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The First Cervical Vertebra

A Plausible Parameter for Use in Forensic Identification?

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Abstract

A review of sequential lateral cephalometric radiographs taken on orthodontic patients at an 18- to 72-month interval was undertaken to determine whether the radiographic profile of the atlas could be useful in forensic identification of human remains. While changes did tend to occur in the morphology of the posterior tubercle, around puberty in the adolescents and young adult sample examined, the lateral profile of the first cervical vertebra can indeed be a useful adjunct in identification, as other features did not alter.

Key words: Atlas; Identification, forensic; Radiography, cephalometric; Vertebra, first cervical.

Introduction

Krogman indicated that, as a rule, the use of radiography to identify skeletal details presupposes at least 2 sets of radiographs: a before and an after set.[1] This assumes that radiographs were taken during the life of the presumed individual, and that such films can be secured and compared with radiographs made of the remains. Hence, radiographic landmarks that are most useful for forensic identification of remains are those for which there is a high probability of their being included in existing radiographs, i.e. landmarks on commonly taken radiographs, such as bitewing and periapical films used for detection of dental caries and periodontal disease, and lateral cephalometric radiographs used in orthodontic assessments.

As early as 1921, Schuller reported that the frontal sinuses, examined radiographically, were of value in identification.[2] Poole (1931) stated that the frontal sinuses of no 2 persons were alike.[3] Use of the frontal sinus as a 'bony fingerprint' is, needless to say, only possible if appropriate posterior-anterior views of the skull have been taken during life, and this is perhaps less likely than for other projections. Nevertheless, 'sinus prints' have been successfully used in identification for many years.[4–5]

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The sphenoid bone has also been promoted for use in forensics, for identification of human remains.[6] One test considers the form and volume of the sella turcica and the angle formed by the clivus and anterior cranial base.[6] As the sella turcica is clearly demonstrated on lateral cephalometric radiographs taken routinely for orthodontic assessment, previous radiographs of this anatomic landmark are likely to be found for individuals from cultures where orthodontics is highly prevalent. Moreover, as the sella turcica is centrally placed, it is likely to be one of the last areas to be destroyed by the forces of circumstance or nature.

Lateral cephalometric radiographs have been used to help in identification in a number of other ways, viz. to calculate endocranial dimensions, to develop an encephalic index, and to estimate cranial volume.[6–9] Using sets of both posterior-anterior and lateral films taken one month apart, Thorne and Thyberg found no difficulty in identification of the individuals in their sample of 100 children and adults.[10] It is no wonder that cephalometric identification of the war dead has been developed.[11–14] With 20 measurements and an index of selectivity of 3 each, one individual can be identified out of 3,5 billion subjects.[14]

Variations in the lateral radiographic profile of the first cervical vertebra have been reported, primarily using retrospective analysis of individual lateral films from orthodontic patients.[15–17] The atlas can be viewed in true profile using cephalostatic techniques employed for orthodontics, as rotary movement of the head does not occur until the level of the second cervical vertebra, or axis. Reported variations include morphological variance in the posterior margin of the superior articular processes, with varying degrees in formation of a bony bridge over the vertebral artery groove, occasional dehiscence of the anterior or posterior tubercle, presence of accessory ossicles and (very rarely) fusion of the atlas to the occiput, or occipitalization of the atlas.[15–17]

Before these variations in the morphology of the first cervical vertebra can be used for identification of remains, it must be established first, that the vertebra remains fairly constant in shape over a reasonable period of time and second, that interindividual variations are significant enough to add to the definitive diagnosis. With this in mind, a retrospective study of the atlas profile in 60 adolescent and young adult orthodontic patients was carried out using sequential standardized lateral cephalometric radiographs taken from 18 months to 5 years apart.

Material and Methods

A retrospective analysis was carried out using pre- and post-orthodontic lateral cephalometric radiographs from 60 adolescents and young adults. The technique utilized was standardized, in that the same radiography unit, cephalostat, source-to-object distance and object-to-film distance were used for each case; the film-screen combination and processing chemistry were also kept constant. All radiographs were examined by 2 of the investigators, using identical viewboxes without background ambient lighting. Tracings were made of the cervical vertebra in each case and the following recorded: age at start of treatment, sex, and time lapse between

pre- and post-orthodontic radiographs. The features examined from the radiographic tracings were:

1. Morphology of the posterior margin of the superior articular process using the classification of Selby *et al.*,[15] viz. no bony bridge, partial bony bridge, and complete bony bridge;

2. Morphology of the posterior tubercle, *viz.* round, square, polygonal, triangular, and crescentic or 'banana-shaped';

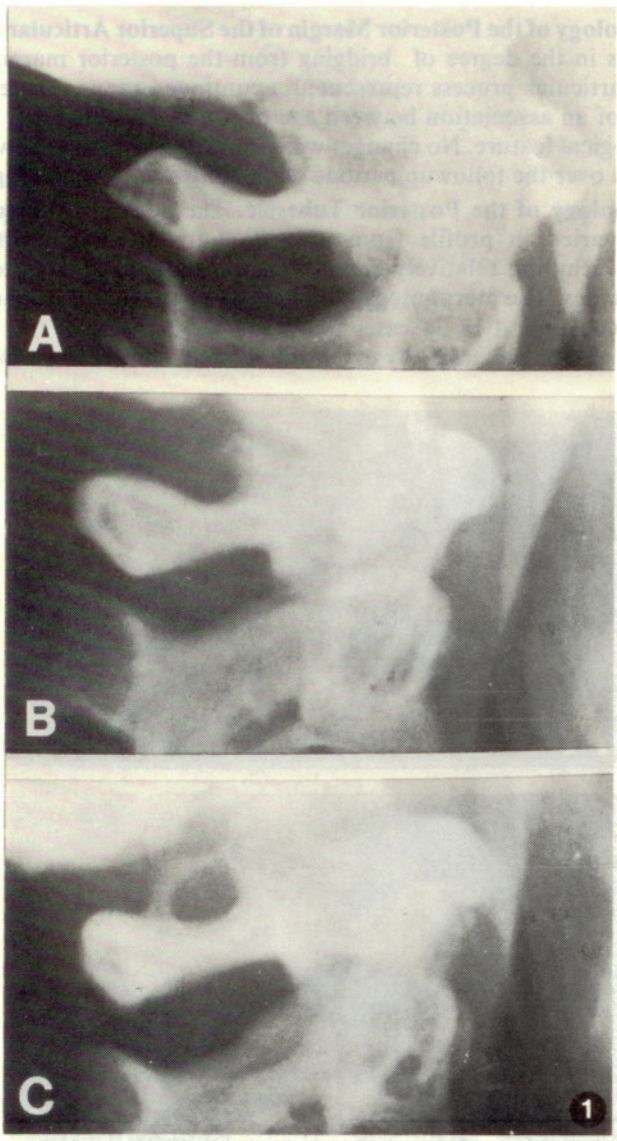

Fig. 1. A. Posterior margin of the superior articular process of the atlas shows no bony bridge. B. Partial bony bridge formation. C. Complete bony bridge formation.

3. Morphology of the anterior tubercle;

4. Morphology of the inferior articular surface, viz; length (the morphology of the superior surface was excluded, as it was often obscured by anatomic superimposition, particularly from the mastoid air cells); and

5. General size and shape of the atlas, as monitored by superior position of radiographs and tracings.

Results

1. **Morphology of the Posterior Margin of the Superior Articular Process.** Variations in the degree of bridging from the posterior margin of the superior articular process represented a continued range. There was no evidence of an association between age or sex of the individual and this morphological feature. No changes were found in this structure within an individual over the followup periods of 18 months to 3 years (Fig. 1).

2. **Morphology of the Posterior Tubercle.** The posterior tubercle morphology varied in profile from individual to individual, with basic contours including relatively round, square, triangular, polygonal and cresentic types. The morphology of the posterior tubercle did change over the followup period in 24 cases (40%). In all these cases the tubercle increased in size, generally by extension distally and, in most instances,

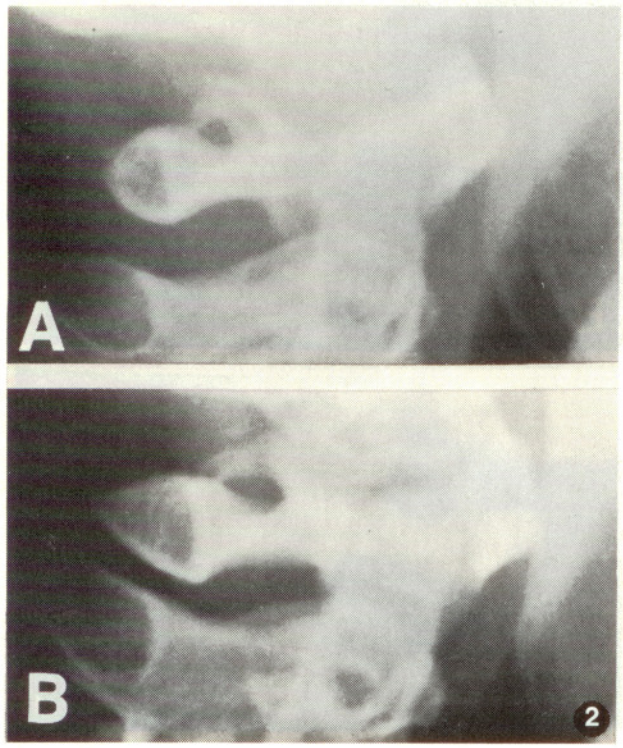

Fig. 2. Female (A) at 11 years; (B) at 14 years. Note the marked distal extension of the posterior tubercle of the atlas.

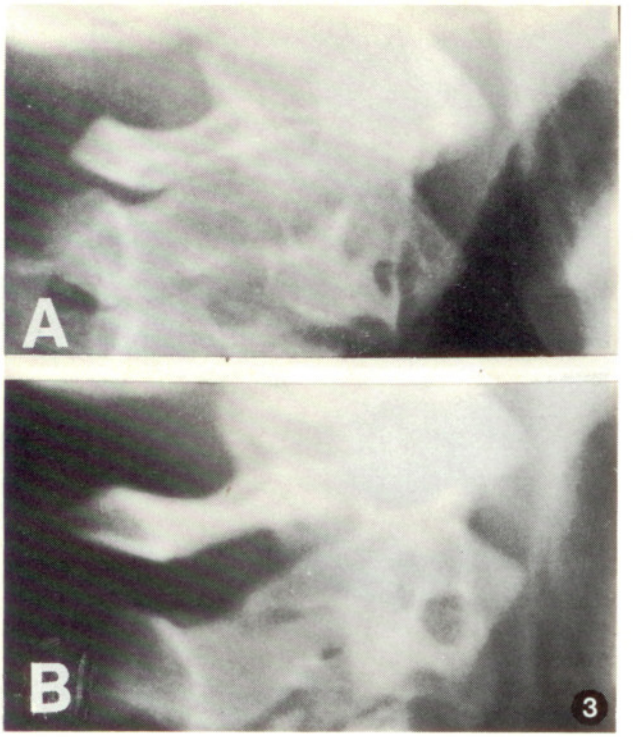

Fig. 3. Male (A) at 12 years; (B) at 15 years. Note the marked distal extension of the posterior tubercle of the atlas.

became triangular (Figs. 2-3). In 2 instances, the extra growth of the tubercle was on the superior margin (Fig. 4) and in one case on the inferior margin. All morphological changes in the posterior tubercle were found in patients commencing orthodontics at around puberty (girls aged 11, boys aged 13-14).

3. **Morphology of the anterior Tubercle.** The anterior tubercle showed little variation in basic shape between individuals, and did not change within individuals over time.

4. **Morphology of the Inferior Articular Surface.** Little variation was found between individuals using this feature; the length of the inferior articular surface in profile was approximately 2 cm in all cases. Additionally, over the followup periods, no change was found for this feature within individuals.

5. **General Size and Shape of the Atlas.** The superimposition of tracings indicated that no 2 individuals from this limited study could be confused, using the atlas profile alone. The cases where the posterior tubercle did modify over time did not change in any other morphological feature (Fig. 5).

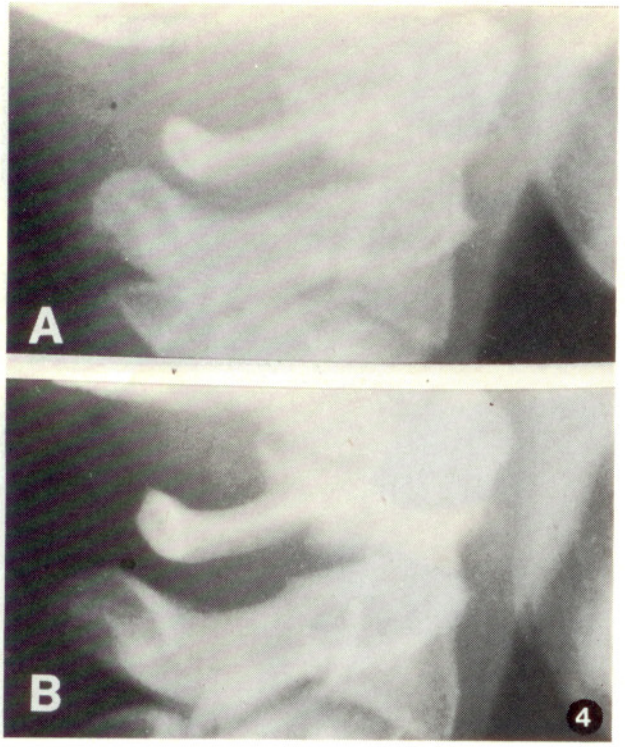

Fig. 4. Female (A) at 11 years; (B) at 13 years. Note the slight superior extension of the posterior tubercle.

Discussion and Conclusions

The findings of this study indicate that there are sufficient variations in morphology for the lateral profile of the atlas to be of use in the differentiation of adolescent or young adult human remains, if previous cephalograms have been made within the time range used in this investigation. It must be noted, however, that the shape of the posterior tubercle can change, even over a relatively short period of months or years and, therefore, this parameter should not be used to negate an otherwise positive identification. In summary, the lateral profile of the atlas may be a useful adjunct in forensic identification procedures, but should not be considered a 'bony fingerprint' replacing frontal sinus contours, the sella turcica or cranial dimensions It should also be remembered that the spine, including the first cervical vertebra, is subject to degenerative changes that may modify its shape, particularly in older persons.

We wish to thank Mrs. Ruth Heinz for word processing, Mr. George Batik for drawing Fig. 5, and Mr. Walt Judy for photographic assistance.

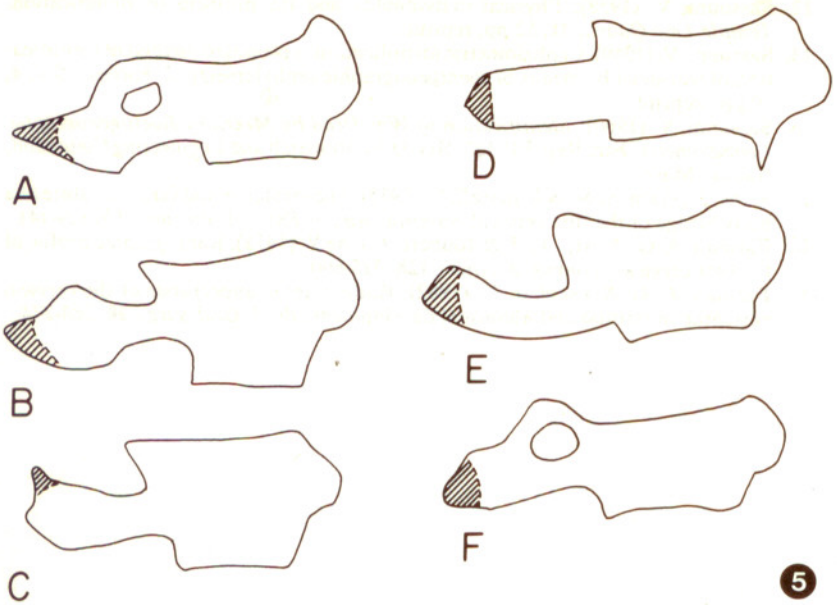

Fig. 5. Examples of morphological changes in the atlas. Note that the only modifications occurring over time all affected the posterior tubercle. The cross-hatched areas represent the change that occurred. (A) Female 11-14 years; (B) Female 11-12 years; (C) Female 11-16 years; (D) Male 14-16 years; (E) Male 13-16 years; (F) Male 13-17 years.

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A Case of Stomatitis Venenata

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Abstract

A case of stomatitis venenata arising from the use of a well-known brand of tooth paste, is described. The clinical presentation of the reaction and the diagnostic procedures are detailed and discussed. The patient endured considerable pain, discomfort and inconvenience for more than 3 weeks before the offending dentifrice was identified.

The exact ingredient was later determined by means of patch testing and proved to be the flavouring agent.

The importance of careful history-taking is stressed. Not only does it prevent unnecessary discomfort to the patient when an early diagnosis can be made but it can also check any allegations by the patient of neglect.

* * *

Key words: Allergic reactions, tooth paste.

Should injury result from the use of a medicament, blame may be laid jointly and severally on the manufacturer and the person prescribing it. Therefore, the dental surgeon should be aware of any manifestations arising from the use of drugs and materials in his practice. In certain cases, however, an allergic response can be elicited. Should such an unforseen allergic reaction occur, neither the manufacturer nor the practitioner can reasonably be held responsible.

Allergic responses, which can appear in various forms on the lips and the oral mucosa, include hyperaemia, ulceration, fissuring, oedema and vesicle and bullae formation.[1,2] Peri-oral leukoderma has also been reported.[3]

Many materials and drugs used in dental practice have been blamed for allergic reactions. Prominent amongst these are dentifrices.[1–6] This is a report of a patient who presented with an allergic response of the oral mucosa to a dentifrice.

Case Report

History. A 41-year-old White male meteorologist was referred by a dentist to the Department of Oral Medicine for the diagnosis and treatment of an acute stomatitis and cheilitis. The patient developed the symptoms 3 weeks before his visit to the above department. He had been treated by his medical practitioner for 14 days for a complaint of xerostomia and painful burning lips and oral mucosa. A diagnosis of sialoadenitis had been made

and the patient was treated with Vitamin B compound tablets and a hexetidine mouth wash. Antifungal therapy was also apparently instituted. The condition deteriorated and a dentist who was consulted prescribed Achromycin and trithioparamethoxyphenolpropine (Sulfarlem) tablets before referring the patient to us.

General Examination. The blood pressure was 139/80 mmHg. Urine analysis was negative, the body temperature was 36,4° C, haematological investigation revealed no abnormal values and bacterial cultures of the oral mucosa indicated a normal oral flora.

Oral Examination. There was mild oedema of the lips and a fine fissuring of the angles of the mouth. The lips appeared dry but salivary flow seemed normal. The gingiva appeared slightly granular and the vestibular mucosa was smooth and shiny. The entire oral mucosa, as far as the palatoglossal arches, was markedly hyperaemic. After questioning, the patient conceded a possible correlation between the illness and a change to another brand of tooth paste. Biopsy specimens were taken from the labial attached gingiva of the right maxillary central and lateral incisor region as well as from the labial mucosa of the right upper lip.

Histopathology. The stratified squamous epithelium of the mucosa showed slight parakeratosis and focal atrophy with the connective tissue papillae almost reaching the surface of the epithelial layers. There was diffuse intercellular oedema of the epithelium with penetration of lymphocytes. The lamina propria displayed a round cell infiltration dominated by lymphocytes. Histiocytes were also present. There were no indications of granulomatous inflammatory changes nor were there any changes in the submucosa. The findings were consistent with stomatitis venenata.

Treatment. After the initial examination, all previously prescribed medication was discontinued. The patient was instructed not to use any tooth paste. A 0,2% chlorhexidene digluconate mouth wash was prescribed for use twice daily. Upon notification of the pathological findings, the treatment was modified. Terracortril aerosol and ointment (terramycin 300 mg and hydrocortisone, 100 mg) were applied 4 times daily to the oral mucosa and the lips respectively. The condition improved dramatically and, on re-examination after 8 weeks, the mucosa was normal. The patient, however, reported that an exacerbation had occurred on the use of a particular tooth paste. Its discontinuation had resolved the reaction.

The patient was recalled for specific patch testing.

Skin. The battery of standardised preparations used at the Department of Dermatology, Tygerberg Hospital, was supplemented with 9 substances, obtained from the manufacturer and representing the constituents of the offending tooth paste, and by a liquorice sweet to which the patient had allegedly reacted. After periods of 48 and 96 hours the test sites were examined. A positive response was elicited only by the liquorice and the tooth paste ingredient marked as dental cream flavour (D.C.F.). This consists of Anethol USP, L'Carvone, Lemon oil 1%, levo menthol, redistilled peppermint and natural spearmint mixture. The respective responses were a mild vesicular reaction and hyperaemia after the first 48 hours of exposure to the allergens. After 96 hours, the D.C.F. site was

markedly hyperaemic and showed the presence of small, round papules. The site was pruritic.

Oral Mucosa. This tissue was tested against peppermint oil, D.C.F. and orabase. Within 24 hours the D.C.F. site was markedly hyperaemic, presenting a reaction similar to that which the patient had displayed originally on presentation at our clinic. At a later recall the ingredients of the D.C.F. were applied individually and in combination in a series of further skin and oral mucosal patch tests. After 72 hours the skin sites displayed a mild papular reaction to the peppermint and the D.C.F., while the oral mucosal site exposed to D.C.F. was markedly hyperaemic within 3 hours.

Discussion

An allergic response to a commonly used material was not identified when the patient originally sought help. He endured considerable distress and discomfort. At the same time, he incurred substantial expense as well as loss of earnings due to absence from employment. Furthermore, medicaments which could have aggravated the condition were prescribed empirically. Hence the importance of careful history taking is stressed once again. The information thus obtained can avoid a magnitude of investigatory and therapeutic procedures.

In this case the patient was found to be allergic to one of the essential oils which have previously been identified as a cause of tooth paste allergies.[3-6] An allergic response depends on a previous exposure to the allergen or a related chemical compound. It has been suggested that these compounds are haptens which combine with an epidermal protein to produce an allergen.[7] After processing by macrophages this allergen is transmitted to the lymphocytes which are thereby sensitised. Antibodies are formed and carried on the surface of these lymphocytes. At a subsequent or later exposure to the original hapten, antigens are again formed and a response by sensitised lymphocytes is elicited rapidly. The concentration of these cells at the site of hapten introduction gives rise to the series of reactions and the release of mediators which evoke the tissue response.[7]

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The Role of the Denture in Identification: A Review

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An early report by Rehfuss[17] describes the use of a denture to incriminate a murderer. The Countess of Salisbury identification in 1835[18], the Parkman identification in 1849[2] and the Haigh acid bath murders in 1949[19] were similarly solved by denture evidence. Since then dentures have contributed repeatedly to forensic successes but only when they have had a characteristic mark or trait which could be traced to an existing record and a particular dental practitioner, laboratory or technician.

The Denture in Isolation

Dentures are often lost or inadvertently intermingled in hospitals, mental institutions, old-age homes or prisons. At the time of death in accidents, murders or mass disasters, dentures can become disassociated from a victim's body.[14,22] The first task in hand, therefore, is to match denture and owner and only then, if identification of the owner is in question, may the information embodied in a denture become usable.

A denture can be matched firstly by the agreement of denture base shape to denture-bearing tissues. If the prosthesis is relatively new, the 2 shapes will correspond better than when it is a veteran. If it is doubtful whether a denture belongs to a certain maxilla, the ruga pattern may be helpful but very often overenthusiastic brushing in time eliminates all detail from the palatal surface. Palatal relief shapes, suction pad chambers and post dams may leave marks that are characteristic.[7]

If a denture is matched to a mouth, its partner may be located by looking for corresponding tooth mould, colour, denture base material or occlusion. A single complete denture will occlude very definitely with its opposing natural teeth because attrition facets develop quickly and because the regular occlusion is very specific.

The Denture with the Body

The process of identifying a victim's body by means of dentures is only possible if a characteristic mark or trait is observable.

Denture Trait. Certain denture features may be traceable to a particular dental practitioner, laboratory or technician. The type of tooth used, both anterior and posterior, denture base material including clear palates, soft linings or repairs and tooth arrangements are examples of these features. Metal-based partial dentures can be varied greatly because of the strength of the base material, and because of this the individual approach of practitioner and technician to clasp, major connector and retention tag shape design often makes them unique. Philipsen[15] helped to identify the body in a drowning in Denmark by tracing the shape of retention tags

under the acrylic saddle of a partial denture to a German dental laboratory. Jakobsen, Keiser-Nielsen and Tolderlund[10] report the identification of a man (fatally burnt in a hotel fire) through his partial denture to a similar one in his already identified, deceased wife's mouth. Because the high melting point and hardness of modern cobalt-chromium alloys make partial dentures relatively indestructible, the invaluable tooth combination information reflected in the denture may be all that remains of a dentition.

The Ruga Pattern. Sognnaes[20] has called for the making of casts of a victim's palate before decomposition sets in. It may be possible to compare it with a denture or cast containing the ruga pattern of the victim, which may be in the possession of dentist or family.

Marks

A properly executed mark in a denture is a valuable aid in identification. Harvey[8] lists 7 methods for doing this. Haines[6] reported that in the Rijeka air disaster only 5 victims remained unidentified, all 5 being edentulous and with unmarked dentures. Petersen and Kogon[14] investigating the Woodbridge air disaster, similarly found no denture marks at all. In the absence of natural teeth, dentures can only be of equivalent use if they are marked.

Ekman and Johanson[4] have set out the requirements of a marker as follows: It must contain a specific identification which is easily readable, be easy to insert and inexpensive, be fire- and acid-resistant, not weaken the denture, allow subsequent relining and repair and be aesthetically acceptable. An example of a specific identification is a national identity number which contains *inter alia* date of birth and country of origin code, as used in international automobile registration.[12] The South African identity number is thus ideal, if a little long. The South African Department of Interior[21] has indicated, however, that the first 10 figures are sufficient for hand sorting as compared with computer sorting and, since the number of cases involved at any particular time is not likely to be excessive, it is suggested that the first 10 figures be used plus ZA. The number is then as long as the number used in Denmark.[15]

In the absence of a proper mark, any inscription can be of assistance.[7] Many dental laboratories score dentures with a number or letters as part of their own administrative systems. Sometimes a convex mark is obtained by scoring the plaster cast before processing. This is undesirable, since the resulting tissue irritation has been known to cause malignancy.[3]

Convenience of insertion is a major factor in general implementation. The IDenture System (Denture Products Division, 3M Company, St. Paul, Minn., USA) is probably the most convenient but has the disadvantage of being superficial and therefore not durable. Johns, Boone and House[11] have tested this method and found very little wear over a simulated 3-year period with the exception of one sample which showed 50% wear. The use of dentures for long periods and the strange cleaning habits sometimes adopted mean that a mark must be covered by at least 0,5 mm of acrylic resin if it is to survive.

Fire resistance is only possible when a high melting point metal is used. The ID-Band (Svenska Dental Instrument AB, Box 420, S194-04 Upplands

Värby 4, Sweden) developed in Sweden has many advantages, including heat resistance up to 1 300° C for 10 minutes and is widely used in Denmark and Sweden. Doubt has, however, been cast on the importance of the fire resistance by Vestermark,[23] Haines[7] and Harvey,[8] who state that dentures, or at least their posterior aspects, will be preserved from destruction by the protective position of the tongue and cheeks even in the most severe cases of burning. Luntz and Luntz[13] report an automobile accident where the bodies were burned beyond recognition but where dentures suffered minimal damage. Ante-mortem records were available and the victim was identified through the material and form of the teeth, the clear palate and 2 repairs in the lower denture. Only one reference can be found in the literature relating to problems arising from incineration of dentures.[1] It is also a fact, however, that in violent disasters dentures are often dislodged from the mouth.[22] A denture may well then be burned but would it be any use even if a mark did survive the heat?

The weakening of a denture must be inevitable when an inclusion creates a plane of cleavage. Any metal insert will do this but not a comparable paper one. Fletcher, Turner and Ritchie[5] have shown in tests for weakness and porosity that onion paper produced the best results while metal foil produced the worst.

The aesthetics of a mark are important. Vestermark's method includes the use of pink paper and red inscription to simulate natural tissues. Since the mark is on the polished surface of the palate, it is conceivably visible to the outside and a metal strip would show more obviously than pink paper.

Discussion

The infringement of personal liberties must be a factor to consider in denture marking,[16] but at the same time it seems likely that the only way of implementing it effectively is legislated enforcement. Harvey[9] has stated: 'It is fascinating that Sweden, to whom many attribute quite liberal views, should have taken more than 3 years ago the seemingly totalitarian step of making the marking of dentures compulsory.' In the past the introduction of national identity documents has caused the public to feel affronted at losing personal liberties but, as human nature will have it, people eventually accept these impositions. Denture marking is a similar process. It is not a matter of direct public health nor are its benefits going to be obvious daily. It is quite simply a matter of returning a lost denture easily to its rightful owner, dead or alive. If identity is unknown, one glance at the denture will quickly solve the problem. In a well ordered, civilised society the community has a duty to respect the sensibilities of its citizens and the due identification and disposal of its dead are inalienable duties, just as the police and the law must be provided with all available information connected with the legal aspects of death.

A government will only legislate when it is satisfied that there is justification for introducing a measure such as denture marking. It will be more easily convinced, furthermore, if the population as a whole has begun to accept the procedure. It is thus necessary for a private body to take the initiative and create the demand through sufficient publicity and voluntary implementation.

A plea is thus made that the dental profession fulfil this role in implementing denture marking. The technician must be expected to co-operate, and the denture wearer must naturally give consent. The extra cost of materials and time will be an obstacle and consequently the technique must be quick, simple and cheap apart from fulfilling the other requirements outlined earlier.

Haines[7] found that of 380 air disaster victims he examined, 97 had dentures and of this number only 7 were marked. This is surely a sad state of affairs when one considers the usefulness of a marked denture compared with the uselessness of an unmarked one.

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The Age of a Tooth Fracture: Its Determination

A Case Report

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Abstract

A fracture of a tooth, allegedly caused shortly before death, was examined with a stereomicroscope and a scanning electron microscope. The appearance of the fracture was compared with that of a freshly fractured tooth. Signs of abrasion were present on the fracture surface of the tooth in question. Occlusion of the dentinal tubules with a smooth dense material was also seen with the SEM. It was concluded that these changes could only occur if a fracture had been present for some time and exposed to the normal oral environment.

* * *

Key words: Tooth fracture, age, stereomicroscopy, scanning electron microscopy.

Fracturing of teeth due to assault can have grave consequences for the assailant especially if the latter is a policeman. It is therefore imperative for the dental expert, when the complainant is examined, to determine among other things the age of such a fracture. When there is no obvious soft tissue or bony damage to help with the diagnosis, such a determination can become a problem. Fracture lines and surfaces will have to be examined carefully for signs of smoothing (abrasion), something which can only occur by use of the fractured tooth.

Teeth in the mouth can be investigated with a powerful magnifying glass or viewer or even by adapting a dissecting microscope. These methods will reveal established abrasion. If the findings can be photographed in colour or black and white there should be no ontoward problem. However, minor abrasion can be more difficult to establish and none of the above tools is powerful enough. On the other hand, if teeth can be removed, as for instance from a corpse, then much more definitive examinations can be carried out with stereographic plotting, the stereomicroscope and the scanning electron microscope (SEM).

The use of the SEM in forensic odontology is relatively new. Sognnaes[1] used it in the identification of Martin Bormann. By scanning the wear marks on teeth he was able to determine a relationship between anterior teeth and a particular dental bridge. Subsequently he used the same tool to examine bite marks.[2] In another carefully documented study Bang[3]

employed the SEM to aid his analysis of tooth marks in a homicide case. He also used stereophotography and stereometric graphic plotting.

This case concerns the age determination of a fracture of an upper left incisor tooth allegedly caused by the police at the time of or shortly before the death of the deceased.

Case Report

A relatively well-preserved adult male body was discovered in a river. As a man from the same area had been reported missing shortly before this discovery, the relatives were asked to identify the corpse. This was done visually but the relatives noticed a broken front tooth which, they claimed, had not been the case at the time of his disappearance. Furthermore, it was intimated that this lesion indicated a possible assault by the police at the time of death or shortly before.

The broken tooth was removed very carefully by the forensic pathologist and sent to the authors for examination and a report.

The Examination. The authors received an upper left central incisor tooth packed in cotton wool. Its distal corner was missing, obviously fractured. The dentine was exposed but not the pulp (Figs. 1, 2). The tooth and the fracture were photographed in black and white and in colour from all angles at a standardised magnification. The surface of the fracture was then studied with a stereo microscope at various magnifications and also photographed (Fig. 3).

For comparison a similar front tooth, which was extracted due to a periodontal disease, was manually fractured and these surfaces investigated

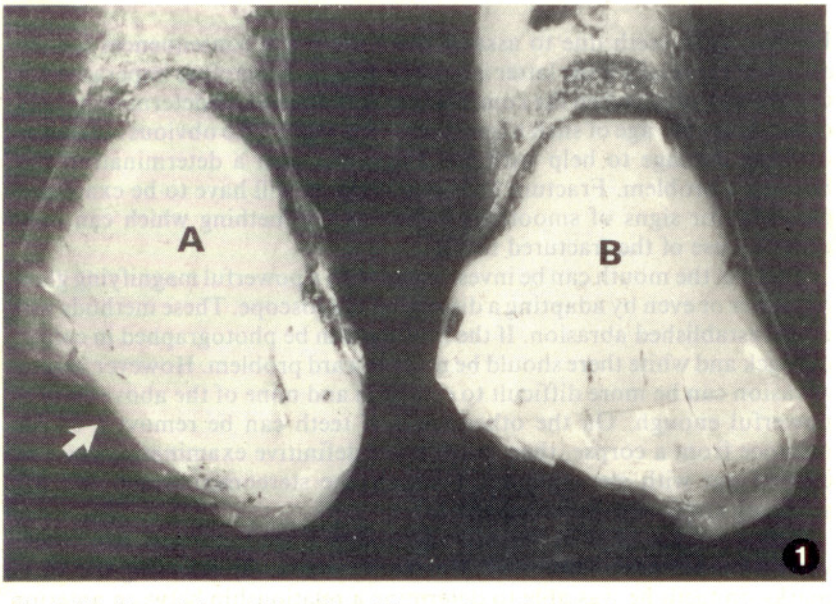

Fig. 1. The lingual view of the referred fractured tooth (A) and the control fractured tooth (B). Note the sharp fracture lines of tooth A (arrow) compared to those of tooth B (Original magnification X 8).

in similar fashion (Figs. 1-4). Models were then made of both teeth, using silicone rubber impression material as the die and acrylic as the cast.

From these studies we concluded that the fracture must have occurred some time before death, as an apparent abrasion facet was detected.

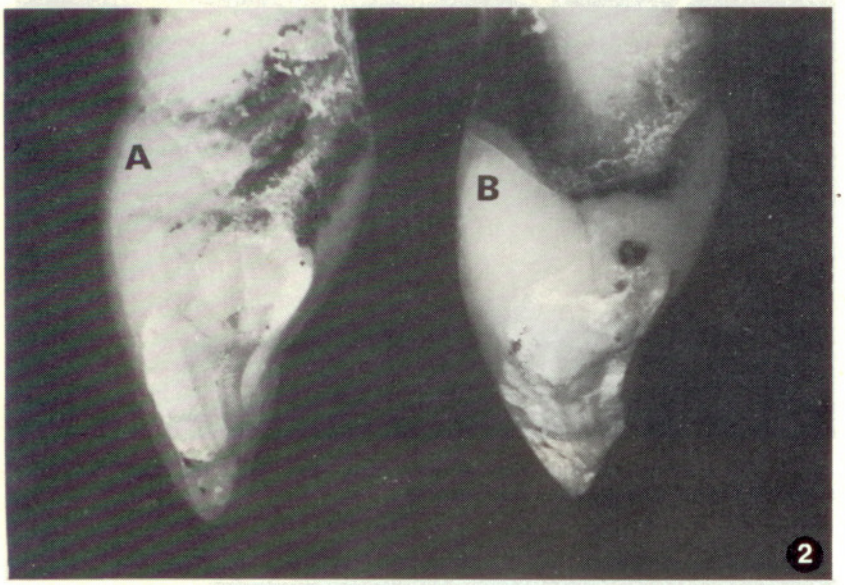

Fig. 2. The distal view of the referred fractured tooth A and the control fractured tooth B. Both teeth show enamel and dentine fractures but no pulpal exposure (Original magnification X 8).

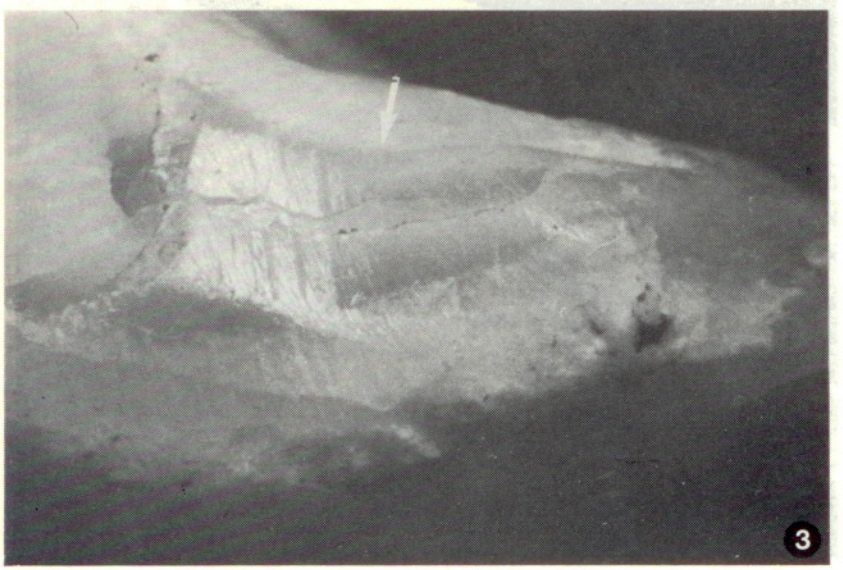

Fig. 3. The stereomicroscopic view of the referred fractured tooth. Note the smooth polished appearance of the surface (Original magnification X 25; arrow).

Fig. 4. The stereomicroscopic view of the control tooth. Note the rough fractured surface (Original magnification X 25; arrow).

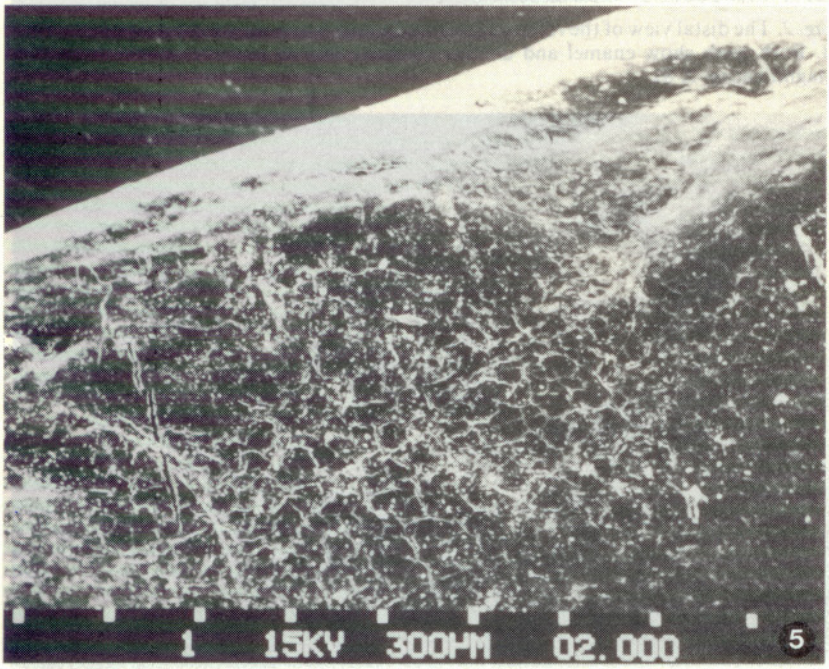

Fig. 5. The fractured surface of the referred tooth. Note the apparent roughness of the surface (SEM. Original magnification X 150).

However, it was felt that further supportive evidence was also necessary and it was decided to compare the fracture surfaces under the SEM. This method allowed for a much more detailed surface study.

With a carborundum disc, blocks were cut from the teeth which included part of the fracture surfaces. These were gold coated and examined with a Cambridge stereoscan Model S 180 M.

Results. Visual examination of the tooth revealed that: the fracture lines of the referred tooth were sharp to the eye. No obvious abrasion was apparent. However, on comparison with the control fractured tooth the lines of the latter were seen to be more jagged (Figs 1, 2).

Stereo microscopy showed a definite smoothing of the fracture of the referred tooth. The edges were rounded and glossy as if polished (Fig. 3). The fracture lines of the control were rough (Fig. 4).

SEM, at 150 X magnification, showed the fracture surface of the referred tooth (Fig. 5) to be rougher than that of the control tooth (Fig. 6). At 1 000 X magnification the surface of the former showed closure of the fractured dentinal tubules by a smooth dense material, whereas the dentinal tubules of the control fractured tooth were wide open and very uneven (Figs. 7, 8). The apparent rough surface seen in the referred tooth at 150 X was in effect due to furrows running between occluded dentinal tubules creating the optical illusion of an uneven surface.

Discussion and Conclusion. We believe that the smooth surface of the fracture of the tooth in question was brought about by abrasion and

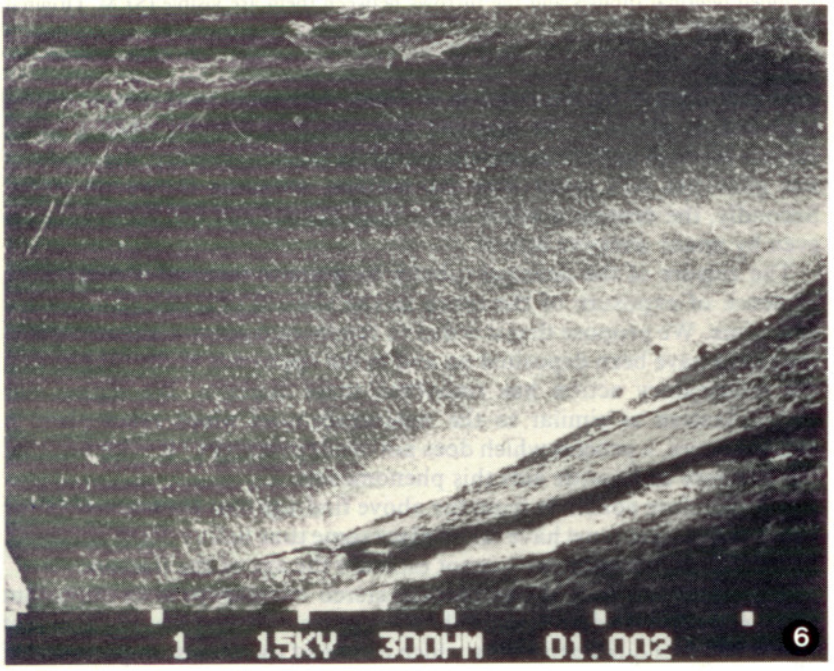

Fig. 6. The fracture surface of the control tooth. Note the apparent smoothness of the surface (SEM. Original magnification X 150).

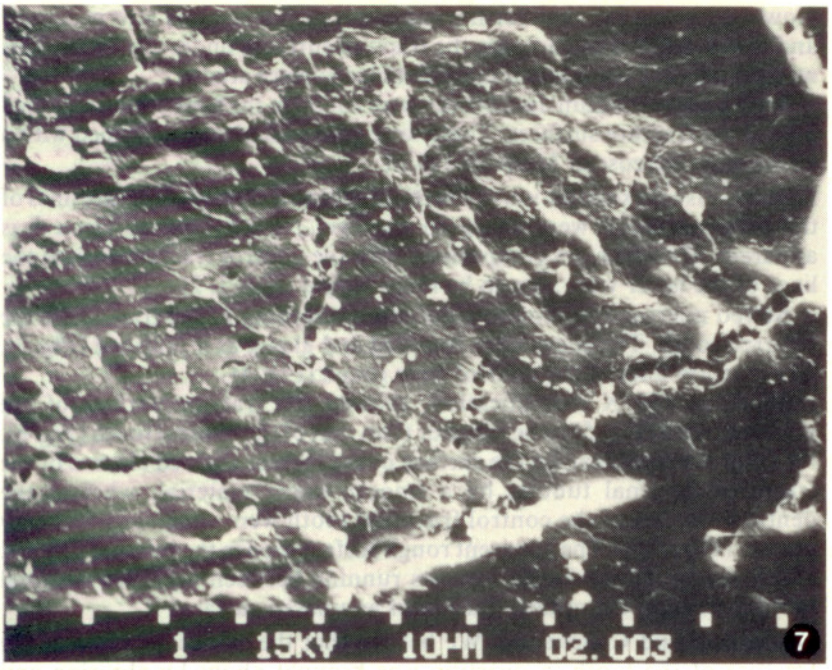

Fig. 7. The smooth remineralized surface of the referred tooth. Some of the partially occluded dentinal tubules and the furrows between them are visible (SEM. Original magnification X 1000).

probably caused by mastication of food. Although food is not usually regarded as abrasive, we contend that this will happen when a tooth surface is rough and the dentine exposed. In the first instance, the food will not glide but will grind over the surface, abrading the rough edges. Secondly, the dentine is much softer than enamel and will be worn away even by minor abrasive action.

The closure of the dentinal tubules by a dense material is compelling evidence of exposure of the tooth to the normal oral environment for sometime. We propose that it is due to remineralization. Calcium salts in the saliva have been deposited on and in the open ends of the tubules and the masticatory action has smoothed these deposits. We regard this mineralization as similar to the remineralization which takes place in enamel caries, a process which does not occur overnight.[4] It is known that the presence of fluoride aids this phenomenon.

We therefore conclude from the above findings that the fracture of the tooth in question must have taken place some time before death occurred. At this stage, however, we cannot estimate the age of the fracture.

This study not only shows that the stereo microscope is an important instrument for the detection of abrasion of fracture surfaces but also that the SEM gives qualitative data which can be of the utmost importance. If remineralization takes place at a set rate and if it can be determined quantitatively by the SEM, then the age of a fracture can be estimated.

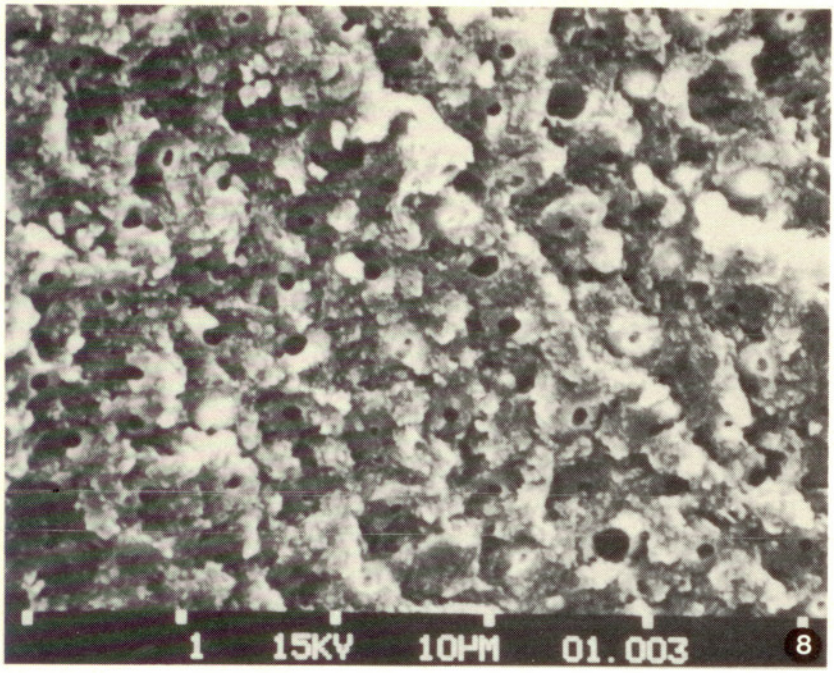

Fig. 8. The rough surface of the fracture of the control tooth with exposed dentinal tubules (SEM. Original magnification X 1000).

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Forensic Odontological Contribution to the Identification of a Denture Wearer

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Abstract

Dental tissues and dental restorative materials are very important in forensic identification. The resistance of teeth to high temperatures plays an important role in establishing identity.

A White man who had been incinerated following an accident in a car which subsequently burnt out, was examined for forensic purposes. No teeth, restorations or dentures could be found. The probable temperature attained within the car during the fire was established in the laboratory.

The conclusion drawn was that the person had had no natural teeth but had worn dentures made of acrylic. Circumstantial evidence later established that this conclusion was correct.

Keywords: Denture, Fire, Identification.

* * *

Dental tissues and restorations are important in forensic identification. The dental identification procedures have often contributed to the identification of both living persons and human bodies after death. In certain circumstances, the dental investigation has been the only means by which positive identity of a person would be established. This is especially true in cases where bodies have been in a state of advanced decomposition. Although human teeth are subject to breakdown throughout life, they remain intact the longest, after death.[1] Dental restorations (including dentures) are, to a large extent, resistant to physical and chemical damage and can frequently be used as the deciding factor in establishing identity. Natural teeth are very resistant to temperature and are, to a large extent, protected by the lips, cheeks and tongue. Should the temperature be extremely high or the teeth exposed to a sudden high temperature, they disintegrate immediately; but if exposed to a gradual rise in temperature, they remain intact up to a temperature of 1 100° C.[2,3]

Case Report

A White man was killed in a collision between a road tanker (carrying nitrogen gas) and a lorry transporting coal. The coal lorry was rammed from behind by the road tanker and both vehicles caught fire.

The body of the driver of the road tanker was so badly burnt that visual identification was not possible. Only a small area, covered by pubic hair, whereby the person could be identified as caucasoid, was still discernible.

At autopsy, the head and face were found severely damaged by the fire (Fig. 1). Of the lower ⅔ of the face, the tongue, though badly burned and contracted, was still discernible. The mandible, except for a portion of the right mandibular ramus, was missing. The identifiable part was 3 x 1,5 cm in size and no soft tissue or muscle was present in relation to the remnant.

The maxilla was largely destroyed, except for the most posterior part. The left tuberosity was clearly palpable but the right tuberosity, though identifiable, was less palpable.

With the aid of a röntgenological examination, the presence of both tuberosities was confirmed (Fig. 2). On the left side, a measurable 1,5 cm portion of the posterior alveolar ridge was identifiable but on the right side, only 0,5 cm of the ridge was discernible.

Examination of the Vehicle. A thorough examination of the vehicle was carried out and all loose and burnt material in the cabin was inspected. The cabin was very badly damaged with a large amount of melted metal present. The search revealed fragments of burnt and brittle human bone from various sizes, some of which were identified as coming from the long bones. However, none could be identified positively as having come from the jaws. In the cabin, a piece of melted material was found with an apparent appearance of molar teeth in a perpendicular relationship to one another. Röntgenological examination of this material showed a uniform opacity not usually associated with teeth and, on these grounds, the presence of tooth material was excluded (Fig. 3).

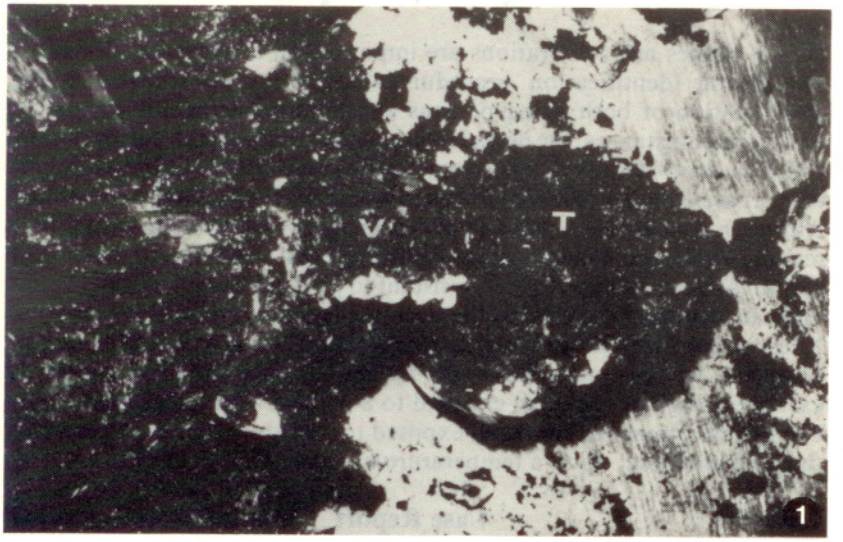

Fig. 1.: Severely charred body. The anterior half of head is almost totally destroyed. T = tongue; V = vertebrae. Note the total absence of jaws.

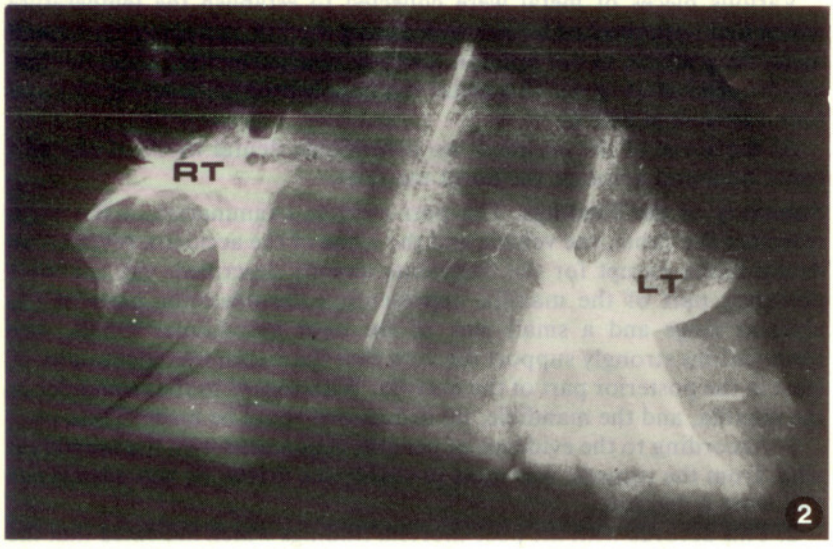

Fig. 2: Rontgenogram of the middle third of the face showing extensive damage to the maxilla. Only the most posterior part including both tuberosities is demonstrable. RT = right tuberosity; LT = left tuberosity.

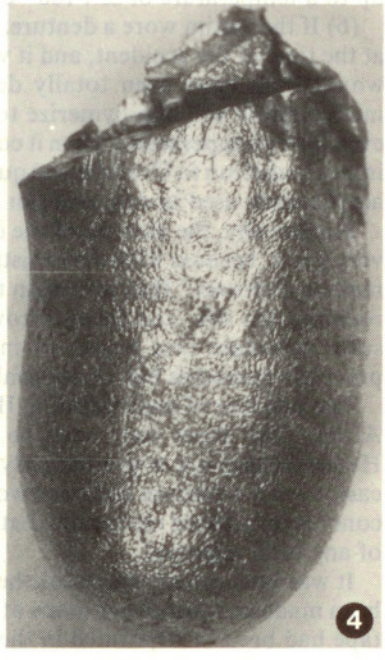

Fig. 3: Material found in the cabin with the apparent appearance of molar teeth in perpendicular relationship (arrows).

Fig. 4: Solidified metal drop.

Various pieces of metal were collected to establish the temperature which had been reached in the cabin during the fire, including a solidified metal drop which, in our opinion, had just reached melting point but had not dropped off (Fig. 4). This metal was later heated in the laboratory and found to melt at 680° C.

At the scene of the accident, no identifiable dental tissue of any sort could be found amongst the burnt material.

Summary of the Findings. The post-mortem examination, a thorough search of the cabin, the vehicle and the scene of the accident, revealed no dental tissue except for the fragments already described, viz. the most posterior part of the maxilla, representing the posterior parts of the alveolar ridge and a small part of the right mandibular ramus. The observations strongly support the view that the victim was edentulous, at least in the posterior part of the maxilla. With regard to the remainder of the maxilla, and the mandible, no deductions could be made. Thus:

1. According to the evidence of persons acquainted with the individual who, from the records, was most probably the driver, he was edentulous and wore a denture.

2. This accords with the post-mortem findings which indicated that the victim was edentulous, at least in the posterior maxillary area.

3. The fact that the temperature in the area of the body reached 680° C means that:

(a) If the victim had had his own teeth, they would have remained intact up to a temperature of ± 1 100° C.[3]

(b) If the victim wore a denture, and the denture had been in the mouth at the time of the accident, and it was made of acrylic with acrylic teeth, it would then have been totally destroyed. In acrylic teeth, polymethyl methacrylate will depolymerize to monomer at 450° C.[4,5] It will burn at even lower temperatures when it comes into contact with any flame. This is in contradiction to Gustafson's[6] quotation from earlier German work, that acrylic teeth used in dentures can resist temperatures of over 1 100° C.

Statistically, the chances of the denture having been made of acrylic are very good, because 92% of dentists in South Africa today used acrylic for making dentures.[7] Had porcelain teeth been used, the chances of the teeth resisting the fire, and being recovered, would have been much greater, since porcelain first begins to melt at 900 - 1 000° C.[2] After melting, porcelain remodels before congealing into its new form.

The practice of incorporating ID tapes in dentures is growing in South Africa. The tapes only start to melt at a temperature of 1 300° C.[8] However, they are at present only being used on a small scale and, in this case, even if a denture had been worn, clearly no ID tape was present. This conclusion is based on the fact that a thorough search failed to reveal traces of any such material.

It was later positively established where, and by whom the denture had been made and that it was made of acrylic, the teeth were acrylic and no ID tape had been incorporated in the denture base.

Discussion

Although identity was only achieved by circumstantial means, it was

possible to make a positive contribution to the identification of the victim. According to the evidence, the victim was an edentulous White man, wearing a full upper and lower denture with acrylic teeth, with no identification tape incorporated into the denture base.

The contribution of the forensic odontologist is of inestimable value in the identification of persons, living or dead and in many varying circumstances.

The case under discussion is an excellent example of the value of forensic odontological investigations in the identification of persons.

Quite apart from the broader contribution, this case demonstrates the role that dentures, and denture marking, could play in these circumstances. The negative findings with regard to the dentures worn by the victim are highly significant, but it would have been even more satisfactory had an ID tape been present in the denture.

The authors wish to thank Mr J. Nell for technical assistance and the photography and Mrs Y. Crots for typing the manuscript.

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Brief Case Reports

Teeth and Alveolar Bone for Blood Grouping

A Case Report

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A relatively well-off couple had a child after 5 years of marriage. They lived about 22 kilometers from the centre of the city. The marriage became precarious after 2 years and the position worsened when a male child was born. The father accused the mother of infidelity and maintained that he was not the father of this child. Testimony from neighbours revealed that the couple quarrelled often and that the child was ill-treated by the father when the mother was not at home. According to their maid, the father often threatened the wife that he would kill the 'illegitimate' child. The maid also maintained that the father caused the baby to fall out of the cradle by pushing it roughly and the child sustained injuries from the fall. Other evidence stated that husband and wife slept in separate bedrooms, the wife with the baby.

At the trial, the story of the disappearance of the child was related as follows:

The mother was working late and after the father returned home from work, he went off to play cards with friends as was his habit. He returned home after midnight and when he looked into his wife's bedroom saw the maid sleeping there but the child and his pillow were missing. A diligent search was carried out, but no trace of the child could be found. The father reported the matter to the police that morning.

The wife, on returning from work, immediately accused the husband of murdering the child and disposing of the body. A search by the Police revealed no sign of the child.

After 2½ months, people living about 3 kilometers from the house of the missing child, smelt a putrid odour being emitted from a disused walled garden. No one entered the area as they thought it might have been a dead cat. After the fourth day, a stray dog was seen chewing a human baby's femur. The Police were informed and they dug up the remains of a baby skeleton (stripped of flesh by the dogs) which was minus a femur. The remains were removed to the Police mortuary.

The wife, on being informed of the discovery, went to the mortuary and identified the body as that of her child and again accused the husband of murdering the child. The husband was apprehended by the Police and subsequently released on bail. The husband denied the accusations of his

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wife and at this stage admitted that he was the father of the child. He also had an indisputable alibi during the time of the disappearance of the child.

The skeleton of the victim found by the dogs was sent to the Calcutta Forensic State Laboratory. The estimated age of the remains was about that of the missing child. Superimposition of the skull radiograph over a picture taken when the child was 7 months old proved to be inconclusive.

In the preliminary trial, the evidence against the father was only circumstantial and although the maid, wife and neighbours accused him of cruelty to the child and suspicious behaviour, there was no definite evidence against him. The father adhered to his alibi and the Magistrate referred the case to the superior court. The judge requested irrefutable proof that the skeleton, which was presented to the court, was that of the missing child. The Forensic Pathologist wanted to use blood typing as a method of establishing paternity. The author was consulted with regard to using the teeth of the victim for blood typing.

Dental Examination

A mutilated skeleton of a baby was examined. The oral cavity revealed that 3 upper and 2 lower incisor teeth were missing. The rest of the deciduous dentition was present except for 2 upper deciduous second molars. Permission was requested to extract 2 teeth and to remove a small amount of alveolar bone for blood group analysis (elution method used by Prof. Kazuo Suzuki). The mother objected because of further mutilation of the skeleton. The judge, however, observed that the skeleton was the property of no one until its identification.

Two tests were carried out on the remains. First, about 5 mg of dental hard tissue and pulp were examined. In the second test, 4 mg of alveolar bone was utilized. These tissues were tested with commercially available normal human anti-A and anti-B serum. In both tests the blood group B was ascertained and this evidence was presented to the court.

The husband's blood group was group A and the wife's blood group was group O. This ruled out the possibility that the skleton was the missing child of this couple. The husband was discharged.

Conclusion:

This case proved that the pulpal tissues as well as alveolar bone contain sufficient blood cells to ascertain the blood group of a victim.

The Forensic Dentistry Congress at The Armed Forces Institute of Pathology, Washington, D.C.

A Report

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This Congress (organized by Dr Russel Corio) was held from 3 to 7 October 1983. It covered the subject and its facets very comprehensively. Lectures were included on the identification of individuals and the importance placed on detail.

Mass disaster played a major role in the programme and many experts in this field spoke extensively on the logistics of this operation. A talk and a demonstration of Forensic Photography were scheduled.

The legal aspects of dentistry were covered very widely. R. J. Hazen (from the FBI) discussed the use and the technique of taking finger prints of mass disaster victims. The skin of the burnt victim's finger is removed and is used as a glove on one's own finger. The skin of the victim is usually very loose and this method allows reproduction of very accurate finger prints in most cases.

I presented a paper on *The Uniqueness of Amalgam Restorations for Identification.* Bite marks were also discussed extensively. There are 2 schools of thought about the recording of bite marks. The one school advocates that impressions should be taken of the marks as these can often be matched with models of the suspect's teeth as well as that of the victim. The other school claims that, due to the distortion of human tissues, it is more important to take photographs of the bite marks. Colour photographs are of less value compared to black and white as the latter show better contrast between normal and damaged tissue. A new technique has recently been developed with the use of infrared photography. This apparently has produced some very interesting results even in old bite marks. This work is still relatively new and not much information was available to date.

The battered child syndrome was discussed at length as well as the legal aspects affecting the general practitioner. Many care centres are available for these victims as well as psychological help for the perpetrators of this offence. There is a very great awareness of this problem in America and a concerted effort is being made to remedy it. Dr. P. Tsaknis discussed the child abuse problem and the types of injuries found in these victims. The psychological aspects of this syndrome are very involved and lead to both parental and sibling psychoses. The public have been made aware of this problem, mainly through the use of television and newspapers, and that it

is their duty to report any such crime. Man's inhumanity to his species never fails to astonish one. An interesting facet of this crime is the psychological aspects of both perpetrator and victim and the difficulty one is faced with when questioning these people.

An *Identification Laboratory* was presented as a full-day exercise during which delegates were involved in the identification of remains of accident victims. This laboratory was organized and presented by Col. Morlang. It gave the participants a very good opportunity to realise the magnitude of a mass disaster and the actual working conditions. This well-presented project was of invaluable experience. Col. Morlang spent a great deal of time obtaining authentic specimens and radiographs and presenting these very realistically.

I spent the following day discussing the logistics of organising a mass disaster laboratory with Col. Morlang. This could be done in time in our own department and could be used to train potential forensic odontologists.

This Forensic Dentistry Congress attained a very high standard and, from a practical point of view, is highly recommended to those interested in this facet of dentistry. A congress of this magnitude makes one aware of how necessary it is to have a disaster team and how inadequate our facilities are in South Africa.