ISSN 2219-6749

I·O·F·O·S

The Journal of Forensic Odonto-Stomatology

Volume 14, n. 2 - Dec 1996

OFFICIAL PUBLICATION OF THE
INTERNATIONAL ORGANIZATION FOR
FORENSIC ODONTO-STOMATOLOGY

CONTENTS

COMPARATIVE STUDY OF EXPERIMENTALLY INDUCED AND POST-MORTEM PINK TEETH

C.A.P. de Almeida[1], E. Daruge[2], E.Daruge Jr.[2] and M. El-Guindy[2]
1.Department of Forensic Dentistry, Federal University of Rio de Janeiro and Forensic Dentistry service (IML) Rio de Janeiro
2. Forensic Dentistry Laboratory, FOP, State University of Campinas - UNICAMP, Campinas, SP, Brazil

ABSTRACT

Forty-eight pink teeth from eight male cadavers, all dying from unnatural causes were studied for the pink tooth phenomenon. Perfusion with whole and lysed blood, at different temperatures was carried out, followed by longitudinal sectioning for histological observation. Another 30 unblemished human teeth were used to reproduce the phenomenon *in vitro* to help clarify its pathogenesis. (**J Forensic Odontostomatol 1996 14:2, 25 - 27**)

Keywords: pink teeth, post-mortem, haemoglobin, dentine

INTRODUCTION

The nature and exact time of death are very important issues in forensic investigation while the development of pink teeth and changes in other features of the oral cavity are considered indicators which can offer useful information about the mode of death.[1,2] Pink colouration has been recognized for some time by post-mortem examiners but its significance and pathogenesis is still unclear.

Post-mortem pink colouration of the teeth has been described by Miles and Fearnhead[3] as being a natural phenomenon. The authors examined sections of teeth obtained from five bodies, two having died from strangulation, two from carbon monoxide poisoning and the fifth from drowning. Analysis showed that the pink colouration was confined to the dentine into which it extended outward from the pulp in varying degrees and that haemoglobin compounds were present.

The replication of pink teeth in experimental animals has been reported.[4] The results obtained lend some support to the suggestion that pigmentation depends on factors occurring at or around the time of death and it seems likely that raised venous pressure resulting in release of erythrocytes into the pulp tissue may be a contributing factor. Based on these experiments Beeley and Harvey[5] suggested that the major constituent responsible for the pink pigmentation is haemoglobin or its derivative.

Kirkham *et al.*[6] reported a case of the body of an 11 year-old Caucasian female which was found in an advanced state of decomposition three weeks after she was reported missing. The crowns of the teeth were distinctly pink, the colour being more intense in the anterior teeth than in the posteriors, and the pigmentation of the roots was deeper than that of the crowns.

The phenomenon of pink teeth has been discussed in a paper by Stanley *et al.*[7] who supported the suggestion that pink teeth in corpses indicates a violent death and in which red blood cells are forced into the pulp cavity. When death occurs, and in the absence of macrophages, the red blood cells cannot be converted to haemosiderin, and haemoglobin break-down products remain in the teeth, staining them a pink to red colour.

It has been suggested that the mechanism of pink teeth formation consists of a rapid increase in venous pressure in the pulp leading to extravasation of erythrocytes into pulp tissue and/or pulp haemorrhage.[8] This is followed by autolysis of the tissue with diffusion of haem in solution into the dentinal tubules and breakdown of haem to protoporphyrin. This compound, responsible for the pigmentation, was isolated from the dentine of pink teeth.[8] The time lapse and the resulting post-mortem decomposition play an important role in the pink teeth phenomenon.[9]

In an attempt to clarify the steps leading to pink staining of teeth, van Wyk[10] set out to produce pink teeth experimentally using cadaver blood and to correlate the time sequence of the colouration with the process of blood haemolysis. The blood from seven cadavers was used to stain seven groups of fourteen teeth each. Circumpulpal discolouration commenced on the sixth day and increased up to the 18th day post-mortem. The author concluded that pink staining of teeth can only occur after haemolysis and that discolouration becomes obvious macroscopically at about six days.

In view of the above uncertainties, it was decided to reproduce pink teeth experimentally under conditions similar to those established by van Wyk.[10] Our intention was to use whole and lysed blood at different temperatures in order to simulate as closely as possible the natural circumstances of the pathogenesis of pink teeth.

MATERIALS AND METHODS

Thirty human teeth in perfect condition were washed and kept in 70% ethyl alcohol. The teeth were divided into 3 groups of 10 each, the pulp was removed and then each root canal was reamed to accommodate a 30×0.7 needle.

The pulp chamber of the first group was filled with whole blood containing 3% sodium citrate to prevent coagulation. In order to test the effect of temperature variation on tooth colouration the second group received cold (-2°C) lysed blood and the third was filled with hot (74°C) lysed blood.

The teeth were stored in a moist environment at room temperature. The control group consisted of 48 pink teeth obtained from eight male cadavers, four of them having died from drowning, two from hanging, one from suffocation and one from shooting. All the teeth were observed daily for 60 days. Longitudinal sections were prepared for histological analysis following the method described by Pearse,[11] and all procedures were performed in the dark to avoid the degeneration of haemoglobin. The human blood was obtained from the blood unit of our department.

RESULTS

The clinical examination of the naturally coloured teeth revealed that the pink colouration started at day 25 after death, the light pink colour observed initially changing to blue, grey-green and purple. The colour alteration always tended to darken, reaching its most intense level at day 35 after death. In the experimentally induced pink teeth, the first group treated with whole blood and 3% sodium citrate showed more evidence of the presence of haemoglobin derivatives than the others. In this group the colouration was observed between 10 and 20 days, while in the others the colour alteration was observed between 2 and 4 days earlier. The predominant colour observed in the experimentally induced teeth was different for each group, the colour observed in the first group was pink while in the second it showed dark purple and in the third presented a grey-green colour. In all the experimental groups the roots presented the same discolouration as observed in the pulp chamber but with more intensity. The results are summarized in Table 1.

DISCUSSION

The biosynthesis of porphyrins is an especially important biochemical pathway because of the central role played by the porphyrin nucleus in haemoglobin. The first step is the condensation of glycine and succinyl-CoA to yield enzyme-bound α-amino-β-ketoadipic acid, which is rapidly converted to δ-aminolevulinic acid (ALA). Two ALA molecules are condensed to form a porphobilinogen ring, and the union of four porphobilinogen rings produces the uroporpherinigen III. This reaction is activated by the interaction of two enzymes, the uroporpherinigen-I-synthetase and the uroporpherinigen-III-co-synthetase. Subsequent reactions of decarboxilations and oxidations help to transform uroporpherinigen into coproporpherinigen III, protoporpherinigen III and protoporpherin III. The incorporation of iron and the addition of globin protein yields the haemoglobin, which requires the enzyme ferrochelatase and haem synthetase.

It is recognized now that the pink tooth colouration is due to an increased pressure in the pulp circulation.[12] The biochemical events start with the reversion of the last two steps in the synthesis chain, the haemoglobin being dissociated into globin protein and haem, the latter compound being spliced into the iron and protoporpherin III molecules which are responsible for the pink colour. The eight bodies examined in our study all presented pink teeth and histological observation clearly showed the presence of haemoglobin and its derivatives in the dentinal tubules.

Different findings were reported by Clark and Law[8] who observed pink teeth in only two of the six drownings examined by them. They also quoted the results of Sims[13] in which 17 bodies recovered from the sea did not have any pink teeth. These results are different from ours, probably because they examined the bodies within a short period after death [one week after death (case III) and 96 hours after death]. Our studies indicate that pink teeth

		Treatment	Colour alteration	First Day of appearance
Experimentally induced	1°	Whole blood +3% Na cit.	Pink	10-20
	2°	-2°c. Lysed blood	Dark Purple	07-15
	3°	74°c. Lysed blood	Gray-green	07-15
Post-mortem		Unnatural death	Blue ⇓ Gray-green ⇓ Purple	25

Table 1. The colour alteration and the inititiation of colour appearing in experimentally induced and post-mortem pink teeth

staining in drowning reaches its optimum 25-35 days after death.

The postulate described above for the development of pink teeth has been further supported by a replication of the phenomenon under controlled conditions. Experimental work undertaken on normal human teeth by infusion of blood into the pulp chamber reproduced the pink colouration phenomenon within 15-20 days. The experiment demonstrated that there should be sufficient blood in the pulp chamber so that on haemolysis a sufficient amount of haemoglobin is present to diffuse into the dentine and impart its red colour. Our findings strongly support the results of van Wyk,[11] who, in a similar experiment, observed the initiation of tooth colouration in 6 days.

Van Wyk[13] later reported that by using ultraviolet light he failed to prove the presence of porphyrin in sections of pink teeth. In order to explain the results obtained by Clark and Law,[8] van Wyk mentioned that those authors added sulphuric acid to the samples which can be responsible for the conversion of the haem into porphyrin and iron. However, van Wyk omits to describe the concentration of the acid necessary to produce such a reaction and Clark and Law do not state the amount of acid used or the reason for using it. In our experiment the ground sections presented the colouration understood to be the result of haemoglobin breakdown. The theory proposed by van Wyk,[13] in which the only conclusion is that the staining reaction indicates the presence of haemoglobin demands further discussion in order to explain the reason why the colouration is only detected a long time after death.

ACKNOWLEDGEMENT

Supported by grants from CAPES, Foundation/MEC and PRPP/UNICAMP.

Address for correspondence
Dr Moustafa El-Guindy, DDS, Ph.D
R. XV de novembro, 1896
CEP 13416-756, Piracicaba, SP, Brazil

REFERENCES

1. Furuhata T, Yamamoto K. Forensic odontology. Springfield: Charles C. Thomas, 1967.

2. Gustafson G. Forensic oral pathology. In: Gorlin RJ, Goldman HM (eds), Thoma's oral pathology. 6th ed. Saint Louis: Mosby, 1970: 115-39.

3. Miles AEW, Fearnhead RW. Post-mortem colour changes in teeth. J Dent Res 1954; 33:735.

4. Whittaker DK, Thomas VC, Thomas RIM. Postmortem pigmentation of teeth. Br Dent J 1976; 140:100-2.

5. Beeley JA, Harvey W. Dental identification and forensic odontology. London: Henry Kimpton, 1976.

6. Kirkham WR, Andrews EE, Snow CC, Grape PM, Snyder L. Post-mortem pink teeth. J Forensic Sci 1977; 22:119-31.

7. Stanley HR, Weisman MI, Michanowicz AE, Bellizzi R. Ischemic infarction of the pulp: sequential degenerative changes of the pulp after traumatic injury. J Endodont 1978; 4:325-35.

8. Clark DH, Law M. Post-mortem pink teeth. Med Sci Law 1984; 24:130-4.

9. Brondum N, Simonsen J. Post-mortem red coloration of teeth. A retrospective investigation of 26 cases. Am J Forensic Med Pathol 1987; 8:127-30.

10. Van Wyk CW. Postmortem pink teeth: in vitro production. J Oral Path 1988; 17:568-72.

11. Pearse AGE. Histochemistry theoretical and applied. 4th ed. Edinburg: Churchill Livingstone, 1985.

12. Sognnaes RF. Forensic stomatology (Part II). N Eng J Med 1977; 296:149-53.

13. Van Wyk CW. Postmortem pink teeth: histochemical identification of the causative pigment. Am J Forensic Med Pathol 1989; 10:1340-9.

NON-ACCEPTANCE OF PROSTHETIC APPLIANCES AT THE FOCUS OF FORENSIC CONSEQUENCES

L. Figgener
Department of Prosthetic Dentistry, University of Muenster, Germany

ABSTRACT

Non-acceptance of prosthetic appliances is not only a clinical problem; it also gives rise to legal proceedings. Not every case of non-acceptance is psychogenically induced, there are often somatic and even iatrogenic causes. Objective treatment deficiencies are subject to forensic sanctions irrespective of any underlying psychosomatic illness. If the dentist is to manage non-acceptance in a responsible way not open to forensic consequences, competent clinical and psychological skills are needed. **(J Forensic Odontostomatol 1996 14:2 28-29)**

Keywords: Non-acceptance of prosthetic appliances, psychosomatic, best practice, litigation

INTRODUCTION

Non-acceptance of prosthetic appliances in particular or of dental care in general often confronts us with serious diagnostic and therapeutic problems and is on the whole a major clinical challenge which gives rise to legal disputes between the dentist and the patient who feels incorrectly treated. This is the point at which litigation enters the formerly harmonious relationship, and is made worse by the demands and attention that these patients have already placed on the dentist's time and skills; and yet the inability of a patient to cope with a prosthetic appliance is not in itself a reflection of its quality. The fact is rather that it may be rejected because of other causes such as of a psychosomatic or geriatric nature. Naturally a deficient appliance and indifferent dental care generally can be expected to cause problems, but these are to be expected.

In most cases however the patient is unaware of the diversity of these situations, they are conscious only of discomfort or of the fact that they cannot cope with the appliance, and understandably assume that the dentist is at fault. What is of concern to the dentist, on the other hand, is whether the lack of success is due to inadequate treatment on their part or whether the patient's discomfort is independent of the treatment, for the problem may involve them in various clinical and, as stated above, forensic consequences.

MATERIALS AND METHODS

In this context we examined all 218 court-commissioned consultancies rendered by our department in the ten-year period from 1983 to 1992.

RESULTS

In 33 of the 218 lawsuits (15%), the dispute centred on non-acceptance of prosthetic appliances or on other complaints which had been interpreted by the dentist as being psychogenically induced.

In 11 cases the experts recorded definitive somatic findings or serious defects which accounted directly for the symptoms reported by the patient. In 10 cases unacceptable treatment was established in patients suffering primarily from psychosomatic disorders and only in the remaining 12 cases was the non-acceptance of prosthetic appliances attributed to psychosomatically induced factors, with no blame due to faults in dental care.

The most frequent defect revealed in this investigation was, in line with other published findings,[2] incorrect occlusion.

DISCUSSION

The results offer impressive evidence that non-acceptance of prosthetic appliances cannot and must not be dismissed out of hand as psychogenically induced and thus passed off *ipso iure* as a responsibility or risk inherent in the patient.

What concerns the dentist is rather that it can be stated with a clear clinical conscience that the work is not the cause of the patient's problems. Like an appointed expert, they too must examine the treatment performed on the patient and be able to deem it correct and in accordance with current best practice.We owe no more but certainly no less to the patient.

Success depends unfortunately often on subjective factors on which clinicians have only limited control, if any, as the German Court of Justice fittingly commented on in a verdict.[1] It is thus not success in itself but rather our skills, knowledge and goodwill - in other words, objective preconditions for success which are concerned with both our contractual and our dento-aesthetic duty towards the patient.

To this extent there has, in fact, always been agreement. In contrast, the question of whether the objective correctness of our work can be defined, and if so how, is a matter of controversial and in some cases highly emotional discussion. The dispute surrounding this topic is new in this form. What is anything but new, on the other hand, is the underlying problem. Doctors and dentists have always endeavoured to give their patients high-

quality treatment in accordance with best practice. On the other hand, an officially appointed consultant has always had to comment, when the correctness of the treatment was being challenged, on whether the treatment was indeed in accordance with best practice.

If dental treatment is a failure because the patient complains that they cannot cope, the dentist should first scrutinise it as a matter of course, remembering that a subjective view may be clouded by many other factors. It is only when no inherent condition and no defect in the dental treatment, which might account for the patient's discomfort, exists that the dental findings can be eliminated as at least a partial cause of the complaints.

It is essential for a patient suffering from a psychosomatic disorder to be assured of adequate dental care. This is a precept of ethics which is consistent with the call repeatedly made by Müller-Fahlbusch[4] for untargeted pragmatism in terms of alibi diagnoses and makeshift therapies to be avoided. For if a psychosomatically ill patient is also suffering from dental problems giving rise to psychosomatic crystallisation, as it were, the already poor prospects of recovery will dwindle rapidly.

Apart from these considerations, clinical routine unfortunately suggests that many a patient not suffering primarily from a psychosomatic disorder responds at some time in a psychogenic way because somatic or even iatrogenic symptoms are either undetected or else ignored; this suspicion is confirmed in the present study and elsewhere.[5] It hardly needs to be pointed out how unprofessional it is for such patients to be branded as psychosomatically ill.

If such cases find their way to court, incorrect diagnoses and therapies will be subject to forensic sanctions irrespective of whether psychosomatic factors are the primary cause of complaints, are merely a cofactor, or play no role in them whatsoever. For all patients, the psychogenically sound and the psychosomatically ill, have a right to treatment carried out with due care from an objective standpoint.

The contract for dental treatment is a service contract. We are accordingly committed - and this has to be emphasised - not to success, but to treatment complying with the best in dentistry and thus creating feasible preconditions for the well-being of the patient.[3]

Non-acceptance of prosthetic appliances conceals a wide range of symptoms, some of them questionable, which may equally be an expression of psychosomatic illness and of somatic or iatrogenic causes. It is this very complexity which forms a tightrope between clinical success or frustration on the one hand and gratitude or disappointment on the other. It is thus also this complexity which compels the dentist to adopt competent diagnostic and therapeutic skills to enable the handling of such situations in a clinically responsible way, not open to forensic consequences.

Address for correspondence:
PD Dr. Dr. Ludger Figgener
Poliklinik für Zahnaerztliche Prothetik A
Zentrum für Zahn- Mund und Kieferheilkunde
Westfaelische Wilhelms-Universitaet Muenster
Waldeyerstr. 30
D-48149 Muenster
Germany

REFERENCES

1. Bundesgerichtshof. Neue Juristische Wochenschrift 1975; 28:305-7.

2. Diedrichs G. Gerichtliche Auseinandersetzungen nach prothetischer Behandlung. Dtsch Zahnaerztl Z 1995; 50:143-5.

3. Figgener L. Kann es in der Sahnheilkunde Garantien geben? Dtsch Zahnaerztle Z 1995; 50:105-7.

4. Mueller-Fahlbusch H. Aerztliche Psychologie und Psychosomatik in der Zahnheilkunde. Stuttgart-New York: Georg Thieme, 1992.

5. Wolowski A, Figgener L. Nicht erkannte oder nicht zur Kenntnis genommene klinische Befunde als moegliche Ausloeser psychischer Auffaelligkeiten. In: Sergl HG, Mueller-Fahlbusch H, Eds. Jahrbuch der Psychologie und Psychosomatik in der Zahnheilkunde, Vol.2, 1991 Berlin: Quintessenz, 1992.

THIRD MOLARS IN THE ESTABLISHMENT OF ADULT STATUS - A CASE REPORT

P. Nambiar,[1] H. Yaacob,[2] and R. Menon[3]
1. Department of Oral Biology, Faculty of Dentistry, University of Malaya 59100 Kuala Lumpur, Malaysia
2. Department of Oral Pathology, Oral Medicine & Periodontology, Faculty of Dentistry, University of Malaya
3. Senior Dental Officer, Sandakan, Sabah, East Malaysia

ABSTRACT

Teeth are the most durable structures in the human body. The timing and sequence of their development, as contained in dental development charts, have been used as valid criteria for age determination. The third molars however are the last teeth to erupt and are regarded as the most variable in the dentition. Age estimation in a legal context, using developing third molars must be carefully applied otherwise justice may miscarry. A case of wrongful use of the technique is presented here. (**J Forensic Odontostomatol 1996 14:2, 30-33**)

Keywords: age determination, tooth development, third molar

INTRODUCTION AND LITERATURE REVIEW

Teeth are the most durable structures in the human body. The timing and sequence of the developing dentition follow a very strict pattern although they are influenced by genetic, nutritional and environmental factors. The accurate appraisal of development of teeth is important to a practising dentist for clinical diagnosis, preventive therapy, surgical intervention, tooth conservation procedures, orthodontic treatment and forensic investigations. Owing to the comparatively low variability of tooth formation in relation to chronological age, it is likely that the method for assessing age, based on stages of tooth formation,[1,2] is more appropriate than those based on other indicators of somatic age.[3]

Authors of standardized dental development charts or surveys,[4-9] some of whom have stressed that in selected cases, age determination within the range of a few months is possible, especially during the intrauterine development and early years of life, have expressed their data in different ways. Generally, the information is given as the timing and the sequence of the various stages of tooth development.[1] The charts usually indicate mean or average age attained plus the maximum and minimum age range of any particular stage of development which is demonstrated as 1 or 2 standard deviations; other workers have used percentiles. The range is necessary to overcome variations amongst races, socio-economic status, gender or even inherited familial traits.

Most researchers prefer tooth formation to tooth emergence (appearance in the oral cavity) for age assessment because emergence of a tooth can be influenced by exogenous factors such as infection or injury to the area, obstruction, crowding, extraction of deciduous teeth or mesial migration of adjoining teeth. Furthermore, if clinical emergence is used as a criterion for age assessment, it can only be applied from six months up to two years, when eruption of the deciduous dentition occurs and after the age of six years to late teens when the permanent dentition takes over. This unreliability has caused many researchers to prefer development of teeth data for the estimation of chronological age. A rating based on development is therefore possible from birth until the completion of the third molar roots. The development of a tooth is characterised by simultaneous changes in both the size and shape of the crown or root. It must be emphasised that all teeth share morphologically distinct stages of mineralization which can be identified by analysing the shape and radiographic studies are able to demonstrate the changes in developmental shape at various ages. The eight-stage mineralization scheme adopted by Demirjian *et al.*[5] is the favourite and more practical when compared with the 14 and 20-stage technique proposed by Fanning[10] and Moorrees *et al.*[2] respectively. The former was supported by Hagg and Matsson[3] and Mincer *et al.*[11]

Once the teeth have erupted six features which are the result of wear-and-tear can be observed: attrition, secondary dentine deposition, recession of the gingiva, cementum apposition, root dentine transparency and root resorption. Using these observations Gustafson[12] was the first to provide a scientific age assessment from the changes while increasing attention has been directed to root dentine transparency which occurs independently of any pathological process affecting the tooth. In recent years there has been great interest in changes in the chemical composition of teeth and it has been reported that aspartic acid in tooth enamel and dentine exhibit increasing racemization with age. This reaction was found to be a good biochronological tool for assessing age and further research is being done in this area.[13,14]

THIRD MOLAR AS AN INDICATOR OF AGE

Dental age can be assessed amongst young children with greater accuracy because many teeth are undergoing development and mineralization simultaneously. However, after the early teens most teeth have calcified and erupted, except for the third molars and this makes it an important choice for age assessment during late teens to early twenties. Furthermore, the use of other biological

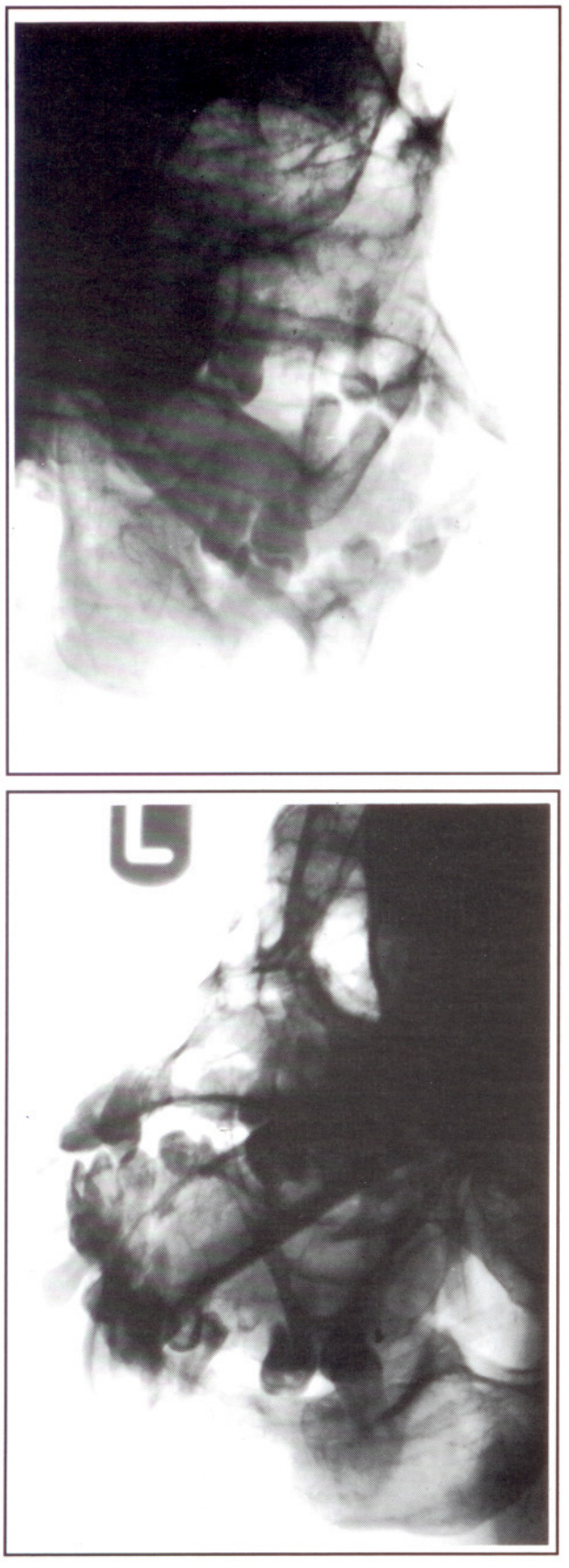

Fig. 1 Lateral oblique radiographs of (a) right side and (b) left side of suspect 1

indicators such as epiphyseal fusion, changes in the pubic symphysis, wrist bones and fusion of cranial sutures are not reliable during these years.[15]

Third molars' positions, anatomy and timing of development are very variable; sometimes they do not exist at all. If Butler's field theory holds merit, then these are the furthest teeth from the key teeth (first molars) and also the last to form. Key teeth usually manifest the ideal characteristics for a particular class of teeth and the third molars which form most distally therefore tend to be notoriously variable[16] being often even larger than the 1st and 2nd molars, and with fused roots. The maxillary third molars generally consist of three cusps, whereas some exhibit four cusps while in the mandible, the variability is between four or five cusps. It has been observed that the third molar formation and eruption occur faster in males than in females.[7,17] This is contradictory to the development of the other teeth where girls have earlier development which is probably because the males are still in the growth spurt period whereas the females have passed it.

CASE REPORT

In 1995 the Borneo Mail reported probably the first case employing the development of the third molars for age estimation in a drug trafficking charge in Malaysia. As the fate of the two indicted persons depended on whether they were juveniles or adults, and they could not provide any legal documentation of their age, it became necessary to establish age by other means. If they were proved to be adults, i.e. 18 years or above, they would both be charged under Section 39B of the Dangerous Drugs Act which provides for mandatory death penalty upon conviction.

Two weeks after the individuals were arrested lateral oblique radiographs were taken to demonstrate the third molars (Figs.1 and 2). Using these rather poor quality radiographs the conclusion reached by the public prosecutor was that the lower third molars were fully formed and the accused must already be 18 years-of-age. However, there was no submission of the radiographs during the trial and if the presiding judge had so requested there was no reason for the defence or the prosecution to object to their display. On the other hand, the judge did not provide any explanation for his "convincing visual observation" that the accused were below 18 years-of-age at the time of arrest on 24th July 1993. Only a physical anthropologist could have made such a statement and only after thorough physical examination. The validity of both assessments could therefore be questioned, and if they were valid, what were the scientific bases for the conclusions? Were any comparisons with published surveys on the development of third molar teeth made?

The authors were then consulted and after carefully examining all the material were able to report that in accordance with the chart of Demirjian *et al.*,[5] the completely formed third molar teeth of the arrested youths matched Stage H of tooth development, a finding which was subsequently compared with the more reliable data provided by Mincer *et al.*[11] Stage H of mandibular third molar development had a mean age of 20.5 years

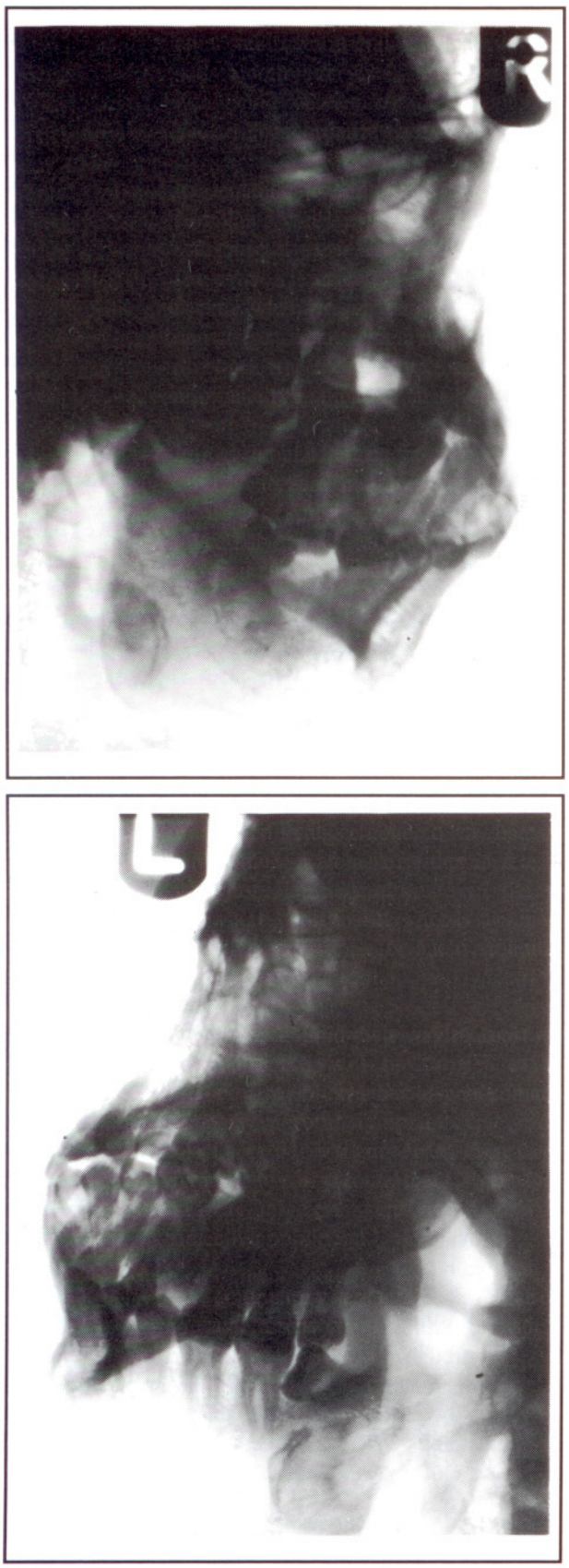

Fig. 1 Lateral oblique radiographs of (a) right side and (b) left side of suspect 2

(American whites) with a range of 18.5 and 22.5 years at one standard deviation. Employing the American black values, the mean age was 21.4 years with a range of 19.1 and 23.7 years at one standard deviation. However, at two standard deviations the lower range values for the American whites was 16.6 years and the American blacks was 16.7 years respectively. These values, when expressed in terms of the normal curve theory, yielded a probability of a white American being more than 18 years-old of at least 90.1%. However there is still 9.9% chance of an individual with Stage H third mandibular molar development being below 18 years-of-age. No probability values were provided for the black population.

DISCUSSION

It is therefore evident from the above analysis that it was incorrect for the public prosecutor to have testified with absolute certainty that the two accused were already 18 years-of-age, solely based on the development of the mandibular third molars. It could have been mentioned however, that it was **likely** that both the accused could have been above this borderline age at the time of arrest. Presenting an expert opinion in court which is based on simple statistical methods is always strongly persuasive, and especially so when it is supported by quantitative research but the interpretation and the consequent judgement of reliability of the evidence must remain in the hands of the court officials. The investigating dentist must always maintain an independent attitude, not partisan to the prosecution or defence in their presentation. A famous French forensic medico-legalist P.C.H. Brouardel[18] in the late nineteenth century has been quoted as follows: "If law has made you a witness, remain a man of science. You have no victim to avenge, no guilty or innocent person to convict or save - you must bear testimony within the limits of science." It is the opinion of the authors that age estimation employing the third molar development based on the available data can only be suggestive. In the case reported the adult status was definitely disputable and the age determination was certainly imprecise enough for any definite conclusion to be made, making the release of the accused in this drug related case a welcome outcome.

CONCLUSION

Teeth which provide the life history of an individual are among the more reliable means of determining age from approximately 10 weeks intrauterine up to old age.[19]

Although Demirjian *et al.*[5] provided an excellent method of age estimation from radiological appearance of mandibular teeth, the age range was only between 3-17 years and third molar development was not included in their investigations. It was the detailed work by Mincer *et al*[11] that provided the missing information regarding the development of these teeth. The reliability of using this to determine juvenile versus adult status is still in doubt however and other modes of age determination must be included. It is also important that dental development data tables should be available for as many population groups as possible so that the age determinations, wherever they arise, can be made more reliable. The use of the few

existing data sets from other population groups can only lead to questionable decisions.

Address for correspondence:
Dr. P. Nambiar
Department of Oral Biology
Faculty of Dentistry
University of Malaya
59100 Kuala Lumpur
Malaysia

REFERENCES

1 Ciapparelli L. The chronology of dental development and age assessment. In: Clark DH, ed. Practical Forensic Odontology. London: Butterworth Heinmann Ltd, 1992:220-42.

2. Moorrees CFA, Fanning EA, Hunt EE Jr. Age variation of formation stages for ten permanent teeth. J Dent Res 1963; 42:1490-502.

3. Hagg U, Matsson L. Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. Eur J Ortho 1985; 7:25-34.

4. Schour I, Massler M. The development of human dentition. J Am Dent Assoc 1941; 28:1153-60.

5. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973; 45:211-27.

6. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Biol 1976; 3:411-21.

7. Anderson DL, Thompson GC, Popovich F. Age of attainment of mineralization stages of the permanent dentition. J Forensic Sci 1976; 21:191-200.

8. Logan WHG, Kronfeld R. Development of the human jaw and the surrounding structures from birth to the age of fifteen. J Am Dent Assoc 1933; 38:379-90.

9. Liliequist B, Lundberg M. Skeletal and tooth development - a methodical investigation. Acta Radiol 1971; 11:97-112.

10. Fanning EA. A longitudinal study of tooth formation and root resorption. NZ Dent J 1961; 57:202-17.

11. Mincer HH, Harris EF, Berryman HE. The ABFO study of third molar development and its use as an estimator of chronological age. J Forensic Sci 1993; 38:379-90.

12. Gustafson G. Forensic Odontology. London: Staples Press, 1966: 105-39.

13. Gillard RD, Pollard AM, Sutton PA, Whittaker DK. An improved method for age at death determination from the measurement of D-Aspartic acid in dental collagen. Archaeometry 1990; 32:61-70.

14. Ohtani S, Yamagishi M, Ogasawara M, Yamamoto K. Age estimation of two unidentified bodies by amino acid racemization in their teeth. Bull Kanagawa Dent Col 1990; 18:23-7.

15. Thomas CJ, Nortje CJ, van Rensburg BGJ, van Wyk CW. Age determination in a living individual - a case report. J Forensic Odontostomatol 1987; 5:59-66.

16. Dahlberg AA. The changing dentition of man. J Am Dent Assoc 1945; 32:676-90.

17. Levesque GY, Demirjian A, Tanguay R. Sexual dimorphism in the development, emergence and agenesis of the mandibular third molar. J Dent Res 1981; 60:1735-41.

18. Brouardel PCH. In Milton H, Knight B: Autopsy. London: WH Allen, 1982:65.

19. Altini M. Age determination from the teeth - a review. J Dent Assoc S Afr 1983; 38:275-8.

IDENTIFICATION OF A SUICIDE VICTIM BY FACIAL RECONSTRUCTION

V.M. Phillips,[1] S. Rosendorff[1] and H.J. Scholtz[2]
1. Department of Oral Pathology, University of Stellenbosch, Private Bag XI, Tygerberg 7505, South Africa
2. Department of Forensic Medicine, University of Cape Town

ABSTRACT

Facial reconstruction is used in an attempt to identify an individual by a three dimensional representation of the facial features using the skull as the foundation after metrical and non-metrical analysis to determine age, race and gender. The skeletonized remains of a female who was reported missing six years previously were recovered from the summit of Table Mountain in Cape Town. Some personal possessions were also recovered, one of which was a shark tooth pendant which the victim's parents recognized. Although there were distinctive dental features, the antemortem dental records had been lost during the initial investigation which therefore precluded identification by this means. However, positive identification was required and facial reconstruction on the skull was undertaken which the parents duly identified. The method used for facial reconstruction is described. (**J Forensic Odontostomatol 1996 14:2 34-38**)

Keywords: facial reconstruction, forensic dentistry, physical anthropology, identification

INTRODUCTION

Positive identification of skeletonized remains depends on comparable antemortem information. In most cases where there are no identifiable features the attempt at identification ends after the establishment of age, race and gender. Identification is quite often achieved by dental records, while in some cases DNA extraction from bones[1] or tooth pulpal tissue[2] may lead to successful identification of a skeleton. When all other methods have been exhausted an attempt at identification may be made by reconstructing the facial features. Computer programmes are available which deliver "identikit" images of faces, but this can never be as realistic as a three-dimensional reproduction.

Several anatomists, physical anthropologists and artists have published their studies of facial reconstruction.[4-7] There is considerable variation in their methods although most depend on previously established soft tissue thicknesses covering the landmarks of the skull[10-12] and standard tables have been published of Japanese,[10] American blacks and whites[12,13] and Russians.[21] Several authors have claimed successful identifications using facial reconstruction[9,14,16,17] but unfortunately there has been no statistical analysis of their success rate and there remains a great deal of speculation with regard to the accuracy of facial reconstruction for identification purposes.

This paper presents a case report of the method used in the successful identification of skeletal remains by means of facial reconstruction.

CASE REPORT

The skeletal remains of a young Caucasoid female were discovered on the summit of Table Mountain in Cape Town in October 1994. The skeleton was lying in a reeded area approximately 200 metres from a pathway (Fig.1) and several personal items were recovered from the area including a wristwatch, sharktooth pendant and a leather handbag containing a plastic waterbottle, a cup and 2 empty packets of sleeping tablets containing diphenhydramine. The number of tablets missing from the "blister-packs" would have amounted to a toxic dose of 20-24mg per kilogram of body mass (fatal dose=25mg/kg).

The remains were collected for transportation to the mortuary and while the pathologist (HJS) was waiting for the cable car to arrive at the summit of the mountain, he

Fig. 1 The reeded area on the top of Table mountain showing the skeletal remains and items of clothing belonging to the deceased.

Fig. 2 The maxilla showing the deciduous tooth (65) with an amalgam restoration (arrow). Several teeth are discoloured.

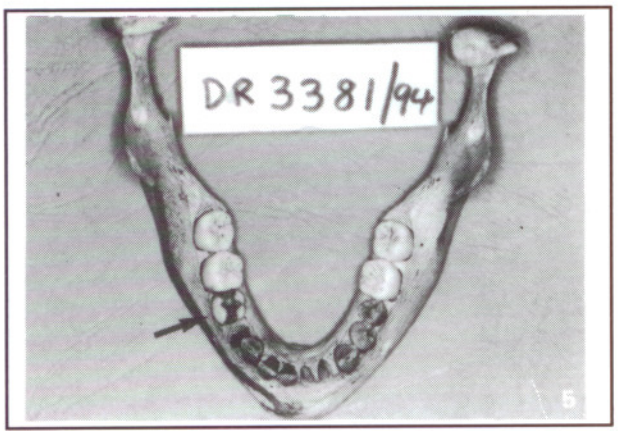

Fig. 3 The mandible showing the restored deciduous tooth (85) (arrow). The gonial angles show slight eversion.

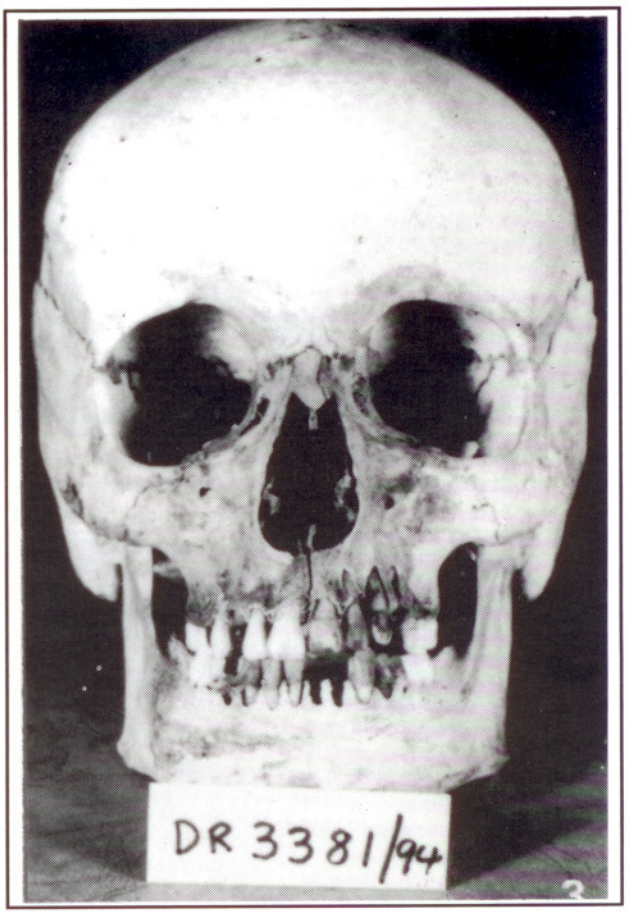

Fig. 4 The skull and mandible of the deceased showing the robustness of the mandible.

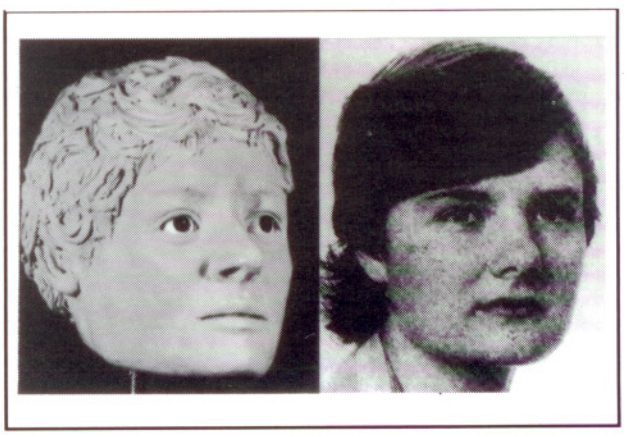

Fig. 5 The comparison between the facial sculpture (left) and the photograph published by the press at the time of RB's disappearance (right).

was overheard discussing the discovery of these skeletal remains by a newspaper reporter who had covered the story of the disappearance of a young woman on Table Mountain six years previously. She had been diagnosed as suffering from a psychiatric illness prior to her disappearance and an extensive search by the police, army and air force at that time had been unsuccessful. As she had disappeared in mid-December her body would have been hidden by the more prolific growth of reeds in which the skeleton was found and this would have accounted for the difficulty in locating the body. The information from the reporter led the investigating officer to the parents of a missing 26-year-old woman who had spent many leisure hours walking on Table Mountain. When the investigating officer showed the parents the wrist watch, pendant and handbag which were found in the vicinity of the skeleton, they identified them as belonging to their daughter (RB).

Several of the teeth had been lost postmortem and further investigation of the site by the author (VMP) revealed many of them in the underlying soil where they had been stained brown by the decomposing vegetation. Postmortem examination of the dentition showed that the maxilla and mandible each contained a deciduous molar (65, 85) which had been restored with amalgam (Figs.2 and 3). Unfortunately, the dental records of RB had been mislaid during the initial investigation 6 years previously and this precluded positive dental identification. Where no other identifiable features are available, the South African courts are prepared to accept personal possessions as a probable identification of human remains, and the skeleton was therefore acknowledged as that of the missing person. The skull and mandible were then referred to author (VMP) for facial reconstruction as a final attempt at identification.

The mandible showed eversion at the gonial angle and was uncha-racteristically robust (Fig.4). The authors

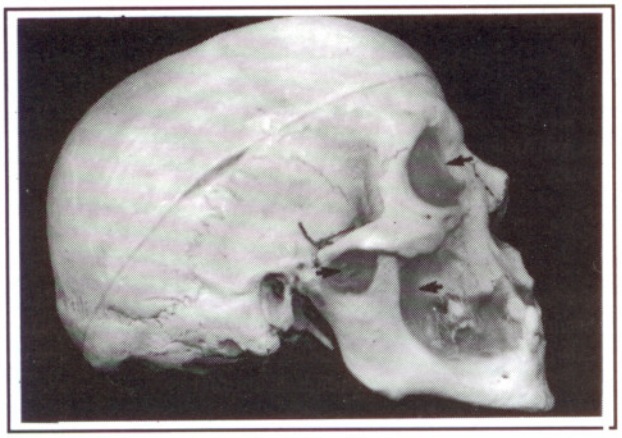

Fig. 6 The skull showing the use of modelling wax to "block-out" undercuts before an impression is taken (arrows).

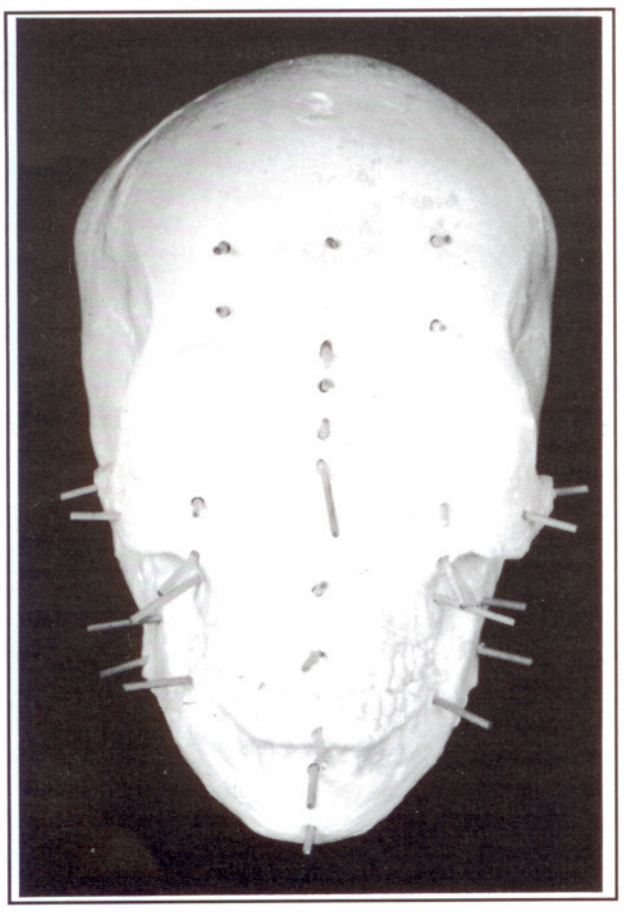

Fig. 7 The plaster cast of the skull showing the dowel sticks representing the soft tissue depths at the different anatomical sites.

(VMP and SR) had not seen any photographs of the deceased and this afforded them the ideal opportunity objectively to construct a face on the skull and only afterwards compare it with the extant photographs (Fig.5).

The parents of the deceased were invited to view the facial reconstruction and the comments of the mother are self-explanatory: "although the sculpture does not look exactly like our daughter, the family resemblance is remarkable, so much so that it looks exactly like our niece. We are satisfied now that our daughter is dead".

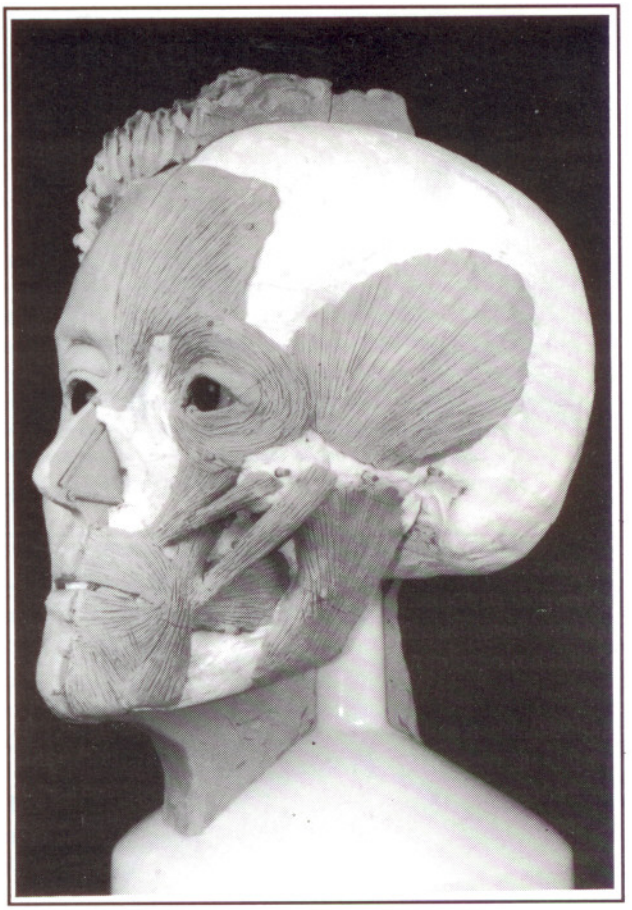

Fig. 8 The facial muscles are constructed in modelling clay.

MATERIALS AND METHODS

The method used by the authors to construct a face on the skull is a combination of several techniques.[7,9,11,14-16]

The skeletal remains including the skull and jaws are analyzed metrically and non-metrically to assess the age, race and gender of the individual.[18] If the teeth are present, Gustafson's method[19] of age determination is undertaken to assess the approximate age. The mandible is then articulated with the skull and jaws which allows a soft tissue profile to be drawn around the underlying bone using the average facial tissue thicknesses for males and females of Caucasoid or negroid origin.[12,13] The construction of the nasal profile using the cephalograph is also undertaken at this time.[20] Once a satisfactory profile is drawn, the nasal fossa, orbits, inferior border of the mandible and the space between the maxilla and the mandibular ramus are blocked out using dental modelling wax (Fig.6)* and an impression of the skull and jaws is taken using a rubber based impression material (Coltene Lab-Putty**). A plaster model of the skull is cast and the reference points of facial tissue thickness[10,11,12] are marked. Shallow holes are drilled into the plaster and thin dowel sticks placed in these holes to represent the thickness of the facial tissues at these points (Fig.7). The muscles of

* A different case is shown to illustrate the technique.
** Colténe AG CH 9450 Alstätten Switzerland

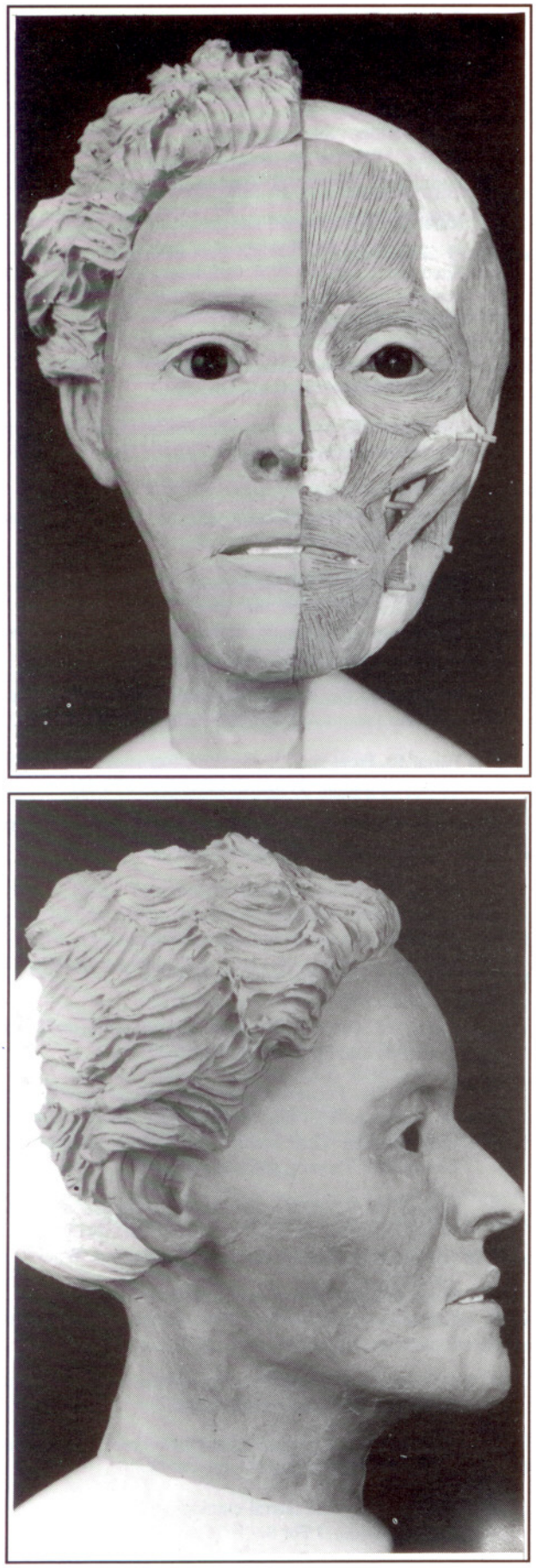

Fig. 9 The "fleshed-out" face sculptured over the facial muscles. (A) Frontal view, (B) Lateral view.

mastication and facial expression are then reproduced on the plaster model using modelling clay (Fig.8) while the eyes are represented by hemispheres of plaster.

The facial features are then "fleshed out" to the depth of the dowel and once the basic face is sculptured the artistic finishing touches, i.e. wrinkles, hair, eyes, etc. are added (Fig.9) and the sculpture can be either viewed by relatives and friends of the missing person or photographs of the facial reconstruction can be submitted to the media for publication.

DISCUSSION

Facial reconstruction is a combination of science and art and is a three dimensional representation of the facial features of an individual using the skull as the foundation. The oldest record of facial feature reconstruction was discovered by Kathleen Kenyon[3] in 1952 during her excavations at the ancient city of Jericho in Israel. She discovered skulls from a level representing approximately 6000 years B.C. which had had the soft tissues removed and the facial features replaced with plaster, which had touches of paint for realism and eyes represented by shells. Sporadic attempts have been undertaken to visualize famous persons by facial reconstruction and in 1895 His[4] reconstructed the features of JS Bach to compare a portrait of the composer with his skeletal remains and to ascertain whether the artist "cheated a little" to flatter the subject.

Three dimensional facial reconstruction is a historical method used to identify human remains which has to compete with the more sophisticated methods of modern computer technology. Several identification programs have been developed and used by the FBI, and American and British police while the Australian police are using a locally produced programme named FACE to identify criminals and missing persons. These computer programs require sophisticated equipment with a large memory capacity and are available from their developers at considerable expense. Their advantages are that the user does not need to have a working knowledge of physical anthropology or have any artistic talent to create a face on the screen. They are furthermore ideal for "Identikit" type of identifications, but they cannot construct a 3-dimensional face on a skull.

Facial reconstruction methods vary considerably and some authors recommend that a drawing or sketch of the face be made before commencing with the 3-dimensional reconstruction.[7,16] Other authors suggest that a rapid method of facial sculpture is to use strips of clay of predetermined thickness to cover the skull and then develop a face on this rudimentary foundation.[9,14] The technique which we follow is to base the facial construction on firstly, a profile drawing including nasal construction using a cephalograph of the skull, secondly, the muscles of mastication and facial expression moulded in clay onto a plaster cast of the skull and thirdly, metric and non-metric analysis[18] of the skull and jaws which

indicate the relative features in different areas of the face. The sculpture of the face is finally "fleshed out" to the estimated depths of soft tissues using the standard tables for particular ethnic groups.[12,13]

Sculpturing a face requires not only an artistic talent but also knowledge of physical anthropology. The advantages of this 3-dimensional method are that it is less expensive and allows the artist time to develop a creative affinity with the face as the soft tissues are replicated, which produces a much more life-like reproduction of the face than a picture on a computer screen. Lines of expression and aging develop as the face is built around the musculature and the natural creases and wrinkles occur as the artist moulds the contours. Unfortunately it is time consuming, but the results are life-like and in a form which acquaintances, relatives or friends of the deceased can relate to and more easily visualize.

The reliability of facial reconstruction as a means to identify a person remains subjective and highly variable results have been published. Gerasimov[17] claimed that most of the 140 court ordered reconstructions he undertook could be identified, while Gatliff[14] and Snow[9] claimed a 70% success rate. Helmer[16] on the other hand only claimed a 50% success rate.

In support of those artists and scientists who believe in and practise facial reconstruction as a means of identification, all will agree that although the ultimate goal is to construct a perfect likeness of the deceased, in reality the best one can hope for is recognition of certain facial features which may be characteristic, such as the prominent gonial angles in the case reported above. The danger of emotional bias should be guarded against, however, as family or friends may be overanxious to make a positive identification. An objective comparison by uninvolved parties using good photographs again as in the case of RB above, is a distinct advantage.

The results of this case have proved encouraging as the resemblance between the deceased and the facial reconstruction was close enough for her parents and the police to make a positive identification.

Address for Correspondence
Department of Oral Pathology
University of Stellenbosch
Private Bag Xl
Tygerberg 7505
South Africa

REFERENCES

1. Hochmeister MN, Budowle B, Borer UV, Rudin O, Bohnert M, Dirnhofer R. Confirmation of the identity of human skeletal remains using multiplex PCR amplication and typing kits. J For Sci JFSCA 1995; 40:701-5.

2. Yokoi T, Aoki Y, Sagisaka K. Human identification and sex determination of dental pulp, bone marrow and blood stains with a recombinant DNA probe. Z Rechtsmed 1989; 102:323-30.

3. Eydoux HP. Jericho, the oldest city in the world. In search of lost worlds. London: Hamlyn, 1971:120-6.

4. His W. Anatomische forschungen uber Johann Sebastian Bach's gebeine und antlitz nebst bemerkungen uber dessen bilder. Sited by Krogman WM, Iscan MY. The human skeleton in forensic medicine. 2nd edn. Springfield, Illinois: CC Thomas, 1986:413-57.

5. Kollmann J, Büchly W. Die persistenz der rassen und die reconstruction der Physiognomie prahistorischer schädel. Sited by Krogman WM and Iscan MY. The human skeleton in forensic medicine. 2nd edn. Springfield Illinois: CC Thomas, 1986:413-57

6. Virchow H. Half schadel halb maske. Zeitschriff fur Ethnol 1914; 46:180-6, 504-7.

7. Krogman WM, McCue MJ. The construction of the living head from the skull. FBI Law Enforce Bull 1946; 15:11-8.

8. Ilan E. Identifying skeletal remains. Internat. Criminal Police 1964; 175:42-5.

9. Snow CC, Gatliff BP, McWilliams KR. Reconstruction of facial features from the skull: an evaluation of its usefulness in forensic anthropology. Am J Phys Anthropol 1970; 33:221-7.

10. Suzuki K. On the thickness of the soft parts of the Japanese face. J Anthropol Soc Nippon 1948; 60:7-11.

11. Farrar F. From skull to visage: a forensics technique for facial restoration. Police Chief 1977; 44:78-86.

12. Rhine JS, Campbell HR. Thickness of facial tissues in the American negro. J Forensic Sci 1980; 25:847-58.

13. Rhine JS, Moore II CE, Weston JT (Eds). Facial reproduction: Tables of facial tissue thickness of American caucasoids in forensic anthropology. Maxwell museum technical series no.2. Albuquerque, University of New Mexico, 19482.

14. Gatliff BP. Facial sculpture on the skull for identification. Am J Forensic Med Pathol 1984; 5:327-32.

15. Rathbun TA. Personal identification: facial reproductions. In Rathbun TA and Buikstra JE (Eds). Human identification: Case studies in forensic anthropology. Springfield: Thomas, 1984:347-56.

16. Helmer RP, Röhricht S, Petersen D, Möhr F. Assessment of the reliability of facial reconstruction. In: Iscan MY. Ed. Forensic analysis of the skull. Toronto: Wiley-Liss, 1993:229-46.

17. Gerasimov MM. The face finder. Philadelphia: Lippincott, 1971.

18. De Villiers H. Identification of the human skeleton. University of Witwatersrand, 1962.

19. Gustafson G. Age determinations on teeth. J Am Dent Assoc 1950; 41:45-54.

20. George RM. The lateral craniographic method of facial reconstruction. J For Sci JFSCA 1987; 32:1305-30.

21. Lebedinskaya GV, Balueva TS, Vaselovskaya EV. Principals of facial reconstruction. In: Iscan MY. Ed. Forensic analysis of the skull. Toronto: Wiley-Liss, 1993:183-98.