for money laundering, and drug smuggling.

One involved the comparison of three photographs; one of a known police arrest photograph (mug shot) and two others from genuine passports with allegedly falsified details. The latter were allegedly used for importation of heroin worth several million dollars. The authors' examination of the photographs concluded that all three were highly likely to be of the same person. This evidence resulted in charges of providing false information to obtain a passport, an offence carrying a maximum penalty of 10 years imprisonment.

The second case involved importation of heroin and laundering of several millions of dollars out of the country through numerous bank accounts opened with false credentials. Search of one of the arrested person's premises found numerous credentials listed under several names. Photographs from several driver's licences, arrest and passport photographs were examined using the technique described here. A positive identification was made and when evidence using the technique described here was presented in court, the suspect pleaded guilty and was sentenced.

The techniques described in this paper apply several different analytical methods, which can be used by the lay observer and/or an experienced anatomist who can confirm the findings using objective interpretational skills. There are many parallels between this type of forensic examination and fingerprint identification:

- both are methods of comparison between a known and unknown source,
- both deal with features subject to elements of distortion,
- both disciplines require an experienced eye and a high level of specialised knowledge,
- both make analyses from photographs of original evidence.

Like fingerprint analysis, interpretation by skilled practitioners is an essential requirement for good forensic science. While computer analysis has improved the efficiency of fingerprint examination, the input of an 'experienced eye' is certainly not obsolete. In comparative photographic analysis, one must be mindful of the fact that computer-generated evidence is still looked upon with some scepticism by courts of law. The technique described in this paper is one which produces physical evidence with which it is difficult to tamper, and in the current legal climate, more acceptable.

6. Conclusions

Facial identification requires the amalgamation of two principally visual sciences: forensic photography and morphological anatomy. The photographer provides the anatomist with images that are copied accurately without further distortion and enlarged to equal magnifications using standard anatomical reference markers. The images have had any staining from previous forensic examinations reduced or eliminated. They provide to the court, information pertaining to the integrity of the photographs, both in terms of evidence continuity and explanation and control of image distortion.

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