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A newly-discovered craniological non-metric trait

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Abstract We identified a bony groove, hitherto undescribed, in the infratemporal fossa region of the cranial base, passing laterally from the *foramen ovale* onto the squamous temporal bone. It was found that this groove was formed by the posterior deep temporal nerve. A study of the extent of the groove in 50 precontact New Zealand Maori adults (28 males, 22 females), 41 precontact Chatham Island Moriori adults (27 males, 14 females), and 32 modern Indian adults (12 males, 20 females) showed that there was a very high incidence of the groove in the Indian crania but much less so in either of the two Polynesian samples. In none of the groups studied was there any evidence of gender-preference, or side-preference, neither for the presence nor the depth of the groove. We hypothesize that this groove is present in other ethnic groups in varying degrees of prominence. Therefore, we feel that this is an extremely useful non-metric trait in forensic and anthropological studies.

Key words Infratemporal groove; posterior deep temporal nerve; non-metric trait; New Zealand Maori; Chatham Islands Moriori; modern Indian.

Resumo Identificámos um sulco ósseo, não descrito até há data, na região da fossa infratemporal da base do crânio, passando lateralmente desde o *foramen ovale* até à porção escamosa do osso temporal. Verificou-se que este sulco foi formado pelo nervo temporal profundo posterior. O estudo da extensão deste sulco foi realizado em crânios de adultos de duas populações anteriores ao contacto com os Europeus, os Maori da Nova Zelândia (28 do sexo masculino e 22 do feminino) e os Moriori da Ilhas Chatham (27 masculinos e 14 femininos) e de uma amostra 32 Indianos modernos (12 masculinos e 20 femininos). Os resultados obtidos mostraram ser muito mais elevada a incidência deste carácter nos crânios de Indianos do que nos das duas amostras Polinésias. Em nenhum dos

grupos estudados foi observada qualquer evidência de preferência de género ou de lateralidade, quer no que concerne à presença quer à profundidade do sulco temporal profundo. Admitindo a hipótese de que este carácter epigenético está presente noutras populações, e com diversos graus de incidência, consideramos ser extremamente útil em estudos forenses e antropológicos.

Palavras-chave Sulco infratemporal; nervo temporal profundo posterior; Maori da Nova Zelândia; Moriori da Ilhas Chatham; Indianos modernos.

Introduction

During a re-examination of the bases of crania held in the Department of Anatomy and Structural Biology, University of Otago, a groove was found emanating from the region of the *foramen ovale*. This groove passed laterally along the roof of the infratemporal fossa and onto the squamous temporal bone, ending soon after. The groove appears to be prevalent in Indian skulls but not in Polynesian skulls. We also found that this groove is produced by the posterior deep temporal nerve (Dias *et al.*, 2001).

We examined the presence/absence, the prominence, the gender-specificity, the side-preference (Stirland, 1993; Steele and Mays, 1995), and the depth of the groove within the three population groups that we studied, namely Maori, Moriori, and modern south-Asian Indian.

Materials and methods

Data for this study were drawn from 91 adult Polynesian pre-European contact crania and from 32 modern adult Indian crania. The bony roof of the infratemporal fossa area was examined under good light, assisted by magnification where necessary. Examination was undertaken as a 'blind' study by one of us (Dias) to avoid any examiner-bias of the findings.

Once the data had been gathered they were assembled into tables: for the 12 male and 20 female Indian crania, and for the 28

male and 22 female New Zealand Maori, and the 27 male and 14 female Chatham Island Moriori crania. The crania had been sexed following the criteria proposed by Keen (1950) which gives 85% certainty. In some cases the dry skull determination of sex was reinforced by chemical evidence (Lengyel and Nemeskeri, 1963; Kiszely, 1974), where a lower level of cortical bone citrate differentiated an adult male from an adult female. This technique had been further refined by one of the authors (Dennison, 1979; Dennison and Kooyman, 1991) to give an 89% correlation between the chemical method and the dry bone method.

Results

The bony groove is artistically illustrated in Figure 1.

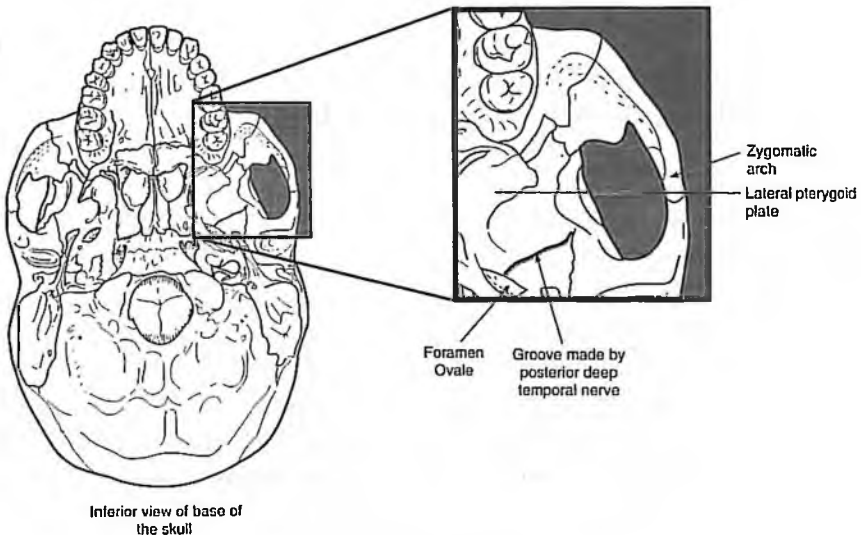


Figure 1. Inferior aspect of the cranium. The groove is indicated.

A photographic example is presented in Figure 2.

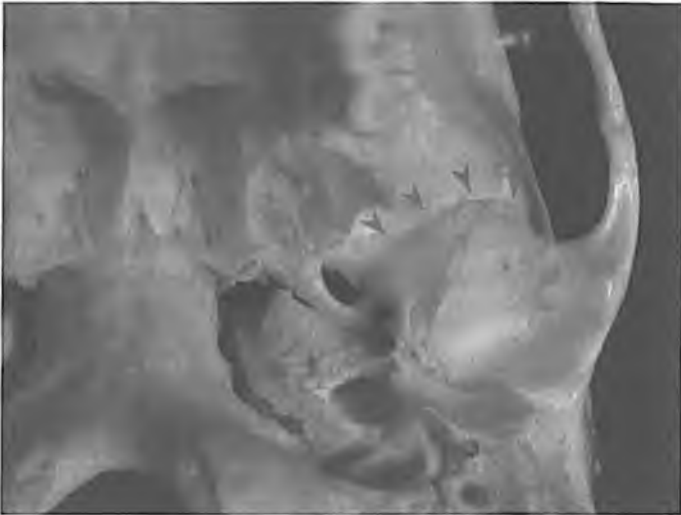


Figure 2. Inferior aspect of an Indian cranium with the groove indicated (Skull designation number – 42).

The data are analyzed statistically in the following sections by cross-tabulating them under different criteria.

Relationship between the ethnic group and the presence or absence of the groove

The sample of 123 crania is cross-tabulated in Table 1 (column variable “ethnic group” *versus* row variable “status of the groove”). For example, the frequency value “6” in the first cell of the table is the number of Indian skulls in which the groove is absent on both sides. A Pearson’s Chi-Square test (Everitt, 1994) was performed at the 5% level of significance to test the following hypothesis:

H_0 : The presence or absence of the groove is independent of the ethnic group

H_a : The presence or absence of the groove is dependent on the ethnic group

Table 1. Status of the temporal nerve groove according to ethnic group.

Status of groove		Ethnic group			Total
		Indian	Maori	Moriori	
Absent on both sides	N	6	25	28	59
	H ₀	(15.3)	(24.0)	(19.7)	
	%	18.75	50.00	68.29	47.97
Present at least on one side	N	26	25	13	64
	H ₀	(16.7)	(26.0)	(21.3)	
	%	81.25	50.00	31.71	52.03
Total		32	50	41	123

The expected frequencies in each cell, assuming that the null hypothesis (H₀) is true, are illustrated inside the round brackets in Table 1. The value of the chi-square test statistic calculated from the SPSS statistical package is 17.814 (with two degrees of freedom), which is significant at the 5% level when compared with the critical value of 5.991. Therefore, we conclude that the presence or absence of the groove depends on the ethnic group.

We then studied the pattern of dependence (Everitt, 1994) by expressing the data as percentages, as illustrated in Table 1. These percentages were calculated by selecting the ethnic group variable as the base variable, and then expressing the frequencies in each cell corresponding with different levels of the second variable ("status of the groove") as a percentage of the base variable total.

For example, the percentage of Indian skulls in which the groove is absent on both sides is 18.75% (6/32). If the status of the groove is independent of the ethnic group, then these percentages in each cell are expected to be approximately equal to the row percentages listed under the column labeled "Total" in Table 1, which are 47.97% and 52.03% respectively. The extent to which each group's percentage departs from the row percentage determines the dependence of the two classifications.

In this study we are interested in investigating how the percentages of crania presenting the groove change between the three ethnic groups. The percentages in the second row of Table 1

demonstrate that for Indians the percentage (81.25%) of skulls with the groove present deviates significantly from the expected (52.03%) value, with the highest deviation being 29.22% (i.e. 81.25% – 52.03%). The next largest percentage deviation occurs in Morioris, and equals 20.32% (i.e. 52.03% – 31.71%), while the lowest percentage deviation is for Maoris, 2.03%.

Relationship between ethnic group and presence/absence of the groove on the left side of the cranium

We then tested whether there was any association between the presence or absence of the groove on the left side of the cranium, and the ethnic group. A chi-square test was performed at the 5% level of significance to test the following hypothesis:

H_0 : The presence or absence of the groove on the left side is independent of the ethnic group.

H_a : The presence or absence of the groove on the left side is dependent on the ethnic group.

The observed frequencies, expected frequencies, and the percentages calculated for the chi-square test are presented in Table 2. The value of the chi-square test statistic is 15.946 (with two degrees of freedom), which is significant at the 5% level compared with the critical value of 5.991. Therefore we conclude that whether or not the groove is present on the left side of the cranium depends on the ethnic group. The percentages calculated in Table 2 demonstrate a similar pattern to that in Table 1.

The percentage of Indian crania (65.63%) with the groove present on the left side deviates significantly from the expected value of 39.84%, with the highest percentage deviation of 25.79% (i.e. 65.63% – 39.84%). The next largest deviation is for Morioris at 20.33% while the lowest percentage deviation is for the Maori sample at 0.16%.

Table 2. Status of the temporal groove on the left side of the cranium, according to ethnic group.

Status of groove		Ethnic group			Total
		Indian	Maori	Moriori	
Absent on left side	N	11	30	33	74
	H ₀	(19.3)	(30.1)	(24.7)	
	%	34.38	60.00	80.49	60.16
Present on left side	N	21	20	8	49
	H ₀	(12.7)	(19.9)	(16.3)	
	%	65.63	40.00	19.51	39.84
Total		32	50	41	123

Relationship between ethnic group and presence/absence of the groove on the right side of the cranium

We conducted a similar test to ascertain whether the presence or absence of the temporal groove on the right side of the cranium correlates with the ethnic groups. The observed frequencies, expected frequencies, and the percentages are presented in Table 3. The value of the chi-square test statistic in this case is 16.561 (with two degrees of freedom), which is significant at the 5% level compared with the critical value of 5.991. This result implies that the presence or absence of the groove on the right side of the cranium depends on the ethnic group. The percentages in the second row of Table 3 show that the percentage of Indian crania (68.75%) with the groove present on the right side deviates significantly from the expected value of 40.65%, with the highest percentage deviation of 28.10%. The next largest deviation is for Morioris, equalling 18.70%, while the lowest percentage deviation is for the Maoris, which is 2.65%.

Table 3. Status of the temporal groove on the right side of the cranium, according to ethnic group.

Status of groove		Ethnic group			Total
		Indian	Maori	Moriori	
Absent on right side	N	10	31	32	73
	H_0	(19.0)	(29.7)	(24.3)	
	%	31.25	62.00	78.05	59.35
Present on right side	N	22	19	9	50
	H_0	(13.0)	(20.3)	(16.7)	
	%	68.75	38.00	21.95	40.65
Total		32	50	41	123

Presence of the groove versus sex, for the combined sample

We tested to see whether there is any association between the presence of the groove and the sex of the individual. The hypothesis tested at the 5% level of significance was as follows:

H_0 : The presence or absence of the groove is independent of sex.

H_a : The presence or absence of the groove is sex-dependent.

The cross-tabulated data with the expected frequencies in this case are presented in Table 4. The value of the chi-square statistic is 0.998 (with one degree of freedom), which is not significant compared with the tabulated value (3.841) at the 5% level of significance. Therefore we conclude that, at the 5% level of significance, the presence or absence of the groove is independent of sex.

Table 4. Status of the temporal nerve groove according to sex.

Sex		Status of group		Total
		Absent on both sides	Present at least on one side	
Female	N	26	30	56
	H_0	(26.9)	(29.1)	
Male	N	33	34	67
	H_0	(32.1)	(34.9)	
Total		59	64	123

Absence of the groove bilaterally *versus* ethnic group

We tested to see whether complete absence of the groove on both sides was related to the ethnic group. The chi-square test statistic value of 17.814 (with two degrees of freedom) is significant compared with the tabulated value of 5.99 at the 5% level of significance. The results are presented in Table 5, and show that the 4.9% value of Indians with the groove absent on both sides is significantly different from the expected value of 48%, compared with the Maori and Moriori values, which are 20.3% and 22.8% respectively.

Table 5. Total absence of the temporal nerve groove, according to ethnic group.

Status of groove	Ethnic group			Total	
	Indian	Maori	Moriori		
	N	6	25	28	59
	H ₀	(15.3)	(24.0)	(19.7)	
Absent on both sides	% within group	18.8	50.0	68.3	
	% of Total	4.9	20.3	22.8	48.0
Total		32	50	41	123

In the converse case, with a chi-square test statistic value of 16.613 which is significant compared with the tabulated value of 5.99 at the 5% level, Table 6 shows that the 3.3% of Moriori skulls with the groove being present on both sides is a significant deviation from the expected 28.5%, compared with the Maori and Indian values.

Table 6. Presence of the temporal nerve groove bilaterally, according to ethnic group.

Status of groove	Ethnic group			Total	
	Indian	Maori	Moriori		
	N	17	14	4	35
	H ₀	(9.1)	(14.2)	(11.7)	
Present on both sides	% within group	53.1	28.0	9.8	
	% of Total	13.8	11.4	3.3	28.5
Total		32	50	41	123

Depth of the groove

Similar application of Pearson's Chi-Square test demonstrated that whether the groove was shallow or deep on the left side (Table 7) or the right side (Table 8) bore no relationship with the ethnic group.

Table 7. Depth of the temporal groove on the left side, according to ethnic group.

Depth of groove		Ethnic group			Total
		Indian	Maori	Mori	
Shallow	N	14	14	8	36
	H ₀	(15.4)	(14.7)	(5.9)	
	% within group	66.7	70.0	100.0	
	% of Total	28.6	28.6	16.3	73.5
Moderate/deep	N	7	6	0	13
	H ₀	(5.6)	(5.3)	(2.1)	
	% within group	33.3	30.0	0.0	
	% of Total	14.3	12.2	0.0	26.5
Total		21	20	8	49

Table 8. Depth of the temporal groove on the right side, according to ethnic group.

Depth of groove		Ethnic group			Total
		Indian	Maori	Mori	
Shallow	N	17	12	8	37
	H ₀	(16.3)	(14.1)	(6.7)	
	% within group	77.3	63.2	88.9	
	% of Total	34.0	24.0	16.0	74.0
Moderate/deep	N	5	7	1	13
	H ₀	(5.7)	(4.9)	(2.3)	
	% within group	22.7	36.8	11.1	
	% of Total	10.0	14.0	2.0	26.0
Total		22	19	9	50

Fisher's Exact Test Statistic (FETS) (Everitt, 1994) was then applied to test, within each ethnic group, whether the depth of the groove on either side was dependent upon the sex of the individual. FETS is used as the expected frequencies in some of the cells are too small. None of the Moriori skulls bore a moderate/deep groove on the left side and so the test could not be applied in that instance (Table 13).

Table 9. Left-side temporal nerve groove depth in Indian crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	8	6	14
	H ₀	(8.7)	(5.3)	
	% within sex	61.5	75.0	
	% of Total	38.1	28.6	66.7
Moderate/deep	N	5	2	7
	H ₀	(4.3)	(2.7)	
	% within sex	38.5	25.0	
	% of Total	23.8	9.5	33.3
Total		13	8	21

Table 10. Right-side temporal nerve groove depth in Indian crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	10	7	17
	H ₀	(10.0)	(7.0)	
	% within sex	76.9	77.8	
	% of Total	45.5	31.8	77.3
Moderate/deep	N	3	2	5
	H ₀	(3.0)	(2.0)	
	% within sex	23.1	22.2	
	% of Total	13.6	9.1	22.7
Total		13	9	22

However, on neither the left (Table 9) nor the right side (Table 10) did the depth of the groove in the Indian crania show any dependence on sex (at the 5% level of significance). The same was true for the Maori crania (Tables 11 and 12) and for the Moriori crania (Tables 13 and 14) respectively.

Table 11. Left-side temporal nerve groove depth in Maori crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	5	9	14
	H ₀	(4.9)	(9.1)	
	% within sex	71.4	69.2	
	% of Total	25.0	45.0	70.0
Moderate/deep	N	2	4	6
	H ₀	(2.1)	(3.9)	
	% within sex	28.6	30.8	
	% of Total	10.0	20.0	30.0
Total		7	13	20

Table 12. Right-side temporal nerve groove depth in Maori crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	6	6	12
	H ₀	(5.7)	(6.3)	
	% within sex	66.7	60.0	
	% of Total	31.6	31.6	63.2
Moderate/deep	N	3	4	7
	H ₀	(3.3)	(3.7)	
	% within sex	33.3	40.0	
	% of Total	15.8	21.1	36.8
Total		9	10	19

Table 13. Left-side temporal nerve groove depth in Moriori crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	2	6	8
	H ₀	(2.0)	(6.0)	
	% within sex	100.0	100.0	
	% of Total	25.0	75.0	100.0
Total		2	6	8

Table 14. Right-side temporal nerve groove depth in Moriori crania, according to sex.

Depth of groove		Sex		Total
		Female	Male	
Shallow	N	2	6	8
	H ₀	(2.7)	(5.3)	
	% within sex	66.7	100.0	
	% of Total	22.2	66.7	88.9
Moderate/deep	N	1	0	1
	H ₀	(0.3)	(0.7)	
	% within sex	33.3	0.0	
	% of Total	11.1	0.0	11.1
Total		3	6	9

Discussion

In a previous study it was found that this groove is formed by the posterior deep temporal nerve, (one of the motor nerves to the temporalis muscle (Dias *et al.*, 2001)). The present study shows that the presence or absence of this groove depends on the ethnic group under examination – it was present in 81.3% of the Indian crania, and was less evident in the Polynesian crania (50.0% presence in the Maori and 31.7% presence in the Moriori crania). The reason for the prevalence of this feature in Indian crania at present eludes us; it may simply be an anatomical variation of the mandibular nerve or its branches, and its prevalence in one group and not in the others indicates that this may be a genetic trait. The feature itself may therefore be a useful non-metric trait to assist in identifying crania from the Indian sub-continent, but we feel that this study should be expanded to include other ethnic groups, hence this trait could be used universally as a non-metric trait.

There did not appear to be any selective preference for the groove on the left or the right sides of the cranium — 65.6% of the Indian crania bore a groove on the left side and 68.8% presented a groove on the right side. For the Maori crania the corresponding values were 40.0% left side and 38.0% right side, while for the Moriori crania the values were 19.5% and 22.0% respectively. This

finding, of a symmetrical feature, would appear to eliminate in all three groups a preferential unilateral activity of temporalis muscle. However, until other ethnic groups are studied it is not possible to say that there may or may not be a selective preference for the groove on one or other sides of the cranium, for those populations. If that is the case, then an anatomical explanation needs to be found to describe this.

The values given above for the Indian crania indicate that the groove is a symmetrical feature, and Table 4 confirms that the groove was bilateral in over half (53.1%) of our Indian sample, yet it is bilateral in only one quarter (28%) of the Maori and just under one tenth (9.8%) of the Moriori. In the Moriori group in fact 68.3% did not have this groove at all, while only 18.8% of Indians had no groove. This shows that not only the presence or absence of the groove but whether it is bilateral or unilateral is strongly-related to the ethnic group.

Our further statistical investigations, on whether the groove was shallow or deep on either side, had no statistical relevance between the ethnic groups, nor between the sexes within each ethnic group. However, when future studies are carried out in other ethnic groups, there may be different conclusions drawn. What we can say, from the present study, is that the presence of the groove is strongly dependent on the three ethnic groups which were studied.

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