SOME ANATOMICAL FEATURES OF THE MANDIBLE

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MANDIBULAR CANAL AND MENTAL FORAMEN

In extreme resorption of the alveolar process of the edentulous mandible the mental foramen and part of the mandibular canal traversing the body of the bone may disappear and the inferior dental nerve come to lie upon the body of the bone in the soft tissues. Such a condition does not appear to have been described in anatomical literature. Gray's *Anatomy* (1954) states that when the mandible resorbs the mandibular canal and mental foramen are close to the alveolar border; Cunningham's *Text-book of Anatomy* (1951)—that 'in old age after the teeth are lost the walls of the sockets are absorbed and the mental foramen is near the upper border'. Morris's *Human Anatomy* (1942), Quain's *Elements of Anatomy* (1890) and the *Text-book of Anatomy* edited by Hamilton (1956), merely mention senile absorption of the alveolar margin. In Cowdry's *Problems of the Ageing* (1952) it is stated that the mandibular canal in the elderly is near the alveolar surface and that the mental foramen appears near or even on the alveolar surface. Last (1954) also indicates that in the edentulous jaw the mental foramen lies nearer the upper border of the mandible. Humphrey (1858), who gives a more complete description than many modern text-books, says that in edentulous old age the inferior dental canal runs along the alveolar border and that the mental foramen comes to lie on its upper edge. Cogswell (1942) does not appear to envisage the nerve lying outside the bone, though the conditions he dealt with mainly concerned the dentulous bone. Edwards (1954) complains of lack of description of the edentulous mandible and states that the mental foramen comes to lie near the ridge. He illustrates what he regards as an extremely resorbed bone which shows, however, the mental foramen still present. Augier (1928) describes the bone as becoming resorbed almost to the mental foramen. Le Double (1906) says that when the teeth fall out the alveolar process is lost and the mandible is reduced to its body. He states later his belief that no one has reported absence of these foramina: 'Je ne crois pas qu'on ait encore fait mention de l'absence des ouvertures en question. En ce qui me concerne, je les ai toujours rencontrées toutes les deux, sur chacune des 822 machoires inferieures.' Praed (1938), however, writes: 'The ridge may be flattened throughout, even involving the mental foramen on one or both sides.'

Surgeons have encountered the nerve lying exposed in the soft tissues (Wallace, 1956), and Gerry (1956), reporting a case of a patient 40 years of age who had been edentulous for 20 years, writes: 'the inferior alveolar vessels were not covered by bone in the bicuspid region where the mandible was only 3–4 mm. thick'. It is possible that in such cases the condition has been regarded as pathological.

Two mandibles are illustrated here which show the disappearance of the mental foramen and part of the mandibular canal. The first specimen (Pl. 1, figs. 1, 2) was

recovered from the dissection room of the Medical School at Sydney University. The body of the bone varies in thickness from 6 to 13 mm. In the second and third molar region and where the upper surface of the body slopes up into the ramus the inferior alveolar nerve was covered by a thin lamina of bone but more anteriorly the mandibular canal was transformed into a groove. This groove became shallow and indistinct in the premolar region. Branches of the nerve passed into the bone, one large branch may be seen in the lateral view of the bone (Pl. 1, fig. 1) entering the bone in the canine region, but the main trunk of the nerve lay along the surface of the bone. This bone shows fairly uniform resorption throughout the body.

The specimen illustrated in Pl. 1, figs. 3 and 4, was a macerated bone which had suffered considerable resorption in the anterior region but possessed a high and sharp ridge posteriorly. This bone had been sectioned transversely for another purpose some years ago (Gabriel, 1946). The sections have been replaced in their correct positions and photographed. Pl. 1, fig. 3 shows that the mental foramen has disappeared. The cranio-caudal view (Pl. 1, fig. 4) shows the canal opening above the upper surface of the much resorbed anterior part of the bone.

In the adult dentulous mandible the mandibular canal, as it passes forward in the body of the bone, lies several millimetres below the level of the mental foramen which it eventually reaches by bending acutely below it and then passing upward (Gabriel, 1946). Hence a considerable amount of bone must be resorbed from the mandible below the level of the mental foramen before the main part of the mandibular canal is exposed.

The following question arises. Does the level or height of the mental foramen relative to the lower border of the mandible alter in post maturity? To test this, measurements of the perpendicular distance of the mental foramen to the lower border were made on 21 dentate, 21 partly edentulous, and 21 edentulous mandibles, and the mean measurement for each group was found to be 13·8, 13·0 and 13·0 mm. respectively. By the usual variance ratio test, the difference between these means is not significant, the variance ratio being 1·80 for $n_1=2$ and $n_2=60$ in the usual notation.

Mandibular foramen

The position and variation of the mental foramen has, over the years, received much attention and there is a considerable volume of literature describing this feature but much less work has been done to describe the mandibular foramen. The position of the mandibular foramen is difficult to define. This difficulty is due mainly, it would seem, to the variability of the angle of the jaw. Many authorities (e.g. Dixon, 1912) have referred loosely to the foramen as lying approximately in the centre of the medial surface of the ramus of the mandible, and, indeed, this statement in many cases proves almost as accurate as the more involved definitions given. Fawcett (1895) writes: 'the canal commences in the ramus midway between its anterior and posterior borders, and at the point of junction of the lower third with the upper two-thirds of a line drawn from the tip of the coronoid process to the angle of the jaw', and further that 'this line passes through the base of the lingula and the beginning of the inferior dental canal or groove leading into it, midway between the anterior and posterior borders of the ramus'. The relation of this line to the lingula has been examined on some thirty bones and up to 10 mm. variation

has been found. The lingula was more often in front of than behind the line. The tip of the coronoid process could be determined with reasonable accuracy and 'the angle' was assumed to be the point of intersection of a line tangential to the lower border of the body (basal plane) with a line tangential to the posterior border of the ramus (rameal plane). No attempt was made to confirm Fawcett's other statement as it was obviously intended to be merely an approximation. Miller (1953), dealing with dentate bones, related the mandibular foramen as from 31 to 58 % of the distance between the mandibular notch and the gonial notch and from 45 to 71 % of the width of the ramus posterior to the anterior border of the ramus. These figures indicate the wide variation to be found.

Lotric (1951) states that the lowest point of the mandibular foramen is on an average 20–25 mm. from the incisura mandibularis and about 20 mm. behind the anterior margin of the ramus and that these ratios are practically constant. He states, further, that the foramen (lowest point?) is in 82 % of cases below the occlusal plane of the lower molar teeth, in 13 % of cases on the same level and only in rare cases above it. Unfortunately Lotric's original paper was not available and the above statement was taken from an abridged account given in *Excerpta Medica* (1951). Augier (1928) describes the mandibular foramen as situated about 2 cm. from the anterior border of the ramus, about midway between the anterior and posterior borders and a little above the level of the teeth. The level mentioned seems somewhat in conflict with Lotric's statement but might be explained by Augier having adopted a different point of reference on the foramen or by the difference between what was meant by 'the level of the teeth' in one case and 'the occlusal plane of the lower molar teeth' in the other.

The writer cannot improve on these definitions of the position of the mandibular foramen, but after making a series of measurements (see Appendix and 'Definition of Measurements',) he finds some correlation of its position with the angle of the mandible and the breadth of the ramus as follows:

(1) A negative correlation of −0·823* was found between measurements of the angle of the mandible and the perpendicular distance between the mandibular foramen and the lower border of the bone which we will call the 'height' of this foramen.

(2) A negative correlation of −0·649* was found between the measurement of the angle of the mandible and the distance between the mandibular foramen and the posterior border of the ramus.

(3) A negative correlation of −0·426* was found between measurements of the angle of the mandible and the minimum breadth of the ramus.

These correlations indicate that the smaller the angle of a mandible, or in other words the more upright its ramus, then the higher will be the mandibular foramen, the greater will be the distance of this foramen forward from the posterior border, and the broader will be the ramus.

Due to the fact that these measurements were of a mixed collection of bones including juvenile and senile, dentulous and edentulous, it might reasonably be inferred that the negative correlation found between the breadth of the ramus and angle of the mandible was merely an expression of the fact that both juvenile

* Each of these coefficients of correlation is significant beyond the level of 0·1%.

mandibles and senile edentulous mandibles may be expected to have, coexisting, slender rami and large angles. To test this matter calculations were made of a series of dentulous adult mandibles. Harrower (1928) in his biometric study of 110 Asiatic mandibles provides excellent material for this purpose and his paper records all the individual measurements he made. Analysis of his relevant measurements of the angle and the rami of those mandibles gives a coefficient of negative correlation of $-0{\cdot}512$ (significant beyond the level of 0·1 %) which confirms the validity of this correlation and clarifies the point.

Although not arriving at the conclusion that the height of the mandibular foramen is related to the angle of the mandible, Allen (1915), in his text-book of local anaesthesia, appreciated that in youth the mandibular foramen lies at a lower level relative to the teeth than it does in the adult. This is indicated by his illustrations showing the direction in which the needle of a local anaesthetic syringe should be advanced in the respective cases of a child, a youth and an adult; and also by his definition of the position of the mandibular foramen which is as follows: 'The mandibular foramen is situated about the middle of the internal surface of the ascending ramus, and in the adult is above the alveolar ridge and in a horizontal plane about 1·5 cm. from the anterior ridge.'

DEFINITIONS OF MEASUREMENTS

Mental foramen. None of the bones examined possessed more than one mental foramen on each side. The lower border of the mental foramen is the part most clearly defined, and measurements were taken from the lowest point on this border.

Mental foramen to lower border is the distance from the above point of reference on the mental foramen to the lower border of the bone perpendicularly below.

Mandibular foramen. The point of reference is the lowest point of the lower border where it merges into the lingula.

Mandibular foramen to lower border is the perpendicular distance from the reference point on the foramen to the lower border of the bone.

Mandibular foramen to posterior border of ramus is the distance from the reference point on the foramen to the nearest point on the posterior border.

Minimum breadth of ramus is the minimum distance between the anterior and posterior borders of the ramus. This is usually at or about the level of the mandibular foramen.

Standard basal plane (after Morant) is a horizontal plane with which the lower border of a mandible makes the most contact when vertical pressure is applied to the regions of the second molar teeth.

Rameal plane. A plane which makes tangential contact with the two most prominent convexities of the posterior border of the ramus.

Angle of the mandible or gonial angle is measured at the intersection of the standard basal plane with the rameal plane.

Perpendicular measurements are perpendicular to the standard basal plane.

SUMMARY

Resorption of the alveolar process of the edentulous mandible may progress to elimination of the mental foramen and part of the mandibular canal.

Correlations of measurements indicate that the more upright the ramus of a mandible then the higher will be the mandibular foramen, the greater will be the distance of this foramen forward from the posterior border, and the broader will be the ramus of the mandible.

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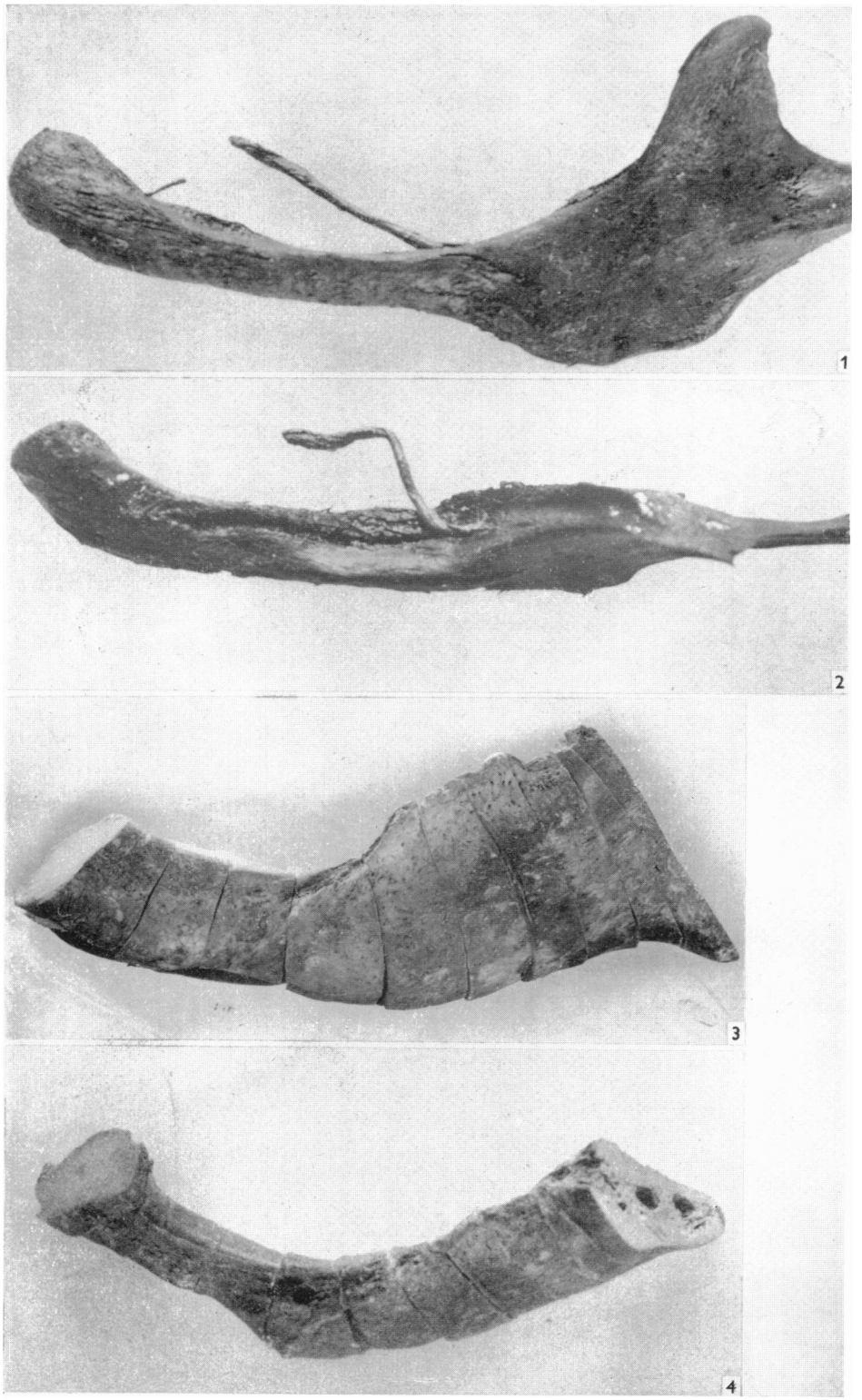
EXPLANATION OF PLATE

Lateral and superior views of the left side (Figs. 1 and 2) and part of the left side (Figs. 3 and 4) of two human mandibles, showing absorption of the alveolar process to below the level of the mental foramen.



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(*Facing p.* 584)

APPENDIX

Mandible	Side	Mandibular foramen to lower border (mm.)	Mandibular foramen to posterior border (mm.)	Minimum breadth of ramus (mm.)	Angle of mandible (°)
A.D. 13	L.	13	9	22	133
	R.	14	10	23	135
921	L.	16	12	28	129
	R.	17	12	27	125
801	L.	21	11	28	129
	R.	19	11	28	129
226B	L.	20	15	34	124
	R.	20	16	33	122
471	L.	17	12	28	138
	R.	17	11	27	138
1	L.	20	9	25	127
	R.	19	11	26	127
3	L.	27	14	32	114
	R.	28	16	32	115
8	L.	16	12	22	135
	R.	15	10	20	140
15	L.	20	14	28	134
	R.	23	15	28	135
4	L.	19	13	24	135
	R.	17	13	22	146
2	L.	27	18	34	106
	R.	24	15	32	108
5	L.	17	11	28	136
	R.	15	11	27	140
7	L.	17	13	27	130
	R.	18	13	27	131
11	L.	22	18	27	118
	R.	21	18	28	120
Jap.	L.	20	20	33	115
	R.	20	20	34	118
800	L.	11	12	25	135
	R.	9	10	24	141
914	L.	25	15	35	115
	R.	25	16	36	110
W.M. 92	L.	25	13	34	113
	R.	27	14	35	113
93	L.	17	14	29	137
	R.	16	13	31	136
94	L.	22	21	35	111
	R.	24	19	35	112
96	L.	20	15	34	123
	R.	21	15	34	121
97	L.	20	13	32	120
	R.	19	12	32	121
107	L.	28	16	35	116
	R.	27	16	34	117
108	L.	28	13	31	111
	R.	27	14	30	114
228	L.	18	15	34	125
	R.	20	14	34	124
229	L.	20	11	30	124
	R.	20	12	29	126

Mandible	Side	Mandibular foramen to lower border (mm.)	Mandibular foramen to posterior border (mm.)	Minimum breadth of ramus (mm.)	Angle of mandible (°)
W.M. 195	L.	24	14	36	120
	R.	27	15	36	116
196	L.	26	16	39	113
	R.	29	17	40	113
187	L.	24	15	31	114
	R.	24	16	31	112
189	L.	28	15	32	110
	R.	28	15	31	109
31	L.	17	16	37	122
	R.	18	16	38	123
32	L.	25	17	30	112
	R.	24	17	30	112
18	L.	15	10	21	130
	R.	28	17	38	121
118	L.	34	17	36	108
	R.	31	15	33	107
150	L.	27	14	35	116
	R.	28	14	36	116
151	L.	21	13	29	125
	R.	22	15	30	122
153	L.	28	16	34	109
	R.	28	16	33	109
154	L.	27	17	35	120
	R.	26	17	37	120
81	L.	20	14	30	125
	R.	20	14	30	125
85	L.	20	15	33	127
	R.	21	14	33	125
86	L.	15	10	27	138
	R.	14	12	25	140
87	L.	18	13	25	134
	R.	19	13	24	133
88	L.	19	14	30	128
	R.	21	14	31	125
91	L.	18	14	30	125
	R.	17	14	29	126
110	L.	21	14	33	117
	R.	22	14	32	119
142	L.	26	14	31	118
	R.	30	15	34	118
146	L.	18	14	34	127
	R.	18	14	33	122
147	L.	23	20	36	110
	R.	26	19	37	118
152	L.	20	10	31	122
	R.	23	10	31	122
252	L.	19	14	34	126
	R.	24	15	35	126
Summary	Means	21·49	14·20	30·98	122·72
	Standard deviation	4·75	2·55	4·31	2·96
	Standard error of means	0·48	0·25	0·43	0·30