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Contents

VARIABILITY OF PALATAL DIMENSIONS IN SOUTH AUSTRALIAN TWINS

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Abstract

Estimates of genetic contributions to variability in three palatal dimensions were obtained from a sample of 70 pairs of South Australian twins aged between 11 and 26 years. Palatal width and length were measured directly from dental models, while palatal height was assessed indirectly from moiré contourographs. For each of the three palatal variables there was evidence of significant genetic variance, with heritability estimates for palatal width and height generally exceeding those for palatal length. Furthermore, palatal height measurements displayed greatest relative variability and strongest correlation between monozygous twins (r = 0.95), suggesting that this dimension could be useful as an additional comparative feature in forensic odontological investigations.

Key words: Palatal dimensions, twins, genetics, forensic odontology.

Introduction

Previous studies of twins have indicated a substantial genetic component to observed variation in tooth size and crown morphology and indeed have confirmed the reliability of zygosity determination based on dental crown features.[1] In contrast, estimates of heritability for dental arch dimensions and occlusal variables are generally lower, reflecting a greater environmental contribution to variability.[2,3]

Few studies have reported data on the relative contributions of genetic and environmental influences to variation in palatal morphology. Lundstrom[4] found significantly larger mean intrapair variances in dizygous (DZ) twins than monozygous (MZ) twins for palatal height, width and arch length.

Shapiro[5] also found some evidence of genetic influence on palatal height and width, although only palatal height in females showed a statistically significant genetic contribution. Variation in palatal length appeared to be under relatively low genetic influence. Riquelme and Green[6] noted a significant component of hereditary variability for palatal width, height and length dimensions, although zygosity classifications based on palatal measurements were only moderately reliable.

Problems related to measurement technique, sample size and methods of data analysis probably account for some of the conflicting results of these previous investigations. The aim of the present study was to quantify genetic contributions to variability in palatal dimensions of South Australian twins after first testing several assumptions implicit in the traditional twin model.

The method of moiré contourography was used to assess palatal height indirectly from standardised photographs, thereby overcoming some of the difficulties inherent in obtaining measurements directly from dental models. The moiré method provides contours of three-dimensional objects from the analysis of the diffraction fringes created by a point light source and an equi-spaced plane grating. This technique, because of its potential to quantify three-dimensional surface contours with considerable accuracy, provides a very useful tool for comparing related biological forms.

Materials and Methods

Dental models of 41 pairs of MZ twins (24 female and 17 male pairs) and 29 pairs of DZ twins (10 female pairs, 8 male pairs and 11 male-female pairs) were included in the study. The subjects, aged between 11 and 26 years, were enrolled in an ongoing study of dentofacial structures of South Australian twins.[7] Only individuals with complete permanent dentitions (excluding third molars) and regular alignment of teeth were included. Zygosities were determined by comparison of several genetic markers in the blood .

Three reference points were identified on each of the maxillary dental models. These were the highest (most palatal) points on the gingival margins of the palatal surfaces of the left central incisor and left and right first molars. The linear distances between each of these points were measured to the nearest 0.1 mm with Mitutoyo digital calipers enabling assessment of palate width (between left and right first molar points) and length (calculated geometrically) to be made. Repeated measurements established the replicability of the measurements obtained.

Palate height was obtained by moiré contourography using a Nikon F camera and 105 mm MicroNikkor lens with the principal point of the lens 440.2 mm from a grating of pitch 0.976 mm and with a single light source 360 mm from the camera (Fig. 1). With this geometry the resultant moiré fringe interval was 1.2 mm. Dental models were orientated to ensure that the plane defined by the three reference points was parallel to the moiré grating by adjusting the model orientation until a template aligned on the reference points produced no moiré fringe (Fig. 2). Moiré photographs were obtained using Kodak Tri-X film ASA 400 processed to give a speed ASA 1600 and printed using standard photographic techniques. The pseudomoiré fringes were eliminated by the smooth horizontal displacement of the grating during exposure of the photograph. Palate heights were estimated by counting the number of moiré fringes (each at 1.2 mm intervals) between the level of the reference points and the deepest point in the palate (Fig. 3). Previous studies have shown that errors involved in this method are small.[8]

The method adopted for the genetic analysis followed that of previous studies of the dentition in US, Indian and Australian twins.[9-10] A number of hidden assumptions implicit in the traditional twin model have been documented by Christian and his colleagues.[11-12]

Firstly, twin zygosities should not be associated with the mean of the trait under consideration as this may indicate biological differences associated with the twinning process.[13,14] A modified t-test based on nested twin data is therefore used to check whether mean values between MZ and DZ twins differ significantly before proceeding with the genetic analysis.[11,14]

Secondly, Christian et al.[11] consider that total variance within zygosities should be equal for the standard twin model partitioning variance into within-DZ and within-MZ components to hold. If there is heterogeneity of total variance, environmental factors resulting perhaps from competitive or convergent influences within twin pairs[15] are postulated to be unequal for MZ and DZ groups. A one-way analysis of variance is used to estimate total variances for MZ and DZ twins and then an F test checks for significance.

Thirdly, estimates of genetic variance will be biased if environmental covariances differ between zygosities.[11] For example, if environmental covariance is relatively greater for MZ than DZ twins, heritability estimates will be exaggerated. Christian et al.[16] consider that if the among-pair mean square of the DZ twins (ADZ) does not exceed the within-pair mean square (WDZ), any evidence for genetic variance must rest entirely with the MZ twins. Under these circumstances it is unlikely that any substantial proportion of the total variance would be genetic[11,16].

Provided that twin data pass the above tests, the classic genetic variance ratio (GVR) is calculated as $F = WDZ/WMZ$ and tested for significance.

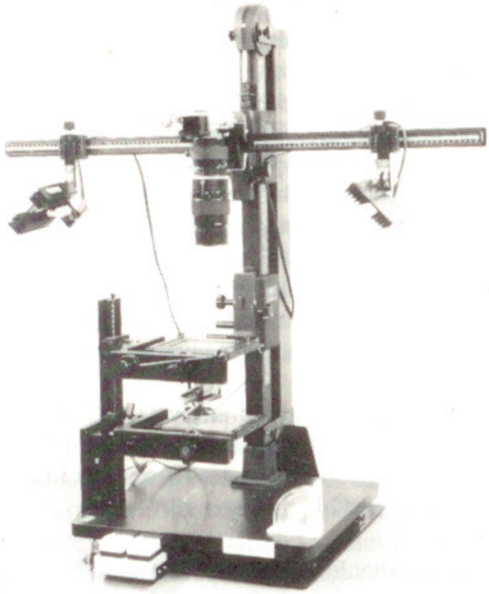


Fig. 1: The apparatus used for the moiré contourography.

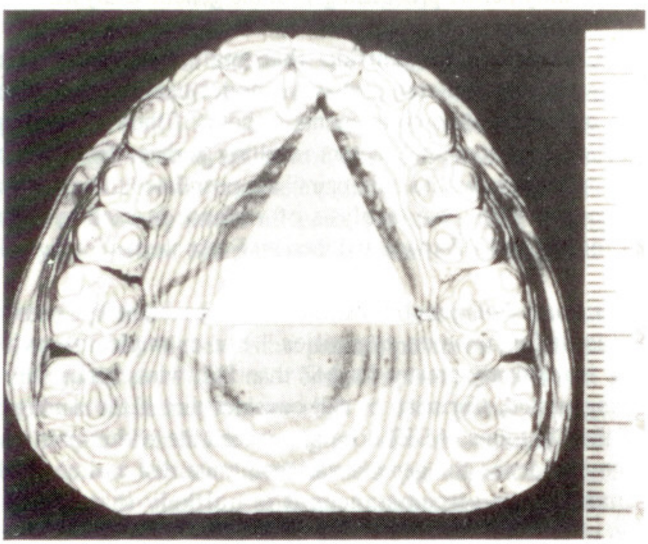


Fig. 2: A triangular template aligned on incisor and molar reference points was used to orientate the dental models for moiré photography.

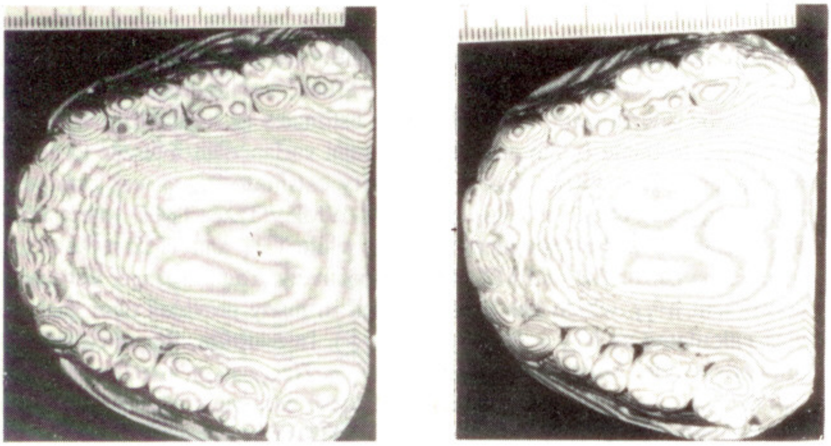
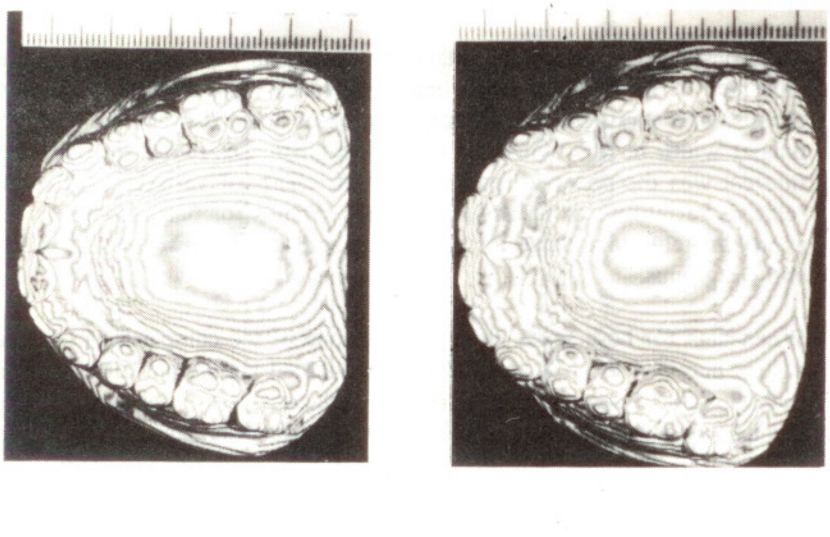


Fig. 3 Maxillary dental models of a pair of male MZ twins aged 26 years (above) and a pair of female DZ twins aged 13 years (below) showing moiré fringe patterns on the palate.



However, if there is evidence of significant heterogeneity of total variances between zygosities, a modified among-component ratio is used to provide an unbiased estimate of GVR[11].

Initially descriptive statistics were computed for palatal dimensions in the MZ and DZ twins providing mean values, variances and intraclass correlation coefficients. Three different estimates of heritability were then calculated to quantify the proportion of total variance attributable to genetic influences. The within-pair heritability estimate h^2_{WP} was computed following Kang et al.[17] as $h^2_{WP} = 4(WDZ-WMZ)/(TDZ+TMZ)$ where WDZ, WMZ refer to within-pair mean squares, while TDZ and TMZ refer to total mean squares for DZ and MZ twins respectively. The Holzinger heritability coefficient h^2_H, which has been reported in many previous twin analyses, was calculated as $h^2_H = (r_{MZ}-r_{DZ})/(1-r_{DZ})$. In addition, the so-called path analysis model heritability estimate $h^2_r = 2(r_{MZ}-r_{DZ})$, used recently by Lundström[18], was determined. Each of these estimates of heritability can theoretically range from zero to 1 (or 0-100%) reflecting the proportion of observed phenotypic variation due to genetic factors. Heritability estimates derived from twin studies are referred to as broad estimates because the genetic influences may include additive, dominance and epistatic effects.

Genetic analyses were initially performed on data for males and females separately. However, no systematic differences in variance estimates were noted between the sexes, and so data were pooled after adding correction factors, equal to the differences between male and female mean values for palatal dimensions, to the female data.

Results

Basic descriptive statistics of palatal dimensions in MZ and DZ groups are presented in Table 1. Values for males exceeded those for females in both groups, with statistically significant differences noted between the sexes for palatal width in MZ twins and palatal length in DZ twins. Of particular interest was the observed pattern of coefficients of variation, reflecting relative variability of palatal dimensions. Values for palatal height were approximately twice those for both width and length variables in both MZ and DZ groups.

When data for both sexes were pooled, none of the comparisons of mean values between the MZ and DZ groups yielded significant differences at $p<0.05$. Table 2 summarizes the results of the analysis of variance showing among-pair mean squares (AMS) and within-pair mean squares (WMS) for MZ and DZ twins, the F test for equality of total variance, and the F test to check whether environmental covariance was greater for MZ than DZ twins,

Table 1: Descriptive statistics for palatal dimensions in South Australian twins

Palatal Dimensions	MZ Twins						DZ Twins					
	Males (n=17)			Females (n-24)			Males (n=12)			Females (n=17)		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Width	35.2*	1.99	5.7	33.5	2.22	6.6	34.0	2.85	8.4	33.6	2.56	7.6
Length	27.0	1.72	6.4	25.9	1.84	7.1	27.3*	1.63	6.0	24.9	1.22	4.9
Height	13.8	1.82	13.2	13.7	1.68	12.3	14.7	1.78	12.1	13.4	1.85	13.8

CV = (SD/Mean) 100

*Mean value in males exceeds corresponding value in females at $p<0.01$

One twin from each pair was included in this analysis, so n refers to individuals

Table 2: Analysis of variance of palatal dimensions showing among-pair mean squares (AMS) and within-pair mean squares (WMS) for MZ and DZ twins, the test of equality of total variance (F) and the test to exclude CMZ>CDZ

Palatal Dimension	MZ		DZ		Total Variance equality F	$C_{MZ}>C_{DZ}$ F=ADZ/WDZ
	AMS	WMS	AMS	WMS		
Width	7.85	0.83	7.50	4.28	1.36	1.75
Length	5.52	0.42	4.36	0.91	1.13	4.78
Height	5.59	0.13	5.21	1.30	1.14	4.03

Table3: Intraclass correlations (r), estimates of genetic variance (GVR) and heritability estimates h^2 for palatal dimensions in South Australian twins

Palatal dimension	r_{MZ}	r_{DZ}	GVR	h^2_{WP}	h^2_H	h^2_r
Width	0.81	0.27	3.45*	0.67	0.74	1.07
Length	0.86	0.65	0.49*	0.18	0.59	0.41
Height	0.95	0.60	1.16*	0.38	0.88	0.70

$p<0.01$

GVR determined from within-pair variances

h^2_{WP} within-pair heritability estimate

h^2_H Holzinger heritability estimate

h^2_r intraclass heritability estimate

i.e. CMZ>CMZ. There was no evidence of significant differences in total variances between zygosities and the ADZ/WDZ ratios all appreciably exceeded unity. Therefore, the assumptions in relation to homogeneity of mean values, total variances and covariances between zygosities all held for the three palatal variables.

Intraclass correlation coefficients, genetic variance estimates and heritability estimates are presented in Table 3. For each of the three palatal variables there was evidence of significant genetic variance. Although the values of the different estimates of heritability for each dimension reflect their different bases of computation, there was a trend between dimensions for heritability estimates for palatal width and height to generally exceed those for palatal length. Of particular interest was the very high correlation between MZ twins for palatal height (r=0.95) and also the high correlations between DZ twins for length and height. Under a strictly polygenic mode of inheritance with additive genetic effects, we would expect maximum values of 1.00 for MZ twins and 0.50 for DZ twins. The fact that the value of the intraclass correlation for MZ twins was so high suggests that this dimension may be under strong genetic influence although it is impossible to rule out common environmental effects that may contribute to similarity in the MZ twins. The reason why the correlations between DZ twins were higher than theoretically expected under an assumption of additive polygenic inheritance may relate to sampling variation or may indeed reflect more complex genetic and/or environmental determinants.

Discussion

Palatal morphology has been studied previously in both normal individuals and also individuals with chromosomal abnormalities including autosomal aneuploidies[19] and sex chromosomal aneuploidies.[20,21] Studies in normal relatives confirm that genetic factors contribute significantly to variability in palatal form, although different dimensions are apparently not influenced to the same degree.[5] Local environmental factors, e.g. thumb-sucking, have also been shown to alter certain dimensions, e.g. palatal width, in monozygous twins.[22]

The present study indicated that heritability estimates for palatal width and height tended to exceed those for palatal length in South Australian twins. In this respect, our results support the earlier findings of Shapiro[5] who also noted a higher genetic contribution to variation in palatal height than length. Indeed Hunter[23], on the basis of a detailed cephalometric study of craniofacial morphology in twins, had suggested that genetic contributions to variability are generally greater for height dimensions than depth dimensions. However, caution is needed in comparing results of different studies as the palatal landmarks used often differ considerably.

Of further interest was our finding that relative variability in palatal height of South Australian twins, as indicated by the values of coefficients of variation, was greater than variability in either width or length measures. This result is even more intriguing when one considers the very high value of the correlation between MZ twins for palatal height (r=0.95). In other words, the palatal dimension that showed greatest phenotypic variability also showed the highest association within pairs of identical twins. Although it should be reiterated that human twin studies only provide "broad" estimates of heritability and that similarities between MZ twins may also reflect common environmental effects operating during development, it would seem that palatal height could well serve as another useful feature in forensic odontological investigations since traits displaying considerable variability and a significant genetic component are likely to be of most value for comparative purposes.

Apart from the potential forensic value of comparisons of palatal form in normal individuals, the significant variations in palatal morphology observed in individuals with certain genetic disorders may also be relevant in some forensic investigations. Patients with Down syndrome have often been described as having high-arched and narrow palatal vaults.[24] However, this clinical impression has not always been confirmed by metric studies. Shapiro et al.[19] noted a reduction in palatal width in Down syndrome together with a marked decrease in palatal length, but were unable to find evidence of markedly high palates.

Westerman et al.[25] recorded palatal dimensions in 40 patients with Down syndrome and found reductions in all three dimensions compared with normal individuals. Palatal length showed the most marked reduction in the Down syndrome group. It would seem, therefore, that palatal length in particular is reduced in the presence of an additional chromosome.[21]

Apart from the effect of autosomal aneuploidy on palatal morphology, it has been suggested that there is also a relationship between the number of X chromosomes and the shape of the palate, with the palate becoming progressively shallower with the addition of each X chromosome.[20] Laine et al.[21] have recently provided some support for this idea by finding that 45X (Turner syndrome) females had a significantly higher mean value for palatal height in the anterior part of the maxilla and reduced values for palatal width. However, these workers point out that it is a narrowed palate rather than a high palate that is the most frequent feature in 45X females. The fact that the high palate in 45X females is apparently restricted to the anterior part of the maxilla fits in with Shapiro's[5] contention that genetic influences on anterior palatal morphology appear to be greater than those for the posterior region.

There should be benefits in both clinical dentistry and forensic odontology from an improved understanding of how genetic and environmental factors contribute to variation in palatal morphology. From a clinical point of view, the treatment of patients with variations in normal dentofacial development (e.g. malocclusions) should be facilitated by a greater appreciation of the causes of the variability. In the forensic field, comparisons are often made between individuals within a single population as well as between different ethnic groups. While it has been shown that differences in palate form exist between different populations, e.g. relatively broad palates being characteristic of Mongoloid ethnic groups[26], the causes of these differences are not well understood.

The present study has confirmed that genetic factors are important in determining variation in palatal form, particularly for height and width. Along with other dental features, assessment of palatal dimensions should help to provide the discrimination necessary for identification in forensic investigations. Even greater utility is likely when techniques such as moiré contourography are also applied, enabling entire surface contours to be compared rather than individual measures which at best only provide crude representations of overall morphology.

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A GRAVE MATTER – DENTAL FINDINGS OF PEOPLE BURIED IN THE 19TH AND 20TH CENTURIES

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Abstract

The exhumed remains of 181 people, buried during the period 1848-1984 were examined. Because of the carelessness of exhumations, only 125 yielded sufficient information to compare the condition of skulls and jaws with the period in the grave, while 63 yielded information about the teeth. No correlation could be shown between the condition of the skulls and jaws and the period interred, but it was found that the better preserved remains belonged to younger people. Dental findings included the presence of healthy and decayed teeth, gold foil restorations, gold and porcelain inlays, amalgam and silicate fillings, and vulcanite and acrylic dentures. Amalgam restorations were present in people buried from 1875 (114 years ago) and vulcanite dentures from 1882 (107 years ago). The characteristics of the earliest amalgam restorations showed that they could have been placed before 1850. Findings of this study indicate that: (a) one cannot on the appearance of exhumed remains estimate the burial period, (b) dental features were well preserved and can be used for dental identification if ante-mortem data are available, (c) advanced dentistry could have been practised in South Africa during the last century, and (d) recovery of human skeletal remains from old cemeteries should be undertaken with care to preserve as much information as possible. A plea is made for closer co-operation between developers of old graveyard sites and scientists in order to preserve as much information as possible.

Key Words: Dental findings; historical exhumations; pink teeth.

Introduction

Dental characteristics have always been a source of important archeological information.[1] Exhumation of ancient, medieval and latter-day burial places have revealed dental findings which often reflect interesting aspects of the population. Such examples of exhumations are of ancient Egyptian skills[2], early Anglo-Saxons[3], medieval Britons[4], medieval Danes[5], 17th to early 19th century populations in Britain[6] and Barbados.[7] On the other hand, there is a dearth of dental information about people buried during the 19th and early 20th centuries. Such information could indicate dental status and the type of dental treatment, allow for evaluation of the dental materials used and help with identification.

The opportunity arose recently when human remains were exhumed from part of an old Dutch Reformed Church cemetery in Wynberg, Cape Town, South Africa, to make way for urban development. Wynberg is one of the oldest suburbs of Cape Town and its congregation was established in 1829, being now the fourth oldest in Cape Town.[8] The earliest inscription on a gravestone is dated 1811 and the latest 1984, but according to the archivist of the Church, the first burial took place in 1848 while the graves with earlier inscriptions were re-burials from elsewhere.

The examination of these remains should therefore have enabled us (a) to correlate the state of preservation of the skulls, jaws and teeth with the burial period, (b) to establish the nature of dental treatment available in Cape Town during the last and early 20th centuries, (c) to determine the dental status of the people interred and to note any gross dental or bone pathology and (d) to assess the state of the remains with regard to possible identification.

Materials and Methods

No register exists of the number of people buried in the cemetery in which there were identifiable and unidentifiable vaults and graves. From the 413 inscribed gravestones and vaults, some information such as the names, date of burial and ages of 479 people could be deciphered (Table 1). Two hundred and nineteen of these were exhumed. Exhumation was carried out by ordinary labourers under supervision of a lay overseer and no attempt was made to follow an archaeological recovery technique. The remains were placed in 30 x 30 x 60 cm wooden containers and where more than one person was buried in a single grave, the combined remains were placed in the same box or boxes. Of the 219 exhumed, the names of 206 (116 females and 90 males) and the ages of 176 (95 females and 81 males) were stated. The average age of the females was 61,42 years (SD 25,2; median 71,5 years) and for males 57,66 years (SD 22,14; median 68 years). The ages at burial varied from 6 months to 104 years for females and 6 months to 93 years for males.

The contents of the containers were scrutinized and those parts of the skeleton of importance to this study were cleaned with a brush under running water and examined with the naked eye or with a 3X magnifying glass. Care was

Table 1: The recorded number of burials and the time of the burials.

Time	*Number of burials*
1811 – 1842	2*
1848 – 1849	2
1850 – 1859	10
1860 – 1869	15
1870 – 1879	35
1880 – 1889	51
1890 – 1899	63
1900 – 1909	57
1910 – 1919	45
1920 – 1929	54
1930 – 1939	37
1940 – 1949	41
1950 – 1969	28
1970 – 1979	14
1980 – 1984	5
TOTAL	**479**

* Reburials

Table 2: The categories indicating the state of the skulls and jaws, the number of cases in each category and the average period of interment of the cases in each of the categories.

Skulls	*Intact*	*Missing*	*Fragmented*	*Without a maxilla*
N	23	31	48	23
Years buried	70,82 (SD 33,36)	74,19 (SD 25,55)	83,19 (SD 22,72)	63,04 (SD 29,34)

Brown-Forsythe analysis of variances P = 0,0416

Mandibles	*Intact*	*Missing*	*Fragmented*
N	42	48	35
Years buried	66,91 (SD 30,56)	75,71 (SD 25,39)	83,66 (SD 24,39))

Brown-Forsythe analysis of variances P = 0,0268

Maxillae	*Intact*	*Missing*	*Fragmented*
N	23	86	16
Years buried	70,83 (SD 33,36)	76,12 (SD 24,97)	74,81 (SD 32,87)

Brown-Forsythe analysis of variances P = 0,7810

Table 3: The categories indicating the state of the skulls and jaws, the number of cases in each category and the average age of the subjects at time of burial in each category.

Skulls	*Intact*	*Missing*	*Fragmented*	*Without a maxilla*
N	21	29	47	25
Age	52,81 (SD 24,81)	66,14 (SD 16,59)	67,43 (SD 15,57)	63,78 (SD 20,85)

Brown-Forsythe analysis of variances P = 0,0416

Mandibles	*Intact*	*Missing*	*Fragmented*
N	38	49	35
Years buried	59,55 (SD 22,80)	66,20 (SD 17,25)	65,24 (SD 17,46)

Brown-Forsythe analysis of variances P = 0.26

Maxillae	*Intact*	*Missing*	*Fragmented*
N	21	86	15
Years buried	52,81 (SD 24,81)	66,32 (SD 17,39)	65,20 (SD 16,43)

Brown-Forsythe analysis of variances P = 0,033

Table 4: Types of restorations, the number of cases with restorations where the period of interment is known.

Type of restoration	*Number of Cases*	*Period of interment (years)*
Silicate) Gold) Amalgam)	1	17
Amalgam	1	38
Amalgam	1	50
Amalgam	1	74
Porcelain	1	83
Gold Foil	1	94
Porcelain) Amalgam)	1	103
Amalgam	1	112
Amalgam	1	114
TOTAL	9	

taken to note obvious damage to or fragmentation of bones caused by the exhumation. Photographs were taken where necessary. Removal of the remnants to other venues for special investigations such as radiography was not allowed. The following variables were recorded where possible: (a) name, gender and age at death, (b) period buried, (c) state of the skulls and jaws, (d) presence of teeth and open tooth sockets, (e) type of dental treatment, (f) type of dentures, (g) dental and bone pathology and (h) whether the state of preservation of the skeletal remains from vaults and graves differed.

Following the above examination the genealogical records of those deceased during the nineteenth century were traced and a search undertaken for the names of dental surgeons who practised in Cape Town during that time.

Results

Data from multiple burials in single graves were excluded because it was not possible to separate the remains. For the rest we were able to establish the period of internment of 181 of the listed exhumed individuals from records. Most of this group were buried between 1880 and 1929 (Fig. 1) which coincided with burial dates of the entire cemetery population (Table 1). Of the 181 listed individuals the remains of 125 yielded sufficient information to compare findings regarding the skulls and/or jaws with the period in the grave. There was no significant difference between the 181 listed individuals and the 125 with sufficient information, when the age, gender and burial periods were compared.

The condition of these skeletal remains was classified as intact, missing or fragmented and in the case of skulls an extra category was included, the so-called "face-less" skull in which the maxilla was absent. Bones broken during exhumation were pieced together and classified as intact. Although there were significant differences between the period of interment and the state of the skulls and mandibles (not the maxillae), no specific pattern was apparent. For example intact structures were not necessarily underground for a shorter period than missing or fragmented structures (Table 2).

When the same parameters were matched with the recorded age of the individuals at time of death, the remains which included intact skulls and upper jaws were consistently and significantly younger than those which were absent or fragmented. Although not significant, the data about mandibles followed the same pattern (Table 3).

There were 63 remains with jaws and/or fragments of jaws with teeth and/or empty tooth sockets. A total of 369 teeth (5,9 per person, range 0-21, SD 5,7)

Fig. 1: A stem leaf analysis[19] of the number of people and the periods of interment. The first column (L to R) gives the period of interment in decades; the second group of figures is a breakdown of the periods of interment in each decade for each person and the last column represents the numbers of people buried during the specific decades.

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STEM LEAF                                    #

 16
 15 2                                        1
 14
 13 7                                        1
 12 566                                      3
 11 12224469                                 8
 10 00000111112223333334577889              26
  9 0001123456677788899                     19
  8 00012222333344455666778888999           29
  7 00011223334445556788889                 23
  6 0001123344555667889                     19
  5 000113345777899                         15
  4 4445566779                              10
  3 0022366778999                           13
  2 0333555668                              10
  1 457                                      3
    ----+----+----+----+----+----
 MULTIPLY STEM.LEAF BY 10**+01
```

Fig. 2: The darkly discoloured teeth similar to the so-called post-mortem pink teeth. Note the gold foil restorations in the left lateral and canine teeth.

Fig. 3: The class IV porcelain inlay from an individual buried 103 years ago and fixed in the cavity with cement.

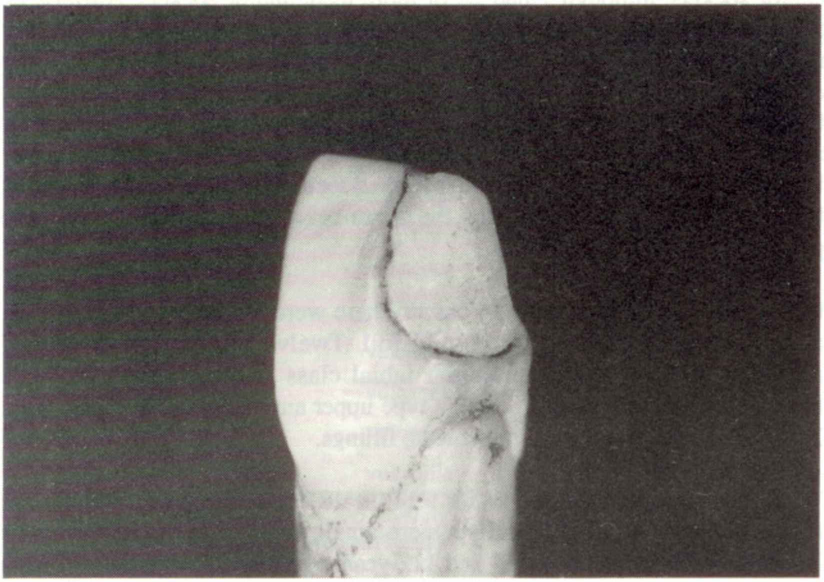
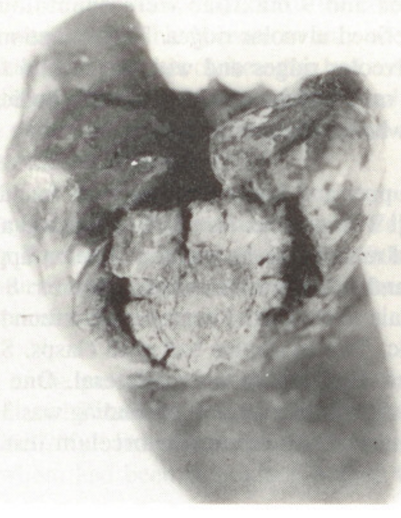


Fig. 4: An example of the earliest amalgam fillings encountered which consists of a mesial and a missing distal restoration in a right mandibular first molar. Note the poor fitting and the deterioration in the amalgam.



and 208 empty sockets (3,3 per person, range 0-27, SD 4,8) were counted. None of the cases where full upper and lower jaws existed had 32 teeth and/or sockets, although 7 had 20 or more teeth and/or sockets. Attrition of teeth was seen in 5 instances, evidence of dental decay (open cavities and root stumps) in 15 and bone destruction due to periodontal disease in 7. Bone destruction varied from minor interdental bone loss to gross bony pocket formation and extensive alveolar destruction. The burial dates of 30 of the 63 cases with dental features were known to date from 1863. One of these, buried 94 years ago, had darkly discoloured teeth (Fig. 2) which with special histological staining of one of the teeth revealed a haemoglobin-type pigment in the dentinal tubules.

Restorations were present in 18 cases. There were 4 with gold restorations, comprising inlays and class V gold foil. Twelve cases had a variety of amalgam fillings. Two mandibular labial class V porcelain inlays were found, one case including a class IV type upper anterior porcelain inlay (Fig. 3). There were 2 examples with silicate fillings.

The burial period was available for 9 of the 18 cases with dental restorations (Table 4). The oldest restorations were amalgam fillings from individuals interred in 1875 and 1877, 114 and 112 years ago respectively. These fillings were brittle, black, ill-fitting and without a cavity lining while the cavities lacked Black's principles of cavity preparation (Figs. 4 and 5). In contrast, an amalgam filling of remains buried 103 years ago was still shiny, hard and solid and the cavity was extended in accordance with present day principles (Fig. 6). The porcelain and gold inlays and the foil were still secure while the porcelain was well matched for colour and fixed with an unknown type of cement.

Forty-three mandibles and 9 maxillae were edentulous and all but 5 mandibles had well defined alveolar ridges. The exceptions had extremely thin bodies without alveolar ridges and with the mental foramina and the nerve channel situated on the alveolar surfaces of the bodies. No other bone pathology of the jaws was encountered.

Thirty-four matching upper and lower dentures were found: 24 vulcanite, 8 acrylic, 2 mixed and all with porcelain teeth. Two sets had a gold base in one of the dentures: a solid mandibular base and a skeleton upper base (Fig. 7). There were 7 upper and 5 lower unmatched dentures: 8 vulcanite and 4 acrylic, all with porcelain teeth. Partial dentures were found in 6 instances: 4 vulcanite and 2 acrylic. Two examples had gold clasps. Suction chambers featured in 6 dentures, 2 of which were bilateral. One denture had the remains of a suction ring. Another interesting finding was 3 sets of vulcanite dentures with sections of flesh coloured porcelain inserts in the labial surfaces (Fig. 8).

Table 5: Number of cases with dentures, the type of dentures and the period of interment.

Number of Cases	*Type of Denture*	*Period of interment (years)*
4	3 acrylic 1 vulcanite	20 – 29
5	3 acrylic 2 vulcanite	30 – 39
2	1 acrylic 1 vulcanite	40 – 49
4	vulcanite	50 – 59
4	vulcanite	60 – 69
4	vulcanite	70 – 79
6	vulcanite	80 – 89
2	vulcanite	90 – 99
2	vulcanite	100 – 107

TOTAL 33*

* All dentures contained porcelain teeth.

The origin of 33 of the 52 remains with denture work could be reliably matched to specific people and the periods in the grave (Table 5).

The oldest identifiable dentures, made of vulcanite, were from persons buried in 1882, 107 years ago. Acrylic dentures first appeared in persons buried in 1945 (Table 5).

A comparison between the condition of the remains from vaults and those from graves was not possible because in only one instance were the contents of a vault intact. The contents of the other had completely deteriorated or had been vandalised. The intact vault which dated from 1875 belonged to a family who exhibited remarkably good dental health. Two members had amalgam restorations (Fig. 4 and 5).

According to available information on old Cape families[9], those people buried in the Wynberg cemetery during the 19th century and at the turn of the 20th century must have been from established families residing in Cape Town and environs.

With regard to the practising dentists in Cape Town during the last century "The Medical and Pharmacy Register of the Colony of the Cape of Good Hope" (30/06/1900)[10] listed 32 licensed dental surgeons in Cape Town in 1900, 8 of whom had been in practice before 1878. The person with the

Fig. 5: Another example of an old amalgam filling where the cavity preparation is not according to Black's principles.

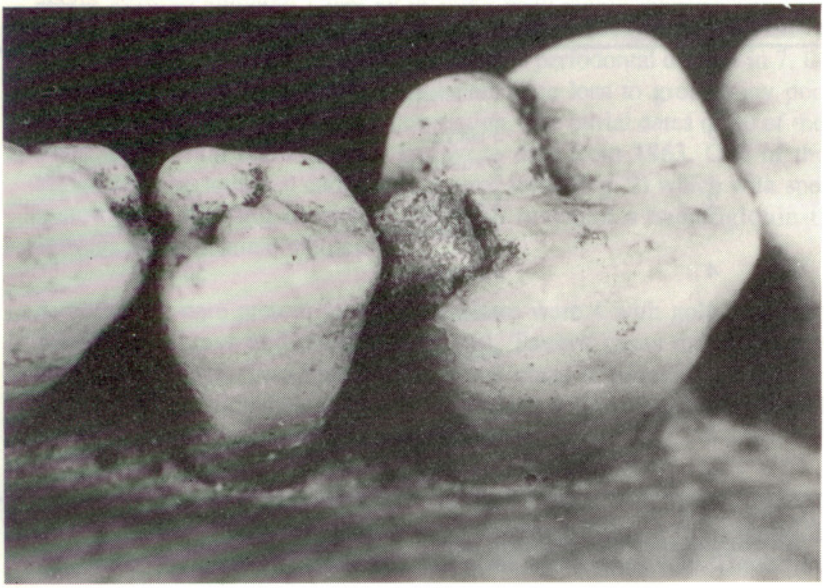


Fig. 6: An amalgam filling of an individual buried 103 years ago. The surface is shiny and the cavity is extended according to Black's principles.

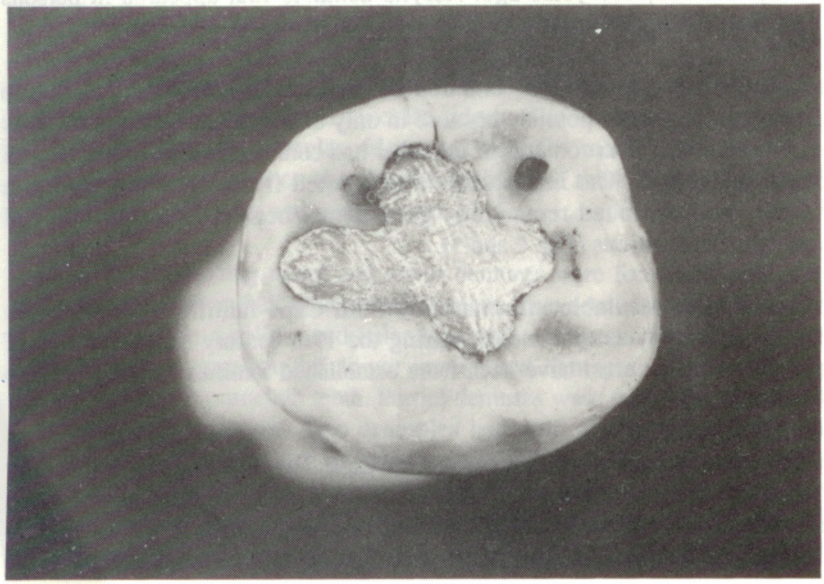


Fig. 7: The skeleton gold base of an upper vulcanite denture.

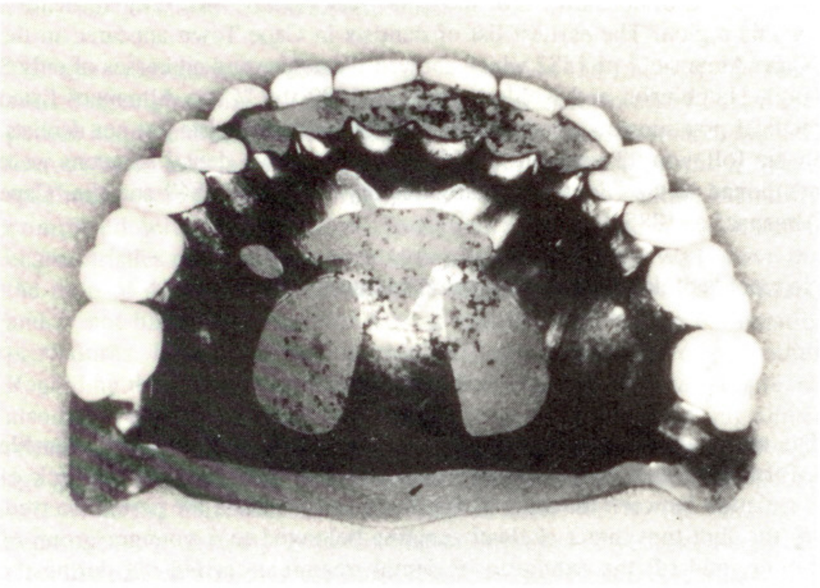
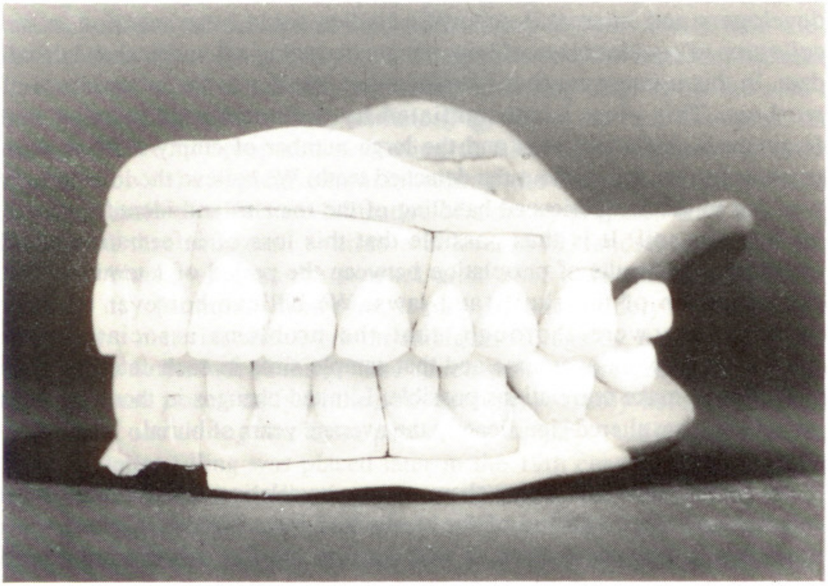


Fig. 8: The gum-coloured porcelain segments including teeth and set in a vulcanite denture. Note that the vulcanite consists of a dark base and posterior part and a lighter anterior segment.



earliest professional qualification was Frank Strickland who received the LDS RCS (Eng) in 1876. In contrast, "Juta's Directory of Cape Town, Suburbs and Simonstown"[11] of the same year (1900) listed only 18 dentists for this region. The earliest list of dentists in Cape Town appeared in the "Cape Almanac"[12] of 1882 which showed the names and addresses of only 3 (Bell, Hutchinson and Kohler). Prior to 1882 the "Cape Almanac" listed medical practitioners, apothecaries, chemists and druggists but not dentists. In the following 3 years (1882-1885) 9 Cape Town dental surgeons were mentioned in the "South African Directory" of 1883-1884[13] and the "Cape Almanac" of 1885.[12]

No records of dental treatments could be traced.

Discussion

The most significant findings of this study were: (a) the loss of valuable information due to the unskilled removal of remains, (b) the lack of correlation between the state of the skulls and jaws and the period interred, (c) the fact that intact skeletal remains belonged to a younger group of people, and (d) the examples of dental treatment carried out during the previous century.

It is realised that the development of a valuable piece of land cannot be delayed unnecessarily for scientific purposes which are not of exceptional archaeological value. On the other hand, reasonable co-operation between developers and interested scientific bodies could have resulted in the collection of a wider range of important anthropological, medical and dental data. In this instance much information was lost due to the inexperience of workers. This view is substantiated by the number of missing and fragmented skulls and jaws and the large number of empty tooth sockets presented to us, but without the detached teeth. We believe the loss of teeth was due to the inexperienced handling of the remains and identification of teeth in the soil. It is thus possible that this loss of information could invalidate the results of correlation between the period of internment and the condition of the skulls and jaws. We believe however that our observations were thorough, that the problems associated with fragmentation were overcome and that sample sizes in each category were sufficient to make correlations possible. Limited changes in these numbers would not have altered significantly the average years of burial.

If the finding is accepted that there was no correlation between the period interred and the condition of the skulls and jaws (Table 2), it becomes important to forensic science. It will confirm the fact that it is unwise to base the burial period of a skeleton on its appearance and condition. Many factors can influence its condition, such as the pH, the type (i.e. clay or sand) and the moisture content of the soil.

The same reasoning can also be used to question the findings that bones with denser structure withstand underground deterioration better than porous bones and that the average age of people whose remains included intact skulls and jaws, were consistently younger than those where specimens were missing of fragmented. We found 42 intact mandibles compared with 23 maxillae, indicating to us the more durable characteristics of the denser bone structure of mandibles. We believe that the ratio of 42 intact mandibles to 23 intact maxillae is a valid finding and is not biased by a greater loss of maxillae due to the exhumation procedures. Loss from exhumation will not favour one or the other. Regarding the finding that intact remains belonged to younger people, we also believe that our findings are correct. Loss of missing and fragmented remains cannot occur selectively and therefore a bias towards younger age groups cannot occur. It is proposed that the bones of younger people will withstand deterioration better. This is borne out by the practice in departments of anatomy to collect skeletal remains of younger people for teaching purposes as they are more resistant to wear and tear, rather than skeletons of older people which are fragile.[14] The fragility of the bones of older people can in part be due to osteoporosis. This may also be the cause to some extent for some of the missing skulls and jaws.

Of special interest to the dental profession are the types and the characteristics of the dental treatment found in individuals who died before the turn of the century. The amalgam work, for instance, includes restorations which are black, brittle and ill-fitting (Fig. 4, 5), but also a solid restoration with a shiny surface (Fig. 6). In the first examples, the cavities were not prepared according to Black's principles, while the latter shows the typical extension along the fissures. It also shows rounded outlines which are indicative of a cavity prepared with a burr. It is known that amalgam, available before 1850, tended to shrink and become black, whereas the product after 1855 was comparable to the present day formula.[15] However, it only became widely accepted as a restorative material after work on amalgam fillings by Black and Witzel in the late nineteenth century.[15] The conclusion is therefore that the brittle fillings were placed early in the 19th century, probably before 1850, and the better one during the latter part of the century. Additional evidence that the latter filling was placed later in the 19th century is the rounded outline of the cavity indicating the use of burrs. The foot-driven dental engine with handpieces which could achieve 2,000 rpm, came on the market in 1872.[15]

As the "good" filling must have been placed at a time when amalgam was still a relatively new material and the principles of cavity preparation by Black not yet published,[16] it does reveal the existence of very progressive dentistry. This is supported further in the same person by the presence of a class IV porcelain inlay inserted with cement (Fig. 3). Although porcelain inlays were used earlier in the nineteenth century, their insertion in cavities with zinc cement started only in the latter half of that century.[15]

The presence of gold foil restorations before the turn of the century is not unusual as it was the standard filling material even before amalgam. Its demise only occurred after 1907 with the invention by Taggart of cast gold inlays.[15] If it could have been proved that the above people were treated in South Africa in that period, it would have indicated that advanced dentistry did exist in this country at that time. The possibility that such treatment was performed elsewhere in the world where it was available cannot be excluded as there is no record of the travels undertaken. We did, however, determine that the persons with the above mentioned dental work were members of established Cape Town families and not immigrants.

The denture work found here also indicates an early high standard of dentistry. Charles Goodyear invented vulcanite in 1850 and the Goodyear Dental Vulcanite Company was founded in 1864 after which the material and its use became available under license, although American dentists were only allowed to use vulcanite freely after 1881.[17] As vulcanite dentures were found in remains buried in 1882, it seems likely that they could have been constructed earlier and under license. It is worthwhile speculating on how soon vulcanite was available in this country after the establishment of the Goodyear Dental Vulcanite Company and whether these early examples were constructed in South Africa or elsewhere.

A special feature of some of the dentures was the coloured porcelain gingival inlays with fused porcelain teeth. These so-called "continuous gums" patented by a dentist, named Allen, were an attempt to render the very unaesthetic vulcanite anterior denture gum more pleasing. They were certainly successful but required great skill and patience to fit them.

The excellent state of preservation of some of the dental work observed in these exhumations shows that it could be used for identification purposes provided some ante-mortem data were available.

The small number of people with natural and restored teeth, the state of the natural teeth, the signs of periodontal disease and the number of edentulous people indicate a general disinterest in preserving the teeth in this community.

The case with darkly stained teeth caused by a haemoglobin-like pigment in the dentinal tubules is similar to the so-called post-mortem pink teeth described and investigated by van Wyk[18] and others. What is unusual about this case is that death was caused by "apoplexia brought on by meningitis", according to the death certificate. This contrasts with the consensus of opinion which favours violent or unnatural death followed by the head of the person being in a dependent position, as the root cause of the tooth discolouration. Haemoglobin pigment escapes from the engorged pulps and diffuses into the dentinal tubules where it can remain for as long as, in this case 94 years.

The lack of personal and ante-mortem dental information about the people exhumed from this cemetery make it impossible to link the type of treatment with the training of the dentists or the country in which they were trained. What is clear is that there were several qualified and licensed dentists at that time who could have undertaken the dental work recorded here.

Conclusion

The findings of this study show that the state of exhumed skeletal remains is not a good indicator of the period of interment and that when such remains are to be studied for forensic purposes great care should be taken with their recovery from graves. This study also points to the importance of co-operation between scientists and developers of old graveyard sites. The opportunity to exhume historic material on such a scale is a rare occurrence. The value to science is exceptional and a special effort should be made to preserve as much information as possible when such developments take place.

Acknowledgements

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ACCURACY IN ESTABLISHING IDENTITY BY MEANS OF INTRAORAL RADIOGRAPHS

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Abstract

The aim of this study was to evaluate the accuracy in establishing identity of individuals by means of different dental characteristics observed in "ante- and postmortem" bitewing radiographs. Three categories of individuals, based on dental therapy conditions, were considered: Group A) no therapy, Group B) simple therapy, and Group C) complicated therapy. Seven examiners were asked to combine "ante- and postmortem" radiographs and all reports were made on standard forms.

The results show that all observers were able to determine identity for the cases in the **simple therapy group**. In contrast, three observers presented incorrect answers on two cases each in the **nontherapy group**. Further, two observers were unable correctly to determine identity for four cases in the **complicated therapy group**. Among a total of seven observers only two observers made no mistakes in any of the groups.

Key Words: forensic odontology, identification, intraoral radiographs

Introduction

Dental radiography is an important tool in forensic odontology because it provides an accurate, permanent and detailed record of the hard tissues.[1,2] Radiographs can also be used for comparative purposes even when tissues are removed e.g. for histopathological examination.[3] Another advantage of radiographs is that they are acceptable as documentation in court.[4]

The use of radiographic images has been considered superior to the direct inspection method because otherwise hidden characteristics of fillings as well as anatomy can be assessed.[5] In addition, the information is presented in such a way that it enables several observers to evaluate the status at different times without having access to the specimen. Notes on paper about dental characteristics are not as reliable as radiographs because they do not provide such a complete and objective a description as radiographic images and do not permit a thorough analysis of multiple structures.

Keiser-Nielsen[6,7] stated that the dental identification of a person may be arrived at through noting a combination of individual dental features. However, a certain combination of features in an unknown body may exist in more than one missing person but, as for the fingerprint method, the risk of misjudgment is reduced if a minimum of concordant features are used and especially if a differentiation is made between ordinary and extraordinary features.

Forensic work is usually performed by only one person and it is essential that radiographs, which help to identify extraordinary features more easily, are used as well as chart notes. In other areas of dentistry, great variations have been demonstrated among observers using radiographs for different purposes.[8,9] The question is whether similar variations exist with respect to the determination of identity by means of teeth and dental restorations registered on bitewing films, the most commonly used radiograph in dentistry and, therefore, also in forensic work.

The aim of this study was to evaluate the accuracy in establishing identity based on the comparison of different types of dental characteristics as observed in bitewing radiographs.

Radiographs

The radiographs used in this study were bitewings from full mouth surveys (FMX) taken of patients referred to the Department of Oral Radiology, University of Göteborg, Sweden. Two sets of FMX, obtained at different times (2–10 yr intervals) were available for each patient. One bitewing radiograph from the first set of FMX was considered an antemortem radiograph while one from the second set was considered a postmortem radiograph. Each radiograph was coded and mounted in a plastic frame.

Three categories, each comprising 20 individuals exhibiting various dental conditions, were considered. In group A no dental restorations were present. In Group B only simple restorations had been performed, that is, occlusal and approximal while in Group C, more extensive restorations had been performed, e.g. bridgework, crowns, root canal therapy etc.

For each group, seven examiners were asked to pair the "ante and postmortem" radiographs.

Examiners

The observers were briefed before hand and informed about the nature of the study but they formed their own criteria for determination of identity. All examiners had extensive clinical experience and comprised six radiologists in the Department of Oral Radiology and one forensic odontologist. The observers worked independently and were allowed to use as much time and resting periods as they found necessary. The images were displayed on a light table and observations were made with the assistance of a viewing device and reported on standardised forms.

Results

In the **simple restorations group B** all observers were able correctly to establish identity for all cases. In the **nonrestorations group A** three observers presented incorrect answers on two cases each. Two of the observers made misjudgments on the same cases. In the **extensive restorations group C** two observers were unable to correctly determine identity for four cases and both observers made the same mistakes. Among a total of 7 observers only two observers made no mistake in any of the groups.

Discussion

Although the comparison of dental radiographs has been considered a highly reliable method for identification purposes, difficulties in the identification process may occur under certain circumstances. In a study by Kullman *et al*[10] concerning identification by comparing the frontal sinuses the only misjudgment was made by an experienced observer. In our study most mistakes were similarly made by the most experienced examiner.

Difficulties were encountered when none of the subjects had had any restorative treatment and there were no characteristics in restorations to be compared. The interpretation of the group A cases is similar to that which arises when discrete anatomical structures, seen on radiographs of the general skeleton, are compared. Several bones and bony structures seen on radiographs were studied by Mulligan *et al.*[11] They stated that scleroses, trabecular patterns, cortical irregularities, traumatic deformities on ante- and postmortem radiographs can provide convincing proof of a victim's identity.

In the cases group A however, and in which misjudgments were made, a more careful comparison of structures such as pulp and root anatomy, spacing between teeth and bone marrow cavities might have reduced the number of errors.

All observers were able correctly to identify the cases with simple restorations. This may be significant because many identification cases involve young persons with few restorations. Gustafson[12] stated that the same number and type of restorations can be found in young individuals. They often have the same number of teeth and it is therefore important to obtain several radiographic projections to be able to identify subtle and hidden characteristics of the restorations. For example, a buccal amalgam restoration can be projected toward the occlusal surface and therefore difficult to distinguish from an occlusal restoration.

Dental caries has declined in recent years and with it the number of fillings. Moreover, composite and glass ionomer dental materials are being more frequently used. This may have led to increased difficulties in comparing characteristics of the restorations because some of these materials have a radiographic density similar to enamel and dentin.[13] Additional difficulties may arise when amalgam restorations are replaced with composite materials.

Several other explanations for the difficulties in arriving at correct identification in some of the cases in this study may be suggested. For example, some bitewing films had been orientated in slightly different ways in the two examinations. In some of the cases we had to compare vertically with horizontally placed films or films differently angulated relative to the teeth or the radiation beam. In practical forensic work this will not be a problem because care can be taken to obtain postmortem radiographs with similar projections to those of the antemortem radiographs.

In groups with more extensive therapy the probability of changes between ante- and postmortem radiographs may be high because of the occurrence of new restorations, extractions of teeth and replacing of amalgam restorations with crowns etc. Indeed, in the two of the incorrectly interpreted complicated cases, extractions had been performed and an upper third molar had erupted. In one case separation of the roots of a lower molar had taken place and in one case a restoration had been fractured and another had been lost.

In the study by Kullman *et al*[10] on observer variation in the evaluation of the frontal sinus in posterior-anterior radiographs in 100 persons, it was found that only one observer out of three missed one case. Compared to the teeth and their restorations and the surrounding bone, which are rather complex, the frontal sinus is much more simple. Furthermore, the size, borders and internal septa of the sinuses make them completely unique in different individuals. When ante- and postmortem radiographs of this structure are available, correct identification is, therefore, almost assured. However, compared to dental radiographs, radiographs of the frontal sinuses are much rarer and in addition, in severe accidents, the frontal bone may have been destroyed.

It is not possible precisely to state the number of similarities between ante- and postmortem radiographs that are necessary to establish identity.[14] The dental identification process can be compared to identification using fingerprints but the number of concordant points necessary for establishment of a positive identity is not stated for that procedure either.

The practice in Sweden is to use 12 concordant characteristics.[15] This number varies between countries and in France, for example, 17 characteristic features are needed, whereas in Switzerland 12 are considered sufficient. Depending on the type of dental characteristics (ordinary or extraordinary) found on the deceased, the number of concordant points to establish a positive identity can vary. On the other hand, if an unusual feature is found, this might be sufficient. In this study we have a well-defined reference group where the antemortem radiographs have a corresponding match in the postmortem follow-up radiographs. Even though each restoration is unique, therapy performed between the ante- and postmortem radiographs can change the characteristics of restorations. This may have been one reason for the poorer results obtained in the complicated therapy group.

It would be interesting further to evaluate the performances of different specialists as the observers in this study were mainly radiologists. This study indicates the need for further development of the method to use dental radiographs for identification purposes and is of special importance with respect to cases without dental restorations. Among those, edentulous individuals may present special problems.

Dental structures and, in the latter case, bone structures only, may provide characteristics comparable to the morphological details used in fingerprint identifications where computerized graphic systems are now increasingly being used. This study emphasizes the importance of having several well trained forensic specialists working together in mass disaster situations.

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FORENSIC ODONTO-STOMATOLOGY IN THE NEW GERMANY

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The German forensic odonto-stomatology working group was founded on October 29, 1976, at the 102nd Annual Meeting of the German Association of Odontologists at Stuttgart. and on November 19, 1977 held its first working session at Gieben. As a result of the discussions between dentists and lawyers held at that time, ten groups were set up, namely:

1. Judgement - civil and criminal
2. Problems of nomenclature
3. Categorising of the characteristics of identity
4. Techniques for the evaluation of forensic odontological findings
5. Sex and age estimation
6. The expansion of the methods of identification of dental treatments
7. The effects of chemical and physical agents on the masticatory apparatus
8. Bite marks and the safeguarding of trace evidence
9. Classification of findings
10. Conclusions on the quality and materials used in dental treatments (HAHN 1978)

During the meeting of the German Association of Odontologists at Mannheim in 1980 various forensic odontological topics were classified as principal themes of the congress.

Because of the fact that the German Association for Legal Medicine is a vital part of the working group, it was decided to rename it "Gemeinsamer Arbeitskreis fur Forensische Odonto-Stomatologie der DGZMK und der Deutschen Gesellschaft fur Rechtsmedizin". Since 1983 Professor Hahn from Kiel has been chairman of the association in recognition of his untiring promotion of forensic odontology.

Our last symposium which took place in Mainz on October 13, 1990, had on its programme the following issues:

1. Cooperation with the police and forensic pathology in cases of identification of unknown bodies

2. The experience of identification by teeth including computer and the quadrant method performed by Wallmeier, German FBI

3. The duty of dentists to keep proper records

At this event, colleagues from the former German Democratic Republic (Berlin, Leipzig and Erfurt) participated for the first time after the "quiet revolution" of November 1989. We are therefore hopeful that the number of forensic odonto-stomatologists will increase in future and will become a considerable force in a united Germany.

We have just got the cooperation between the police and forensic pathology underway, establishing permanent contacts between these experts, largely as a result of criticism from Norway that it was difficult to cooperate with German experts in cases of identification.

Since we, the German working group, have become full members of IOFOS this year, we aim to establish as many contacts with fellow forensic odontologists as possible. We would particularly like to promote

1. International communication in disaster victim identification,

2. Cultural factors in forensic odontology and

3. Coordination of data resources and research in forensic odontology.

These topics are in fact embodied in the programme of the IAFS/IOFOS congress and we strive together with our colleagues towards a "Professional Profession".

Cooperation between forensic pathology and the criminal investigation authorities:

At present the identification committee of the state run German FBI in Wiesbaden has five experienced odontologists at its disposal at home and abroad.

In addition to the work of this identification committee we have recommended that systematic cooperation be encouraged between the different Institutes of Forensic Pathology and the state services of forensic medicine of the Federal Republic of Germany on the one hand and the local dentists on the other hand, particularly in the field of identification of living and deceased persons. At present there are 24 institutes and 29 services in the 11 states of the Federal Republic of Germany and 9 institutes and 7 services in the 5 states of the former German Democratic Republic.

Each institute and each service should, in case of need, have two experienced dentists available for consultation and to advise in keeping proper records as required for identification. They would facilitate considerably the work of the public prosecutor and the police. In the case of international identification the English language Interpol forms and recommendations for record keeping should be used. We feel strongly about this cooperation because presently there is a discrepancy between the number of identifications and the available workforce of odontologists and forensic pathologists.

The Committee of Forensic Odonto-Stomatologists should be given the names and addresses of the dentists who are working for the services and they can then quickly arrange contacts in order to investigate a particular case. In this way, the colleague abroad, who is working for an identification committee, will not be forced to investigate in a foreign country and in a foreign language.

In May 1990, the heads of the institutes of forensic pathology were informed of these issues at a meeting in Frankfurt. Such interdisciplinary work by odonto-stomatologists with forensic pathologists has existed in Scandinavia since 1966 where over 200 dentists have been trained in forensic odontology. They have received certification and are available at any time.

In 1976 an identification committee was formed in the German Democratic Republic at the Institute of Forensic Pathology and Criminology in the University of Leipzig. This committee is mainly concerned with scientific work in identification which is reported annually. At this institute young scientists (forensic pathologists as well as odontologists) have the opportunity to train, research and lecture on identification problems. They are supervised by forensic pathologists, odontologists, criminalists, anatomists and anthropologists who take part in this training programme. Identical groups exist in all 16 Forensic Institutes in the German Democratic Republic. The course for students of odontology covers 10 periods of general forensic pathology, 2 periods of which are set aside for forensic odonto-stomatology.

On October 3, 1990 the Basic Law (Constitution) of the Federal Republic of Germany came into effect in the five states of the former German Democratic Republic and East-Berlin. This had the effect that the General

Attorney of the Federal Republic of Germany became, in cooperation with the identification committee, public prosecutor for the whole of Germany. The General Attorney of the German Democratic Republic will be abolished or his services be used elsewhere. The functions of the Central Office of Investigation of the German Democratic Republic in East-Berlin will be taken over by State Bureaux of Investigation.

Chapter 5 of the Treaty of Unity, which covers the accession of the German Democratic Republic to the Basic Law of the Federal Republic of Germany, deals with civil administration and jurisdiction. It determines that a new administrative organization has to be built in the new part of Germany which is supposed to be equivalent to that of the Federal Republic of Germany.

The identification committee of the German FBI is well prepared for this situation and is having talks on this newly developing cooperation between forensic medicine, odontology and public prosecutors in all the federal states as well as in the five new states of the former German Democratic Republic. Article 8 of the Treaty of Union does not even mention the name of the German Democratic Republic anymore.

THE INTERNATIONAL ASSOCIATION OF FORENSIC SCIENCES 12TH TRIENNIAL SCIENTIFIC MEETING AND THE TRIENNIAL GENERAL ASSEMBLY OF THE INTERNATIONAL ORGANISATION OF FORENSIC ODONTO-STOMATOLOGY, ADELAIDE, 24-29 OCTOBER, 1990.

A. The Scientific Meeting

Attended by 958 registrants, from 41 countries, who presented 677 papers, I.A.F.S. - 90 Adelaide marked a departure from the usual conference style in a number of ways. It was the first time that this meeting had been convened in the southern hemisphere. The format of the scientific program was carefully structured to cover all the specialities of forensic science and yet avoid simultaneous presentations in overlapping fields. This was achieved by scheduling four consecutive plenary sessions on the afternoon of the first day, utilising thematic symposia at the sectional level, and employing posters as the preferred vehicle for free communications. The posters were presented as chaired non-competitive sessions in the exhibition hall simultaneously with the trade exhibition. The poster is an appropriate format for reporting scientific data and updating methodology and affords a significant advantage for those whose first language is not English. Another factor that contributed to the outstanding success of the conference was the carefully chosen venue - the new Adelaide Convention Centre complex located in North Terrace immediately adjacent to a variety of fine hotels offering a full range of accommodation and only metres from the city centre and the lush park environs of the Torrens Lake and the Festival Centre.

The four plenary lecturers addressed such contemporary issues confronting forensic science as education, training and assessment (Tilstone, Australia), progress through international cooperation (Knight, UK), what the law expects of forensic science (Starrs, USA) and ethics of forensic science (Murdock, U SA) .

The odontology section encompassed the Cranio-Facial Identification Group and forensic anthropology as well. A particular feature of the program was the development of the section theme Professional Excellence through International Cooperation and Communication by means of a series of symposia which focussed upon a number of aspects of DVI management. The legal implications of mass disaster investigation were discussed by

Vermylen (Belgium), and the Scandinavian model of utilization of visiting DVI experts was explained by Jacobsen (Denmark). Goers (Australia) described his own experience as the next of kin of air crash victims and emphasised the importance of providing the relatives of victims with sympathetic support and understanding and the need for DVI to be under the control of independent state authorities rather than involved parties such as the airlines concerned. McFarlane (Australia) dealt with problems associated with the management of stress among the secondary victims. These issues were illustrated by accounts of specific disasters presented by Clark (UK), by Lorentsen and Stene-Johanson (Norway), Duflou (Australia) and Ligthelm and van Niekerk (South Africa). The repatriation of American war dead from Laos was described by Schneider (USA).

A related symposium dealt with computer programs devised for processing DVI data. Actual demonstrations of a number of these programs were given by Tenhunen (Finland), Hagen, Endris and Wallmeier (Germany), Brown, Elliot and Hashimoto (Australia and Japan), Arneman, Wilkins and Griffiths (Australia) and Tsutsumi, Ueno and Takei (Japan). Hashimoto, Misu and Suzuki (Japan) described a computer program for determining the discrimination potential for certain dental treatment configurations in a Japanese population. A novel approach to the problem of the influence of social cultures on the practice of forensic odontology took the form of a panel discussion by international representatives Thomas (South Africa), Chao (Singapore), Yusof (Malaysia), Rabbi Morris (Australia), Solheim (Norway) and Hashimoto (Japan). The discussion was moderated by Mr. Keith Conlon, a well known television personality and explored cultural mores associated with death, autopsy, identification procedures, organ donation and burial. The contrasting cultural attitudes revealed by this sparkling debate served to stimulate serious consideration of the issues that must be addressed in the management of any disaster involving international victims.*

CRANIO-FACIAL IDENTIFICATION: A number of systems for cranio-facial identification were described. Computer assisted superimposition of a digitised image was discussed by Helmer and Zaborsky (Germany), Lan, To and Wang (China), and Fushimo (Japan). A combined video and photographic superimposition apparatus was described by Seta, Kimijima, Myasaka, Yoshimo, Sato and Miyake (Japan). Facial tissue thickness was studied by O'Grady and R. Taylor (Australia) and cases of facial reconstruction were reported by R. Taylor, O'Grady and Clement (Australia). The significance of photographic perspective in cranio-facial superimposition was discussed by Furue, Hashimoto, J. Taylor, Suzuki and Brown, (Japan and Australia). A manual device for positioning the skull was described by Wilkins, Griffiths and Middleton (Australia) and a computerdriven apparatus for mounting and manipulating the skull was developed by J. Taylor and Brown (Australia).

AGE ESTIMATION: The reliability of the application of the I.B.A.S. System to age calculation was shown by Lopez-Nicholas, Gomez, Zapata and Lumar (Spain) to be limited by the considerable individual variability of teeth in the same individual. A simplified method utilizing only height of gingival recession and translucency was shown by Lamendin, Humbert, Tarenia, Baccino, Brunel and Nossintchouk (France) to be independent of sex, type of tooth and its location in the mouth, and does not require destruction of the tooth. Solheim (Norway) found that the correlation between secondary dentine and age varied between different types of teeth and the scoring system adopted. The correlation increased by utilizing several methods for measuring secondary dentine.

Cementum annulation counts carried out by Romaniuk and McGrory (Australia) using incident interference microscopy provided an accurate means of estimation of age at death for a caucasion population.

DENTURE MARKING: Thomas (Australia) reviewed the perennial issue of denture marking and stressed the urgent need for a concerted nationwide effort to achieve a consistent and uniform implementation of this measure.

BITEMARKS: The intercanine distance was found by Aboshi, Takei and Onotsuka (Japan) to be the most significant dimension for identification of a bitemark. Nambiar and Brown (Australia) reported four cases of non-human bitemarks in such items as scuba diving equipment (white pointer shark), reflex fire extinguisher hoses (opossum), electrical cables (water rat) and telephone cables (kangaroo?). Jakob (Switzerland) presented a technique for reproducing jaw movements using a Gerber condylator, permitting impressions in different jaw positions to show the pattern of damage produced in a bitemark.

A relatively new technique of reflective long-wave ultra violet photography was used by Nambiar, Neville, Emerson and J. Taylor (Australia) to enable visualisation of a bitemark injury even after six months. Identification of teeth producing the mark was achieved by using a computerised "shape match" program. The same program was used to determine the optimum camera angle (between 90° and 75°) for the photographing of bitemarks.

BIOLOGY: Nakajima, Ide and Kitsuka (Japan) found significant variations in the thickness of cortical bone and the arrangement and distribution of trabeculae in the mandible and maxilla. A study by Olsson, Holden, Palamara, Phakey and Clement (Australia) of heat treated human bone and teeth using x-ray diffraction, light microscopy and scanning electron microscopy showed correlation between temperature change and variations in colour structure and phase between 200°C and 1600°C.

RADIOGRAPHY: The application of radiovisiography for forensic and clinical purposes was demonstrated by Rötzscher and Green (Germany and Australia). Du Saucey, Brown, Eitzen (Morocco and Australia) minimised difficulties associated with the placement and retention of intra-oral films for post mortem dental radiography by the use of an inflatable balloon catheter to support the film in the mouth. Brown, Pardell, Pfeiffer and Eitzen (Australia) modified a heavy duty camera tripod to allow the attachment of a standard dental x-ray tube for use as a portable unit for either mortuary or field work. Problems associated with the rapid transmission of clear meaningful intra-oral radiographs urgently needed for DVI was resolved by Brown and Taylor (Australia) by using the Canon Colour Laser Copier (Canon Australia Pty. Ltd., South Road, Thebarton, South Australia) to produce an enlarged (A4 size) copy which can then be transmitted legibly by facsimile.

CASE REPORTS: McCullock, Bertelsen, Keur and Owen (Australia) reported a number of cases illustrating identification of burn victims by dental comparison, three dimensional facial reconstruction, and the interpretation of ante-mortem and post-mortem cranial and dental radiographs. A case of the misidentification as ivory of knife handles seized by Customs was investigated by Wilson, Brown and Nambiar (Australia). Several tests were described confirming that the handles were a plastic imitation of ivory.

ANTHROPOLOGY: The interpretation of skeletal remains from a mass grave in the northern Ukraine was discussed by Oettle (Australia) with special reference to cause of death, weaponry used, sexing, ageing and estimation of numbers of the victims.

Newman (Canada) successfully used cross-over electrophoresis to analyse blood residues from archaeological stone tools dated from ca. 11,200 B.P. to ca. 1000 B.P.

A progress report by Wood and Hodgson (Australia) on human skeletal remains recovered from the wreck of the HMS Pandora, lost with 35 lives in 1791 on the Great Barrier Reef, described evidence of attacks by marine life and green staining due to longtime contact with copper alloy. Eventual identification of the remains by reference to Royal Naval records in London is anticipated. D. Framery, Baccino, M.F. Framery and Telmon (France) compared the os pubis method of Suchey-Brooks for age determination with the phase analysis of the sternal extremity of the fourth rib proposed by Iscan.

The blackish staining present on human teeth recovered from an archeological site in southern Norway was examined by Beyer-Olsen and Risnes (Norway). The distribution and extent of the staining was independent of sex and age and the nature of the staining is currently under investigation.

Rötzscher reported on the activities of the Forensic Odontology Working Group in the Federal Republic of Germany during the past 12 years. Clement, O'Grady and Bertelsen (Australia) described recent developments in the provision of services, education and research in Victoria, Australia.

* **FOOTNOTE:** Video tapes of this symposium are available in VHS, (Pal and Secam) at a cost of A$45 by air mail. Payment in Australian $ with order to: Editorial Office, Forensic Odontology Unit, University of Adelaide, GPO Box 498, Adelaide, South Australia, 5001.

B. The General Assembly

This was held at 3:00 p.m. on 28th October 1990 with an attendance of 23 persons. Dr. K.A. Brown (President) occupied the chair and Dr. A. Lake (Secretary) recorded the minutes. Official representatives of 12 member societies responded to the roll call and 4 new societies (India, Korea, Spain and Germany) were formally inducted into membership. The treasurer, Dr. Lake, reported a healthy state of the organisation's funds, due to the low secretarial and maintenance costs and to the high rate of interest paid by Australian banks on cash investments. Society reports were presented by the representatives of South Africa, Great Britain, Finland, Norway, Sweden, New Zealand, U.S.A., Canada, Belgium, Germany, Spain and Japan.

Journal of Forensic Odonto-Stomatology - The present board and structure will be maintained and the journal will be printed in Australia where competitive production costs have been obtained. Special bulk rates will be available by arrangement with member societies. Because of variations in exchange, the subscriptions will be payable only in Australian currency.

New Executive - Dr. Klaus Rötzscher was elected president with the recommendation to select a slate of officers from Germany.

Subscription was set at Dm.80 payable in that currency.

Note: The venue for the 1993 IAFS meeting was subsequently announced for Dusseldorf, Germany.

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