Abstract

The comparison and superimposition of dental images, including radiographs, are accepted methods for identification in forensic odontology. We demonstrate the use of subtraction imaging as a method for objectively displaying the degree of image concordance in cases where image superimposition is unavailable.

Introduction

Identification of a deceased person in forensic odontology requires that the examiner compares dental information from a missing person with that from a deceased. In order to form an opinion as to the likelihood that both sets of information derive from the same individual, it is necessary to demonstrate the degree of similarity in pairs of radiographs to the non-expert.

In Australia, the basis rule of expert evidence requires that the expert is able to demonstrate to a court the observations and facts on which their opinion is based, and show the reasoning that they have applied on that basis to reach their conclusion.

Comparing images such as dental radiographs provides an excellent basis for an opinion, but it can be challenging to objectively demonstrate the degree of similarity in pairs of images to the non-expert.

A range of subtraction techniques is available in such circumstances that can be used to show the precise differences between pairs of similar images, and this permits the non-expert to visualise clearly the basis for the expert opinion.

Radiographic Comparison and Superimposition

Two dental radiographs were obtained in relation to a trauma case. One was from a person believed to be missing (Figure 1 (a)), and the other was taken from the mandible (lower jaw) of a deceased person (Figure 1 (b)).

Radiographic Comparison

(a) Antemortem radiograph of missing person.

(b) Post-mortem radiograph of corresponding region of mandible of deceased.

Figure 1

Comparing the two images side-by-side (Figure 1) shows evident similarities between the features of the lower teeth common to both radiographs. However, it is apparent that the radiographs appear quite different, since one shows upper teeth (a) and the other does not (b). This may be confusing to a jury and fails to adequately demonstrate the degree to which the dental features correspond.

Image superimposition (Figure 2) may be undertaken, when the two images are sufficiently similar, to objectively demonstrate the degree of similarity. In this case, the post-mortem image has been placed over the antemortem image, and has been progressively decreased to show a comparison between the two images.

While this gives a good impression of the similarity of the relevant portions of the two images, it still does not permit a quantitative visual measure of the degree of correspondence.

Subtraction Imaging

Subtraction imaging can be performed by: printing two images in layers, one above the other; or if the top layer is made into a negative, this is superimposed on the antemortem radiograph. If the density of the layer is now decreased by 50%, all of the radiographic information is superimposed on all of the negative information.

Subtraction Imaging in a Document

The same technique could be applied to documents. When this technique is applied to the post-mortem and ante-mortem radiographs, it is immediately possible to determine that the fillings demonstrate conclusively that they are indeed the same (Figure 3).

Figure 3

Subtraction Imaging Applied to the Radiographs

When this technique is applied to the post-mortem and ante-mortem radiographs, it is immediately possible to determine that the fillings demonstrate conclusively that they are indeed the same.

The contrast width of the disparity at the edges of the dental image decreases proportionately as they cross the same image, so the differences are made more evident. The minor differences in position make the fact that the two photographs were taken at different times and under different conditions, apparent.

The other anatomical features of the two images are seen to be identical, confirming that the same individual is involved.

Figure 4

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Discussion

Subtraction imaging has the power to demonstrate objectively the degree of similarity of two or more images. It provides a way of demonstrating the basis of an expert opinion in respect of similarity of images to a lay audience that avoids the need to estimate the quantitative similarity of the points, and is a technique that can be easily understood by the non-expert when it is demonstrated to them.

There are many methods of digital subtraction that could be applied. One of the most common uses the “subtraction” tool in Photoshop. However, this process involves calculations that happen behind the scenes, resulting in “magic” for the viewer. We have adopted the current technique because every step is visible, and the theory is easily demonstrated.

It can also easily be applied to other types of image analysis. For example, Figure 5 shows the result of subtraction comparison of two similar documents that highlights the differences between the two in an unambiguous way.

Figure 5

Application to Other Disciplines

We believe that this technique may be of value in other forensic disciplines where the comparison of images to demonstrate the degree of similarity is an important aspect.

Below we demonstrate how it might be used in the comparison of fragments of document.

Subtraction Imaging in a Document

When the same technique is applied to an extracted from a document, the differences become very evident (Figure 6).

Clearly, these two versions of the same document would have very different outcomes.

Subtraction imaging permits us to easily visualise similarities and differences between images in a quantitative way, and to demonstrate these in a simple way before a court.

Figure 6

Conclusion

Subtraction imaging can be used to demonstrate the similarities or differences between images used in evidence in an objective way that is easily understood by the layman.

We have found it to be particularly useful when we have used images to demonstrate identity on the basis of dental radiography, as it clearly indicates the scope of the opinion to a non-technical audience.

It is simple to perform, and we believe that it is potentially equally valuable as a method of comparing images in other fields of forensic investigation.

Subtraction imaging in forensic dental identification

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