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Contents

ACCURACY IN ESTABLISHING IDENTITY IN EDENTULOUS INDIVIDUALS BY MEANS OF INTRAORAL RADIOGRAPHS

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ABSTRACT

The aim of this study was to evaluate the degree of accuracy in establishing identity in edentulous individuals by using occlusal "ante- and postmortem" radiographs of the maxilla. Twelve examiners with the following background; six dental radiologists, four other specialists in dentistry and two dental students were asked to combine the radiographs.

The results showed that six of the 12 observers were able to correctly establish identity for all 20 cases. Five of these observers were dental radiologists and one of them was a prosthodontist. The other specialists made 3-8 identifications. The senior and the junior dental students made two and four incorrect identifications. The findings from this study emphasise the importance of having more than one forensic specialist signing the identification form. The results also indicate that examiners well trained in oral radiology are able to determine a positive identity even in cases where the teeth are not present.

Key-words: Identification, edentulous, radiography, forensic odontology.

INTRODUCTION

In a deceased person, impossible to identify by other means, the teeth may provide sufficient information to establish identity beyond reasonable doubt[1]. Variations in number, form and positions of remaining teeth as well as in the number, type and extent of dental restorations often yield a satisfactory number of individual characteristics to compare with those recorded in dental records and, above all, in previous dental radiographs[2].

A much more difficult situation may arise when a deceased person is edentulous. In some countries this situation has been foreseen, leading to recommendations or regulations to include a personal marking (steel plate or engraving of initials) in the denture base[3-5]. However, in a recent report Thomas [6] stated that in Australia and New Zealand many dentures were not marked. In these cases a possible identification medium could be the bony pattern seen in postmortem and antemortem radiographs and whether it is sufficiently identical over time and different between individuals to allow for accurate identification.

The aim of this study is, therefore, to determine to what extent radiographs of edentulous jaws can be used to establish identity of individuals.

MATERIAL AND METHODS

Radiographs

The radiographs used were anterior maxillary occlusal projections of the maxilla. The radiographs were from "full mouth surveys" taken on patients referred to the Department of Oral Diagnostic Radiology, University of Goteborg, prior to treatment with new dentures. The radiographs were obtained with varying dental X-ray machines. The radiographic parameters were 60-65 kV and FSD was 20-28 cm

Two sets of radiographs, taken at different times (range: 5-12 years, mean 6 years) were available for each patient. From those, one occlusal film from each of the first set of radiographs was considered the "antemortem" radiograph while one from the second was considered the "postmortem" radiograph. Each radiograph was coded and mounted in a plastic frame. Twelve examiners were asked to combine 20 "ante- and 20 postmortem" radiographs.

Examiners

The twelve examiners had different clinical experience. Six were radiologists and teaching at the Department of Oral Diagnostic Radiology. The other six observers were four different dental specialists and two dental students who had passed the 2nd and 4th years of the dental course, respectively. These persons had shown interest in or been directly involved in practical forensic work.

RESULTS

The results show that of the 240 observations 23 errors were made. Six of the 12 observers were able to correctly establish identity for all cases. Five of these observers were radiologists and one of them was a prosthodontist. However, one of the radiologists was unable to identify two cases. The other specialists made either three, four or eight incorrect identifications and the senior and junior dental students made two and four incorrect identifications respectively. No errors were made by the observers in the case shown in Figures 1a and 1b. Three errors were made by the observers in a case (Figs. 2a and 2b) where a residual cyst was removed between the "ante- and the postmortem" radiograph. In Figs. 3a and 3b the "ante- and postmortem" projections are very different. Five errors were made by the observers in this case.

DISCUSSION

The observation abilities of the radiologists were significantly superior to the other specialists, a finding also of our previous, similar study on individuals with teeth[8]. This is to be expected since the radiologists who are better trained to analyse radiographs should be better able to evaluate the effect of projection differences and changes in time. In the study by Kullman et al[9] on observer variations among radiologists who studied the frontal sinus on 100 "ante-" and "postmortem" radiographs, it was found that only one error was made. In view of the findings from these studies, it appears that radiologists perform well in these types of studies.

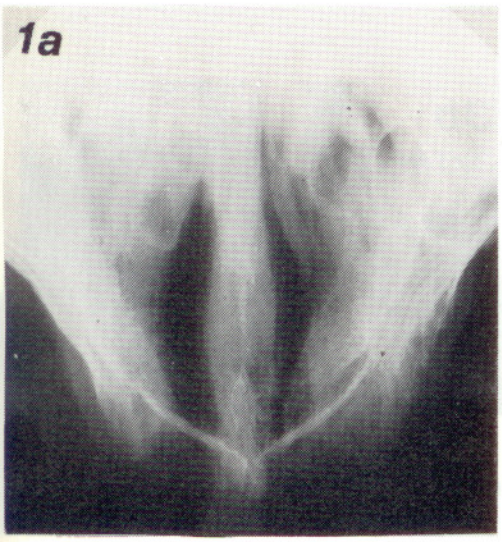
The dental students did not seem to make more mistakes than the specialists, which indicates that it is not only the specific training in the field of forensic odontology that is of importance. The students had recently had several seminars on interpretation of radiographs and did their evaluations at the end of the quarter, when the course in oral radiology was completed. This might have been advantageous for their ability to assess the ante- and postmortem findings on the radiographs.

It is important to consider the difference between experimental studies and routine forensic work. In the present experimental study, the observers had 20 antemortem radiographs to match with 20 postmortem radiographs. It could, for example, be argued that this type of experimental design is different from the practical forensic work where supplementary chart notes are usually included. However, chart notes are often incomplete and in edentulous cases they can be expected to yield limited information. Therefore, whenever possible radiographs should be integrated in the investigation after fatal accidents and in homicides, particularly since they can be used as evidence and convincing proof in court.

The above results emphasise the importance of having more than one forensic specialist signing the identification form, a procedure that is also recommended in textbooks on Forensic Odontology[2]. In view of the findings in this study, it seems to be an advantage to include an oral radiologist as a member of the forensic team.

Radiographs can serve as convincing proof of identification in mass disasters and homicides because the radiographs are permanent records of the dental data[2] and provide information about anatomy and dental restorations. Another advantage is that the ante- and the postmortem findings on radiographs can be studied and compared by several persons at different times. Usually, numerous restorations can be cross-matched and striking similarities of distinctive configurations of the restorations can be found. In edentulous persons however, only the bone morphology can be compared which might make the identification process more difficult. However, if the person had dentures they are usually marked with a metal label or engraved with the first letters of the person's name. It should be remembered that even if a denture is found in a person's mouth, it might not belong to that particular person[7].

Multiple factors come into play when identity of an edentulous person using introral radiographs has to be determined. Comparisons of ante- and postmortem radiographs are based on observing marrow spaces, nutrient canals, incisive canal, median suture, retained roots, impacted teeth, scleroses and/or lucencies. However, bone resorption at the alveolar crest and possible changes in the trabecular pattern in edentulous patients might cause difficulties in comparisons over a period of time. Moreover, the degree of bone resorption is difficult to evaluate in intraoral radiographs obtained with different projections. In the present study there seemed to be an increase in the amount of bone because the postmortem radiographs were taken with a smaller angle towards the maxilla, compared to the angulation in the antemortem radiographs. It is fortunate that, in forensic odontology, optimal postmortem projections can usually be obtained.



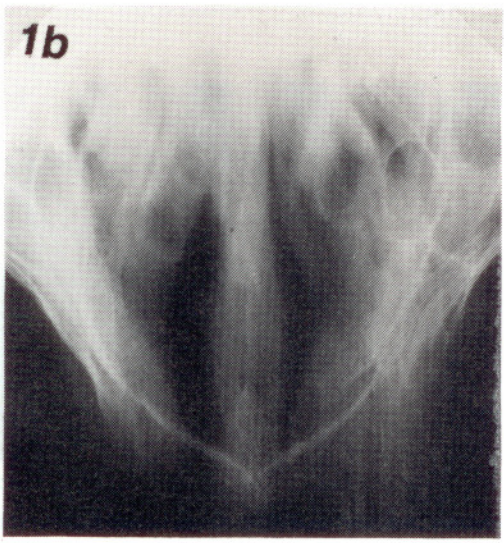
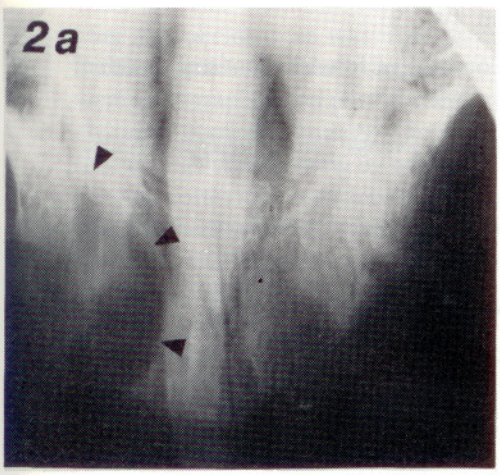


Fig. 1a "Antemortem" radiograph. Fig. 1b "Postmortem" radiograph. No errors were made by the observers in this case. The projections and the contrast are very similar on the radiographs taken in 1975 and in 1985.



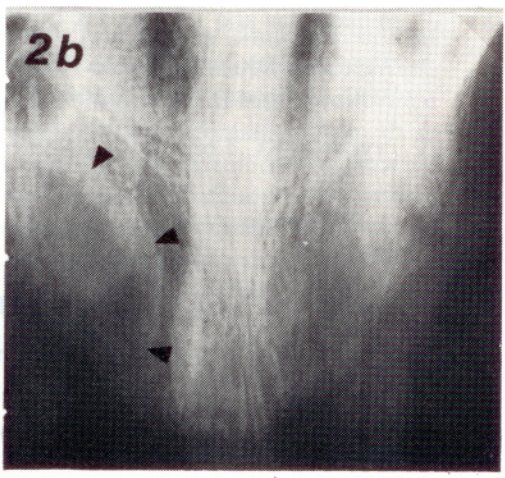
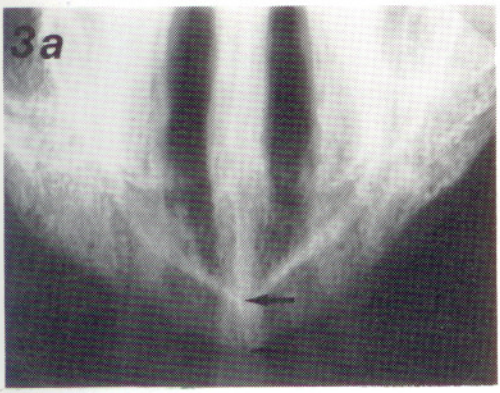


Fig. 2a "Antemortem" radiograph. Fig. 2b "Postmortem" radiograph. Three errors were made by the observers in this case. A residual cyst (arrows) is seen on the undistinct "antemortem" radiograph from 1977. The "postmortem" radiograph is taken six years after surgery. The border of the lesion is indicated (arrows).



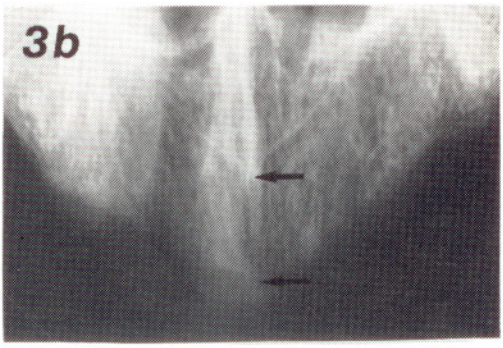


Fig. 3a "Antemortem" radiograph. Fig. 3b "Postmortem" radiograph. Five errors were made by the observers in this case. The projections are very different. The "ante- and the postmortem" radiographs seem to have been mixed up, but a "gain" in alveolar bone (arrowed) as seen on the "postmortem" radiograph was an artifact in this case.

REFERENCES

1. Luntz LL. X-ray techniques in dental identification. In: Luntz LL and Luntz P eds. Handbook for dental identification. Techniques in forensic dentistry. Philadelphia and Toronto: J.B. Lippincott, 1973:91.
2. Whittaker DK, MacDonald DG. A color atlas of forensic dentistry. London: Wolfe Medical Publishers, 1989.
3. Frykholm KC, Lofberg PG. Protesemarkning. Svensk Tandl Tidskrift 1968: 61: 177-82.
4. Harvey W. Identity by teeth and the marking of dentures. Br Dent J 1966: 121: 334-40.
5. Jerman AC. Denture identification. J Am Dent Assoc. 1970: 80: 1358-9.
6. Thomas CJ. The forensic implications of denture marks and marking. Abstract, 12th Meeting of the Int. Ass. of For. Sci., Adelaide, October 24-29, 1990.
7. Jakush J. Forensic dentistry. J Am Dent Assoc 1989: 119: 356-68.
8. Borrman H, Grondahl H-G. Accuracy in establishing identity by means of intraoral radiographs. J Forensic Odonto-Stomatol 1991: 8: 31-6.
9. Kullman L, Eklund B, Grundin R. The value of the frontal sinus in identification of unknown persons. J Forensic Odonto-Stomatol 1990: 8: 3-10.

EXHUMATION FOLLOWING INCORRECT IDENTIFICATION

A CASE REPORT

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ABSTRACT

The exhumation of two victims of a light aircraft accident was performed in February 1991 at Oudtshoorn, Cape. The exhumation was ordered by the magistrate on request of the parents of one of the victims who suspected that their son had been wrongly identified at the postmortem examination. At the pre-burial autopsy all the victims were positively identified, but the identity of two of the victims was subsequently reconsidered and reversed because one of them wore a silver bracelet. Burial then took place. The exhumation was ordered one month after the accident at which stage the bodies were in an advanced state of decomposition. Oral autopsies were performed on each of the victims, the jaws were radiographed and postmortem dental records drawn up. Dental records were obtained from the dentists who treated them and the information from these records was used to draw up ante-mortem dental records. A comparison between the postmortem and ante-mortem records showed that the victims were incorrectly identified and reburial in the correct graves was subsequently carried out. This case again emphasises the importance of dental identification in cases of severe burning, mutilation or decomposition in order to avoid mistaken identity and incorrect burial in the future.

INTRODUCTION

An exhumation of human remains in South Africa is not a common occurrence. It must be ordered by a magistrate or the attorney-general of the district where the person is buried and is only considered if there is strong evidence that a crime has been committed or for humanitarian reasons. In the case of reinternment of remains at a different location, according to the will of the deceased, the application for exhumation and reburial is organised by undertakers. The reinternment of the exhumed body is the responsibility and at the expense of the authorities who ordered the exhumation.

The postmortem examination of the exhumed body is undertaken by the state pathologist who is accompanied by the person who undertook the original postmortem examination. Other forensic experts may also be required to examine the remains and express their opinions. Specimens are collected and submitted for laboratory analysis in the usual manner, but autolysis of the tissues must be taken into account when interpreting the results.

A case of mistaken identity of two victims after an aeroplane crash is reported. Only after exhumation and examination by forensic odontologists was correct identification established.

CASE REPORT

In January 1991 a light areoplane carrying four passengers crashed at Oudtshoorn in the eastern Cape. All the occupants were killed. At the autopsy all of the victims were positively identified by members of their families. Just before the bodies were released for burial, however, doubt was expressed as to the identification of two of the victims (G.C. and J.D.F.) who were severely mutilated. The father of one of them (G.C.) maintained that his son sometimes wore a silver bracelet and as one of the victims had a silver bracelet on his arm he felt that an incorrect identification had been made. As no other evidence to the contrary was forthcoming, the identities of these two bodies were reversed, despite a certain amount of controversy from the rest of his family and police.

Subsequently, after the funeral, the mother of G.C. expressed her strongest doubts about the identification of her son. She maintained that he only wore a silver bracelet infrequently and she was sure that he had not worn it on the day of the accident. This then led to the search of the parents' house and the apartment of the deceased where the bracelet was eventually found. The magistrate in Oudtshoorn was approached with this new evidence and he then ordered an exhumation of the two alleged incorrectly identified bodies, requesting the state pathologist to investigate the matter. Because of the mutilation and decomposition of the bodies the only means of identification was by dental examination. The authors were contacted and one month after burial we examined the remains of the two victims, J.D.F. and G.C.

POSTMORTEM EXAMINATION

The bodies were in an advanced state of liquefactive decomposition and examination was only possible with the use of repirators. The jaws of the victims were removed and placed in formol-saline solution in labelled containers. Postmortem radiographs (Figs. 1 and 3) of the jaws were taken and a postmortem dental records (Figs. 5 and 7) was drawn up for each victim. The body labelled 8/91 was alleged to be G.C. and 9/91 was presumed to be J.D.F.

ANTE-MORTEM RECORDS

Well documented ante-mortem dental records and radiographs (Figs. 2 and 4) were obtained from the relevant dental practitioners. Ante-mortem dental records (Figs. 6 and 8) were accordingly drawn up for comparison with the postmortem findings for each victim. The dental records consisted of written record cards and "bitewing" or periapical radiographs of the posterior teeth.

RESULTS

Postmortem examination of the jaws and radiographs (Fig. 1) of body 8/91 showed that all the teeth were present and that there were several amalgam restorations in the posterior teeth. The 3rd molars 18, 28 and 38 were partially erupted and the 48 was impacted. The lower left lateral incisor (32) was missing (Fig. 5). The jaws and radiographs (Fig. 3) of body 9/91 showed that the 1st maxillary premolars (14 and 24) and the 2nd mandibular premolars (35 and 45) were missing. The 3rd molars (18, 28 and 48) were partially erupted and the 38 was unerupted. There were also amalgam restorations in some of the posterior teeth (Fig. 7). It was then a simple matter to distinguish between the two bodies. When the ante-mortem dental records were examined it was found that G.C. (Fig. 8) had had orthodontic treatment and that his 14, 24, 35 and 45 teeth had been extracted whereas J.D.F. (Fig. 6) had all his premolars. The two corpses could thus be correctly labelled. However, to avoid any possible doubt the ante- and postmortem charts for both victims were completed and utilised to confirm the positive identification of both bodies. Reburial of G.C. and J.D.F. could then take place to the satisfaction of all parties.

DISCUSSION

Cases of incorrect visual identification that have later been corrected by dental identification have occurred in a fire in Oslo[1], in the Aberfan disaster[2] and in air disasters[3,4]. Cameron and Sims[5] stated that a particular advantage of dental identification is that it is made on the evidence of written records that are compiled by dental surgeons before the death of the unidentified person. Identification does not therefore depend on involvement of distressed relatives, who are usually deeply shocked. These judgements are often unreliable, particularly when they are purely visual. Not only is it an unpleasant task for a relative to attempt this, especially when a large number of severely mutilated corpses have to be viewed, but there is also a strong need to achieve something positive, however poor the resemblance to the missing person may be.

During the autopsies on the victims J.D.F. and G.C. doubt was expressed as to their identification. The presence of a silver bracelet on the wrist of one of the victims, which the father of G.C. maintained that his son occasionally wore, was mistakenly accepted as definitive evidence for conclusive identification. Stevens[6] has described experiences of several cases of false identifications and one of false negative identification where items of unmarked jewellery were used. There are very few people, even those trained in pathology, who can make objective decisions when emotionally involved in the death of a relative.

This case again stresses two important points. Firstly, the social pressure placed on the police, in the case of mutilating accidents, to bury the victims as soon as possible. This happens in small towns where prominent and influential people are involved. They unfortunately have the ability to override the accepted procedures with the occasional disastrous consequences. Secondly, in accidents where mutilation and severe burning of the victims occurs, it is essential that the authorities make absolutely sure that they have positive identification of the corpses before they release them for burial. It is far easier and less traumatic for the relatives to delay a funeral by a day to allow expert scientific proof of identification to be obtained than to obtain a court order for an exhumation which is costly and which causes further distress to the relatives. There is a mass of experience which has shown that where ante-mortem records are available, the use of fingerprints or the dental formula are the best methods of identifying burnt or mutilated corpses. Experts should be consulted on a far more regular basis to avoid grave mistakes.

CONCLUSIONS

Two severely mutilated victims of an air crash were mistakenly identified at the original postmortem examination by means of a bracelet and not by established scientific procedures such as dental charting.

When dental examination was carried out body 8/91 was found to be J.D.F. with 18 concordant features between ante- and postmortem dental records while body 9/91 was identified as G.C. with 24 concordant features.

To depend on unmarked jewellery as a means of identification has thus been shown to be unreliable and it should be treated at all times with caution.

REFERENCES

1. Strom F, Taverud G. Die brandkatastrophe in Oslo 1938 und die ergebnisse der zahnarzt lichen mitarbeit bei der identifiziering der verungluckten. Dtsch Zahn Mund-u Kieferheilk 1940; 7: 720-31.
2. Knott NJ. Identification by teeth of casualties in the Aberfan disaster. Br Dent J 1967; 122: 144-9.
3. Haines DH. Dental identification in the Stockport air disaster. Br Dent J 1967; 123: 336-42.
4. Ashley KF. Identification of children in a mass disaster by estimation of dental age. Br Dent J 1970; 124: 167-71.
5. Cameron JM, Sims BG. Mass disaster identification. Forensic dentistry. London: Churchill Livingstone, 1974: 117.
6. Stevens PJ. Fatal civil aircraft accidents. Bristol: John Wright and Sons, 1970: 142-7.

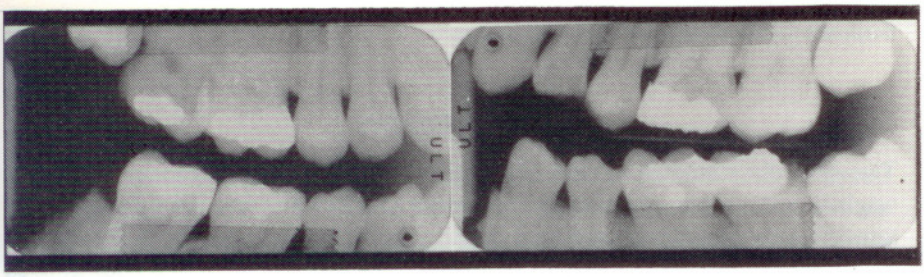

Fig. 1 Postmortem dental radiographs of the jaws of victim 8/91.

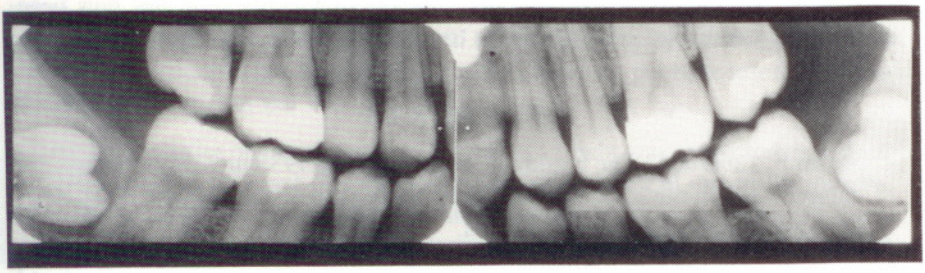

Fig. 2 Ante-mortem dental radiographs of patient J.D.F.

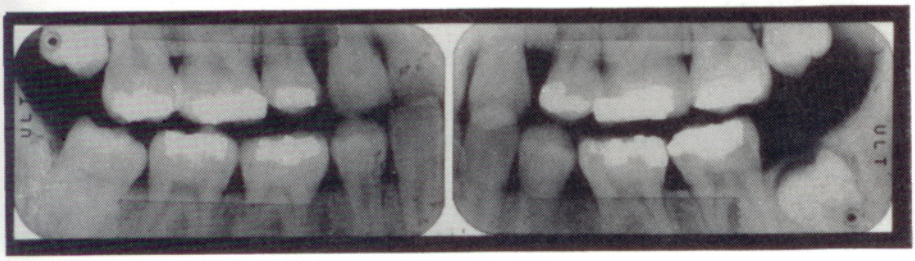

Fig. 3 Postmortem dental radiographs of the jaws of victim 9/91. Note that the maxillary 1st premolars (14 and 24) and the mandibular 2nd premolars (35 and 45) are absent.

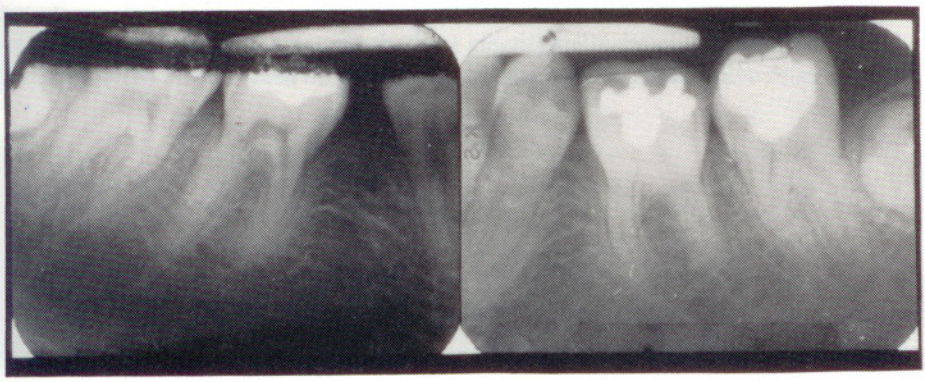

Fig. 4 Ante-mortem periapical radiographs of patient G.C. Note that the mandibular 2nd premolar (35 and 45) are absent.

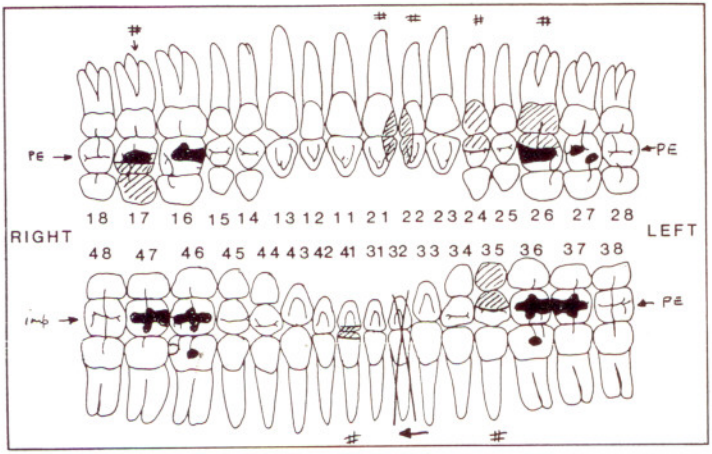

Fig. 5 Postmortem dental record of victim 8/91. (PE = partially erupted; imp = impacted; # = fractured tooth; ← = mesial drifting of tooth).

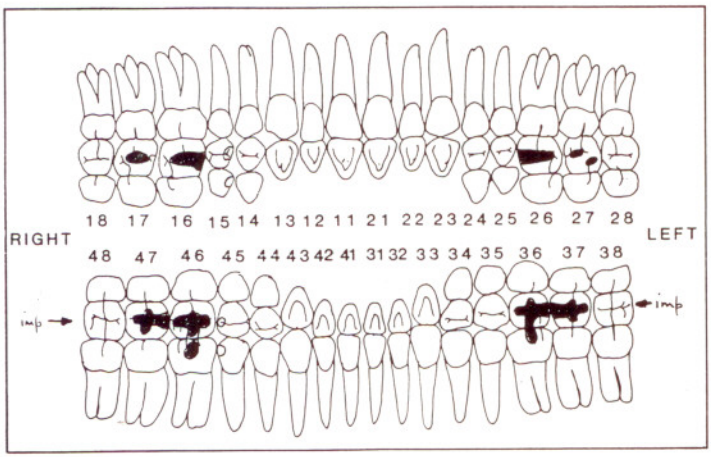

Fig. 6 Ante-mortem dental record of J.D.F. (imp = impacted).

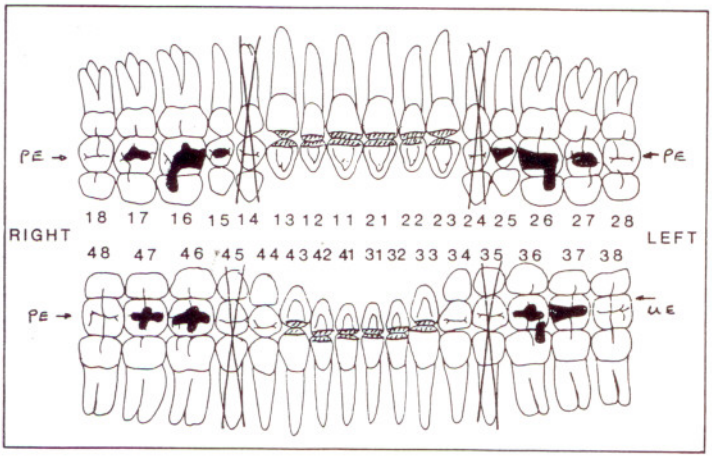

Fig. 7 Postmortem dental record of victim 9/91. Note that the maxillary 1st premolars and mandibular 2nd premolars are missing. There is attrition of the incisors and canines (PE = partially erupted; ue = unerupted).

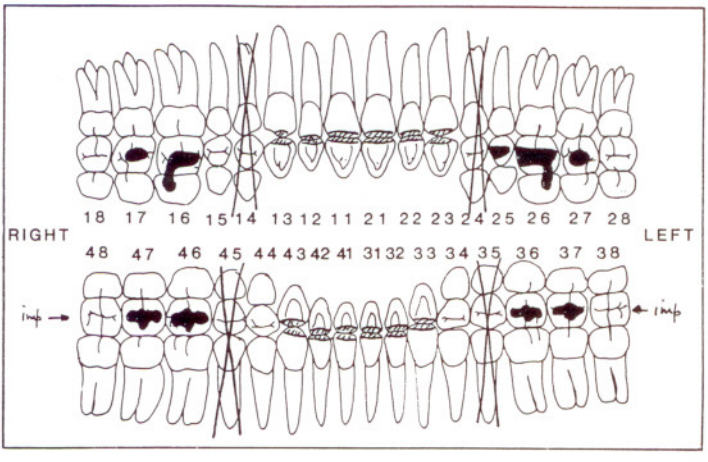

Fig. 8 Ante-mortem dental record of G.C. Note that the maxillary 1st premolars and mandibular 2nd premolars are missing. There is attrition of the incisors and canines (imp = impacted).

DENTAL IDENTIFICATION AFTER THE DASH 7 AIRCRAFT ACCIDENT AT TORGHATTEN, NORTHERN NORWAY, MAY 6th, 1988*

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*Paper presented at the 12th Meeting, International Association of Forensic Sciences held in Adelaide, Australia, October 24-29, 1990.

ABSTRACT

The accident occurred when a Dash 7 aircraft hit a steep mountain side and fell approximately 70 metres. A fire broke out immediately and all 33 passengers and three crew members perished. Most of the victims were found in or near the wreckage and burnt by the fire. The identifications were carried out by the Norwegian Identification Commission which included four dentists. One dentist, together with a pathologist, co-operated with the police at the site of the accident. All 36 victims were identified and in 32 cases (89%) dental identity was established. This success was mainly due to systematic radiographic recordings of the victims and a comparison with ante-mortem radiographs. The Norwegian computer programme for identification was successfully tested during this investigation.

Keywords: Mass disaster, radiographs, computer identification.

INTRODUCTION

Torghatten, a small mountainous island near Bronnoysund in northern Norway, is well known as a tourist attraction because of a large, natural hole through the mountain. This special rock formation has been a source of old legends about how a hole was made by giants shooting arrows at each other.

The Dash 7 aircraft (Fig. 1) on approaching the Bronnoysund Airport on a dark and foggy evening, crashed into the steep cliff of the Torghatten mountain on 6 May 1988[1]. The point of impact was at 183 metres above sea level, which was approximately 200 metres lower than the recommended altitude for planes approaching the airport. The accident investigations revealed that the 'plane's altimeter had shown the correct height.

The 'plane's course was at an angle to the cliff. The tip of the wing hit the mountain first, the body then turned towards the mountain wall and after impact fell approximately 70 metres and caught fire (Fig. 2). The burning petrol developed an intense heat especially in the cockpit area, causing the metal to melt.

All 33 passengers, two pilots and one stewardess died immediately. Five of the bodies were found on a small mountain ledge near the point of the impact, while the remaining victims were found close to or inside the burned wreckage of the aircraft. The amount of damage caused to the victims varied in proportion to a body's distance from the centre of the heat. The bodies found in the cockpit area were almost completely incinerated.

WORK AT THE SCENE OF THE ACCIDENT

The members of the Norwegian Identification Commission were notified later that evening. One group, including a forensic medical expert and a dentist, arrived at the site of the accident the next morning where the registration work and the collection of the victims started immediately. The place where each body was found was clearly marked with a number on a wooden pole and the necessary registration and photography was carried out (Fig. 3). The dentist checked the teeth of each victim before the body was removed and the identification team carried out the registration of the bodies and packing for transportation. Teeth from the incinerated victims were carefully collected from the ashes and separately packed. In addition the dentist assisted the police and the pathologist in locating the victims, the registration, and the packing.

When this work was completed, assistants were called in to carry the victims to a place from where a helicopter could transport them to the regional hospital in the city of Trondheim. Despite the rather difficult working conditions, the work at the scene of the accident was completed in three days.

THE POST-MORTEM EXAMINATIONS AT THE HOSPITAL

At the hospital, two teams of pathologists carried out the autopsies. Two dentists performed the dental examination (Fig. 4); one examined while the other recorded the information on a pink INTERPOL Disaster Victim Identification form for dead bodies. In most cases the jaws were removed for examination and stored for later re-evaluation and additional radiography. The two dentists served both pathology teams.

Dental radiographs of all the victims were taken. These included at least two bite-wings, and in most cases also periapical radiographs. A mobile X-ray unit was used and the radiographs were developed immediately in an automatic developer installed in the autopsy room. It was an advantage to receive the result at once so that necessary additional X-rays could be taken immediately. Modelling clay was used to reconstruct fragments of the jaws for radiography.

Periapical radiographs were taken of discoloured teeth and teeth which were suspected of being rootfilled and also of fixed prosthetic restorations. Such dental treatment is characteristic and usually well documented in the ante-mortem records. Radiographs were also taken to detect tooth coloured synthetic restorations in the anterior teeth.

ANTE-MORTEM DENTAL RECORDS

The fourth dentist in the group was chiefly occupied with collection of ante-mortem dental information. He contacted the victims' dentists personally. Provisional information from the dental records was obtained by telephone and initial comparisons could be performed. The dental records, including radiographs, were subsequently sent in by mail or by direct delivery through the police (Table 1). This direct contact with the dentists proved to be of great importance. It is difficult for the police, who are unfamiliar with the nature of our work and dental terms, to be certain of the nature of the material we need. Furthermore, dentists often hold back information as they may not realise its value.

The dental records were transcribed to a yellow INTERPOL form for ante-mortem dental data. It was the first time these forms were used in a major accident in Norway, and they proved to be most useful for documentation and for comparison with the post-mortem form.

Ante-mortem radiographs were received for all the missing persons (Table 2). Only seven of these included full-mouth or panoramic X-rays. For the 28 missing persons where radiographs were obtained, bite-wing exposures were most frequently found.

TEST OF IDENTIFICATION PROGRAMME FOR MICROCOMPUTERS

This identification system is based on a Vista data base programme which was developed by Ove Sakshaug. The programme follows INTERPOL's Disaster Victim Identification form, and includes medical and technical data. Each part of the form has a corresponding page in the programme containing the same spaces for information. Ante-mortem data can be selected from the yellow forms and used as a search medium either separately or in combination. The programme is able to make a search to match one specific point of information, or by an automatic search may suggest the most likely combination.

A portable computer was installed in the autopsy room which made it possible to carry out the data registrations in parallel with the post-mortem examination. When the dental registration of the victims was completed the post-mortem results were entered into the computer. Characteristic information from the ante-mortem material was selected and the computer automatically searched through the post-mortem data for bodies with these characteristics. The ante-mortem information received was not fed into the computer because the post-mortem registrations were considered more complete and accurate. The most likely identification was selected by the computer and then checked by manual comparison of the forms and the radiographs.

The computer gave an indication of the identity of most of the victims. Time was saved in the comparison phase and the computer programme satisfied our requirements. It will be used in future disasters.

DENTAL COMPARISONS

The yellow and pink dental forms were housed in plastic folders for easy comparison. Based on the results of the computer comparison, a final manual comparison was made. If a dental identity could not be excluded a dental comparison report with a conclusion was written on a special form developed for the Norwegian Identification Commission (Fig. 5). This document was signed by two dentists and served as an evaluation of the dental evidence in the final identification of the victim by the Identification Commission.

The results of the odontological comparisons are shown in Table 3. Due to the extraordinarily good ante-mortem information we could contribute to the identifications in all cases; in 32 cases identity could be established by dental comparison alone.

THE FINAL IDENTIFICATIONS

All 36 victims in this aircraft disaster were identified, with the final ID-meeting held five days after the accident.

From Table 1 it can be seen that only in one case we did not receive a written dental record. However, a panoramic X-ray secured sufficient evidence to establish the identity. The final identifications were based on an evaluation of all available evidence, including technical, medical and dental information. The victims could then be released to their families for burial.

SELECTED CASES

Case 1

One of the missing persons was known to have complete upper and lower dentures with no denture marking. The conclusion used in such a case would be "dental identity possible". In this case the dentist had taken a radiograph in which an impacted canine was observed. The tooth had not been removed and radiographic examination of the victim's upper jaw showed the impacted tooth (Fig. 6). This radiographic information made our conclusion "dental identity probable". The final identification was based on age estimation and technical findings such as clothing with initials, wristwatch and spectacles in addition to the dental findings. The case demonstrates that radiographic examination, even of edentulous regions, may at times provide important information.

Case 2

One of the pilots was recovered from the completely burned out cockpit. His body was almost totally incinerated. In the ashes around the position where the head was presumed to have been, a number of teeth were found. As is usual in such cases, the enamel of the teeth was lost and also the amalgam fillings had fallen out or had melted. With a magnifying glass it was possible to find traces of cavity preparations in the carbonised dentine and in this way part of his restorative dental status could be established. This proved to be sufficient for the conclusion of "dental identity established". This point illustrates the importance of careful recovery of the remains at the scene and also a detailed study of carbonised teeth using a magnifying glass to obtain evidence as strong as possible.

DISCUSSION

The Norwegian Identification Commission[2] was established in 1975 and each member of the team is conversant with his duties and routines. Equipment is prepacked and stored at the Central Criminal Bureau of Investigation in Oslo. This made it possible for the team to be at the scene of the accident, 900 km from Oslo, within 13 hours of the disaster, thus reducing the chance of disturbance to the wreckage and to the bodies. All descriptions, handling and packing of the bodies for transportation could be performed by the members of the Commission which included medical and dental experts.

For optimal preservation of the victims, it was found to be most important that dental and medical experts were present at the disaster site until all the victims had been removed from the area. The second case illustrates this clearly. In addition, the experts also assisted the police in the work with the victims. This practice has become a routine in larger accidents in Norway.

The accuracy and reliability of the post-mortem dental recordings were found to be satisfactory due to the teamwork of two dentists, where one dentist carried out the examination and the other recorded and verified the findings.

Experience has shown that bite-wing X-rays are useful for identification and should be taken during the examination of the bodies. In cases of extensive injuries where bite-wings cannot be obtained, periapical radiographs should be taken. Bite-wing exposures are valuable for many reasons. These radiographs were present in almost all the ante-mortem dental records received. The angle of projection of bite-wing radiographs is easier to reproduce than for periapical X-rays. For victims with few restorations, for example children and young adults, it is important to be able to compare details like contours of fillings, normal anatomical structures like rotations, shapes of roots and pulps, spacing between teeth as well as the pattern of bony trabeculae. Such details have become increasingly more important in dental identification since the reduction of the caries incidence and the number of dental restorations.

In this disaster dental identity could be established in 89 per cent of the victims while earlier experience has shown only about 50 per cent[3]. This was mainly due to the good quality of ante-mortem dental records received from the dentists. Also, careful preservation of the evidence by a dentist at the accident site and accurate post-mortem registrations performed by two dentists working together as a team were considered important to the excellence of the result. In addition, radiographic comparison increased the number of positive dental identifications.

Considering the difficult conditions following an accident in a mountain area and long transportation to the mortuary, the completion of the task in five days was considered most satisfactory. This efficiency was mainly due to the careful preparation and planning of such operations carried out by the Identification Commission. No time was lost in political discussions of who should be the members of the commission and every person knew his special function and responsibilities. Special training sessions in mock accidents also contributed to the efficiency of the team. The equipment necessary for the work was packed in advance and ready for use.

REFERENCES

1. Solheim T, Stene-Johansen W, Lorentsen M, Sakshaug O. Flyulykken i Torghatten 6. mai 1988. Identifiseringsarbeidet og tannlegenens jornaler. Nor Dent J 1989; 99:40-7.
2. Solehim T. Kriminalpolitisentralens faste identifiseringsgruppe og dens anmodninger til tannlegene. Nor Dent J 1977; 87:19-23.
3. Solheim T, Dahl JE, Glaso JB, Sundnes PK, Ronning S. "Alexander L. Kielland"-ulykka og identifikasjonsarbeidet. Nor Dent J 1985; 95:291-6.

Table 1

Ante-mortem dental records obtained after the Torghatten disaster 1988 (n = 36).

	No.	Per cent
Original records	32	89
Copy of records	3	8
No dental record	1	3

Table 2

Radiographic documentation on missing persons after the Torghatten disaster (n = 36).

Type of radiographs	No.	Per cent
Full mouth X-ray/OPG	7	19.5
additional exposures	4	
additional bite-wing	4	
Bite-wing	26	72.5
Additional exposures	19	
Periapical exposures only	3	8

Table 3

Results of dental comparisons (n = 36).

Conclusion	No.	Per cent
Identity established	32	89
Identity probable	4	11
Identity possible	0	0

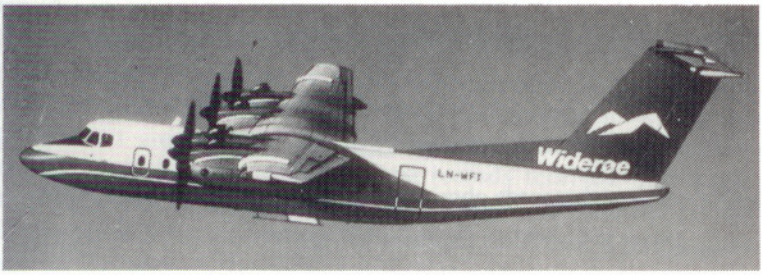

Fig. 1
Dash 7 aircraft from the small Norwegian company Wideroe similar to the one that crashed.

Fig. 2
Disaster site at Torghatten. F indicates flattened area in the rock cliff where the right wing first hit the mountain and from where five deceased had to be taken out by helicopter. X marks the point where the aircraft hit the mountain. Arrows indicate a black stripe in the mountain caused by the burning of fuel. W marks an area where parts from the aircraft and a number of dead people were recovered. The bent arrow indicates the tail of the aircraft. The main part of the aircraft and additional victims were found further down the slope.

Fig. 3
The incinerated remains of body number 34 (arrows) marked for photography and on-site description.

Fig. 4
Two dentists (WSJ and OS) examine a disarticulated jaw. With one dentist examining and the other taking notes, the data become more accurate and reliable.

ODONTOLOGISK SAMMENLIGNING Sak nr:

LIK MED UKJENT IDENTITET

FUNNSTED: Torghatten	**Funn nr:** 6
POLITIDISTRIKT: Helgeland	**Funn dato:** 7/5-1988

er odontologisk sammenlignet med

SAKNET PERSON

NAVN: LAURITSEN, Lars Kristian	**Fødsels nr:** 140306-4617
ADRESSE: Lenningvn. 16, 8900 BRØNNØYSUND	**Savnet:** 6/5-1988

det kan etter vår/min mening trekkes følgende

KONKLUSJON

ODONTOLOGISK IDENTITET SANNSYNLIG

BEGRUNNELSE

Konklusjonen bygger på følgende sammenfallende trekk:
- tannløs underkjeve
- tannløs overkjeve
- invertert retinert hjørnetann i overkjeven

UNDERSKRIFT

INSTITUSJON/SAKKYNDIG: ID-gruppen Tore Solheim	**Sted og dato:** Trondheim, 11. mai 1988
	Underskrift: Tore Solheim
KONKLUSJONEN TILTRES	**Underskrift:**

Fig. 5
The form for the result of the odontological comparison signed by two dentists for quality control used by the Norwegian Identification Commission.

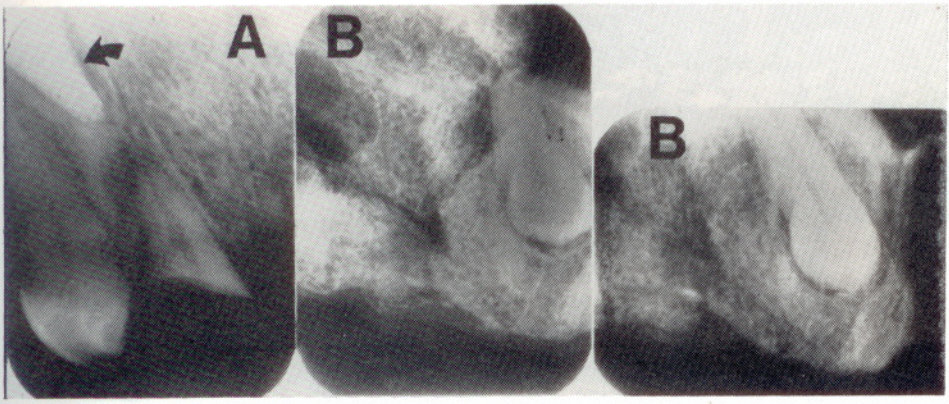

Fig. 6
Case 1. Ante-mortem radiograph (A) showing an impacted canine. Post-mortem radiographs (B) of the edentulous maxilla revealed the canine.

INTERNATIONAL CO-OPERATION IN A DENTAL IDENTIFICATION

Leif Kullman[1] and Bardhyl Cipi[2]

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2. Department of Forensic Medicine, University of Tirana, Albania.

ABSTRACT

A case of international identification of an unknown male, where the teeth were essential in establishing identity is described. A noteworthy aspect of the procedure was the teamwork between the police and other authorities, and the forensic odontologist and medical examiners in Albania and Sweden. In Albania a forensic medical examiner handled the dental examination, since forensic odontology is not yet acknowledged. The importance of having dental and medical ante-mortem registers for missing persons in every country is stressed. This is best administered in co-operation with the police authorities.

Keywords: Identification, forensic odontology, dental register, computer.

INTRODUCTION

Identification by means of the teeth has long been an established and well recognised method[1,2] and is nowadays used in many countries[3]. It is at its most useful in cases where the soft tissues have undergone advanced putrefaction, burning or are completely missing and where the usual police identification methods, such as confrontation and fingerprints cannot be used. The teeth are the most resistant tissue in the body and they can be used with success on skeletonised material found in almost any circumstances.

Successful identification rests on a comparison between ante- and post-mortem data. As the post-mortem data are readily to hand the important and often unsatisfactory link lies in the ante-mortem dental records. The assumption is that there is an idea about who the deceased might be, but if not the task will be more difficult. Some help can then be obtained from registers, especially computerised ones, containing ante-mortem dental records of missing persons. Should the victim be a registered missing person it will be simple for the computer to match up the dental data, in countries such as Sweden where this facility exists[4].

A prerequisite for these registers is a law that requires all medical and dental personnel to make and then preserve records for a number of years after the latest treatment. The Scandinavian countries have passed such a law, which includes the preservation of radiographs, photographs and dental casts, but this is not yet the case in Albania.

When an unknown dead person is found in Sweden and the identification cannot be established through the usual police channels, the forensic odontologists will be asked to assist. The post-mortem dental findings are recorded and are matched against the ante-mortem data of missing people by means of a computer. These ante-mortem data will have been recorded in the computer as soon as the person disappeared and are preserved until the person is found dead or alive. These routines have recently been agreed upon with the police, and the same rules exist for medical ante-mortem records. In an international identification case the same routine applies but now in co-operation with Interpol in Sweden. If, for example, a skeletonised body is found in Africa, and the authorities suspect that it could be a Swedish citizen, the ante-mortem dental data transposed to the newly adopted Interpol forms are sent, together with the usual medical and police data to the country where the body was found. If the person was recorded in our database in Sweden, the forms can be directly written out with a laser printer and are sent abroad with copies of radiographs.

CASE REPORT

On 15 July 1989, in the early hours of the morning, an unknown male body was found on the Adriatic seashore near the village of Poro in the Vlora district in Albania (Fig. 1). The body had reached a stage of slight putrefaction and the hands and feet were partly macerated. The body wore a grey sweatshirt with the words "STREET PERFORMANCE MANHATTAN N.Y.C." inscribed on it, and also blue shorts with white stripes. The head had some blonde hair and an ear-ring could be seen in the left ear (Fig. 2). The body was taken to Vlora city where an autopsy was carried out (B.C.). Upon internal examination pulmonary emphysema with subpleural hemorrhagic points and asphyxia were found as well as sand particles in the respiratory tract and venous stasis of the internal organs. The skull demonstrated the start of suture closure of the vault and the estimated length of the body was 175 cm.

A dental examination was made (B.C.), all teeth being present except the third molars and four first premolars. The latter seemed to have been extracted a long time ago, probably for orthodontic reasons. All teeth were found to be almost without abrasion, with some amalgam fillings, especially those in the upper jaw.

The examiners reached the conclusion that this corpse belonged to a young male, not older than 30 years and probably of Nordic origin. The cause of death was found to be mechanical asphyxia by drowning and it was concluded that the body must have been in the water for at least a week. Efforts were made to ascertain the possibility of this being an Albanian citizen, to no avail. The corpse was thus buried in the cemetery of Vlora City and the Albanian Foreign Ministry was informed that the body probably originated in a foreign country.

At this time, however, a young male was already listed as missing in Sweden where he was living. He was 23 years old and gone "inter-railing" in June with some mates to the south of Europe. On 9 July they had reached Brindisi in Italy and taken a ferry for the island of Corfu in the Mediterranean Sea. During the night between 9 and 10 July, the young man disappeared from the ferry leaving his luggage behind. This was reported to the police in Greece and also to the Swedish Interpol section by his parents, who had had a telephone call from their son's friends shortly after his disappearance.

It was in the last days in July therefore that we (L.K.) received some ante-mortem dental records and intraoral radiographs of this missing person at the Institute of Forensic Medicine in Stockholm. The data were recorded in our computerbase together with all other missing Swedish citizens. Some months later, at the beginning of September, Interpol in Sweden received a message about the unknown body in Albania. A description of the body and the clothes were also available in the message and it was obvious that the inscription on the T-shirt was the same as on that of the missing man.

Interpol in Stockholm suspected that this could be the missing Swede and decided to send a complete dental and medical description to Albania asking the authorities there, through the Ministry of Foreign Affairs, to exhume and re-examine the body, with particular attention to the teeth.

The ante-mortem dental data were therefore written out in English in the dental part of the older forms of Interpol (Fig. 3) for missing persons and sent together with intraoral radiographs and all other descriptions such as height, hair colour, shoe number and so on, to the authorities in Albania through the usual, but slow, diplomatic channels.

In February the next year the already skeletonised body was exhumed and a fresh, complete dental post-mortem examination carried out (B.C.). The new post-mortem findings were in complete accordance with the corresponding ante-mortems and an identity with the missing young Swedish citizen could be established. This was reported to the Swedish authorities and the body was taken back to Sweden.

On arrival another autopsy was held and post-mortem dental radiographs taken to be compared with the ante-mortems (Fig. 4). The results from Albania could be confirmed and the victim was satisfactorily reburied in his family cemetery.

DISCUSSION

In Sweden a medical doctor must write a death certificate, where the cause of death and identity of the deceased person is established, before burial or cremation of a deceased can be considered. The same law applies in Albania.

If identity is uncertain at autopsy and especially if the body is in a state of advanced decomposition the forensic odontologist and the dental recordings become important, and most cases can be solved since most people have at some time visited a dentist, dental disease being very common. Despite this, cases do occur where it is not possible to establish an identity and special regulations must be applied in order to bury an unknown body. This is unsatisfactory and perhaps most so for the relatives who are left with a lifelong doubt. Sweden has a couple of cases of failure to establish identity each year.

Increased travel nowadays has led to increased risk of fatality occurring abroad and Interpol has had problems with unidentified bodies for a long time. It cannot be stated enough that beside the usual police and medical descriptions it is important to record the post-mortem dental findings. Then, even if the missing person is from another country identity is easy to establish provided that a missing persons register, containing ante-mortem dental data is available. Several countries, including Scandinavia are able to provide this facility while the many who cannot make the process of identification nationally and internationally that much more difficult.

ACKNOWLEDGEMENTS

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REFERENCES

1. Gustafson G. Forensic Odontology. London: Staple Press, 1966.
2. Keiser-Nielsen S. Person identification by means of the teeth. A practical guide. Bristol: J. Wright & Sons Ltd, 1980.
3. Hill I and eds. Forensic Odontology. Its scope and history. Bicester: IOFOS, 1984.
4. Kullman L, Solheim T, Grundin R, Teivens A. Computer registration of missing persons. A case of Scandinavian co-operation. Forensic Science International (in press).

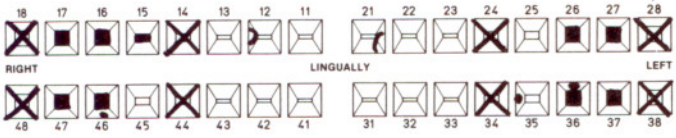
Fig. 1 The unknown male body lying on the seashore.

Fig. 2 Close-up picture of the head.

3 [X] Male [ ] Female

DENTAL DATA
(RE-ARRANGED)

11	Intact	distal comp. (syntetic)	21
12	distal comp. (syntetic)	intact	22
13	intact	intact	23
14	missing antemortem	missing antemortem	24
15	occlusal amalgam	intact	25
16	occlusal amalgam	occlusal amalgam	26
17	occlusal amalgam	occlusal amalgam	27
18	missing antemortem	missing antemortem	28



48	missing antemortem	missing antemortem	38
47	occlusal amalgam	occlusal amalgam	37
46	occlusal, vest. amalgam	occlusal-ling. amalgam	36
45	intact	mesial amalgam	35
44	missing antemortem	missing antemortem	34
43	intact	intact	33
42	intact	intact	32
41	intact	intact	31

Specific data on crowns, bridges and dentures

Further data (occlusion, attrition, anomalies, smoker?, periodontal status etc)

The teeth 18,38 and 48 retinated 1988. No information about 28.
All first premolars extracted a long time ago of orthodontic
reasons, no diastemas today.

Radiographs

Bitewings available from the last years.

Further material

Age at time of disappearance

24 years

Un 06-488

Fig. 3 The ante-mortem dental data, which were sent from Sweden to Albania.

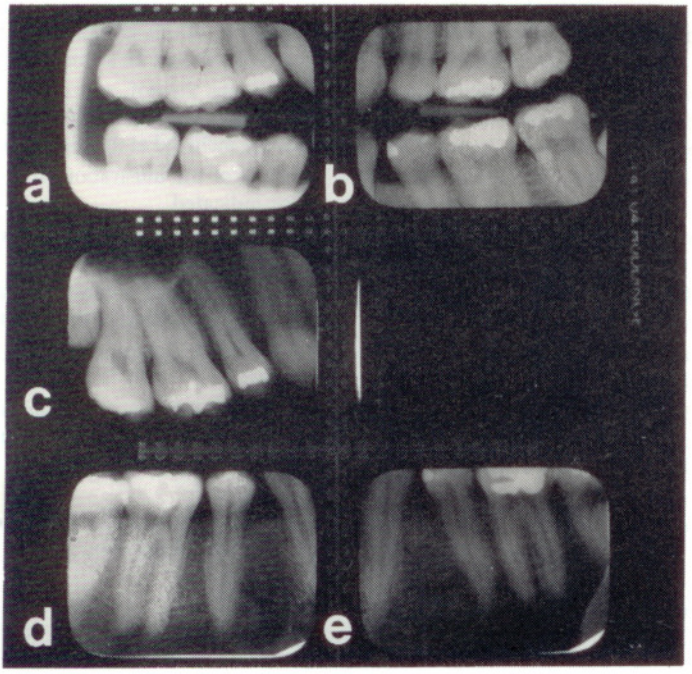


Fig. 4 Radiographic comparison. Ante-mortems (a, b) and post-mortems (c, d, e).