Occluso-Cranial Correlates of Attrition in a Preliterate Population

A cross-sectional study

J. A. Kieser
H. T. Groeneveld
C. B. Preston
S. J. Flax

Evaluation of dental casts of 202 living Lengua Indians from Paraguay finds progressive reduction in overjet with age, but no Class III or indication of altered relationship of mandible to cranial base.

KEY WORDS: • AGE • ATTRITION • OCCLUSION •

Incisor relationships in the normal human dentition are said by REINHARDT (1983A) to change from a positive overjet to an edge-to-edge configuration with the progression of occlusal attrition. Based on measurements of 43 individuals of unknown age and sex, he further postulated that continued attrition results in negative labial overjet or relative mandibular prognathism.

It is the purpose of the present investigation to further explore the age-related differences in incisor and molar relationships in a preliterate population of known age and sex distribution.

— Materials and Methods —

Artificial stone casts of the dental arches of 202 living Lengua Indians from the Chaco area of Paraguay are used for this study. Individual age determinations were made from the records of the Sociedad Missionera en Sud America at Makthlawaya, which served the community studied (JACOBSON ET AL. 1977, KIESER AND PRESTON 1981 AND KIESER ET AL. 1983). Measurements were only performed on casts which showed excellent clarity and normal occlusion in centric relation.

Author Address:
Dr. J. A. Kieser
3 Bellavista Centre
Reeders Street
Haddon, 2091 Johannesburg
SOUTH AFRICA

Julius Kieser holds B.Sc. and B.D.S. degrees from the Witwatersrand University, where he is attached to the Department of Orthodontics.

Hennie Groeneveld Holds a D.Sc. from the University of Pretoria, where he is Professor of Statistics.

Charles Preston is Professor and Head, Department of Orthodontics, at the Witwatersrand University and holds B.D.S. and M. Dent. degrees from the same institution.

Steven Flax is a postgraduate student in the Orthodontics Department, Witwatersrand University, and holds a B.D.S. degree.

Labial incisor overjet was measured as the minimum horizontal distance from the most mesial part of the labial surface of the lower first incisor to the labial enamel surface of the mesial part of the upper central incisor edge. Molar overjet was measured as the minimum horizontal distance from the buccal enamel surface of the mesiobuccal cusp of the maxillary first molar to the enamel convexity of the mesiobuccal cusp of its isomere.

All measurements were taken with a vernier depth gauge according to the method described by REINHARDT (1983A, 1983B). Intercoronal distance, defined as the maximum distance between the cemento-enamel junctions of isomeres, was measured on central incisors and first molars. Where applicable, the means of left and right measurements were calculated prior to statistical analysis.

Lateral cephalometric headfilms of 30 male and 30 female Lengua Indians were selected for clarity, alignment of cephalometric landmarks and excellence of occlusion. Acetate tracings were made and S-N-A (sella-nasion-subspinale), S-N-B (sella-nasion-supramentale) and A-N-B (subspinale-nasion-supramentale) angles were measured and grouped according to age and sex. Summary statistics, Pearsonian correlation coefficients and analyses of variance (STEEL AND TORRIE 1960) were conducted on the seven variables considered.

— Findings and Discussion —

Preliminary analyses of variance conducted on each of the variables, testing for age and sex differences as well as for interaction between age and sex, are displayed in Table 1. With the exception of

Table 1

Results of Two-way Analysis of Variance Testing for Age and Sex Differences and Age-Sex Interactions for All of the Variables Considered

Variable	F-ratio Test (p-values) Age	Sex	Age-Sex Interaction
Incisor Overjet	0.0001*	0.1882	0.1239
Molar Overjet	0.0001*	0.3454	0.4968
Incisor Intercoronal Distance	0.0001*	0.0282*	0.2889
Molar Intercoronal Distance	0.0001*	0.0321*	0.0019*
S-N-A	0.0360*	0.8594	0.8640
S-N-B	0.2646	0.6375	0.9914
A-N-B	0.8045	0.8668	0.6378

* $p<0.05$

S-N-B and A-N-B angles, all variables showed significant age-related differences ($p < 0.05$).

In order to further explore the meaning of the above results, it was decided to conduct analyses of variance with reduced models incorporating only the significant factors. Table 2 lists the probability values of F-ratios, least-square means and standard errors of a one-way analysis of variance conducted on incisor and molar overjet values. The mean incisor labial overjet was 2.7mm in the second decade of life, but only 1.5mm in the group over fifty years. This difference is significant at the 0.01 probability level. Surprisingly, no negative incisor overjet values were recorded, suggesting that the Lengua Indians did not wear their dentitions into class III relations as suggested by PEREIRA AND EVANS (1975).

MURPHY (1958) first proposed that a closing rotation of the mandible with progressive attrition provides a link between dental wear and the development of an edge-to-edge bite. More recently, REINHARDT (1983A) hypothesized that upward pivoting of the mandible on its functional arc provided an explanation for the observed changes in incisor relationships from a positive overjet through an edge-to-edge configuration to negative labial overjet.

We reason that such a pattern of secondary mandibular rotation would be reflected in age-related differences in those measurements that relate mandibular relation to the anterior cranial base. Of the three angular variables investigated (A-N-B, S-N-B and S-N-A), only the S-N-A angle showed significant age-related variation (Tables 1 and 3). A one-way analysis of variance on the S-N-A angle values in a reduced model failed to show a definite pattern of age dependence, so this finding was rejected as being spurious.

The failure to demonstrate significant age-related differences in A-N-B and S-N-B angles clearly suggests that there is no consistent difference in the position of the mandible relative to the anterior cranial base with age. We attribute the observed progressive lessening of labial incisor overjet values to a wearing away of characteristically protrusive incisors, rather than to mandibular repositioning.

This hypothesis is further supported

Table 2

Results of One-way Analysis of Variance Testing for Age Differences in Molar and Incisor Overjet

	Incisor Overjet			Molar Overjet		
Age Group	N	Least-square Mean	Standard Error	N	Least-square Mean	Standard Error
-19	11	2.73	0.24	11	2.06	0.19
20-29	32	2.67	0.14	32	1.89	0.11
30-39	27	2.48	0.15	28	1.71	0.12
40-49	13	1.98	0.22	9	1.50	0.21
50-	26	1.51	0.16	18	1.05	0.15
F ratio		0.0001 ($p < .05$)			0.0001 ($p < .05$)	

by the findings of JACOBSON ET AL. (1977), who showed that Lengua craniofacial patterns were characterized by large A-N-B angles, which they suggested resulted from a clockwise (hyperdivergent) rotation of the upper and lower jaws relative to the anterior cranial base.

Buccal molar overjet in the Lengua Indians was found to diminish from an average of 2.06mm in those under twenty years of age to an average of 1.05mm in the over-fifty age group (Table 2). This pattern of reduction was similar in both sexes (Table 1), and was shown to be significantly, if rather weakly, correlated with age-related differences in the incisor labial overjet and in molar and incisor intercoronal distances (Table 4).

Our findings thus lend support to Osborn's theory that molar helicoidal plane development may occur in the absence of age-related crossbite formation (OSBORN 1982). These findings also underline our own earlier suggestion that

Table 3

Results of One-way Analysis of Variance Testing for Age-related Differences in Angles S-N-A, S-N-B and A-N-B

		S-N-A		S-N-B		A-N-B	
Age Group	N	Least-sq Mean	Standard Error	Least-sq Mean	Standard Error	Least-sq Mean	Standard Error
-19	5	84.3	1.42	79.5	1.49	5.3	1.15
20-29	14	84.5	0.85	79.0	0.89	5.6	0.69
30-39	21	87.0	0.69	80.8	0.73	6.2	0.56
40-49	5	81.9	1.42	77.1	1.49	4.7	1.15
50-	16	86.0	0.80	797.	0.83	6.1	0.64
F ratio		0.0152(p<.05)		1.6334		0.1674	

Table 4

Pearsonian Correlation Coefficients between Molar and Incisor Overjet and Intercoronal Dimensions

	Molar Overjet	Incisor Intercoronal Distance	Molar Intercoronal Distance
Incisor Overjet	0.31(0.0053)*	0.60(0.0001)*	0.28(0.0156)*
Molar Overjet	—	0.28(0.0284)*	0.38(0.0003)*
Incisor Intercoronal Distance	—	—	0.4990.0001)*

* p<.05

helicoidal plane development is related to the occlusal plane at eruption, as well as to an abrasive diet, less abrasion-resistant enamel, and a longer interval betweeb the eruption of first and third molars (KIESER ET AL. 1984).

Of all the variables investigated, only intercoronal distance showed sexual dimorphism (Figs. 1 and 5).

Close examination reveals significant age-dependent patterns for both incisor and molar intercoronal distance values, with the mean incisor intercoronal distance 4.2 mm less in the over-fifty age group (10.3mm over fifty years of age, compared to 14.5mm under twenty).

Similarly, table 6 shows mean molar intercoronal distance to be 10.2mm in

Table 5

Two-way Analysis of Variance Testing
for Sex Dimorphism in Intercoronal Dimensions

	Incisor Intercoronal Distance			Molar Intercoronal Distance		
Sex	N	Least-square Mean	Standard Error	N	Least-square Mean	Standard Error
Male	40	13.21	0.30	52	9.84	0.19
Female	40	13.23	0.32	42	9.21	0.22
F-ratio		0.0282($p < .05$)			0.0321($p < .05$)	

Table 6

Results of a Two-way Analysis of Variance
Testing for Significance of Age-related Differences
in Intercoronal Dimensions

	Incisor Intercoronal Distance			Molar Intercoronal Distance		
Age Group	N	Least-square Mean	Standard Error	N	Least-square Mean	Standard Error
-19	19	14.54	0.60	19	10.15	0.40
20–29	25	14.49	0.38	28	10.32	0.23
30–39	20	13.34	0.40	27	10.07	0.24
40–49	9	10.93	0.60	9	8.91	0.43
50–	21	10.29	0.39	21	8.18	0.27
F ratio		0.0001($p < .05$)			0.0001($p < .05$)	

the second decade of life and 8.2mm after fifty years of age.

Although no significant age-sex interaction could be demonstrated in the reduction patterns of incisor intercoronal distances, molar intercoronal distances did exhibit a clear age-sex interaction. Males showed a higher reduction rate than females (Table 7). These findings underline those of VAN REENEN (1982), who reported higher rates of attrition in males than in females. They are in contrast to those of TOMENCHUCK AND MAYHALL (1979) and of MOLNAR ET AL. (1983), who reported higher attrition rates in females than in males.

— Conclusions —

The most important conclusion to be drawn from the present investigation is that the mandible does not alter its position relative to the anterior cranial base in response to dental wear. It is suggested that the observed age-related decrease in incisor overjet values of Lengua Indians reflects a progressive wearing away of prognathic incisors rather than secondary mandibular rotation.

Although continued attrition in Lengua Indians was found to have led to the formation of edge-to-edge bites in some individuals, negative overjet values were

Table 7

Results of a Two-way Analysis of Variance Testing for Significant Differences between Age-related Intercoronal Dimension Differences in Males and Females

	Incisor Intercoronal Distance			Molar Intercoronal Distance		
Age Group	N	Least-square Mean	Standard Error	N	Least-square Mean	Standard Error
			Male			
–19	5	15.51	0.81	5	10.99	0.54
20–29	19	14.98	0.60	12	11.32	0.34
30–39	11	13.57	0.54	16	10.37	0.30
40–49	5	11.95	0.81	6	8.77	0.49
50–	10	10.02	0.57	13	7.76	0.33
			Female			
–19	14	13.56	0.90	14	9.31	0.60
20–29	16	13.99	0.45	16	9.32	0.30
30–39	9	13.12	0.60	11	9.78	0.36
40–49	14	9.90	0.90	13	9.04	0.70
50–	11	10.57	0.54	8	8.59	0.43
F ratio		0.2889			0.0019($p < .05$)	

not recorded. Similar patterns of molar overjet reduction with age were shown to characterize Lengua dental wear, prompting the suggestion that molar helicoidal plane development is not ineluctably linked to molar crossbite formation.

Sexually dimorphic attrition patterns were only demonstrated in reductions in incisor and molar intercoronal distances, with the age-sex interactions found to be significant only in the molars.

Sincere thanks are due to President A. Stroessner of Paraguay who made available air transport, food and equipment during the expedition's stay in the Chaco. We wish also to thank Professors A. Jacobson and C. B. Pereira and Dr. V. A. Boettner for their assistance in the collection of the material, and the staff of the Mission Anglicana for their invaluable assistance.

References

Jacobson, A., Preston, C. B., Boettner, V. A. and Pereira, C. B. 1977. The craniofacial pattern of the Lengua Indians of Paraguay. *Am. J. Phys. Anthrop.* 47:467-472.

Kieser, J. A. and Preston, C. B. 1981. The dentition of the Lengua Indians of Paraguay. *Am. J. Phys. Anthrop.* 55:485-490.

Kieser, J. A., Preston, C. B. and Evans, W. G. 1983. Skeletal age at death: and evaluation of the Miles method of ageing. *J. Arch. Science* 10.:9-12.

Kieser, J. A., Groeneveld, H. T. and Preston, C. B. Patterns of dental wear in the Lengua Indians of Paraguay. *Am. J. Phys. Anthrop.* 66:21-29.

Molnar, S., McKee J. K. and Molnar, I. 1983. Measurement of tooth wear among Australian Aborigines: serial loss of the enamel crown. *Am. J. Phys. Anthrop.* 61:51-65.

Murphy, T. 1958. Mandibular adjustment to functional tooth attrition. *Austr. Dent. J.* 3:171-178.

Osborn, J. W. 1982. Helicoidal plane of dental occlusion. *Am. J. Phys. Anthrop.* 57:273-281.

Pereira, C. B. and Evans, H. 1975. Occlusion and attrition of the primitive Yanomami Indians of Brazil. *Dent. Clinics N. Am.* 19:485-498.

Reinhardt, G. A. 1983a. Attrition and the edge-to-edge bite. *Angle Orthod.* 53:157-164.

Reinhardt, G. A. 1983b. Relationships between attrition and lingual tilting in human teeth. *Am. J. Phys. Anthrop.* 61:227-237.

Steel, R. G. D. and Torrie, J. H. 1960. *Principles and Procedures of Statistics.* McGraw Hill, New York.

Tomenchuck, J. and Mayhall, J. T. 1979. A correlation of tooth wear and age among the Igloolik Eskimoes. *Am. J. Phys. Anthrop.* 51:69-78.

van Reenen, J. F. 1982. The effects of attrition on tooth dimensions of San (Bushmen). *In: Teeth: form, function and evolution* edited by Kurtén, B., Columbia University Press, New York.