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Contents

An Oral Pathology Profile of A Group of Juvenile Delinquents

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Summary

Habits, facial features and oral mucosal lesions were compared between 2 groups of pupils of the same ethnic origin, one group from reform institutions and another from high schools.

Facial tattoo marks, lip scars, mucoceles, chewing lesions of the cheeks and lips, red atrophic patches on the palate, focal epithelial hyperplasia and mucosal lesions associated with excessive smoking were significantly commoner among the inmates of reform institutions. On the other hand, lesions associated with dentures were commoner in school pupils. This dissimilarity can be attributed to their differences in life styles and the practice of certain habits.

The specific patterns of facial features and oral lesions seen in the inmates of reform schools can be regarded as a characteristic oral pathology profile for that group.

It is known that groups of people practise certain customs which can result in distinctive features for that group. A good example is the type of tooth mutilation which occurs among indigenous people of parts of Southern Africa.[3,5,6] Certain oral habits, e.g. betel nut chewing and snuff dipping, may cause distinctive oral lesions. Awareness of lesions due to these habits can help identification in cases of unknown identity.[8] In addition the findings of Van Wyk,[8,9] Van Wyk, Staz and Farman[f1] and Arendorf and Van Wyk[1] suggest that subjects with a similar background who live together in special circumstances may cultivate habits which cause a characteristic pattern of oral lesions.

This study aims to show that in the Cape Peninsula institutionalized juvenile delinquents of a specific ethnic origin exhibit a pattern of facial features and oral lesions quite different from non-institutionalized teenagers of the same ethnic origin, thereby forming a unique oral pathology profile.

Key words: Epidemiology, Oral Disease

Materials and Methods

Two groups of subjects were compared, pupils from corrective institutions and pupils from ordinary government schools. All were from European-African-Malay extraction and referred to as Cape Coloureds.

The institutionalized group comprised the inmates of the 3 corrective schools in Cape Town, 809 males and 159 females. Their ages varied from 13 to 20 years with a mean age of 16,8 years. All of these subjects had histories of long-standing misdemeanour.

To obtain suitable control subjects, pupils of non-institutionalized schools were examined. A sequential random sample of 10 schools was drawn from among the high schools in greater Cape Town. A sampling frame was drawn from each school by enumerating all pupils according to age and sex and 10 pupils of each sex were randomly selected from each of the age groups 14 - 19 years. Because of absenteeism and a high drop-out rate in the senior classes, especially among the girls, it was not always possible to obtain the full quota in each of the older age groups (Table 1). There were 532 males and 496 females with a mean age of 16,4 years.

All subjects were examined by the author under standardized lighting conditions and all abnormalities of the oral mucosa, lips and face recorded. Histories were taken and additional information noted about smoking, alcohol intake, participation in contact sports and oral and facial injuries. As lip scars featured prominently among the males of the corrective institutions, it was decided to pay special attention to this feature and all the boys in the largest of the institutions were re-examined (474 boys). This variable was included in the examinations of the scholars of the government schools.

Results

Habits. The commonest habits in the 2 groups were smoking and the chewing of the lips and cheeks. Comparison of the habits in the 2 groups by the chi-square test using 2 x 2 contingency tables, showed that both habits occur significantly more commonly among the reform school subjects ($P<0,001$; Tables 2 and 3).

Tattooing was another custom practised by males of the corrective institutions and facial tattooing was a striking feature in 4% of these subjects (Fig. 1).

It is suspected that fellatio is also practised by some males in the corrective schools. This, among other forms of chronic irritation, will give rise to red atrophic patches on the palate.[9] Twenty-one subjects with red

Table 1 : Sample from Government Schools

Schools	*Males*	*Females*	*Total*
*A	60	54	114
*B	59	57	116
*C	60	57	117
*D	60	54	114
†E	0	54	54
‡F	58	0	58
*G	60	58	118
*H	60	53	113
*I	60	53	113
*J	55	56	111
Total	532	496	1028

*Co-educational; † Girls' school; ‡ Boys' school

Table 2 : Smoking Pattern

	Smokers				*Non-Smokers*			
	Male		*Female*		*Male*		*Female*	
Schools	147	(27,6%)	46	(9,3%)	385	(72,4%)	450	(90,7%)
Institutions	771	(95,3%)	132	(83%)	38	(4,7%)	27	(17%)

Fig. 1. A drawing showing the various positions and types of designs of facial tattoo marks.

palatal lesions were encountered and 16 of these, all in males of the corrective schools, fulfilled the criteria for lesions caused by fellatio (Fig. 2 and Table 3).

Lesions. A variety of lip and intra-oral lesions was observed (Table 3), some of which are not catalogued in the *International Classification of Diseases: Application to Dentistry and Stomatology* (WHO 1973). Those not included in the manual are:

Linea alba (a thickened epithelial ridge on the cheeks at the level of the occlusal surfaces of the molar and premolar teeth);

A cigarette lesion of the lips (a keratin tag or 'wart' on the lips produced by smoking cigarettes until a smouldering ember remains, Fig. 3);

A depigmented patch on the lip (a localized loss of melanin pigment caused by long-standing burning of the lip by hot cigarette ends[7] (Fig. 4);

Table 3 : Number of Subjects with Lesions

		Institutions						*Schools*					
		Male		*Female*		*Total*		*Male*		*Female*		*Total*	
	Subjects	809		159		968		532		496		1028	
ICD	*Lesions*		%		%		%		%		%		%
528.71	Leukoedema	536	(66,3)	118	(74,2)	654	(67,6)	160	(30)	95	(19,2)	255	(24,8)
	Linea alba	196	(24,2)	32	(20,1)	228	(23,6)	61	(11,5)	45	(9,1)	106	(10,3)
528.72	Smoker's palate (a)	94	(11,6)	20	(12,6)	114	(11,8)	9	(1,7)	1	(0,2)	10	(1)
	Cigarette lesions on lips (b)	158	(19,5)	26	(16,4)	184	(19)	3	(0,6)	0		3	(0,3)
	Depigmented patches on lips due to cigarette burns (c)	35	(4,3)	1	(0,6)	36	(3,7)	0		0		0	
	Smoker's lesions (a), (b), (c)	241	(29,8)	54	(34)	295	(30,5)	11	(21,1)	1	(0,2)	12	(1,2)
528.6X	Leukoplakia	28	(3,5)	2	(1,3)	30	(3,1)	2	(0,4)	0		2	(0,2)
529.5	Fissured tongue	52	(6,4)	14	(8,8)	66	(6,8)	39	(7,3)	37	(7,5)	76	(7,4)
529.1X	Geographic tongue	3	(0,4)	0		3	(0,3)	18	(3,4)	9	(1,8)	27	(2,6)
750.01	Tongue tie	0		0		0		2	(0,4)	1	(0,2)	3	(0,3)
529.2X	Median rhomboid glossitis	3	(0,4)	0		3	(0,3)	5	(0,9)	2	(0,4)	7	(0,7)
	Red atrophic patch on palate	16	(2,0)	0		16	(1,7)	2	(0,4)	3	(0,6)	5	(0,5)
528.73	Focal epithelial hyperplasia	26	(3,2)	14	(8,8)	40	(4,1)	1	(0,2)	1	(0,2)	2	(0,2)
528.93	Chewing lesions	51	(6,3)	24	(15,1)	75	(7,7)	22	(4,2)	21	(4,2)	43	(4,2)
528.90	Fibro-epithelial polyp	7	(0,9)	0		7	(0,7)	0		2	(0,4)	2	(0,2)
527.61	Mucoceles	59	(7,3)	0		59	(6,1)	4	(0,8)	3	(0,6)	7	(0,7)
210.43	Fibrous epulis	3	(0,4)	0		3	(0,3)	0		0		0	
SNOP—8070	Squamous papilloma	2	(0,3)	1	(0,6)	3	(0,3)	0		0		0	
	Granular appearance of lips	103	(12,7)	0		103	(10,6)	12	(2,3)	1	(0,2)	13	(1,3)
528.91	Denture associated lesions	0		0		0		2	(0,4)	9	(1,8)	11	(1,1)
	Friction spot	77	(9,5)	11	(6,9)	88	(9,1)	39	(7,3)	30	(6)	69	(6,7)

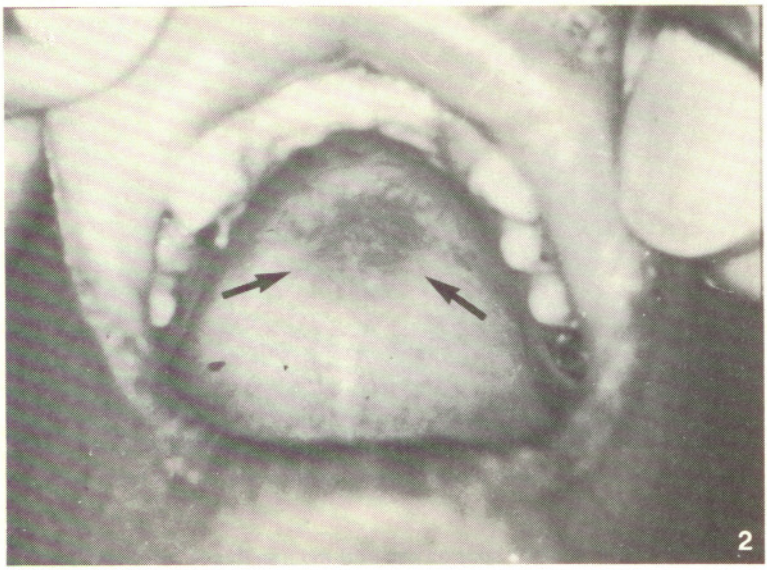

Fig. 2. A typical palatal lesion seen among males of the reform institutions.

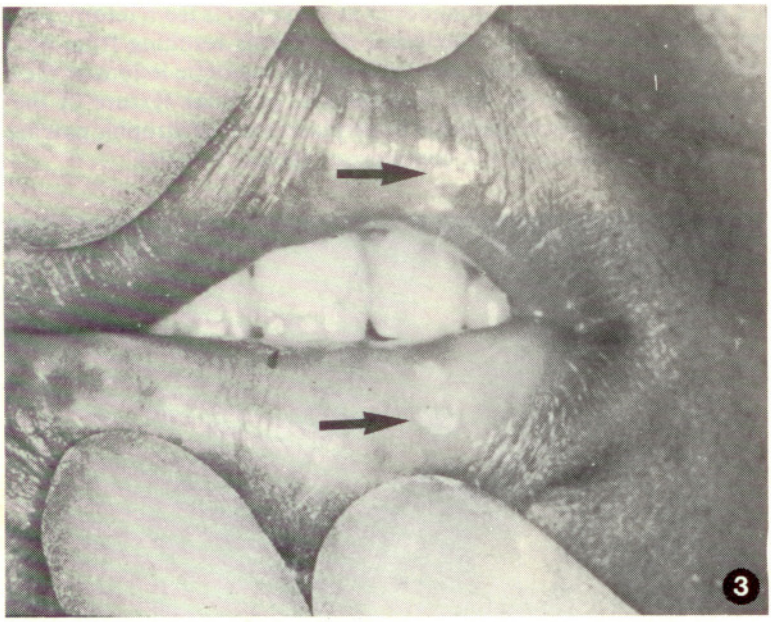

Fig. 3. The typical white keratin crusts (arrowed) on the lips in the cigarette lesion.

A red atrophic patch on the palate (a lesion presumedly caused by various forms of chronic physical irritation and sometimes infected by *Candida albicans*);

A granular appearance of lips (a dry granular texture of the lip mucosa which develops in heavy smokers of cigarettes and homemade cigarettes smoked to their very ends); and

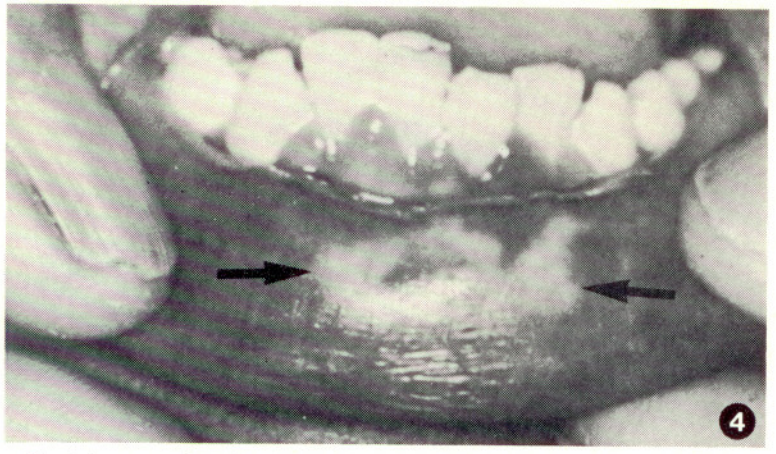

Fig. 4. An area of localized loss of melanin on the lower lip of a heavy smoker.

The friction spot (a white spot on the oral mucosa due to longstanding chronic localized irritation, such as from a broken tooth or sharp cusp, Fig. 5).

There was a notable difference in occurrence of some of these lesions in the 2 groups. Significantly commoner in the subjects from reform schools were: lip scars (Table 4), mucoceles, the lesions resulting from lip and cheek chewing, leukoedema, smoker's palate, cigarette lesions of the lips, depigmented patches on lips, leukoplakia, granular texture of the lip mucosa, *linea alba*, focal epithelial hyperplasia and red atrophic patches on the palate (Chi-square, 2 x 2 contingency tables, $P<0,01$).

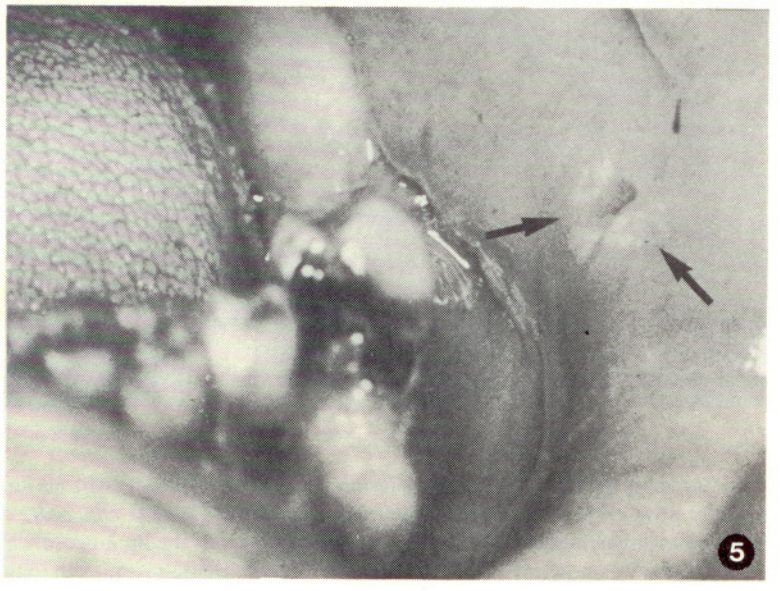

Fig. 5. A typical white friction spot on the cheek (arrowed) due to a broken tooth.

Table 4 : Lip Scars in Males

	Number	*Number with Scars*
Institution	474	232
School	532	15

$P<0,001$

The aforementioned lesions also showed a definite sexual distribution, being far more evident among males than among females. In addition, there was a significant relationship between smoking and leukoplakia, smoker's palate, the depigmented patch of the lip, the cigarette lesion of the lip and the granular texture of the lip mucosa (χ_1^2 $P<0,001$). In the case of leukoedema an association with smoking was found in the government schools (χ_1^2 $P<0,001$) but not in the institutions.

Only 2 types of lesions were significantly commoner in pupils of government schools — denture-associated lesions (χ_1^2 $P<0,005$) and geographic tongues (χ_1^2 $P<0,001$).

Discussion and Conclusion

The difference in facial appearance, the frequency and the type of habit practised and the pattern of oral lesions in the 2 groups can be attributed to their differences in life style. Pupils in the corrective institutions are generally of poor social background and have histories of misbehaviour and violence. In addition, the circumstances in the institutions appear to be conducive to the evolution of certain customs, one being tattooing. The latter is a marked feature of Cape Coloured convicts and Slabbert[4] suggests that 'the prison (corrective institutions?) situation appears to be a major contributory factor to an increase in the incidence of tattooing'. Slabbert found that the face and neck were tattooed in 24% of her sample of ex-prisoners.

Fighting is very much part of the life of the male delinquents, even while in the remand schools. According to their histories, fighting is the most important cause of the lip scars. Such an injury will sometimes disrupt salivary drainage from the smaller salivary glands, causing pooling of mucus in the lip mucosa with the resultant development of a mucocele. This is the explanation given for the common occurrence in the remand school boys of this type of cyst.[1]

It is of interest that chewing of cheeks and lips, leading to a distinctive type of lesion, was commoner in institutionalized subjects. Van Wyk *et al.*[11] suggest that institutional confinement may produce stress situations, this habit being an expression of tension. In addition, they propose that imitation of habits may also play an important role. If this is true, then it is understandable why it occurs more often among the remand subjects.

Smoking will also influence the pattern of oral lesions. The irritative characteristics of the smoke cause pathological changes in the oral epithelium and the hot cigarette ends cause the specific lip lesions mentioned earlier. This explains the significant relationship between smoking and some of the oral lesions and why these lesions were so widespread among the institutionalized teenagers who were heavy smokers. Smoking also accounts for the difference in prevalence of these

lesions between the sexes.

Leukoedema is somewhat of an enigma as a relationship with smoking may or may not be present. It has been proposed that other factors such as cheeck sucking[10] and a racial disposition[2] might also play a role. If this is so, it will to some extent elucidate this paradox.

The other lesions significantly commoner in institutionalized subjects were focal epithelial hyperplasia, the red atrophic patch on the palate and *linea alba*.

Focal epithelial hyperplasia was probably encountered more often among reform pupils because it is a viral disease of low infective threshold. Spreading requires close proximity for long periods and living conditions in the institutions fulfil this requirement.[8] The red atrophic palatal lesion could be due to fellatio, a custom known to occur in such institutions. The cause for the higher prevalence of *linea alba* is uncertain. The line appears to be generated by the close approximation of the cheek mucosa to the occlusal surfaces of the teeth. However, if this is so, the distribution should be equal for all groups. It is therefore suggested that smoking aggravates its development. Thus it will be more conspicuous among the reform pupils who smoke more often.

The fact that denture-associated lesions were more evident in scholars of the government schools, reflects the difference in background between the 2 groups. The non-institutionalized children are better off and are more likely to receive sophisticated dental treatment, which includes dentures.

This study indicates a relationship between life style, habits, the pattern of oral lesions and facial characteristics. The oral lesions of Cape Coloured juvenile delinquents showed a distinctive pattern, most probably due to certain aspects of their life style. This pattern can be regarded as an oral pathology profile of these young persons.

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The Palatal Rugae in Forensic Odonto-Stomatology

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Abstract

The rugae have often been equated with finger prints and likewise display total individuality. Their potential role in identification is consequently obvious, particularly as travel disasters are not infrequent.

To study the ruga pattern a new classification was created and applied in a study of 6 samples of genetically differing population groups: Negroes, Caucasians, Coloured (Cape Peninsula, a hybrid group), Coloured (Namaqualand, the same hybrid group but from a different part of the country), Asian Indians and San (Bushmen of the Kalahari). All, except where indicated, came from the Cape Peninsula of South Africa.

Statistical testing revealed that there was no sexual dimorphism, that populations possess different ruga patterns but that there is at best a 72,2% chance of identifying the race of a single individual.

Thus the only possibility of the ruga pattern being useful in forensic work is to compare its imprint with the original, so that identification can be effected or otherwise.

Key words: Palatal rugae, racial differences, identification.

The rugae have often been equated with finger prints. It is generally agreed that they do not change during life except with growth as reflected in angle or surface area and that they are completely individual.[2,4,6,10,13] Their potential role in identification is consequently obvious and has occupied the minds of research workers for many years. The increase in travel, particularly by air, and the resultant disasters makes the recording of the ruga pattern important.[4]

Comoy[6] reviewed the state of rugoscopy and concluded that, when an easy and simple method for recording and communicating a ruga classification is found, the ruga pattern will embody great benefits. Kogon and Ling[10] have produced a method for photographing casts and tracing the ruga pattern which they are then able to superimpose on a series of casts until the one being sought is found. Carrea[4] claims that his classification will ensure ease and simplicity of communication of the rugae to any part of the world where it might be needed. Rugae never

change, are completely individual and, when finger prints are lost, rugae can play an important role in identification, particularly if his classification is used. He further refers to the interesting possibility of preventing the fraudulent substitution of race horses by checking their ruga patterns.

Keil[9] has indicated that paternity cases may be assisted by including the rugae in a multi-variate discriminant analysis. Doubt is, however, cast on paternity determination by means of rugae alone by Lysell[13] and he is unenthusiastic about the use of rugae in identification. They are not as useful as finger prints and it is very rare that some other characteristic will not be available for this purpose. Krefft[11] is likewise sceptical about the use

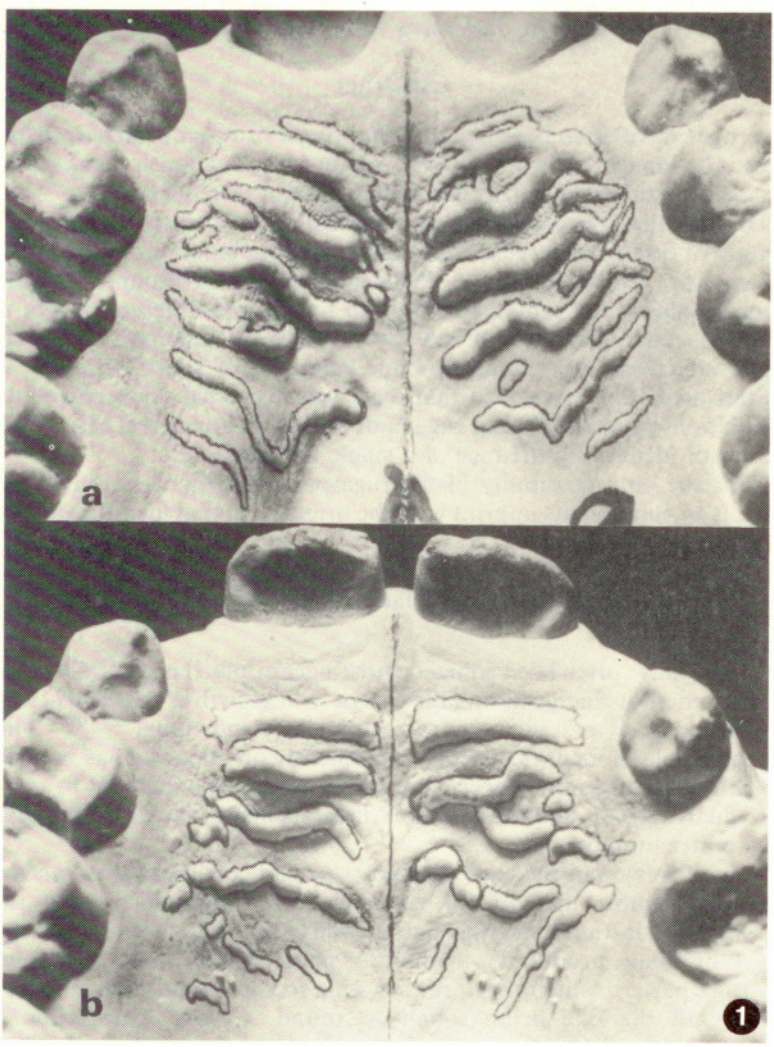

Fig. 1. Two ruga patterns, (a) and (b), showing total individuality.

of rugae in identification and states that air disaster victims are usually so mutilated that the palates are in any case unusable.

Classification

A study of the ruga pattern cannot be undertaken without a classification. Because they have an intricate and complex formation and are absolutely individual to all persons[6] (Fig. 1), direct comparison between 2 or more ruga patterns is impossible unless each is reduced to a set of common denominators. This is a classification. Each of the features is given a symbol or number which can then be used for recording and, if desired, statistical analysis. The record thus obtained makes comparison with other patterns possible.

The classifications of Gŏria[8], Lysell[13], Carrea[4], Basauri[3], Lima[12], Caruso[5] and Tzatscheva and Jordanov[17] have been studied closely and have all been found to possess limitations. Lysell's scheme[13] is the most satisfactory and has formed the foundation of the classification established and used by Thomas and Kotze (1983 *a*).[14]

Materials and Methods

The palatal ruga patterns of 6 population groups (comprising 603 juveniles) found in southern Africa, principally in the Cape Peninsula, were studied.[15]

Fig. 2. Distribution of population samples.

They all differ physically and were considered to have different gene-sets arising from different parentage. They are southern African Negroes, Caucasians of European extraction, Cape Coloureds (2 groups: one from the Cape Peninsula labelled *Peninsula Coloured* and the other from Garies labelled *Namaqualand Coloured*), Asian Indians and Bushmen (San of the Kalahari, Fig. 2 and Table 1). The experimental procedures were described by Thomas and Kotze (1983 *b*).[15]

Table 1: Age and Sex Distribution of the 6 Population Samples

Race	*Age*				*Sex*		*Total*
	Mini-mum	*Maxi-mum*	*Mean*	*SD*	*Male*	*Female*	
Negro (Ne)	6	9	7,84	0,51	45	55	100
Caucasian (Ca)	7	9	8,31	0,51	50	50	100
Peninsula (C(P)) Coloured	6	9	7,86	0,45	50	50	100
Namaqualand (C(N)) Coloured	6	13	7,88	0,99	64	36	100
Bushman (Bu)	5	13	6,87	1,83	59	45	111*
Indian (In)	6	10	8,08	0,94	54	38	92

*The sex of 7 individuals could not be recorded.

Results

1. Tests for sexual dimorphism proved that it was undetectable. The univariate counts which displayed the greatest gap between males and females, when tested statistically, yielded non-significant probability levels t (0,05, 99) = 1,97 (annular rugae); 1,53 (cross-links); 1,36 (unification 2); 1,36 (unification with non-primary); (t (0,05 91) = 1,50 (unification with non-primary); (all $p > 0,05$) (Thomas, 1981).

2. Racial classification by means of the ruga pattern was made possible by using the jackknife classification[16] (Table 2). In this test tabulation of actual groups is read on the left and statistical classification of each individual in his group is read horizontally. The horizontal total consists of the number in the sample and the vertical total gives the number of cases from all the groups which have been classified alike. The varying ability to classify correctly is therefore reflected in the 'percent correct' column (correct classification divided by sample total x 100). The Bushmen are thus the best classified and the Coloured (Peninsula) are the worst classified.

This test was carried out with varying combinations of population groups: all the groups (Table 2), all excluding Bu, all excluding Bu and C(N), C(P) and In, and Ca and Ne (Thomas and Kotze[16]).

Discussion

The uniquely individual nature of a biological system such as the human body is reflected in such structures as the finger prints, lip folds, palm prints and the palatal rugae. This individuality and the exposure in the body which allows observation and recording has caused these structures

Table 2: Jackknife Classification for All Groups, All Variables

Race	*Percent Correct*	*No. of Cases Classified*						
		Ne	*Ca*	*C(P)*	*C(N)*	*Bu*	*In*	*Total*
Ne*	53,7	51	8	13	13	0	10	95
Ca	54,1	12	53	10	10	0	13	98
C(P)	25,3	17	17	25	14	0	26	99
C(N)	55,7	10	14	6	54	0	13	97
Bu	72,2	8	1	0	7	52	4	72
In	36,8	7	17	19	12	0	32	87
Total	*48,7*	*105*	*110*	*73*	*110*	*52*	*98*	*548*

*See Table 1 for abbreviations

to be implicated in forensic science and to become important in identification.

None of these features, however, inherently contains information about the owner. It is only when an existing record of the structure exists (such as a finger print record or denture marking), which includes details of the owner or clues to where this information may be found, that the actual can be compared with the image and found to coincide or otherwise.

This study of the ruga patterns in different populations has shown that the rugae do not contain inherent information about a single individual. It was, however, established that in a population there are insignificant sex differences and that there is at best a 72,2% and at worst a 25,3% chance of determining the race of an individual. While the chance is not 100%, it can therefore be stated that the race of an individual cannot be determined with certainty from the rugae (Thomas and Kotze[16]).

The fact that yet another classification of the rugae was proposed and used seems to indicate that shortcomings will always be found in existing classifications. The rugae, with their almost unlimited small variations, lend themselves to a multitude of possible criteria. It does not take much in the way of personal inclination by an investigator to change a variable here and there. Lysell's basic classification[13] of the 3 types of ruga seems to have stood the test of time and has been used repeatedly, including this project. It is seemingly destined to survive, but only in research where not much more than a basic ruga count is to be used and where the rugae are part of other, wider observations. Where the project is exclusively concerned with the ruga pattern and a wide range of parameters is necessary, the classification assumes the individuality and outlook of the research worker. It is for this reason that there is not much hope entertained for the establishment of a universally acceptable and accepted classification which could be useful in forensic odontology.

Fellingham and Kotze[7], however, reviewing various methods for odontological identification, including the discrete kernel method as used by Aitken and MacDonald[1] concluded that a statistical investigation of available information in identification is a far more rational procedure than leaving it to the intuition of an investigator.

The ruga pattern is destined to be useful if its form has been recorded wittingly or unwittingly together with the identity of the owner in a denture (Fig. 3), a photograph (Fig. 4), a cast (Fig. 5) or any other medium capable

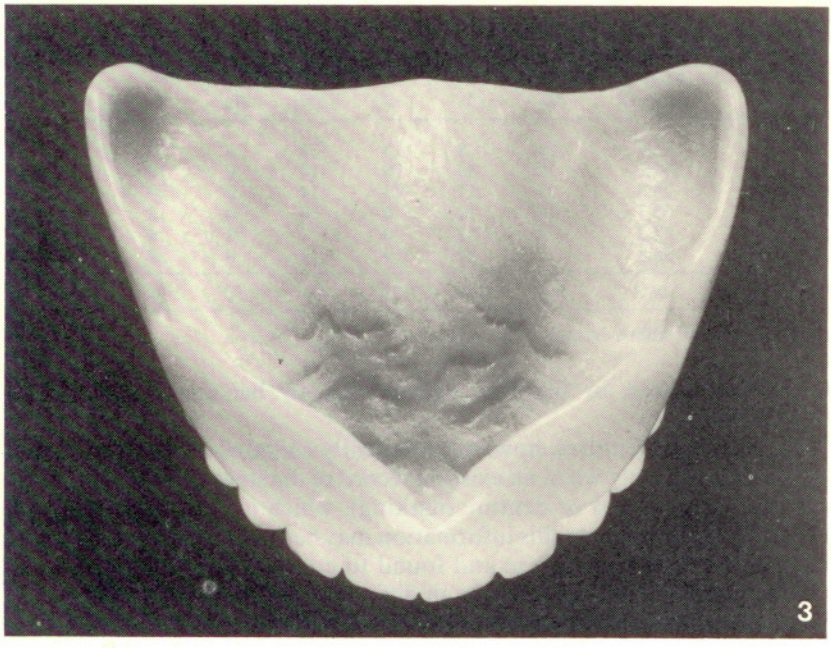

Fig. 3. The ruga pattern recorded in a denture.

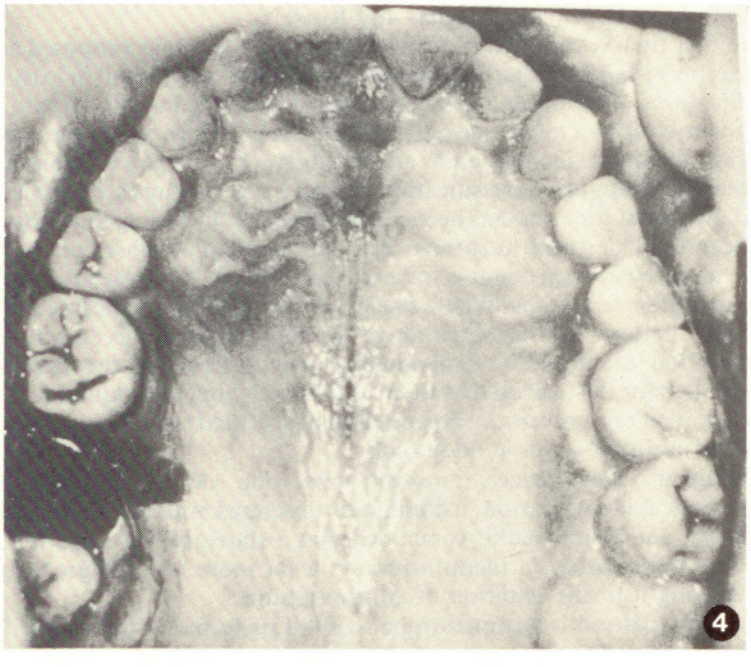

Fig. 4. The ruga pattern recorded on a photograph.

Fig. 5. The ruga pattern recorded on a plaster cast.

of capturing its imprint. With this record, and an acute awareness of all the possible permutations of ruga shape, it is possible to identify corresponding features in the original pattern and so identify the owner.

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Registration of Bite Marks: A Preliminary Report

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Bite mark comparison represents a vital contribution by dentistry to the forensic sciences[13]. The investigation of bite marks principally involves a comparison between the bite mark found and the bite of a suspect.

Many reports have been published in which bite marks have played a decisive role in identification of suspects. According to Gustafson,[5] such bite marks may be found on materials left at the site of a crime, or on humans involved in assaults, when either the victim or the attacking criminal may carry the marks.

According to Beckstead, Rawson and Giles[1], the technique on which testimony is based has to be an accepted, reliable method which produces accurate results. Because of the relative rarity of bite marks, only a handful of cases has been examined. Little experience, essential in the evaluation of bite marks, has therefore been gained until recently. Only a few workers have carried out experiments in this field, despite the fact that a scientific approach would give us much more information about the proper evaluation of bite marks.

Because of the role played by small details on teeth and dental restorations and the difficulty in their evaluation, it becomes necessary for one especially trained in dental procedures to take charge of a bite mark investigation, to take the impressions, organize the casting of stone models and finally to evaluate the details elicited by the entire procedure. A forensic *pathologist* is *not* qualified to handle bite mark analysis, since the techniques and data interpretation require the knowledge of a dentist. Even dental experts in the field of bite mark analysis admit to the difficulties inherent in bite mark comparison[5].

The appearance of a bite mark is influenced by the type of material in which the bite is present. For example, bite marks can be found in food substances, flesh (or skin) or almost any other material. Bite marks could furthermore be inflicted by a variety of subjects including humans or various animals. Gustafson (1966)[5] showed that the female breast is an area where bite marks are often found. Other areas include the face, neck,

Key words: Bite marks, Identification, Impressions

cheek, chin, arms and forehead. Sognnaes[12] also stated that bite marks are amongst the classical features present in the battered child syndrome.

In 1974 Dinkel[17] pointed out that there is still no generally accepted approach to the evaluation of bite marks and Butler[3] stressed the need for better systems for evaluation and classification of bite marks. A large variety of methods has been employed to study and identify bite marks.[1,4,5,7,8] One of the most effective ways for registration of bite marks is the impression method[6,9,10,13] Sognnaes[11] stated that scanning electron microscopy (SEM) also plays an important part in identification of bite marks.

The value of the impression method rests upon the fact that bite mark identations of the skin are exactly reproduced in a 3-dimensional model and thus the dimensions of depth and shape are provided for comparison.

Requirements for an Impression Material (Modified from Stoddart[14])

1. It must flow easily and be capable of producing the finest detail;
2. It must be quick-setting at room temperature;
3. It must be durable and dimentionally stable.

Elastic impression materials are currently used most often for impression-taking, with the new addition-curing silicones probably the best at this stage (according to our own pretesting), providing excellent detail, elasticity and dimentional stability.

The relatively long polymerization time (8-10 min) of all elastic impression materials, however, is a disadvantage when used on live subjects. No victim, after being subjected to an assault, would enjoy being submitted to an impression procedure taking such a long period. In addition, replicas have to be made from the impression, an additional step which further increases the time necessary to complete the procedure.

The purpose of the current study was to determine the applicability and accuracy of an auto-polimerizing Bis-GMA resin used as an impression material for forensic purposes. This study was conducted by visual, stereo-microscopic and scanning electron microscopic evaluations.

Materials and Methods

In preliminary pretesting studies the authors experimented on cheese, bread, polony, pig skin and various other materials, in order to find a material that would simulate the appearance of bite marks on human flesh most accurately. Sheep's trotters proved to be the most reliable and accurate material.

Fifteen students volunteered for this study.

One sheep trotter was given to the group and one of the students (unknown to us) inflicted bite marks on 3 different areas of a sheep trotter. Fig. 1 demonstrates one of these areas. Immediately after the bites had been inflicted, an impression was taken of these maxillary bite marks with an autopolimerizing Bis-GMA resin.* The orange coloured low viscosity resin was allowed to flow into the bite marks, where it polymerized automatically within 3 minutes, turning yellow after setting (Fig. 2).

*Tinted Delton fissure sealent, Johnson and Johnson, New Jersey, U.S.A.

Fig. 1. Maxillary (Mx) bite mark on a sheep's trotter.

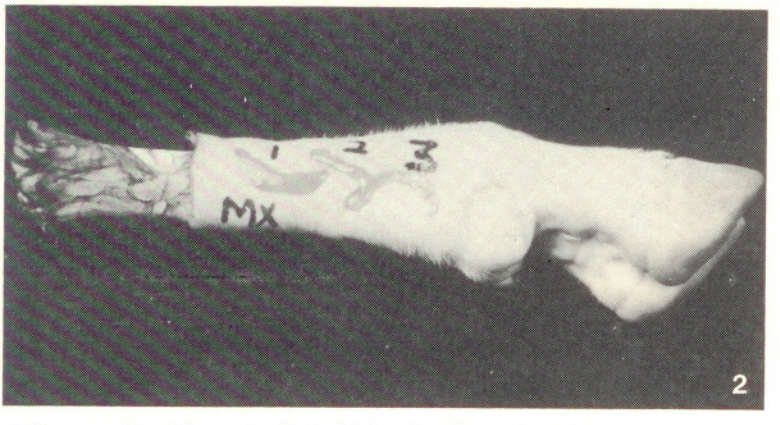

Fig. 2. Three maxillary bite marks filled with low viscosity unfilled Bis-GMA resin. Bite mark No. 1 was used for comparison purposes.

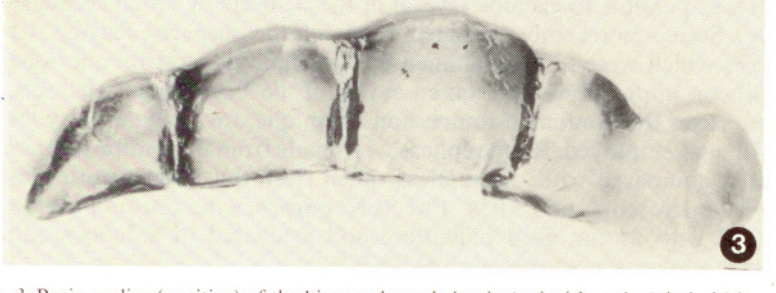

Fig. 3. Resin replica (positive) of the bite mark made by the 'culprit' on the 'victim' (sheep's trotter).

Maxillary bitemark (MX) No. 1 was used as the bite mark representing the culprit, as the other 2 marks flowed into each other, thereby complicating the matter. By lifting off bite mark No. 1, a positive replica was available *immediately* (Fig. 3). The mandibular bite marks were ignored for the purpose of this study.

All the students participating in the project were considered possible 'suspects' in this biting case. All were asked to bite into a piece of addition-curing silicone rubber impression material‡ (of putty consistency) in such a way their maxillary teeth left bite marks of about 3 mm deep in the impression material (Fig. 4). All these impressions were subsequently filled with the same Bis-GMA resin and the replicas removed thereafter. These replicas (positives) were compared with replica No. 1 manufactured from the bite marks in the sheep's trotter.

The comparison consisted of 3 stages, e.g.:

1. Direct visual comparison;
2. Stereomicroscopy; and
3. Scanning electron microscopy.

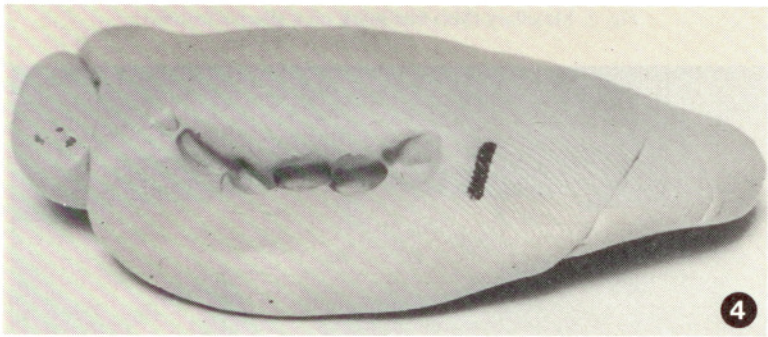

Fig. 4. Shallow bite marks of one of the 15 'suspects' (students) made into an addition-curing silicone impression putty. Replicas obtained from these bite marks were compared with the replica made from the bite marks on the sheep's trotter.

On visual, stereomicroscopic, as well as SEM comparisons, possible features of resemblance on all the suspects were evaluated, such as form, size, incisal edges, attrition and abrasion patterns. Relative positions of teeth, rotations, as well as gaps between teeth, could also be seen.

It was possible to exclude several of the suspects by visual comparison only. Stereomicroscopy excluded more of the suspects, leaving 4 bite marks which were to be examined by the scanning electron microscope.

Silicon impressions were taken *in vivo* of the 4 most likely suspects. In these cases the laminated impression technique, involving a putty and a wash, was employed. Resin replicas were made from these impressions and finally compared with the replicas taken from the sheep's trotter in the stereo microscope and SEM. For SEM purposes the resin replicas were coated with 25 nm gold/palladium and evaluated in a Jeols scanning electron microscope operating at 15 KV.

‡Exaflex, G. C. International, Japan.

SEM evaluation of the teeth of the 'culprit' in this case displayed a specific abrasion pattern on the incisal part of the tooth and proved to be highly significant for identification purposes (Fig. 5). It was therefore relatively easy to pinpoint the student who inflicted the bite on the sheep's trotter.

It is also important to note this in this study it was possible to identify the culprit on examination of the maxillary bite mark only.

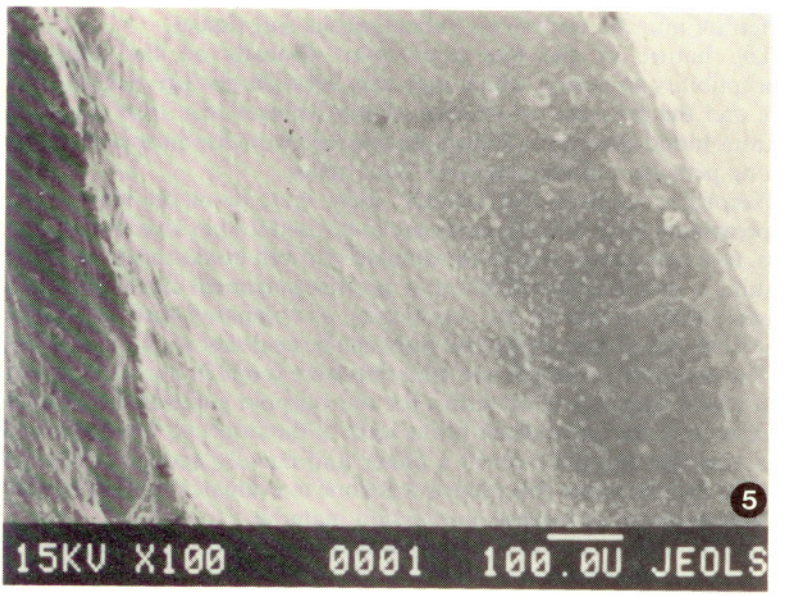

Fig. 5. Scanning electron microscope photograph (x 70; original x 100) of the incisal edge of culprit's tooth showed definite concave abrasion — highly significant for identification purposes.

Discussion

The value of the impression method rests upon the fact that bite mark indentations of the skin are reproduced exactly in a 3-dimensional model and thus the dimensions of depth and shape are provided for comparison with the dentition of the suspect.

It must be understood that *at the time* of the bite mark injury, particular tooth mark indentations will be present. The passage of time, however, results in a smoothing out of the tooth depressions. The latter phenomenon occurs as a result of oedema due to injury, post-mortem changes and the inherent ability of the plastic skin, dermis and subdermal tissues to reconstitute the original contour of the body surface (Sopher[13]). Sebata[10] stated that bite marks which do not break the skin surface will persist for as short an interval as 3 minutes or as long as 24 hours, depending upon the bite pressure applied. Harvey *et al*[6] stated that face bites fade more quickly than bites upon other body areas and, furthermore, that bite marks upon females fade less rapidly than bites upon males.

In any bite mark comparison, it must always be kept in mind that numerous variables exist in the imprint pattern of incisal and occlusal surfaces when inflicted upon human skin. Skin is an elastic medium capable of distortion due to pressure and the anatomical position of the bitten part. Due to the elastic fibres in the dermis, skin tension varies greatly, depending upon the relative position of the bitten area.

As a result of biting force, bite mark injury varies between mere contact with the skin surface to a deep, incised puncture wound which may penetrate into the underlying subcutaneous soft tissues.

The nature of the bite injury also depends on the individual's susceptibility to injury, which may vary according to age, sex, site of the bite and the presence or absence of any diseases (e.g. liver disease and various blood disorders). Elderly people tend to bruise more easily than do young persons and females more than males.

According to Berg and Schaidt[2] there must be marks left by 4 or 5 approximate teeth if these marks are to be used for positive identification. It is, however, not primarily the number of tooth marks that is essential in making a positive identification. A positive statement can be given if the characteristic details of the bite marks, as compared with the suspect's dentition, are of such a type that there can be no doubt about their identity.

The addition-cured silicone materials were found in our study to be the best elastic impression materials for our purpose and were subsequently used to take the impressions of the teeth of the suspects. On the victim (in this case the sheep's trotter) a faster and equally accurate material is needed and therefore this project was done to evaluate the effectiveness of a resin material as forensic impression material.

The Bis-GMA resin used in this study conformed to the requirements set for impression materials:

(a) It is quick-setting (3 minutes as opposed to 10 minutes for elastic impression materials);

(b) It has a suitable viscosity and flow;

(c) It produces excellent detail.

In addition it is also translucent and helps the operator to ensure that the bite mark has been filled without air bubble inclusion.

The exothermic reaction of the resin is still a concern. The authors do not know what the effect on vital tissues will be. Histological studies on the effect of the heat on tissues should be performed to determine whether the material might inflict permanent damage. In fact, during clinical tests on shallow bite marks on the author's own hands, it was found that the self-curing resin elicited an undesirable pain response on curing and also produced tissued damage and even blister formation, *thus excluding the use of this product on live tissue.* The authors subsequently used a white-light curing unfilled Bis-GMA resin* with great success. This resin also provides excellent reproduction of bite marks without the visible tissue damage encountered with the self-setting resins. The polymerizing of the light-curing resin is performed by means of short periods of exposure to a light source, thereby limiting the development of heat to almost zero. The effect

*Helio Seal, Vivadent, Schaan, Liechtenstein.

of this small rise in temperature will, however, also have to be determined, as well as possible tissue toxicity effects of this resin.

Although Sognnaes[12] showed in 1977 that even superficially similarly looking teeth can produce unique bite marks, we feel that bite mark registration should be seen as one of many aids involved in deciding the identity of a person. Because of nearly similar features that might be present in the bite marks and the dentition of the (wrong?) suspect, we agree with Ström[15] that it is better to confine any statement to a *probability* rather than a *certainty*. Bite marks on humans can have so many varying factors (such as the time lapse since the attack took place, blood and saliva in the bite marks, the force of the bite, the action of the tongue, the depth of the bite and swelling), that it is better to take a cautious view[18] by using bite marks to prove the *innocence* of a suspect and *not his guilt*. Further studies are needed to substantiate the reliability of our techniques[16] before we can say with confidence that we are able to demonstrate the uniqueness of a bite *at all times*.

The following precautions are important:

1. Before taking impressions, always first take photographs of the area with a scale indicator placed next to the bite. The distance at which the photograph was taken should also be noted.
2. Also ensure that a saliva sample is first taken (if enough saliva is present). It is possible to determine the blood group of the assailant by this means.
3. Obtain permission from the victim and the suspect to take the impressions. The dentist might be liable for assualt upon a suspect if voluntary permission has not been granted in the absence of a court order.[13]
4. Try to obtain impressions *as soon as possible after the attack* for greatest accuracy. This is very often almost impossible. Always see to it that accurate store models (e.g. Velmix) are fabricated from the impressions for future records.
5. It is advisable that a positive identification be confirmed by *at least 2* dentally qualified forensic scientists.

Conclusions

It can be concluded from this study that a chemically curing unfilled Bis-GMA resin can be used with success to register bite marks under *experimental conditions* and *on non-vital tissues* and that a light-curing unfilled Bis-GMA resin can be used on *vital human tissue* under *certain conditions*.

Much more research is needed, especially in determining the effect of using the light-curing resin in clinical cases where there is a possibility of histological damage to vital tissues and where there are complicating factors such as numerous bite marks, blood, saliva and swelling which might interfere with the effectiveness of the material.

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The Permanent Mandibular Third Molar

Its Value in Age Determination

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The use of teeth as an indicator of age dates back to the first half of the last century. In Britain, at that time, the law decreed that children under 7 years of age were not responsible for any crime they may have committed. It was therefore important to prove that a child was less than 7 years of age. It was often very difficult to prove age as, particularly at that time, there was no registration of birth. Thomsen[5] stated in 1836 that:

'... if the third molar hath not protruded, there can be no hesitation in affirming that the culprit has not passed his seventh year.' (Johanson[5]).

By the 'third molar' he meant the first permanent molar erupting after the 2 deciduous molars. The dental age of an individual can be determined by comparing the radiographic appearance of the developing teeth with charts prepared by, among others, Schour and Massler[4], Nolla[3] and Gustafson and Koch[1]. During the development of the teeth, up to about 15 years of age, accuracies of approximately one year should be obtainable. The third molars are mostly not included in the afore-mentioned charts, probably because of the great variation in eruption times, which are greater than for any other tooth. It is therefore advisable to use the development of the root of the third molar in the assessment of age (between 15 and 21). It is supposed to be little influenced by different factors.

According to Johanson,[2] very little is known about root formation of the third molar in relation to age. The purpose of this investigation was to determine the value of the developing root of the third molar tooth in the assessment of age between 15 and 21 years.

This paper reports the findings of a preliminary retrospective study of standardised panoramic radiographs of 500 dental patients. The age of the patients was correlated with the radiographic appearance of the stage of development of the root of the third mandibular molar (48).

Materials and Methods

(a) *Material.* Five hundred routine panoramic radiographs of Coloured patients taken in the Faculty of Dentistry, University of Stellenbosch, were used for this study. Only patients between 15 and 21 years old were included. Of those thus selected at random, 222 (44,4%) were males and 278 (55,6%) were females.

(b) *Method for Evaluating Stages on Radiographs.* Only the right mandibular third molar (48) was studied because Johanson[2] proved

statistically that there is no significant difference in the development of the third molars in the upper and lower jaws; neither is there any between the left and right sides. To evaluate the development of the root of the tooth it is necessary to define clearly the different stages, which are easily followed on radiographs.

Development of the Root. The stages of completion of the root were evaluated primarily with reference to the cemento/enamel apical length of the root. In the assessment of these stages in an individual, his pantomographs can be conveniently compared with the standard (Fig. 1).

Grade I: The first stage of the root is visible with about 5 mm already formed and the cleft being present.

Grade II: The root has reached a quarter of the future length.

Grade III: The root has reached one third of the future length.

Grade IV: The root has reached one half of the future length.

Grade V: The root has reached two thirds of the future length.

Grade VI: The root has reached three quarters of the future length.

Grade VII: The root is practically fully developed. Only the apex is not closed.

Grade VIII: The apex is fully formed and it is possible to see the contour of the periodontal membrane.

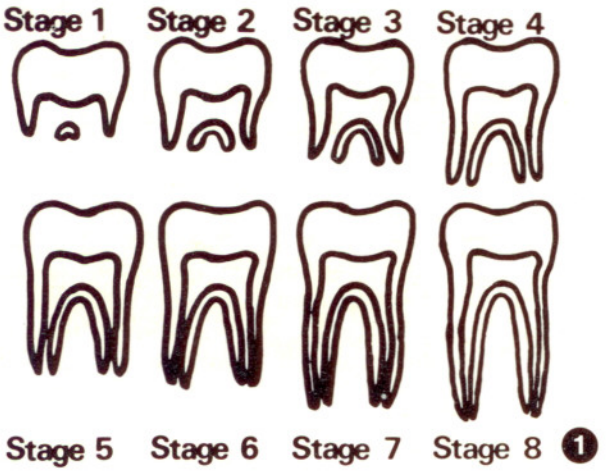

Fig. 1. The pantomographs were compared with the 8 stages as illustrated.

Findings

In Fig. 2 (where the values for the age-at-appearance of the 8 stages of third molar root formation are set forth) irregularities can be seen around stages 4, 5 and 6 in the generally upward progression of the mean across the stages. These irregularities can be removed by combining stages 4, 5 and 6 as shown in Fig. 3. Stages 1 and 2 were combined after carrying out pairwise statistical tests for differences of the mean among the stages.

If stages 1 and 2 are combined (Fig. 4a), i.e. the cleft is present or the root has reached a quarter of its future length, the mean for these 2 groups is

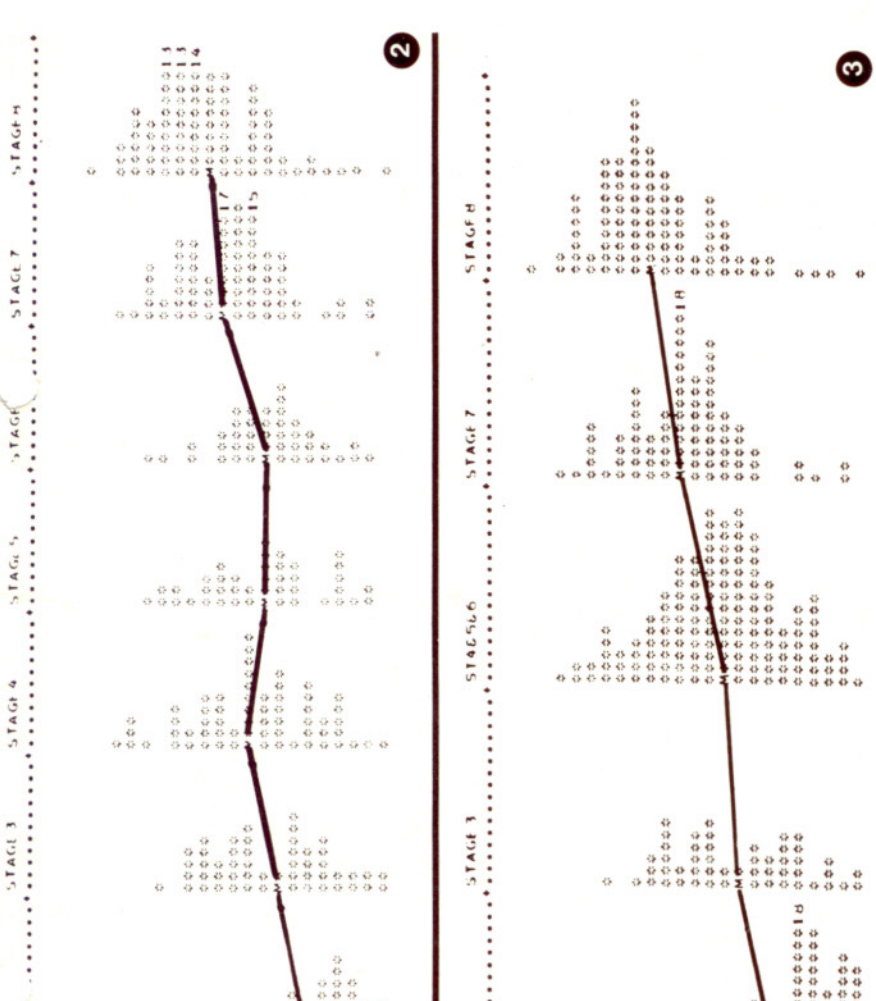

Fig. 2. The values for the age-at-appearance of the different stages. Irregularities can be seen around stages 4, 5 and 6.

Fig. 3. Irregularities can be removed by combining stages 4, 5 and 6.


FIG 4a

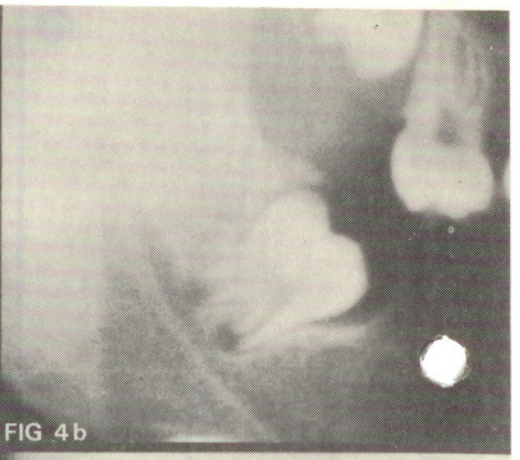
FIG 4b

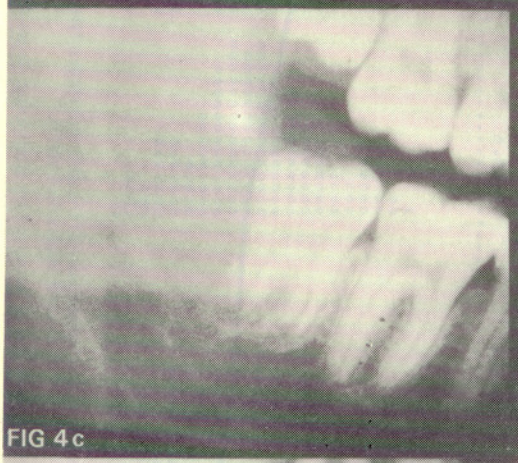
FIG 4c


FIG 4d

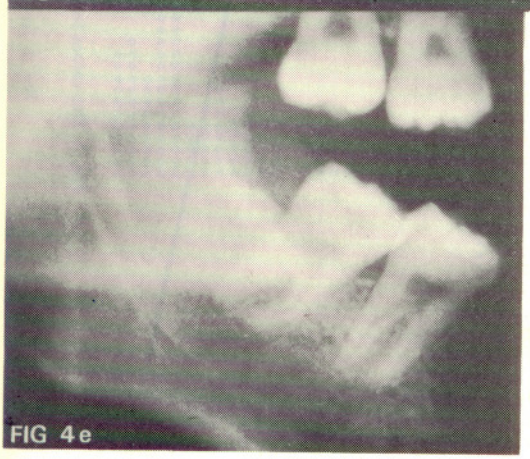
FIG 4e

Fig. 4a. If stages 1 and 2 are combined, the mean for these 2 groups is 16,5 years.

Fig. 4b. The mean age in stage 3 was 17,5 years.

Fig. 4c. The combination of stages 4, 5 and 6 showed a mean of 17,8 years.

Fig. 4d. The tooth is practically fully developed and showed a mean of 18,5 years.

Fig. 4e. The mean age for closing of the apex was 19 years.

16,5 years with a standard deviation of 1,3 years. The mean age in stage 3 (Fig. 4b) was 17,5 years with a standard deviation of 1,3 years.

The combination of stages 4, 5 and 6 (Fig. 4c) showed a mean of 17,8 years, with a standard deviation of 1,3 years.

Stage 7, when the root is practically fully developed (Fig. 4d), showed a mean of 18,5 years with a standard deviation of 1,1 years. The mean age for stage 8 (Fig. 4e), i.e. closing of the apex, was 19 years with a standard deviation of 1,2 years.

Discussion

In terms of sharp discrimination between age groups (i.e. within 3 to 6 months), analysis of molar root development data for Coloured patients indicates that root development of the 3rd molar tooth does not provide the most satisfactory method of age determination between 15 and 21 years. If we estimate the age of an individual child in a given root stage as the average age for that root stage, the resulting estimate may differ from the true age by as much as 29 months in some cases because of the observed statistical variation about the average.

On the other hand, this investigation compared very favourably with the study which was done by Johanson[2] in 1971 and, in fact, shows a smaller standard deviation across the mean of the various stages. We believe that one of the reasons for a standard deviation of this magnitude may be due to an error of observation resulting in misclassification. To eliminate similar discrepancies in the future, we intend to use few stages, i.e. by dividing the root formation into 5 stages instead of the current 8, viz.:

Stage 1: The root is visible with about 5 mm already formed and the cleft being present.

Stage 2: The root has reached one third of the future length.

Stage 3: The root has reached two thirds of the future length.

Stage 4: The root is practically fully developed; only the apex is not closed.

Stage 5: The apex is fully formed and it is possible to see the contour of the periodontal membrane and, in addition to visual observation, we intend to measure the root from the enamel junction — all stages.

Conclusion

In this preliminary investigation it was found that the age of an unknown person could be ascertained with 95% confidence within 2,4 years of the true value and with 99% confidence within 3,6 years of the true value. The third molar and its root development are therefore valuable in determining age between the period 15 to 21 years.

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The Uniqueness of Amalgam Restorations for Identification

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Summary

The measure of uniqueness of the filling patterns of 100 patients between the ages of 18 and 76 was calculated by a devised formula. The measure of uniqueness is found to be *large* if the same type of filling occurs often and *small* if there is a wide variety of fillings on a particular tooth. Combinations of filling patterns on adjacent teeth were also examined and their measure of uniqueness approached zero when 3 or more teeth were calculated together. In the ideal case the measure of uniqueness will be zero when all the fillings, or their combinations, are different. The first molars had the greatest variety of filling patterns and should be regarded in a new light for identification purposes.

Dental identification is of prime importance in the identification of victims of mass disasters because of the unique characteristics of teeth. Fundamental in dental identification is the comparison of ante-mortem and post-mortem dental records. This is difficult when fragmentation has taken place and the only materials left are pieces of jaws or even single teeth.[2,5] Often these teeth are restored with amalgam which is the commonest filling material used by dentists throughout the world and becomes the only characteristic available in the identification of a victim.

However, in a definitive statistical study of characteristic dental features, Keiser-Nielsen[4] stated that a minimum of 12 features are necessary for a positive identification. The characteristics included all types of dental restorations, prosthetic appliances, missing teeth and pathological lesions.

In an expansion of the approach put forward by Keiser-Nielsen[3], Fellingham and Kotze[1] indicated that at either end of the range where, on the one hand we have a mouth of almost entirely normal teeth or, at the other end, an almost edentulous mouth, there are few possible configurations. We are then unlikely to be able to identify persons with any degree of certainty. In the central part of the range, however, where the subject may have an assortment of normal, decayed, missing or filled teeth, a specific configuration is likely to be rare and should lead to a positive identification in most cases.

This study investigated the patterns of amalgam restorations with regard to their measure of uniqueness for identification.

Key words: Amalgam restorations; Identification

Materials and Methods

At the Faculty of Dentistry of the University of Stellenbsoch, each patient receiving restorative dental treatment has a pantomograph, full-mouth periapical roentgenographs and a complete dental charting done before treatment is commenced. All treatment procedures are recorded. From these exact dental records, the files of 100 patients who had received conservative dental treatment, were examined. As most persons using air travel in South Africa are White young-to-middle-aged middle class adults, white patients were selected over the age of 18 years. They were from 18 to 76 years and there were 58 males and 42 females. The teeth in these patients were recorded using the F.D.I. coding system for tooth and quadrant and the restorations noted using the conventional surface description.

For computer analysis teeth were identified by their F.D.I. code and a system was devised whereby individual surfaces, or combinations of these surfaces, would be represented by a 2-digit number. Each tooth has 5 surfaces. The occlusal surface is represented by 01, the mesial surface by 02, the distal surface by 04, the buccal surface by 08 and the lingual surface by 16 (Fig. 1). In this system, the number of the surfaces could not be in

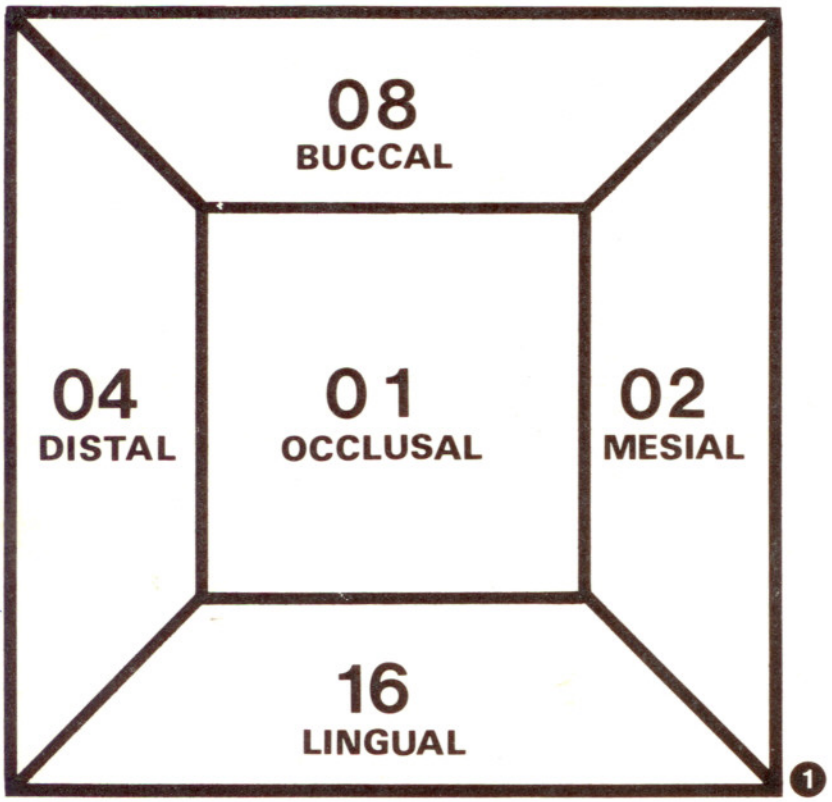

Fig. 1. A diagram of a tooth showing the 2-digit code for each surface.

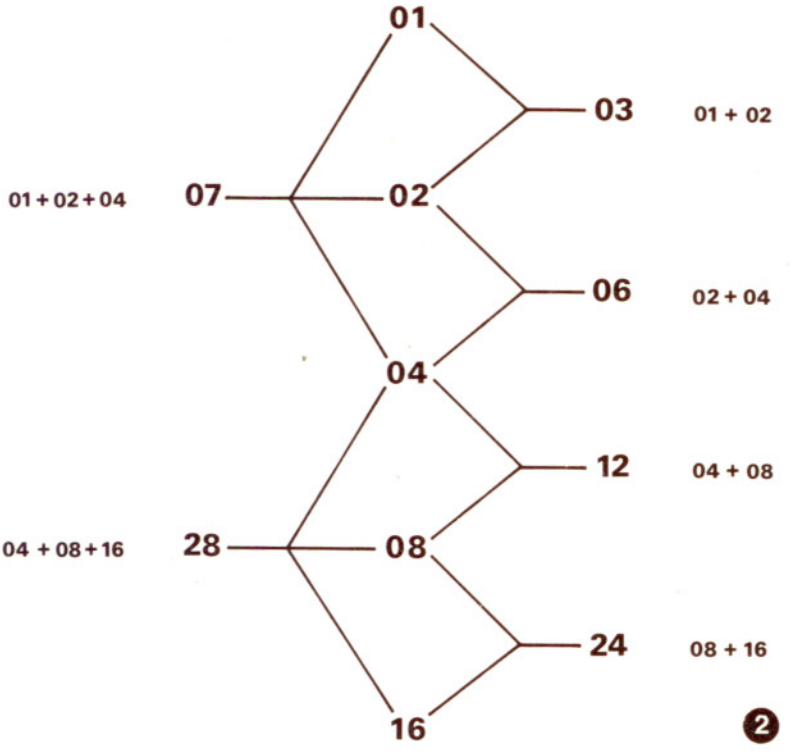

Fig. 2. The 2-digit system of coding in which patterns of amalgam fillings are represented by the addition of the codes.

sequence, viz. 01, 02, 03, 04 and 05, because combinations of these surfaces would cause duplication, e.g. 01 + 02 = 03 (Fig. 2). Patterns of fillings would then be entered into a computer as set out in Table 1A. This provides 31 variations of filling patterns without duplication. Only a maximum number of surfaces connected by a single filling were recorded per tooth for this study. Other variables could then be added such as missing teeth, unfilled teeth, different types of filling materials as well as fixed prosthetic appliances (Table 1B).

The uniqueness of the patterns of the amalgam fillings was measured by the following formula:

$$\text{Measure of uniqueness} = \frac{\text{The sum of (the frequency of each type of of filling} - 1)^2}{\text{The number of distinct values}}$$

The number of distinct values considered were as follows:

If the tooth was filled with amalgam in various patterns (01 to 31); present but unfilled (32); missing (33) or filled with any other type of restorative material (41).

This measure of uniqueness will be *large* if the same type of filling occurs often. Conversely, the measure will be *small* if there is a wide variety of fillings on a particular tooth which are unlikely to be repeated. In the ideal

Table I: Codes Representing Types of Fillings and Variations (Attenuated)

A: Pattern of Computer Code	
Occlusal Filling (0)	= 01
Mesio-occlusal filling (MO)	= 03 (02 + 01)
Mesio-occlusal-distal filling (MOD)	= 07 (02 + 01 + 04)
Mesio-occlusal-distal-buccal-lingual filling (MODBL)	= 31 (02+01+04+08+16)
B	
Unfilled tooth	= 32
Missing tooth	= 33
Gold filling	= 34
Gold crown	= 35
Porcelain crown	= 36
Bridge	= 37
Tooth coloured filling	= 41

Table 2: The Measure of Uniqueness of the Upper Right First Molar

Filling Code	*No.*	*(Frequncy - 1)²*
01 (Occlusal)	23	$(23 - 1)^2 = 484$
03	12	$(12 - 1)^2 = 121$
04	2	$(2 - 1)^2 = 1$
07	9	$(9 - 1)^2 = 64$
09	3	$(3 - 1)^2 = 4$
11	2	$(2 - 1)^2 = 1$
12	1	$(1 - 1)^2 = 0$
15	1	$(1 - 1)^2 = 0$
17	3	$(3 - 1)^2 = 4$
18	1	$(1 - 1)^2 = 0$
19	6	$(6 - 1)^2 = 25$
20	1	$(1 - 1)^2 = 0$
21	3	$(3 - 1)^2 = 4$
23	7	$(7 - 1)^2 = 36$
27	2	$(2 - 1)^2 = 1$
31	4	$(4 - 1)^2 = 9$
32	10	$(10 - 1)^2 = 81$
33	9	$(9 - 1)^2 = 64$
41	1	$(1 - 1)^2 = 0$

Total: 19 Variations $\sum (f - 1)^2 = 897$

No. of Distinct Values = 19 (i.e. 19 variations)

Therefore: $\sum \frac{(\text{Frequency of Distinct Values} - 1)^2}{\text{No. of Distinct Values}}$

$= \frac{897}{19}$

= 47.21, which is the measure of uniqueness.

case the measure will be 0 when all the codes, or its combinations, are different. This analysis of the multiplicity of fillings will then result in the unique identification of the subject. Table 2 explains the calculation of the measure of uniqueness of the upper right first molar.

Results

Table 3 shows the measure of uniqueness of patterns of amalgam fillings for each tooth. The values varied from 4250 for the lower right central

Table 3: The Measure of Uniqueness of Patterns of Amalgam Fillings for Each Individual Tooth

Quadrant	*3rd Molar*	*2nd Molar*	*1st Molar*	*2nd Premolar*	*1st Premolar*	*Canine*	*Lateral Incisor*	*Central Incisor*
Upper Right	475.86	112.75	47.21	139.75	127.154	568.33	403	374.75
Upper Left	536.14	105.71	35.48	163.2	128.85	665.5	436.43	395.25
Lower Left	553	109.93	55.211	212.67	283.0	1 059.57	1 296.67	2 608.33
Lower Right	357.67	62.5	63.12	135.27	359.5	1 625	2 603	4 250

incisor, to 35.48 for the upper left first molar. The first molars have the lowest overall measure of uniqueness. The incisors have the highest value. There is also a difference between upper and lower incisors as well as upper and lower canines. The differences between the upper and lower premolars are small, as is the difference between the left and right sides of the mouth.

Table 4 indicates the measure of uniqueness of patterns of amalgam fillings when teeth are examined in combination. This measure approaches 0 when 3 or more teeth are examined in combination.

Table 4: The Measure of Uniqueness of Combinations of Fillings

	Tooth/Teeth			
Upper right	8 475.86	8+7 19.4	8+7+6 1.07	8+7+6+5 0.439
Upper right	7 112.75	7+6 4.07	7+6+**5** 0.6	**7**+6+5+4 0.239
Upper right	6 47.21	6+5 3.94	6+5+4 1.15	6+5+4+3 1.07
Upper left	8 536.14	8+7 19.47	8+7+6 0.63	8+7+6+5 0.18
Upper left	7 105.71	7+6 2.69	7+6+5 0.62	7+6+5+4 0.12
Upper left	6 35.48	6+5 3.9	6+5+4 0.53	6+5+4+3 0.42

8 = 3rd molar
7 = 2nd molar
6 = 1st molar
5 = 2nd premolar
4 = 1st premolar
3 = canine

Discussion

The results show that the variations of amalgam fillings that can occur in the first molars are far greater than for any other teeth. Therefore their measure of uniqueness approaches 0. This means that the number of patterns in which a first molar can be filled is far greater than in any other tooth. In contrast, the measure of uniqueness in the incisors is high, which means that the variation in patterns of amalgam fillings is limited.

(Compound amalgam fillings on these teeth are rare). This implies that the patterns of amalgam fillings on first molars can be important for identification.

If the combinations of patterns of fillings are taken for more than one tooth (Table 4), then the measure of uniqueness of these combinations rapidly approaches 0. Thus the chance that this combination will be seen in another individual becomes remote. These combinations are thus very useful for identification.

The code developed here allows the notations of all patterns of individual fillings, both separate and in combination per tooth as well as the types of filling materials. However, we are at present limited to programming only the *maximum number of surfaces connected by a single filling*. If programming can record individual fillings on all surfaces, the measure of uniqueness will be decreased substantially and the patterns of the restorations will considerably enhance the identification characteristics of each tooth.

This study suggests that the amalgam restorations on the first molars can be regarded in a new light because the filling patterns of teeth, when examined individually or in combination, may provide the 12 necessary characteristics for identification.

The author wishes to thank Dr. T. J. v. W. Kotze for his help in the derivation of the formula of uniqueness, Mr. W. B. de V. Smit for the coding of the surfaces of the tooth; and the staff of the MRC at Tygerberg for computerizing the results of the above study.

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Possible Amalgam Damage to Lenticular Glass during Tooth Restoration

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Summary

A patient under treatment for tooth decay alleged that during the procedure one of his lenticular glasses had been chipped because a piece of amalgam dropped onto it. Such a possibility was consequently investigated.

The chipped part of the glass was investigated microscopically. This area (as well as an identical, undamaged area) was etched with a concentrated HNO_3 - $HClO_4$ solution and analysed for the presence of mercury by atomic absorbtion spectrometry (A.A.S.). The glass strength was also tested by dropping a steel rod (10 times the mass of the alleged amalgam cylinder) on it followed by microscopic examination for possible damage. Amalgam was dropped experimentally on a marked spot and the area etched with the above acid solution to ascertain whether such amalgam-glass contact is demonstrable by A.A.S.

It was found that the chipped glass area had not been in contact with amalgam and could thus not have been damaged by amalgam. Furthermore, more than 10 times the normal amalgam mass (used for restoring a tooth), applied in the form of a rod, could not damage the lenticular glass.

A case of possible damage to spectacle glass during a dental procedure has not yet been reported. A recent incident in which a patient alleged that damage had been caused by a falling fragment of prepared amalgam was investigated thoroughly to test the patient's claim.

Key words: Amalgam; Lenticular glass

Materials and Methods

1. Light Microscopy

The lenses were examined carefully under various magnifications by light microscopy. The extent and nature of the damage was noted and photographed.

2. Simulation of the Events which Might have led to the Damage.

2.1 Amalgam: An undamaged area was selected and marked. This area was placed directly in line with a glass tube of known diameter, which was clamped in a stand and from which an amalgam cylinder was dropped onto the glass. A quantity of amalgam normally used by students was mixed,

loaded and discharged, using a standard amalgam carrier. The small cylinder of amalgam was carefully picked up and weighed.

This was repeated at different heights and varying impact forces. The lens was then prepared for spectrometry to determine the presence of mercury.

The lens was again observed microscopically for signs of damage.

2.2 Steel Rod: A solid steel rod with the same diameter as that of the amalgam cylinder, but weighing 10 times as much, was now prepared and allowed to fall onto the marked area of the lens, in the same way as in the amalgam trial.

Various impact forces were applied similarly (by varying the height from which the cylinder was dropped) and possible damage sought microscopically.

2.3 An Attempt to Scratch the Glass: This was made with a hardened cylinder of set amalgam as well as with the steel rod and the area on the lens examined microscopically.

Results

1. No trace of mercury could be found by A.A.S. on the lens which was originally claimed to have been damaged. Mercury could, however, be found by A.A.S. after experimentally dropping the amalgam on the lens.

2. Impact caused by simulated amalgam cylinders revealed no damage when examined microscopically.

Impacts caused by the steel cylinder weighing 10 times as much as the amalgam cylinder also failed to produce damage to the lens even though the distance between the cylinder and the lens was increased to a distance

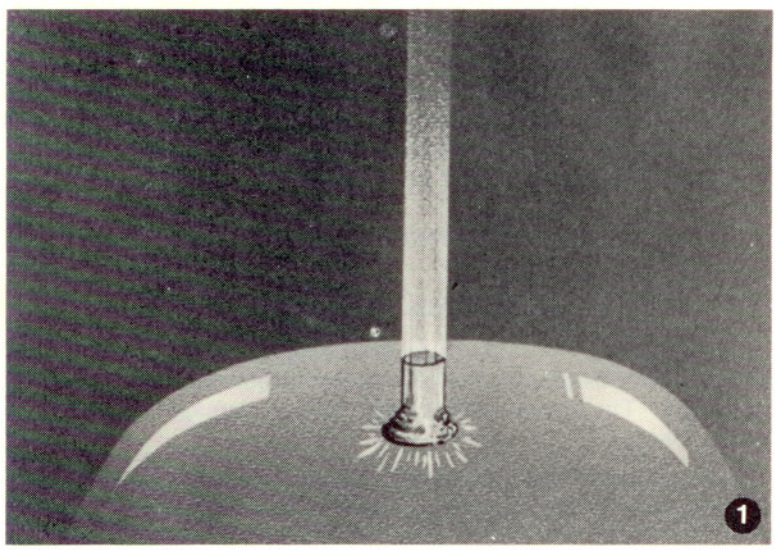


Fig. 1. Distortion due to plastic property of amalgam, which has not set, when striking an object.

greater than could occur in practice with a patient in the recumbent position and the amalgam carrier held at eye level of the operator.

3. Efforts to scratch the lens with *hardened* amalgam as well as the steel cylinder proved negative.

Discussion

The potential energy of an object at a certain height is transformed into kinetic energy when the object falls. This energy will distort the falling object on impact and will also exert a force on the object struck. The force caused by the steel cylinder will be much greater than that caused by the amalgam cylinder, because not only is the steel cylinder 10 times heavier but steel is distorted less on impact than amalgam is distorted (Fig. 1).

If a solid steel cylinder, weighing 10 times as much as a plastic amalgam cylinder, failed to cause damage when dropped onto a lens at a height greater than the practical possible height from which the amalgam could be dropped, then it is highly unlikely that the claimed damage was, in fact, caused by the amalgam.

When the damaged lenticular glass (Fig. 2) is examined under various magnifications, distinct scratch marks are observed (Figs. 3-5).

It is a geological fact that a substance with a greater Brinell hardness scratches one with a lesser hardness. Both amalgam and steel have a Brinell hardness less than that of lenticular glass.

Lastly, if A.A.S. is considered, the claim becomes even more suspect. In the original scratch marks no mercury could be detected, whereas it was easily detected in the experimental combination.

Conclusion

It was postulated that the patient tried to recover the cost of replacement of his damaged spectacles, which he had dropped accidentally.

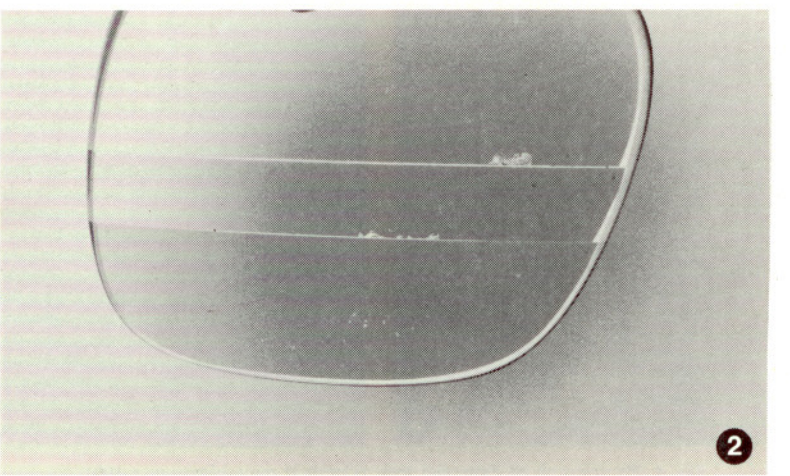


Fig. 2. Photograph of damaged lenticular lens.

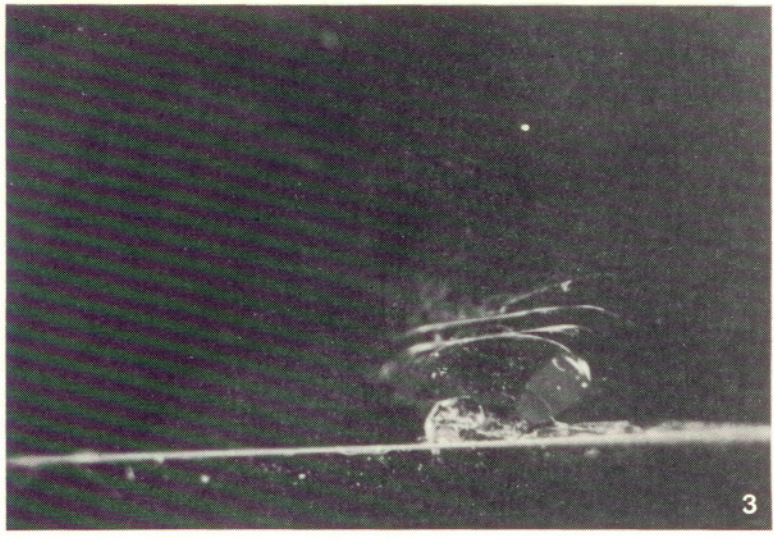
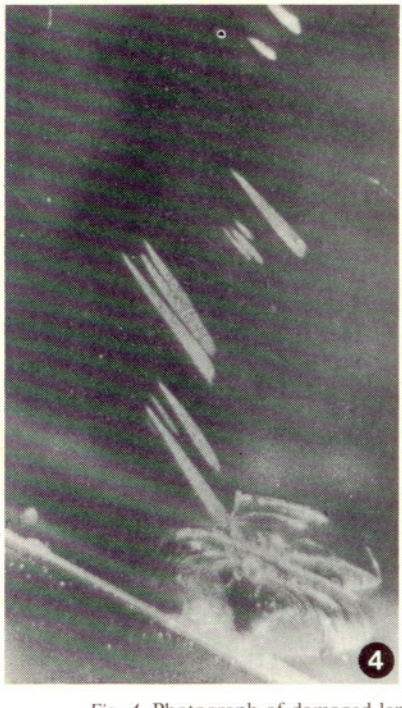


Fig. 3. Photograph of damaged lens. (Original magnification: x 100).



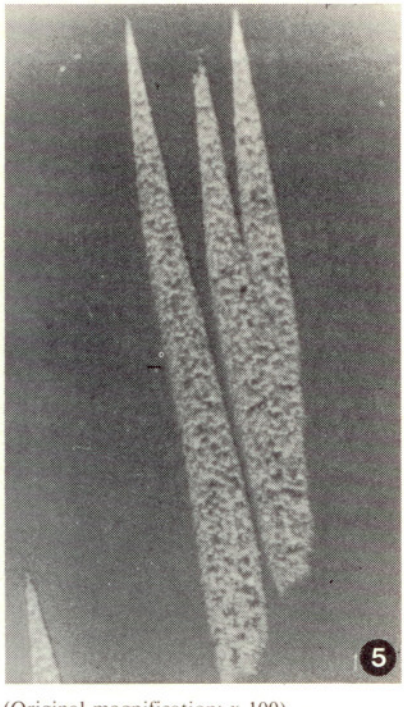


Fig. 4. Photograph of damaged lens. (Original magnification: x 100).

Fig. 5. Photograph of scratch marks on lens. (Original magnification: x 300).

He was, however, informed that it was the opinion of the investigators that his glasses fell on the ground, slid and that the resulting scratches were caused by silica particles and that his claim would be resisted in a court of law. The patient immediately withdrew his action.

The authors wish to thank Mr Marius Jooste for the photography and Mr A. Louw for the drawing.

Is Forensic Odontology Faced with Fictional Controversy?

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Popular interest in the famous and infamous is insatiable. The more famous or the more infamous, the greater is the public appetite for news, good or bad, especially controversial issues, factual or fictional. Forensic odontology has not been spared its share.

During a number of years I have been involved in research ranging from the scientific evaluation of the dental relics of George Washington (Fig. 1)[1] to the post-mortem dental identification of Adolf Hitler and company (Fig. 2).[2] No group has been more intimately scrutinized than those holding dominant public office. Dead or alive, there has been an all-consuming interest in their affairs of state as well as their affairs of heart and health. Some have been more secretive than others. A few might have hoped to get away with it, but not for long and evidently not forever.

1. George Washington

One of the most well-established odontological fictions is that George Washington had wooden teeth, as every kindergarten kid learns. No wonder I have been accused of being an iconoclast for having published documentary data to the contrary. For I have not discovered the slightest evidence that President Washington ever had wooden teeth. If he did, it would historically be much like President Reagan wearing vulcanite dentures. During Washington's time wooden teeth had been out of style for a century, but had been formerly popular in the Orient, where fancily carved wooden dentures carried elegant inlays of polished mother-of-pearl incisors. To be sure, President Washington himself was quite secretive when it came to his roots — both dental and parental.[3]

My studies here and abroad have shown that Washington's dentures were mainly made of ivory from elephant and hippopotamus, in one case apparently from walrus ivory and in another from something as ordinary as cattle incisors.[4]

Washington's most famous dentures were mysteriously stolen from the Smithsonian Institution on 18 June 1981.[5] A few days later I arrived to give a lecture on Washington at the International Congress of Forensic Sciences in my native town of Bergen, Norway. The result was that the local newspaper (tongue in cheek, I trust) suggested that I was probably the main suspect in the recent theft of these dentures from the Smithsonian Museum. However, since the FBI had been unable to capture either the real culprit or retrieve the real relic, I am glad to say that I was able to bring,

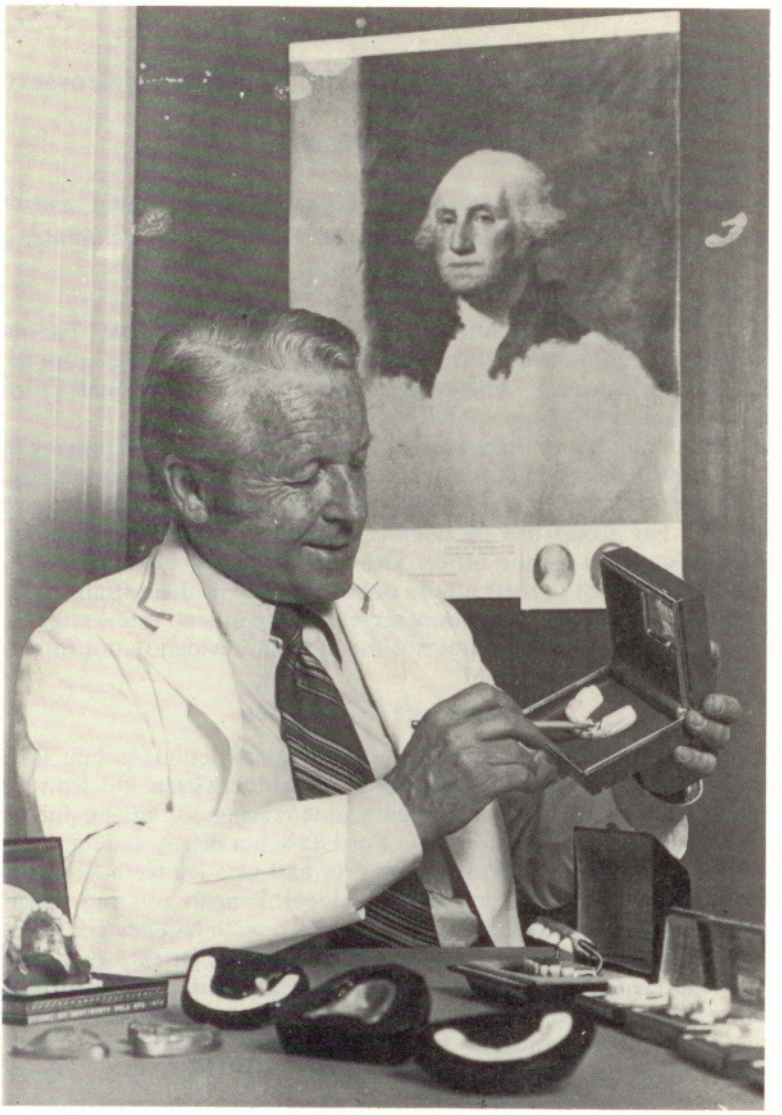

Fig. 1. The author demonstrates some of his work from re-creating President Washington's dental relics, in the manner and material they were made of two centuries ago.

The ivory retention aperture which whiggled loose Washington's last rooted tooth is shown in first inauguration denture of 1789.

Lower left (at elbow) is shown the author's reproduction of the ivory-gold dentures (from Washington's second term of office, made in 1975), stolen in 1982, and now replaced by the author in the exhibit of Smithsonian's Museum of American History, Washington, D.C.

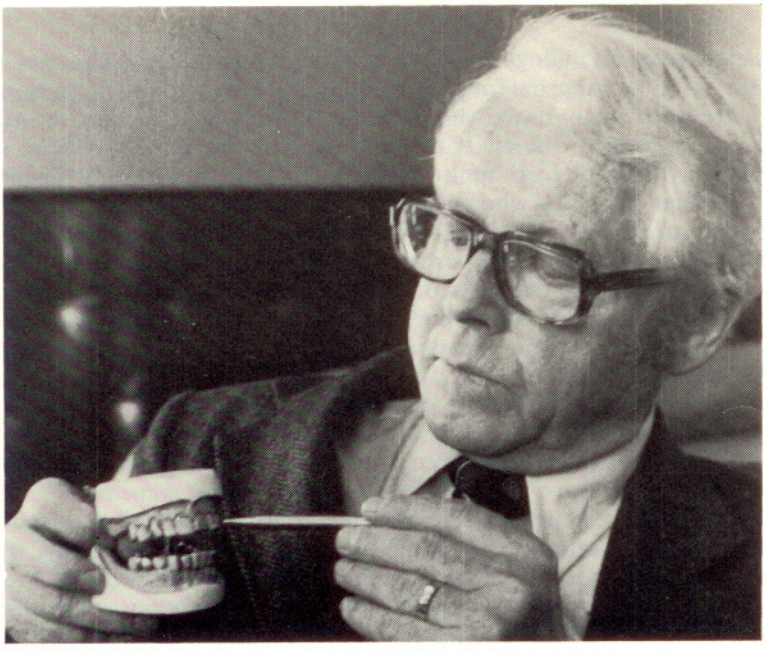

Fig. 2. The author demonstrates one of the models he made for identification of the Nazi leaders. He points here to one of the many extraordinary dental features of Hitler's many crowns and bridges.

in 1982, a special present to Washington for the celebration of his 250th Smithsonian gala birthday anniversary, namely, a duplicate set that I re-created in my laboratory at UCLA. This set combined elephant ivory and hippopotamus carved tooth-like segments, with a *gold palate plate,* which is believed to have been the most probable reason for the theft. The FBI is still investigating the case.

I should add that there were, in fact, half a dozen wooden pegs which connected the elephant ivory base of the lower denture with the hippopotamus enamel-covered dentine segments. To tell the truth, I did cut down a branch of a cherry tree in the UCLA botanical garden next to our dental school to create my reproduction now on exhibit in the Smithsonian.[5]

While it is not directly related to forensic odontology, I might also add in passing that I do not know of any evidence that George Washington, as a young boy, did, in fact, cut down the branch of a cherry tree in his father's garden. Yet one should excuse the tradition and survival of such sidelights by the fact that George Washington's world was hungry for any information that related to his glorious position in history. Undoubtedly, every youngster in the new United States was inspired by such an example of complete honesty as that of the young George Washington, one who 'could never tell a lie.'

2. Modern Mythology

Money-making mythology goes far beyond such innocent case histories. In our times it is not unusual for popular magazines to announce sensational stories of the living or dead, who either are, or have been, engaged in local, national or foreign affairs. If too personal, the living always have an opportunity to bring forth multi-million dollar law suits to deny fictional controversies; but those who have passed away cannot defend themselves.

Shortly after I arrived in California in the early 1960's, I was looking for a home near UCLA, on a little street in Brentwood, almost next door to the home of Marilyn Monroe. Based on the coroner's report, I was soon to realize the sad fact that she died as a result of suicide. Twenty years later (1982), popular magazine headlines claimed that, rather than having committed suicide, she actually was murdered. Shortly thereafter, another headline in a competitive news magazine claimed that Marilyn was still alive, albeit not well, but a patient in a mental hospital. There, allegedly, she had been hidden through arrangement by the Kennedy administration to silence preposterous romantic and political embarrassments.

It was further claimed that Marilyn Monroe's diaries had been found and provided confirmatory reasons for this fate of hers. Thus, the Coroner's post-mortem identification of Marilyn Monroe and the conclusion that she died from suicide have failed to carry any weight when confronted with competition between forensic science and fictional mythology.

3. The Case of Adolf Hitler

When it comes to 'post-mortem' diaries, the potentially most significant money-making myth of the century relates, of course, to the 1983 rigmarole regarding the recovery of Hitler's diaries. Allegedly, the diaries were recovered from a crashed plane that had left Tempelhof Airport in Berlin on a flight to Salzburg towards the end of April 1945.

Because I had published material relating to a crashed plane on that route at that period, in connection with odontological forensic studies on Adolf Hitler *et al.*,[2] I soon received a number of urgent calls from *Stern* Magazine in Hamburg and its Chief Editor, Mr. Peter Koch, and also from *Stern's* New York and Los Angeles offices. Asked to what extent I could shed light on that event, I could at least help to verify that some Hitler Berlin documents had been packed but lost in April 1945. I knew this from having twice interviewed and several times corresponded with Käthe Heuserman, who served as the chairside dental assistant for Dr. Hugo Blaschke, the principal dentist for Adolf Hitler and the other VIP Nazis from 1937 until 1945. According to Heuserman, she had been ordered by Dr. Hugo Blaschke to pack various documents from their office in Berlin and some unfinished dental work. This was to be passed on to Salzburg where Dr. Blaschke would meet the plane and take the material to Hitler's Berchtesgaden hideout.

As it turned out, Dr. Blaschke was captured by American forces in Salzburg on 28 May 1945. When interrogated by the American intelligence officers, he stated that the plane never arrived in Salzburg even though it had left Berlin on the night of 21 April. This, then, appeared to fit in with

the crashed plane which, on that very date, had left Berlin with various documents on the way to Salzburg. This could thus be used as a partial 'evidence' for the alleged recovery of Hitler's diaries. There are also supposed to be details regarding certain dental records and intraoral dental X-rays that Käthe Heuserman had packed and air-freighted that day, but have as yet not been recovered. Ironically, before this was communicated to me, the Russians had already stated, erroneously,[6] that they had recovered these dental records and X-rays in Berlin from Käthe Heuserman in early May 1945. Not so.[2]

Here, then, is another conflict of forensic odontology and fiction which took years to resolve. I was able to investigate the documentation, dental charting and treatment data reported by Dr. Blaschke, as compared to 5 head and jaw X-rays which I was fortunate to locate in American archives back in the early 1970's. These were authenticated and dated radiographs taken of Hitler following the assassination attempt in July 1944. From these various data it could be convincingly established with a total of 26 concordant points (Table 1) far in excess of what would be required even from fingerprints, that Hitler's post-mortem remains had, in fact, been recovered and autopsied following the fall of Berlin in early May 1945.

Notwithstanding such published scientific documentation,[2,7] public interest in the publicized controversy of Hitler's identification has not ceased. An Associated Press release recently reported that Hitler's identification was questionable because his dentist once was included in a snapshot which also showed a nearby Adolf Hitler. Had Hitler's dentist, who happened to be a graduate of the University of Pennsylvania (1911) and in Berlin favoured by barons and bankers, later on become an unscrupulous full-blooded Nazi? If so, he *allegedly* might have kept busy to oversee that a double of Hitler was buried in Berlin with dental treatment records identical to those shown in the captured German jaw and head X-rays of Hitler. (These I recovered in the American archives,[2] i.e. ENT X-rays taken of Hitler to diagnose jaw and sinus trouble resulting from the assassination attempt in 1944). The lady author, married to a full-time dental practitioner in the USA, concluded that Hitler's dentist had been involved (at whatever time Hitler had decided he would *lose* the war) in making a very complicated falsified burial arrangement of a fictitious body!

The truth is that Dr. Blaschke had already left Berlin for Salzburg 10 days before the bunker suicide and Viking funeral of the real Hitler. Thus, if the only evidence for this forensic dental plot was that Hitler's dentist had been seen in a picture that also included his VIP patient, Adolf Hitler, one can only recall that President Reagan, following his tragic assassination attempt, stressed, on the way to the operating room, that he hoped none of his doctors were Democrats; or that, on the contrary, all of his doctors were good Republicans. By the same token, I think one can be sure that Hitler insisted that his dentist *not* be a Communist. Back in the early 1930's, I witnessed the Sunday street battles between the Brown Shirts, the Nazis, and the Black Shirts, the Communists, when I did my first anatomical dissections as a Norwegian transfer student at Leipzig University. The above, widely publicized Hitler misidentification scenario

Table 1. Comparative conclusions regarding Adolf Hitler's dental condition

Reference Number (FDI)	*Jaw & Tooth Areas*	*Blaschke (Dentistry) 1944/45*	*Bezymenski (Autopsy) 1945/68*	*Sognnaes (Overview) 1975*
1 (18)	UR M-3	Missing	Missing	Missing
2 (17)	UR M-2	Missing	Missing	Missing
3 (16)	UR M-1	Missing	Missing	Missing
4 (15)	UR P-2	Pontic	Pontic	Pontic
5 (14)	UR P-1	Crown	Pontic	Pontic
6 (13)	UR C	Crown	Crown	Crown
7 (12)	UR I-2	Pontic	Dowel/Pontic (?)	Pontic
8 (11)	UR I-1	Dowel Crown	Crown	Dowel Crown
9 (21)	UL I-1	Window Crown	Window Crown	Window Crown
10 (22)	UL I-2	Dowel Crown	Dowel Crown	Dowel Crown
11 (23)	UL C	Crown	Pontic	Pontic
12 (24)	UL P-1	Pontic	Pontic	Pontic
13 (25)	UL P-2	(Crown, 1944)	Missing (1945)	(Crown, 1944)
14 (26)	UL M-1	(Pontic, 1944)	Missing (1945)	(Pontic, 1944)
15 (27)	UL M-2	Missing	Missing	Missing
16 (28)	UL M-3	Missing	Missing	Missing
17 (38)	LL M-3	Crown	Crown	Crown
18 (37)	LL M-2	Pontic	Pontic	Pontic
19 (36)	LL M-1	Pontic	Pontic (?)	Pontic
20 (35)	LL P-2	Crown	Crown	Crown
21 (34)	LL P-1	Pontic	Pontic	Pontic
22 (33)	LL C	Crown	Crown	Crown
23 (32)	LL I-2	Involved pulp	Intact	Involved
24 (31)	LL I-1	Intact	Intact	Intact
25 (41)	LR-I-1	Intact	Intact	Intact
26 (42)	LR I-2	Intact	Intact	Intact
27 (43)	LR C	3/4 Crown	3/4 Crown	3/4 Crown
28 (44)	LR P-1	Intact	Intact	Intact
29 (45)	LR P-2	Crown	Crown	Crown
30 (46)	LR M-6	Pontic	Pontic	Pontic
31 (47)	LR M-7	Missing	Missing	Missing
32 (48)	LR M-8	Missing	Missing	Missing

This table (reproduced from Sognnaes[2]) indicates a total of 26 concordant points between antemortem and postmortem data on Hitler's extremely extraordinary dental disease and therapy history. (For other earlier reports see also Sognnaes (1972): *Harvard Dental Alumni Bulletin,* **32** (2): 52-59; and Sognnaes and Ström (1973): *Acta Odontologica Scandinavia,* **31:** 43-69, 1973).

It is believed that few, if any, postmortem evaluations from fires, crashes, murders, etc. have been confirmed by comparably detailed publications of the individual documentary data involved in proof of identification.

has not, as yet, been seen in any peer-reviewed scientific journal with appropriate scientific cross-references.

There have, of course, been other journalistic attempts to indicate that Hitler had doubles and that, hence, there may be many Hitler bodies lying around. In my own post-war interview and correspondence with the late Dr. Albert Speer in Heidelberg, I heard no evidence that he had ever detected any sign of a double, notwithstanding their many meetings and

travels together. A double, merely presenting a moustache and Hitler hairdo, is one thing — to have a double ready to demonstrate 26 extraordinarily characteristic dental features to be available for potential post-mortem documentation and identification is quite another. In my view, this is totally absurd.

Yet, the Hitler myths continue. Not very long ago, one weekly news magazine headlined: 'Hitler alive and well in South America.' (He would be going on 100!) More recently: 'Hitler's bodily remains never found.' Following the fraudulent Hitler diary stories, I have been inundated with letters regarding other potential 'souvenirs', as it were, from the Hitler period, including dental work and related documentation.

4. The Case of Eva Braun

Beyond Adolf Hitler, the popular press has been no less interested in his mistress and wife for a night, Eva Braun. I have never questioned that Eva Braun is dead, and that she died in Berlin in April 1945, together with Hitler.[2] But I have not been able to convince myself, on a *scientific* basis, that her post-mortem remains have been adequately identified.[8] When I reported on that conclusion at the International Congress of Forensic Sciences in Bergen, Norway, in June 1982,[9] it turned out that a foreign journalist in the audience went a step further. He took the liberty of prepublishing some of my material and then arrogantly went even further, concluding that Eva Braun was still alive and well.[10]

Unlike my own sober scientific deduction, this deliberate forensic fiction then hit the headlines all over the world. As a result, I became flooded with letters from dozens of individuals who claimed they had seen Eva Braun alive at various times and places, here and abroad. Thus the myth was evidently of far greater interest than the factual scientific findings.

Another problem was that the Russian scenario regarding Eva Braun's post-mortem identification among the remains found around the Berlin bunker early in May 1945, was also very flimsy. First of all, the body referred to as No. 13 had half a dozen steel bomb splinters with haemorrhage in the thorax. More importantly, the only stated clue the Russians could claim for having found the body of Eva Braun, was a dental bridge.[6] The preparation of such bridgework has indeed been confirmed as having been made by the Nazi VIP's dental technician, Fritz Ecktmann, whom I interviewed in Germany after his release from 10 years in a Russian prison.[8]

In addition, I have obtained from Russian archives a secret report from this very dental technician in which he, in 1945, describes the work that he did for Eva Braun. In this report, handwritten in German, he explained and prepared diagrams of this very crucial bridge. Importantly, he added that Eva Braun did not wish to show gold when she smiled and had insisted that he put in white plastic facings on the cheek-side of the bridgework. Incredibly, the Russians claim that this bridge was completely intact with 'white outer facings', found in the mouth of the body allegedly attributed to Eva Braun's Berlin autopsy.[6] But at the same time the Soviet autopsy pathologist observed that a large portion of the right side of body No. 13's face had been completely consumed by fire, including the right portion of

the mandible and the adjacent alveolar bone and dental roots that supposedly had carried the bridge. That bridge, the Russians claimed, was found together with the post-mortem remains.[6] In truth, they got the bridge from the Berlin dental office.[8] It had become too late in April 1945 to insert the bridge in Eva's mouth!

Again, the fictional mythology has here taken precedence over forensic odontology. It turns out that 2 of my Scandinavian dental colleagues, to whom I provided a privileged copy of my new Ecktmann report from the Russian archives, have seen fit to disregard completely the fact that this bridge had been made with plastic facings.[11] At the same time, my Ecktmann document indicated that he had prepared several porcelain incisor crowns for Eva Braun, which, in fact, was also confirmed to me by the dental chairside assistant, Frau Heuserman.[8,12] Yet the Russians did not report the slightest trace of these baked porcelain crowns which, unlike the plastic bridge acrylic, could so easily have survived the fiery post-mortem funeral in Berlin. Body No. 13 could be anybody's bombed body.

5. The Case of Martin Bormann

Of all the infamous Nazi leaders, no one has been the subject of more books, newspapers and magazine articles than Hitler's right-hand man, Martin Bormann. There were many profitably publicized alleged 'sightings' of Bormann in various parts of the world following World War II. *Recognition is not identification.* But Bormann has allegedly been 'identified', after 1945, in a number of countries, including Austria, Bavaria, Italy and, of course, in a number of countries in South America, notably Argentina. In fact, it has also been claimed that Bormann served as a double spy, working with the Russians so as to help them defeat Hitler in Stalingrad. Also, my native Scandinavia at one point has been reported to have 'seen' Bormann after the war.

Among the half-dozen books written about Martin Bormann's post-war escapades, the most famous was probably the one by the Hungarian-American writer, Ladislas Farago.[13] I visited him in his home in Connecticut and was reluctantly permitted to examine some of the documentation. (At first sight I thought *he* was the real Bormann!) Superficially, his papers looked impressive. But I venture to suggest that whereas a covering page or two appeared to have authentic-looking stationery with imprints of South American governmental origin, some of the attached documentation looked very suspicious. These included various lists of properties that the Nazis had taken from German citizens as well as the numbers and weights of gold objects from various thefts of jewellery and dental crowns and inlays. When I examined the Nuremberg trial documentation in the United States archives, I found such listings available. Copies could be attached to appropriate governmental stationery. Undoubtedly this required a considerable ingenuity to obtain and coordinate, and above all, to sell at a profit.

At the same time, the facial photographs shown in these various Bormann books and claiming to be his likeness did not appear very convincing to me from the point of view of anatomy and physiognomy. As a matter of fact, during my postwar forensic travels in South America, I

saw and heard on the beaches of Rio de Janeiro and Buenos Aires many Bormann facsimiles, superficially quite convincingly resembling the original in terms of size, shape, age and accent as well. Perhaps it may reasonably be assumed that even if they were not Bormann himself, they may well have belonged to the Nazis who did, in fact, escape to South America, only a few of whom have since been caught and put to trial, notwithstanding Mr. Wiesenthal's dedication.

A sudden change in the Bormann story happened in 1972, when the remains of 2 bodies were discovered next to the Lehrter railroad station in Berlin. One of these skeletons was tentatively considered probably to belong to one of Hitler's physicians, Dr. Leopold Stumfegger. (He was responsible for handing out the potassium cyanide death capsules to Hitler's bunker friends.) It turned out that Dr. Stumfegger and Martin Bormann, in the company of Hitler's youth leader, Artur Axman, tried to escape from the bunker on the first day of May 1945. They were running from the bunker area on the railroad overpass that terminated at Lehrter railroad station. Years later, on a visit to Berlin, I had the opportunity to interview Artur Axman. He explained how they had tried to jump off the elevated railroad station bridge only to be surprised by a group of Russian soldiers. Axman attracted the Russians' interest by the impressive manipulation of his artificial mechanical arm, replacing the one that had been shot off on the Russian front. With that preoccupation, Axman told me, Stumfegger and Bormann were able to move away, but not very far. For only a few hundred yards from the railroad station, Axman soon saw 2 bodies, those of the long Stumfegger, and the short Bormann, lying on the Invaliedenstrasse bridge. He saw no evidence of blood or gunshot wounds and suspected that both had become surrounded by Russians and therefore had swallowed the potassium cyanide death capsules.

Two post office workers at the Lehrter railroad station post office have confirmed that they buried these 2 bodies right across the street next to the station. Later I also interviewed the man who found the 2 skeletons, a Mr. Zehl, a construction worker who had been given the task of digging a channel for a sewer pipe at the site. Ironically, he was part of a team building a structure, now completed, for the establishment of a Forensic Research Institute!

Soon after this discovery, the skeletal remains were brought south to the Frankfurt area where the prosecutor, Joachim Richter, was responsible for further study. My initial correspondence and contacts with him were fruitless. But later on, following a long letter to Chancellor Willy Brandt, and also facilitated by interview and correspondence with Dr. Albert Speer, then in Heidelberg, I was finally given permission to investigate the post-mortem identification of the skeletons. It helped to speak, write and read German!

I happened to be in Europe giving a presentation at an International Forensic Congress in Rome, Italy, when good news reached me. Though it was Oktoberfest time in Germany, I was able to obtain an accommodation legally to pursue my comparative observations. One of the 2 skulls, which at first was widely announced to be that of Bormann, turned out to be that of Dr. Leopold Stumfegger, who was the physician who had handed out the potassium cyanide death capsules to Hitler's colleagues. Unlike

Bormann, he actually had a very long skull with quite good teeth. Hence, the news photographers had considered him more *photogenic* than the other round skull which had a front tooth temporarily displaced. Hence, the skull of Dr. Stumfegger got on the television, news magazines and newspapers all over the world as the alleged skull of Martin Bormann with the caption that this was: 'The End of a Legend.'

It soon turned out that the Stumfegger skull could, in fact, be identified by military records. He had been an officer in the medical corps. Obviously, the real Bormann skull led to a good deal of confusion, until it was possible for me to relate my information on antemortem dental data, provided through descriptions, diagrams and treatment analysis by his dentist. When these were compared with my photographs, X-rays and careful inspection of that other Berlin skull, it became evident that there were extremely extraordinary types of dental crowns, bridgework and dental disease, including peridontal bone breakdown, which made the comparison completely convincing with 16 concordant points between the antemortem and postmortem information.[2,7]

From this, I concluded, as reported in detail elsewhere,[14-16] that Bormann never escaped from Germany back in May 1945, and consequently cannot have been seen anywhere in the world, since then, notwithstanding the numerous 'sightings' alleged in so many publications, magazine reports, newspapers and half a dozen books. He evidently committed suicide by taking the cyanide death capsule when he was surrounded by Russians next to Lehrter railroad station on 2 May 1945. Interdental glass splinters were found.[15]

Was this the end of the legend? Apparently not. Not long ago I had a visit from a prominent German journalist who, after a renewed Bormann search in South America, asked me to review what he had been *sold* as actual dental records and X-rays recently taken of a patient who, camouflaged under another name, was alleged to be none other than Martin Bormann. When I subjected the data to scientific scrutiny, it turned out to be the most naive and meaningless documentation I have ever seen. To the credit of the German journalist, and his European publishing company, the whole thing was dropped there and then. They had been taken in another costly fraud.

6. General Comments

One might well ask how on earth can so much have been written about the famous and infamous, based almost entirely on pure speculation? Some of the strange scenarios may well be attributed to popularization and publicity in the search of fame, fortune or both. What is most surprising is that a relatively precise science, such as forensic dentistry which, like fingerprints, can provide accurate quantitative data, has been ignored so arrogantly. Even sophisticated scientific publications, reported in peer-reviewed journals, have sometimes had to take second place to purely imaginary presentations. In other words, fictional mythology tends to be swallowed hook, line and sinker, even in the face of extensive forensic research.

Fortunately, the most recent fraud involving Hitler's alleged diaries was

detected at an early stage through precise scientific research methods. Nevertheless, from recent letters, telephone calls and conversations, I have noticed a considerably intensified interest in various speculations regarding other relics allegedly attributed to the Nazi period, including some related to the subject of forensic odontology.

7. Questionable Queries

Have we heard the last of questions of the past? Did Hitler have dentally identical 'twin' doubles? Is Bormann still alive and well in South America? Is Eva Braun around, an attractive septuagenarian? Was Marilyn Monroe murdered, or is she in fact still alive, albeit not well, in a mental hospital? At the other extreme, did President Washington perhaps actually have wooden teeth, notwithstanding forensic research to show otherwise? FBI to the contrary, am I perhaps the prime suspect, who allegedly stole Washington's most famous gold and ivory dentures from the Smithsonian? Might another sceptical forensic writer be around the corner, some mystifying headline hunter or an enterprising journalist with a new twist on money-making myths?

8. Concluding Comment

Whenever I read headlines which seem frankly fictional, I am reminded of my so-called 'Examen Philosophicum' at the University of Oslo as a young student back in the early 1930's. In the final lengthy written examination on the history of ancient Greece, one of the questions was to identify and explain the philosophy of Gorgias, the Italian-born Athenian sophist and rhetorician. While I did not remember a great deal of specific details, I did recall one thing that the professor had emphasized about the period; 'As a sceptic, Gorgias went so far as to even question the perception of his own existence. One must assume, therefore, that Gorgias chose to debate blatantly contrived issues, and that he tried to deny those things which in fact were most clear or obvious to everyone else.' The professor summed up Gorgias by saying:

'This philosopher went to a point where one frankly cannot know whether to take him seriously or not. One can only assume that he tried to see how far he could go by *giving a certain touch of probability to the most absurd.*'

Gorgias was admittedly dealing with intellectual exercises for their own sake. Are the sceptical Gorgias speculators of today more motivated by fame or fortune or both? Or is it simply that *controversy thrives on arrogance and ignorance?* I hope not for any longer in the field of Forensic Odonto-Stomatology.

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