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Original Article:

Anatomy of the Mandible: Developmental Variations and Clinical Significance

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Abstract: Introduction: Anatomical structures serve as landmarks for dental procedures. Therefore, in our present study, we determined the most common anatomical variations of mandibles. Material and Methods: The study included 50 dry mandibles from the department of human anatomy obtained from patients of Moldavian origin. The obtained data was analysed using descriptive statistics and Pearsons correlation. A p level of less than 0.05 was considered to be statistically significant. Results: The mandibular foramen was situated in the inferior 1/3 of mandibular ramus in 30 cases (60%). In 20 cases (40%) the mandibular foramen was situated in the middle of the ramus. Both premolar foramen and accessory mandibular foramen were encountered in two cases respectively (4%). Mylohyoid bridging was also encountered in two cases (4%). The condylar morphology differed according to its surface and was classified in to four types: type A - superior surface flattened, type B - superior surface convex, type C - superior surface angled and type D - superior surface rounded. The morphology of the left condylar process according to the types: A – 20 cases (40%), B – 16 cases (32%), C – 2 (4%), D – 12 (24%). The morphology of the right condylar process according to the types: A – 16 cases (32%), B – 20 (40%), C – 6 (12%), D – 8 (16%). There were four common forms of the lingula: triangular lingula (type 1), truncated lingula (type 2), lingula seen as a less prominent nodule (type 3), lingula assimilated in the mandibular ramus (type 4). The lingual type from the right side: type 1 – 8 (16%), type 2 – 18 (36%), type 3 – 18 (36%) and type 4 – 6 (12%). The lingual type from the left side: type 1 – 10 (20%), type 2 – 18 (36%), type 3 – 18 (36%) and type 4 – 6 (12%). Conclusions: The anatomy of the mandible has several clinically significant anatomical variations, which should be taken into consideration in daily dentist practice. The data provided in the article discusses some of the variations of the development and morphological parameters of mandibles from the Moldavian population.

Key Words: Mandible, Mandibular foramen, Mental foramen, Premolar foramen, Condylar morphology, Lingual, Mylohyoid bridging

Introduction:

The mandible is the largest bone of the facial skeleton. It is also one of the most frequent archeological discoveries that gives perspective on the human phylogenesis. The anatomy of the mandible is tightly linked to its function and changes of the period of life.(1) It is currently at special attention since there are multiple procedures that require precise knowledge of the regional anatomy. Some of the anatomical structures serve as landmarks for dental procedures like inferior alveolar nerve block, mandibular implant treatment, and mandibular osteotomies.(2) The variations in the position, shape, and size of others may greatly impact the performance of the surgical procedures.(3)

This subject is further complicated by the fact that the anatomical variability depends on the different ethnic groups and on populations of different races. Therefore, in our present study, we determined the most common anatomical variations of mandibles, which may be useful in alveolodental and maxillofacial surgery as well other specialists.

Material and Methods

The study included 50 dry mandibles from the department of human anatomy obtained from patient of Moldavian origin. The damaged bones and those, having pathological abnormalities were excluded. The mean distance of mandibular foramen from the anterior border, posterior border, mandibular arch and the base of the ramus and percentile of distance were measured as described by Shalini (2016).(2) The condylar morphology was classified into 4 types: superior surface flattened (type A), superior surface convex (type B), superior surface angled (type C) and superior surface rounded (type D) according to the study by Yale and co-workers (1966).(4) The morphology of the lingula was classified into 4 types: triangular lingula (type 1), truncated lingula (type 2), lingula seen as a less prominent nodule (type 3), lingula assimilated in the mandibular ramus (type 4) based on the study by Tuli and co-workers (2000).(5) The obtained data was analysed using descriptive statistics and Pearsons correlation. A p level of less than 0.05 was considered to be statistically significant.

Results

The mandibular foramen was situated in the inferior 1/3 of mandibular ramus in 30 cases (60%). The mean distance to mandibular foramen from the anterior border of ramus of mandible was 15.15±2.23 mm on the right side and 15.69±2.42 mm on the left side, from posterior border was 11.85±4.07 mm on the right side and 10.0±3.91 mm on the left side, from mandibular notch was 23.08±6.7 mm on the right side and 17.38±3.12 mm on the left side, from the base of the ramus was 23.46±3.66 mm on the right side and 22.08±7.27 mm on the left side. Accessory mandibular foramen was encountered in two cases (4%) (Fig. 1). Mylohyoid bridging was also encountered in two cases (4%) (Fig. 2).

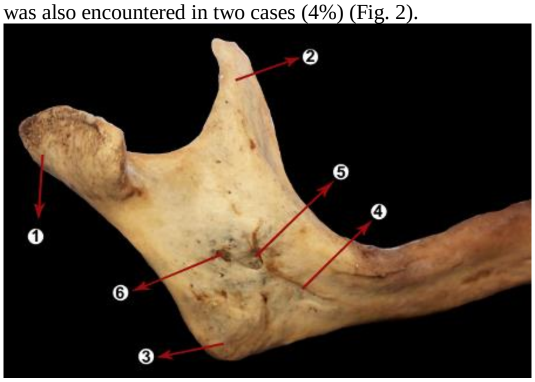

Figure 1. Accessory mandibular foramen

1 – condylar process, 2 – coronoid process, 3 – angle of the mandible, 4 – mylohyoid groove, 5 – mandibular foramen, 6 – accessory mandibular foramen

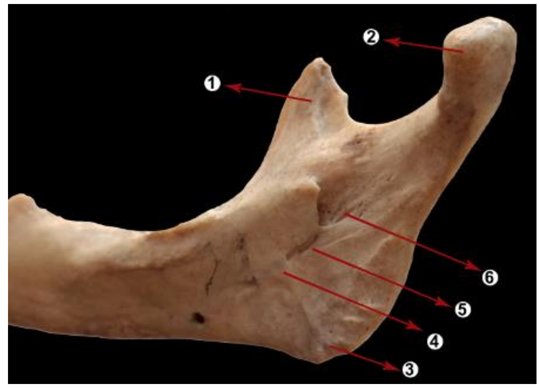

Figure 2. Mylohyoid bridging

1 – coronoid process, 2 – condylar process, 3 – angle of the mandible,4 – mylohyoid bridging, 5 – mylohyoid groove, 6 – mandibular foramen.

Mandibular foramen width was 3.2±0.61mm. In 20 cases (40%) the mandibular foramen was situated in the middle of the ramus.

Mental foramen width was 2.69±0.78 mm. Mental foramen was located on the anterior surface of the corpus of the mandible, posterior to the mental tubercle and had a round shape in 30 cases (60%). Mental foramen had an oval shape in 20 cases (40%).

Topographically the mental foramen was located at the level of the second premolar in 34 cases (68%). There was a positive linear correlation between size of mandibular and mental foramen (Pearsons r=0.433, p=0.027).

Premolar foramen was encountered in two cases (4%) (Fig. 3).

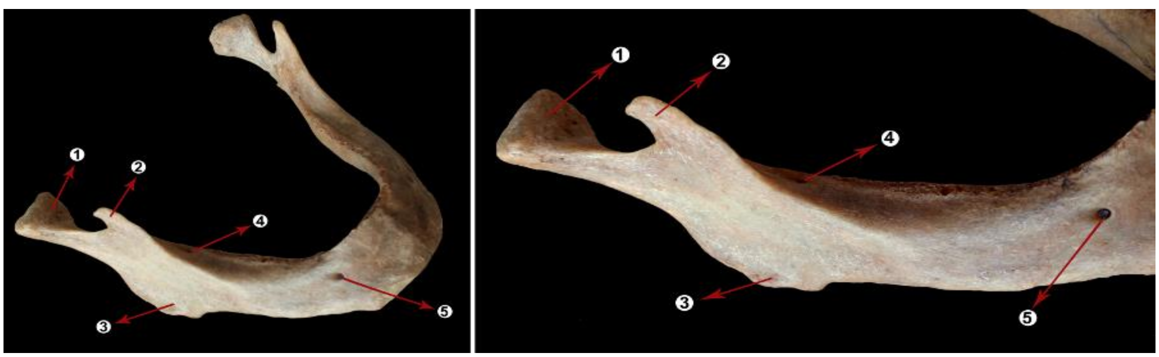

Figure 3. Premolar foramen (1 – condylar process, 2 – coronoid process, 3 – angle of the mandible, 4 – premolar foramen, 5 – mental foramen.

Figure 4. Morphological classification of the condylar process.

Type A - superior surface flattened, type B - superior surface convex, type C - superior surface angled, type D - superior surface rounded

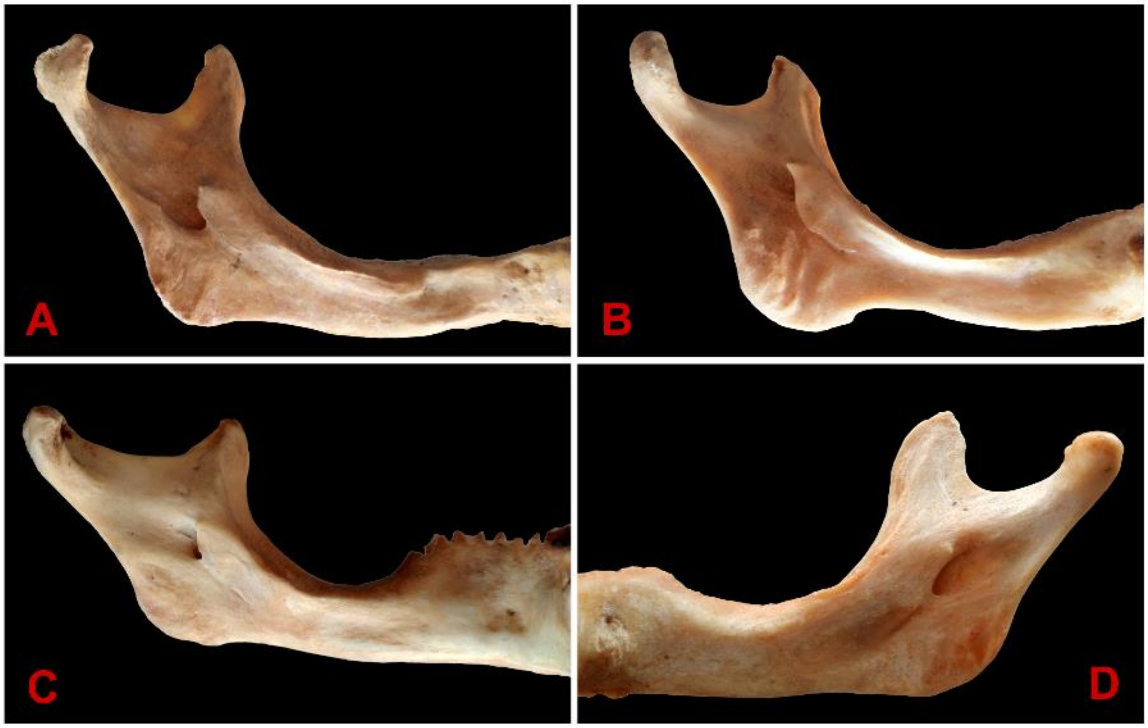

Figure 5. Morphological classification of the lingula. A - type 1, truncated. Shows quadrangular apex. B - type 2, triangular. Shows a broad base and a pointed apex. C - type 3, nodular. Almost completely incorporated into the mandibular ramus. D - type 4, assimilated. Fully incorporated into the mandibular ramus.

The condylar morphology differs according its surface. The results were classified in 4 types: type A - superior surface flattened, type B - superior surface convex, type C - superior surface angled and type D - superior surface rounded (Fig. 4). The morphology of the left condylar process according to the types: A – 20 cases (40%), B – 16 cases (32%), C – 2 (4%), D – 12 (24%). The morphology of the right condylar process according to the types: A – 16 cases (32%), B – 20 (40%), C – 6 (12%), D – 8 (16%).

There were four common forms of the lingula: triangular lingula (type 1), truncated lingula (type 2), lingula seen as a less prominent nodule (type 3), lingula assimilated in the mandibular ramus (type 4). The lingual type from the right side: type 1 – 8 (16%), type 2 – 18 (36%), type 3 – 18 (36%) and type 4 – 6 (12%). The lingual type from the left side: type 1 – 10 (20%), type 2 – 18 (36%), type 3 – 18 (36%) and type 4 – 6 (12%) (Fig. 5).

Discussion

In our present study, we determined the most common anatomical variations of mandibles obtained from people of Moldavian origin. The distance to the mandibular foramen as well as its form and size varies depending on the studied population. Unilateral accessory mandibular foramen is present in 13.72-29.2% of mandibles and seems to be predominantly on the right side.(1, 2) The embryological basis for this type of variation is that initially, three inferior alveolar nerves, innervating each of the three groups of mandibular teeth. Later on, they fuse to form one inferior alveolar nerve. Failure to fuse may result in the formation of accessory mandibular foramen and canal. This is further supported by the fact that up to 40% of inferior alveolar nerves are scattered resembling its embryological past.(6) In our study the incidence is lower (4%) which can be explained by either ethnical particularities or small number of mandibles (50 included in the study).

Taking into account the variety of methods of anesthesia of the inferior alveolar nerve, the main anatomical points to consider are:

1. The lingula, at the entrance of the inferior alveolar nerve into the canal (spina spix anesthesia)
2. Torus mandibulae – the point of convergence of bone cords from the coronary and condylar processes (Vazirani-Akinosi mandibular nerve block, mandibular anesthesia by Veisbrem)
3. The base of the neck of the condylar process, under the place of attachment of the lateral pterygoid muscle (Gow-Gates anesthesia).

When anesthesia of the lower lunar nerve is performed according to the traditional technique (anesthesia spina spix), the success and failure of anesthesia can be influenced by individual variations in the anatomical parameters:

1. The localization of mandibular foramen with respect to the anterior margin of the branch and the occlusal plan of the molars (for medium parameters it is assumed 1 cm and 1.5 cm, respectively)
2. The type and size of mandibular lingual and fat tissue in the area of mandibular foramen. Obviously, the more pronounced in type 1 and. Can lead to difficulties in the diffusion of anesthetic into soft tissues and nerve.
3. Close localization of arteria alveolaris inferior - the frequency of blood aspiration when performing a sample of about 10-15%.(7)

The location of the accessory mandibular foramen and mandibular foramen is clinically important, because the spread of local anaesthetic affects the efficiency of the inferior alveolar nerve block.(8) The presence of accessory mandibular foramen and additional branches of inferior alveolar nerve may lead to increased rates of failure of inferior alveolar nerve blocks as all the branches may not be anaesthetized.(9) The accessory mandibular foramen has also been reported to be the site for the spread of tumors following radiotherapy in the lateral surface of the mandible.(10) Finally, the location of the mandibular foramen is essential for mandibular surgeries inferior alveolar nerve is at a greater risk during surgical procedures.(2)

Unfortunately, the smaller size of the accessory mandibular foramen may limits its visualization in traditional radiographs of the mandible. Panoramic radiographs of the mandible have limitations like distortion, overlap and magnification, which may lead to false interpretation of important anatomical structures.(11, 12)

Premolar (retromolar) foramen is found unilaterally in 3.2% of cases on the left side and in 5.3% on the right side.(3) It is formed by the neurovascular bundle and includes striated muscle fibers, thin myelinated nerve fibers, venules and a muscular artery.(13)

A single accessory mental foramen can be identified in 4.17% of cases, has an oval shape and is usually located at the level of the second premolar root.(3, 14-16) The predominant type is a single mental foramen (76.9%) and there seems to be no significant association between occurrence, location and shape of mental foramen and sides of the mandibles ($p>0.05$).(15)

There were four common forms of the lingual. According to the original study triangular lingulae were found in 68.5% sides, truncated in 15.8%, nodular in 10.9% and assimilated in 4.8% sides.(5) In our study triangulate and nodular types were predominant, each representing 36% of the cases. The triangular lingual was encountered in 18% of cases and assimilated in 12%. Similar results were found on both sides.

The frequency of the mylohyoid bridging varies 2.60-16.4% of cases.(17-20) We had only one case of mylohyoid bridging (4%). It may also depend on ethnicity since its incidence largely varies.(19) Its incidence seems to increase with age. Clinically, mylohyoid bridging may compress the mylohyoid neurovascular bundle, leading to neurological or vascular disorders.(21) The mylohyoid bridge results from ossification of the membrane continuous proximally with the sphenomandibular ligament and stretching the length of the mylohyoid groove medial to its neurovascular structures.(20, 22) The ossification can be total or partial. In case when it is only partially converted, the ossification can be proximal or distal, single or multiple.(20) This is not an uncommon finding since there are other ligamentous structures that can undergo ossification during lifetime.(23)

The condylar morphology was classified into 4 types (according to Yale and co-workers): superior surface flattened (type A), superior surface convex (type B), superior surface angled (type C) and superior surface rounded (type D).(4) As compared to the original study, in our group of mandibles the type D is more common that type C. There are also other forms described in the literature as excavated form, oblique shape, small round condyles and flattened condyles.(24) Finally there are numerous conditions causing alterations in shapes and size of mandibular condyle such as edentation, developmental defects, genetic syndromes, degenerative joint disease, inflammatory disease, infectious diseases, cysts, tumors and other.(25) It should also be noted that the changes that affect the teeth over lifetime (tooth extraction, abrasion) can lead to rearrangement of the mandibular joint. This can explain why types A and B are seen more frequent in the population.

This study was conducted in Moldavian population which is a strong point of the article since the data about Moldavian population is not that abundantly present in the literature. The weak points are the number of cases included in the study and the fact that sex was not taken into consideration while analyzing the mandibles.

Conclusions

The anatomy of the mandible has several clinically significant anatomical variations, which should be taken in consideration in daily dentist practice. The data provided in the article discuses some of the variations of the development and morphological parameters of mandibles from the Moldavian population. This can be useful for alveolodental and maxillofacial surgery as well for other specialists.

References

1. Padmavathi G, Tiwari S, Varalakshmi KL, Roopashree R. An anatomical study of mandibular and accessory mandibular foramen in dry adult human mandibles of south Indian origin. *IOSR J Dent Med Sci.* 2014;13:83–88.
2. Shalini R, RaviVarman C, Manoranjitham R, Veeramuthu M. Morphometric study on mandibular foramen and incidence of accessory mandibular foramen in mandibles of south Indian population and its clinical implications in inferior alveolar nerve block. *Anatomy & Cell Biology.* 2016 Dec;49(4):241-8.
3. Udhaya K, Saraladevi KV, Sridhar J. The morphometric analysis of the mental foramen in adult dry human mandibles: a study on the South Indian population. *Journal of Clinical and Diagnostic Research : JCDR.* 2013 Aug;7(8):1547-51.
4. Yale SH, Allison BD, Hauptfuehrer JD. An epidemiological assessment of mandibular condyle morphology. *Oral surgery, Oral Medicine, and Oral Pathology.* 1966 Feb;21(2):169-77.
5. Tuli A, Choudhry R, Choudhry S, Raheja S, Agarwal S. Variation in shape of the lingula in the adult human mandible. *Journal of Anatomy.* 2000 Aug;197 (Pt 2):313-7.
6. Chavez-Lomeli ME, Mansilla Lory J, Pompa JA, Kjaer I. The human mandibular canal arises from three separate canals innervating different tooth groups. *Journal of Dental Research*. 1996 Aug;75(8):1540-4.
7. Fehrenbach MJ. Gow-Gates mandibular nerve block: an alternative in local anesthetic use. *Access (ADHA)*. 2002;34-37.
8. Parirokh M, Yosefi MH, Nakhaee N, Abbott PV, Manochehrifar H. The success rate of bupivacaine and lidocaine as anesthetic agents in inferior alveolar nerve block in teeth with irreversible pulpitis without spontaneous pain. *Restorative Dentistry & Endodontics*. 2015 May;40(2):155-60.
9. Samanta PP, Kharb P. Morphometric analysis of mandibular foramen and incidence of accessory mandibular foramen in adult human mandibles of an Indian population. *Rev Arg Anat Clin*. 2013;5:60–66.
10. Fanibunda K, Matthews JN. Relationship between accessory foramina and tumour spread in the lateral mandibular surface. *Journal of Anatomy*. 1999 Aug;195 (Pt 2):185-90.
11. Haas LF, Dutra K, Porporatti AL, Mezzomo LA, De Luca Canto G, Flores-Mir C, et al. Anatomical variations of mandibular canal detected by panoramic radiography and CT: a systematic review and meta-analysis. *Dento Maxillo Facial Radiology*. 2016;45(2):20150310.
12. Pancer B, Garaicoa-Pazmino C, Bashutski JD. Accessory mandibular foramen during dental implant placement: case report and review of literature. *Implant Dentistry.* 2014 Apr;23(2):116-24.
13. Bilecenoglu B, Tuncer N. Clinical and anatomical study of retromolar foramen and canal. *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons.* 2006 Oct;64(10):1493-7.
14. Paraskevas G, Mavrodi A, Natsis K. Accessory mental foramen: an anatomical study on dry mandibles and review of the literature. *Oral and Maxillofacial Surgery.* 2015 Jun;19(2):177-81.

15. Eboh DE, Oliseh EI. Analysis of mental foramen in dry human mandibles of adult Nigerians. *African Journal of Medicine and Medical Sciences*. 2014 Jun;43(2):107-13.
16. Igbigbi PS, Lebona S. The position and dimensions of the mental foramen in adult Malawian mandibles. *West African Journal of Medicine*. 2005 Jul-Sep;24(3):184-9.
17. Nikolova SY, Toneva DH, Yordanov YA, Lazarov NE. Morphometric study of the mylohyoid bridging in dry mandibles. *Anthropologischer Anzeiger; Bericht uber die biologisch-anthropologische Literatur*. 2017 Jul 01;74(2):113-22.
18. Sawyer DR, Kiely ML. Jugular foramen and mylohyoid bridging in an Asian Indian population. *American Journal of Physical Anthropology*. 1987 Apr;72(4):473-7.
19. Manjunath KY. Mylohyoid bridging in South Indian mandibles. *Indian Journal of Dental Research : Official Publication of Indian Society for Dental Research.* 2003 Oct-Dec;14(4):206-9.
20. Arensburg B, Nathan H. Anatomical observations on the mylohyoid groove, and the course of the mylohyoid nerve and vessels. *Journal of Oral Surgery (American Dental Association* : 1965). 1979 Feb;37(2):93-6.
21. Narayana K, Narayan P, Ashwin K, Prabhu LV. Incidence, types and clinical implications of a non-metrical variant--mylohyoid bridging in human mandibles. *Folia Morphologica*. 2007 Feb;66(1):20-4.
22. Ossenberg NS. The mylohyoid bridge: an anomalous derivative of Meckel's cartilage. *Journal of Dental Research.* 1974 Jan-Feb;53(1):77-82.
23. Covantev S, Belic O, Mazuruc N. Double suprascapular foramen: a rare scapular notch variation. *Russian Open Medical Journal*. 2016; 5: e0306.
24. Juniper RP. The shape of the condyle and position of the meniscus in temporomandibular joint dysfunction. *The British journal of Oral & Maxillofacial Surgery*. 1994 Apr;32(2):71-6.
25. Hegde SPB, Shetty SR. Morphological and Radiological Variations of Mandibular Condyles in Health and Diseases: A Systematic Review. *Dentistry*, 2013; 3:154.