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Incidence, types and clinical implications of a non-metrical variant — mylohyoid bridging in human mandibles

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Mylohyoid bridging (MB) is a non-metrical variant of the human mandible. The incidence and types of MB were investigated in 264 mandibles (edentulous 116, semi-dentulous 90 and dentulous 58). No mandible showed a complete type of MB, although 19 (7.2%) mandibles had a partial type. These were classified into two subtypes: distal partial (DP; Type I) and proximal partial (PP; Type II), depending on their location over the mylohyoid groove. The MB was present unilaterally in 7.76% of edentulous mandibles: right side 5.17% (3.45% PP type and 1.72% DP type) and left side 2.59% (1.72% PP type and 0.86% DP type). Of the semi-dentulous mandibles 3.33% had DP type of MB, 1.11% on the right side and 2.22% on the left side, and of the dentulous mandibles 1.72% had DP type of MB on the right side. A total of 13 mandibles out of 264 (4.92%) had unilateral MB. No dentulous mandible had bilateral MB, but 3.45% of edentulous and 2.22% of semi-dentulous mandibles did have. In total, 6 mandibles out of 264 bones (2.27%) had bilateral MB. Of the bilateral incidences 1.72% of edentulous mandibles had a DP-DP combination and the remaining 1.72% had a PP-DP combination. However, both instances of bilateral MB in semi-dentulous mandibles were of PP-DP combination. The incidence or types of MB showed no statistically significant differences between the groups or sides ($p > 0.5$; χ^2 test). In conclusion, the complete type of MB is a rare occurrence. The incidence increases with age, as edentulous mandibles had a higher incidence of MB than the other two groups. Clinically, MB may compress the mylohyoid neurovascular bundle, leading to neurological or vascular disorders.

Key words: mandibular foramen, mylohyoid nerve, inferior alveolar nerve, mandibular teeth, mylohyoid muscle, Meckel's cartilage

INTRODUCTION

The human mandible has some non-metrical variants, showing variations in the shape and size of the coronoid processes and lingula, the location of the mandibular foramen, and the retromolar foramina and canal [10, 11, 13]. These variants play a very important role in surgical procedures that involve the mandible, in the failure of nerve blocks, for example, or accidental damage of blood vessels [12]. The presence of accessory bony pieces over the mylohyoid groove could compress the mylohyoid neurovascular bundle [7], which runs downwards and forwards on the inner surface of the ramus and body of the mandible [18]. In some mandibles the groove

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may be converted into a narrow bony tunnel through which the mylohyoid neurovascular bundle has to course to its final distribution [14]. The bony plates stretch either from end to end or only over a small part of the mylohyoid groove, a condition known as mylohyoid bridging (MB), which may be classified as partial or complete, depending on the extension over the mylohyoid groove [4]. Some researchers have also classified MB into common–uncommon, bridge–lingula and distal (Type I)–proximal (Type II) types [5, 19].

The MB has been studied in different populations [1, 4, 7, 17], and the incidences range from 0.47% in Europeans [14] to 32.2% in Africans [8], suggesting that it is a population-specific non-metrical variant. Moreover, MB is considered to be a discrete cranial hyperostotic variation and is therefore one of the epigenetic features useful in physical anthropological studies [5–7, 9, 19]. The MB is formed as a result of the ossification of a membrane derived from Meckel's cartilage that is proximally continuous with the sphenomandibular ligament [14]. The MB could compress the mylohyoid neurovascular bundle against the bone, which might result in some clinical conditions. The present study was planned to investigate the incidence and types of MB, its clinical implications and their possible relationship with dentulous states of the mandibles.

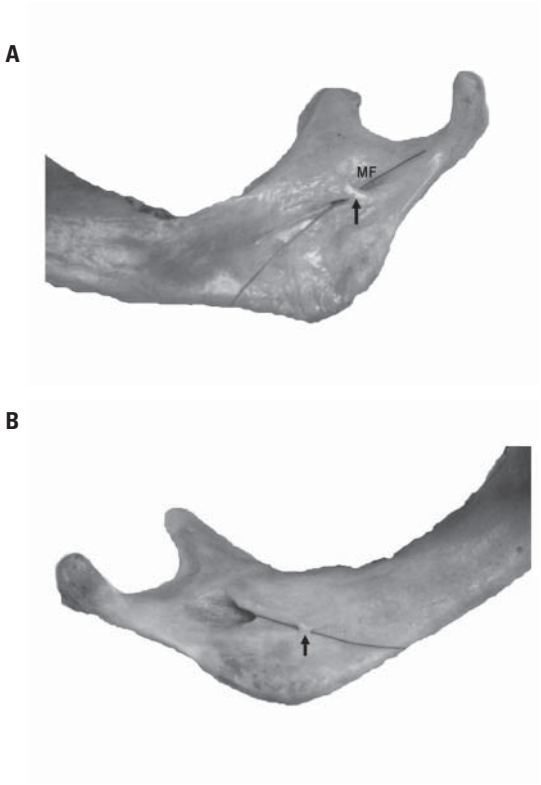

Figure 1. Photographs of mandibles showing partial types of MB. **A.** An edentulous mandible with a PP type of MB is on the right side (arrow), which has partially converted the mylohyoid groove into a canal (note a probe has been passed through the canal); the mandibular foramen (MF) has been converted into a circular opening; **B.** Another edentulous mandible with a DP type of MB on the left side (arrow).

MATERIAL AND METHODS

The study included 116 edentulous, 90 semi-dentulous and 58 dentulous human mandibles of Indian origin. All were adult mandibles, the exact age and sex of which were unknown. All bones were observed for the presence of MB and if this was present a further classification was made in each bone, characterising it either a complete or a partial MB. No complete MB was observed, and the cases of partial MB were further classified into proximal-partial (PP; Type II) and distal-partial (DP; Type I) subtypes, depending on the location of the MB [19]. A comparison of the present results was made with the incidences of MB reported by earlier authors.

Data were analysed for significance of occurrence in relation to side and group by means of the χ^2 test, with the level of significance set at $p < 0.05$.

RESULTS

The MB is a bony spicule over-bridging the mylohyoid groove either throughout or over a small part of the groove. When present, MB converts the underlying groove into a narrow tunnel through which the mylohyoid neurovascular bundle passes. There was no complete type of MB in any mandible observed in the present study. We observed only a partial type of MB (Fig. 1). The PP type (Type II) was formed just as a backward extension of the lingula (Fig. 1A), whereas the DP type (Type I) was nearer to the distal end of the groove (Fig. 1B). When both unilateral and bilateral cases of MB are considered, a total of 19 mandibles out of 264 bones (7.2%) had this trait. The numerical side distribution of partial MB in three groups of mandibles (upper panel) and the total percentage side distribution (lower panel) are shown in Figure 2. The MB was present unilaterally in 7.76% of edentulous mandibles (N = 116), 5.17% on the right side and 2.59% on the left side (Fig. 3). In the unilateral incidence of MB, on the right side 3.45% were of PP type and 1.72% were of DP type, whereas on the left side 1.72% were of PP type and 0.86% were of DP type (Table 1). Of the semi-dentulous mandibles (N = 90) 3.33% had DP type of MB, 1.11% on the right side and 2.22% on the left side. Of the dentulous

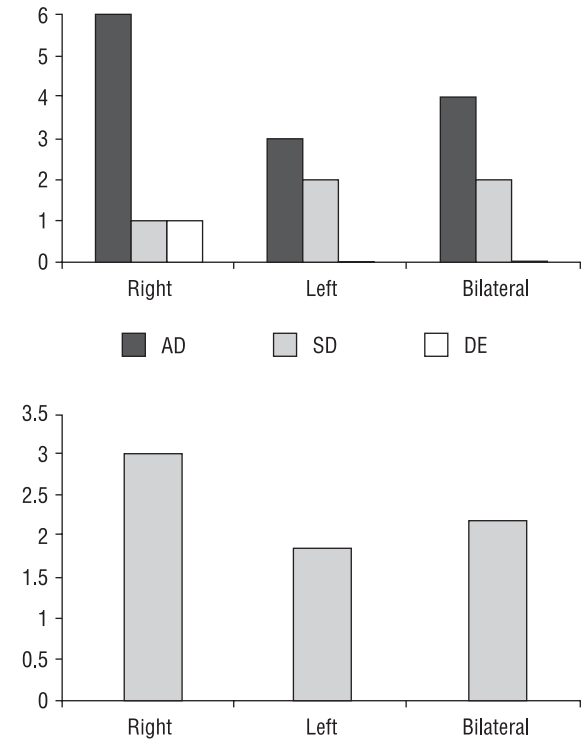

Figure 2. The incidence of partial MB in human mandibles. The upper panel shows the numerical side distribution of partial MB in different groups, whereas the lower panel shows the side distribution of partial MB in percentages, when the incidence in the three groups is considered together; AD — edentulous, SD — semi-dentulous, DE — dentulous mandibles. The incidence did not show any differences between the groups or sides ($p > 0.05$; χ^2 test).

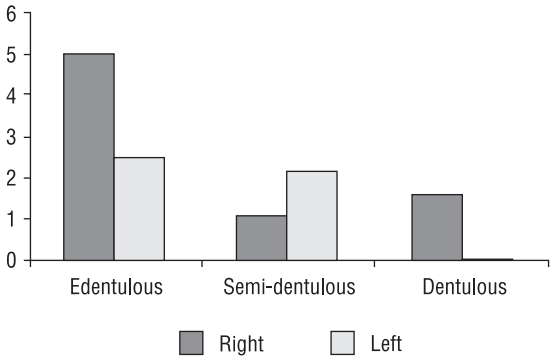

Figure 3. Side distribution of percentage incidences of partial MB in 3 groups of mandibles.

mandibles (N = 58) 1.72% had DP type of MB on the right side (Fig. 3). A total of 13 out of 264 mandibles (4.92%) had unilateral MB.

No dentulous mandible had bilateral MB, but 3.45% of edentulous (N = 116) and 2.22% of semi-dentulous (N = 90) mandibles did have (Table 2).

Table 1. The unilateral incidence of partial MB in mandibles

Groups	Mandible number	Right side	Left side
Edentulous	1	PP	–
(N = 116)	2	PP	–
	3	PP	–
	4	PP	–
	5	DP	–
	6	DP	–
	7	–	PP
	8	–	PP
	9	–	DP
Semi-dentulous	10	DP	–
(N = 90)	11	–	DP
	12	–	DP
Dentulous	13	DP	–
(N = 58)			

PP — proximal partial, DP — distal partial. The difference between the sides or groups was not significant ($p > 0.05$)

Table 2. The bilateral incidence of partial MB in mandibles. Note that bilateral MBs were not seen in dentulous mandibles

Groups	Mandible number	Right side	Left side
Edentulous	14	DP	DP
(N = 116)	15	DP	DP
	16	DP	PP
	17	PP	DP
Semi-dentulous	18	PP	DP
(N = 90)	19	PP	DP
Dentulous	–	–	–
(N = 58)			

The dentulous mandibles did not show bilateral incidences of MB. PP — proximal partial, DP — distal partial. The difference between the sides or groups was not significant ($p > 0.05$)

In total, 6 mandibles out of 264 bones (2.27%) had bilateral MB (Fig. 2). Of the bilateral cases 1.72% of edentulous mandibles had a DP-DP combination and the remaining 1.72% had a PP-DP combination. However, both incidences of bilateral MB in semi-dentulous mandibles were of PP-DP combination. When subjected to statistical analysis, there were no significant differences between the groups or between the sides ($p > 0.5$). The incidence of 7.2% in the

Table 3. Percentage incidences of MB in various populations

Reference number	Populations	Incidence of MB (%)
[3]	American Whites	11.50
[4]	North Indians	8.63
[6]	Hokkaido Ainu	11.10
[6]	Neolithic Jomon	10.30
[6]	Modern Japanese	5.00
[7]	North east Indians	2.98–7.14
[8]	Khoisan	32.20
[9]	Indians	6.39
[14]	Europeans	0.47
[16]	Pre-Columbian Chileans	4.09
[17]	East Asians	2.60
[19]	Late Byzantine	9.00
Present study	Indians	7.20

present results is in consensus with earlier reports, although it diverges insignificantly (Table 3).

DISCUSSION

The MB has been considered an important anthropological non-metrical variant of the mandible which is useful in population studies [5]. On the other hand, many authors believe that MB, not alone but with other cranial non-metrical variants, acts as an important genetic marker [6, 16], although there are reports to the contrary [8]. The results from the present study indicate that the complete type of MB is a rare occurrence, although some authors have found this trait in some mandibles [4]. A total incidence of 7.2% is less than that in northern Indians (8.63%) [4] or American whites (11.15%) [3]. Nevertheless, the incidence reported [7] in another northern Indian sample (2.98–7.14%) is in consensus with the present study (Table 3). Differences in the incidence of MB may be due to variations related to era, climate, diet, geography, race or sex, as non-metrical variants are known to depend on these factors [5, 19], although the incidence of MB did not show any sex difference [16, 17]. Following a comparison with different races, we observed that Europeans have a very low incidence, whereas the Khoisan population has an astoundingly high incidence (Table 3), although Hanihara and Ishida [19] reviewed incidences of MB in 81 populations in which Moriori (> 40%), Aleuts (38%) and Patagonian (32%) populations showed very high incidences of MB. On the other hand, other populations, such as Indians, Japanese, East Asians, Chileans, and Americans, have a comparable incidence of MB (2.6–11.5%; Table 3). This variation, therefore, may be dependent on the various factors listed above. Thus we believe that MB may be a useful non-metrical marker in population studies.

The two types of MB, namely DP and PP, correspond to types I and II respectively [5]. Type I is formed as a result of the ossification of the periosteum over the mylohyoid groove, whereas type II is formed after the ossification of the sphenomandibular ligament, as a result of which it appears like a backward extension of the lingula [7, 19]. In this case, MB alters the shape of the mandibular foramen (Fig. 1A), which might compress the inferior alveolar nerve or affect the inferior alveolar nerve block. The mandible develops from a fibromembranous tissue lateral to the inferior alveolar nerve and also from the ventral part of Meckel's cartilage [18]. During development the membrane covering the mylohyoid groove ossifies at variable locations either proximally, distally or at the middle, sometimes with multiple ossifications [1]. This trait seems to have a positive correlation with age, as the incidence was greater in edentulous mandibles, albeit without any statistical significance, possibly owing to the ossification of the sphenomandibular ligament as age advances. Although there was no significant side difference, MB seems to be expressed more on the right side than on the left. Clinically, MB may be significant, as the mylohyoid nerve passes through the tunnel, which may be compressed against the bone, imparting neurological disturbances. The mylohyoid nerve itself is known to present many variations in its course and distribution [2, 15]. The presence of MB would therefore further worsen the neurological disorders associated with the mylohyoid nerve.

In conclusion, the partial types of MB are more common than the complete types and tend to be formed as age advances. The MB can act as a marker in population studies and, clinically, may compress the mylohyoid neurovascular bundle.

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