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Morphometric analysis of mandibular canal: clinical aspects

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SUMMARY

Results of morphometric analysis of the mandibular canal (MC), carried out on 105 conserved mandibles, 70 being dentate and 35 edentate, was performed. The analysis was carried out on consecutive sections, at mutual intervals of 0.5 cm. In the mandibular ramus sections were carried out obliquely, approximately in the frontal plane, and horizontally, from mandibular foramen to the lowest region of the vertical part of the MC (all together two sections). In the mandibular corpus, consecutive transversal sections were carried out between existing teeth, or at mutual intervals of 0.5 cm in edentate regions.

The obtained results pointed out the very close relationship between the MC and lingual cortical plate of the mandibular ramus. In its horizontal part, the average diameter of the MC was 2.6 mm. It was situated more lingually in the molar region; towards the front, it approached the vestibular cortical plate, being closest to it in the region of the second premolar. Similar relationships of the MC and both cortical plates existed in edentate jaws. Relationships of the MC and tooth root apices varied; however, the MC was closest to the apices of the third molar. Mesially from the mental foramen, a clearly defined incisive canal was present in 92% of the dentale mandibles, but only in 31% of the edentate ones. The nearest to the incisive canal was the apex of the first premolar.

The authors point out the importance of presented results in everyday practice, especially in oral and maxillofacial surgery. Having in mind the existing relationship between the MC and neighbouring structures, it is possible to avoid the injury of its content during several oral surgical procedures in mandibular ramus and corpus.

KEY WORDS:

Mandibular canal - Morphometric analysis.

RÉSUMÉ

L'ANALYSE MORPHOMÉTRIQUE DU CANAL MANDIBULAIRE: ASPECTS CLINIQUES

L'analyse morphométrique du canal mandibulaire (CM) a été faite sur 105 mandibules conservées. Parmi ces mandibules, 70 étaient partiellement édentées et 35 totalement édentées. Les distances du CM de la couche compacte osseuse de la mandibule et des apex des racines dentaires ont été mesurées sur les coupes successives pratiquées à une distance de 0,5 cm. Dans la région de la branche montante mandibulaire les coupes successives ont été pratiquées suivant le plan horizontal, de l'orifice postérieur du canal mandibulaire à la terminaison de la partie verticale du CM. La région du corps mandibulaire a été traitée par des coupes verticales. Ces sections ont été faites successivement à travers l'espace entre chaque deux dents ou à une distance de 0,5 cm dans les régions édentées.

Les résultats obtenus montrent que le CM se dirige obliquement de haut en bas et en avant, très proche de la lame osseuse linguale. Dans la partie horizontale son diamètre est de 2,6 mm en moyenne. Dans la région des dents molaires le CM est très proche de la lame osseuse linguale; en cheminant en avant, le CM s'approche de la lame osseuse buccale dont il est le plus proche dans la région de la P2. Dans les mandibules édentées, le CM a des rapports semblables.La distance du CM des apex des racines dentaires est variable, pourtant il est le plus proche des apex des racines de la M3. Mésialement du trou mentonnier, le canal incisif était clairement individualisé dans 92% des mandibules avec la denture conservée, et dans 31% des mandibules édentées. La première prémolaire était la plus proche du canal incisif.

Les auteurs montrent l'importance des résultats présentés pour la stomatologie clinique, surtout pour la chirurgie orale et maxillofaciale. Compte tenu des rapports du CM avec les structures voisines on peut éviter des lésions de son contenu au cours de certaines interventions chirurgicales sur la branche montante et sur le corps de la mandibule.

MOTS CLÉS:

Canal mandibulaire - Morphométrie.

INTRODUCTION

The mandibular canal (MC) is the main canal of the mandible which commences with the foramen at the inner side of the mandibular ramus, runs downwards, then forwards, under the lower teeth roots and ends by dividing into mental and incisive canals. From the mandibular foramen, the MC winds to the mental foramen in a double S-shaped curve, mainly placed closer to lingual than to buccal side of the mandible (Reich, 1980). The mandibular canal, as well as its branches, contains the main neurovascular bundle of the mandible — the inferior alveolar nerve and the same-named blood vessels (Williams and Warwick, 1980).

Morphometric analysis of the mandibular canal has a special clinical significance because of the possible proximity to the lower tooth roots in its horizontal part. Due to that, its content can be damaged even during simple tooth extraction or minor oral surgery in the lower jaw. Also, the growing cysts or tumours in the lower jaw may erode bony walls of the canal, coming into direct contact with the neurovascular bundle of the mandible. Finally, the content of the mandibular canal can be damaged in the course of traumatic or operative jaw fractures.

Although the height of the MC in the mandibular corpus has been thoroughly investigated (Carter and Keen, 1971; Nortje et al., 1972; Schroll, 1975), more significant data relevant to oral surgery practice can be obtained by three-dimensional determining of its relationship to bone surfaces of the mandible and to the teeth; literature regarding this matter, however, is scarce (Haerle, 1977; Reich, 1980). For this reason, the aim of this report has been to complete already published results of our previous investigations of the MC position and its relationship to neighbouring structures (Bogdanovic et al., 1985; Obradovic et al., 1991; Obradovic et al., 1992) and to discuss clinical aspects of its morphometric analysis.

MATERIAL AND METHODS

Morphometric analysis of the MC was carried out on 105 conserved mandibles, 8 of which had all teeth, 62 were partially edentate and 35 totally edentate.

Determination of the distance between the canal and adjacent anatomical structures was carried out on consecutive sections, at mutual intervals of 0.5 cm. In the mandibular ramus, sections were carried out obliquely, approximately in the frontal plane, and horizontally, from mandibular foramen to the lowest region of the vertical part of the MC (all together two sections). In the mandibular corpus, consecutive transversal sections were carried out between existing teeth, or at mutual intervals of 0.5 cm in edentate regions, from the retromolar trigonum to the mandibular symphysis.

RESULTS

Morphometric analysis of the MC pointed out the very close relationship between the canal and lingual cortical plate of the mandibular ramus. At the beginning, near the mandibular foramen, in fact, the MC

was very near to both cortical plates due to the small width of the mandibular ramus in this region (Tab. 1); also, the buccal cortical plate was, on the whole, wider than the lingual one. However, going downwards close to the lingual cortical plate, the MC gradually slided away from the buccal cortex and the posterior margin of the mandible. In the mandibular ramus, the average diameter of the MC was about 3 mm.

Table 1.
Distances between MC and outer bony surfaces of mandibular ramus*.
Tableau 1.
Distances entre le CM et la surface osseuse de la branche montante mandibulaire.

Distance	Section			Diameter ($\bar{X}$)
	height	(vertical)	(horizontal)	
MC/ling. side	1	0.5	0.2	3.0
	2	1.5	1.2	
MC/bucc. side	1	4.0	3.5	
	2	2.5	2.5	

* Mean values in mm.

In its horizontal part, the average diameter of the MC was 2.6 mm with a thin wall of cortical bone (Tab. 2). It was situated more lingually in the molar region; towards the front, however, the MC approached the vestibular cortical plate, being closest to it in the region of the second premolar. Similar relationships of the MC and both cortical plates existed also in edentate jaws, although the MC was, generally speaking, situated more centrally in those cases.

Table 2.
Distances between MC and outer bony surfaces of mandibular corpus*.
Tableau 2.
Distances entre le CM et la surface osseuse du corps mandibulaire.

Distance	Region of section			
	M3/dist.	M2/M3	M1/M2	P2/M1
MC/ling. side	1.9	1.7	2.3	2.3
MC/bucc. side	3.4	4.9	5.5	3.1

* Mean values in mm.

Relationships of the MC and tooth root apices varied; however, the MC was closest to the apices of the third molar (Tab. 3). The most distant from the canal were second premolar roots, but exceptions do exist and the MC can be closest to that tooth (Fig. 1).

Table 3.
Distances between MC and root apices
Tableau 3.
Distances entre le CM et les apex radiculaires.

Tooth/Root	Distance of MC (mm)	Diameter ($\bar{X}$) (mm)
8/D	1.82	
8/M	3.22	
7/D	4.30	
7/M	5.54	2.6
6/D	4.35	
6/M	5.70	
5	6.00	

Fig. 1: Close proximity of the MC to the alveoli of both premolars.
Fig. 1: Proche proximité du CM des alvéoles des prémolaires.

Mesially from the mental foramen, a clearly defined incisive canal was present in 92% of the dentale mandibles but only in 31% of the edentate ones. The average diameter was 1.2×0.9 mm in dentate mandibles and 0.9×0.4 mm in edentate ones (Tab. 4). In dentate mandibles, the nearest to the incisive canal was the apex of the first premolar, which was somtimes in direct contact with the incisive canal wall. Usually, the most distant from the canal was the apex of the lateral incisor. In the region of the first incisor, as a rule, the incisive canal couldn't be detected as a clearly defined anatomical formation. In edentate mandibles, the incisive canal was clearly defined only in a smal number of cases and could hardly be noticed in poorly spongious bone of the resorbed mandible. However, it was sometimes clearly visible even in edentate mandibles (Fig. 2).

Table 4.
Diameter of incisive canal (IC) and its distance from root apices.
Tableau 4.
Diamètre du canal incisif (IC) et sa distance des apex.

Tooth	Distance of IC (mm)	Diameter ($\bar{X}$) (mm)
4	12.5	1.2×0.9
3	14.7	(dentale)
2	14.5	0.9×0.4
1	(13.8)	(edentate)

Fig. 2: The incisive canal clearly visible in edentate mandibular corpus.
Fig. 2: Le canal incisif clairement visible dans le corps d'une mandibule édentée.

Table 5.
Distances between incisive canal (IC) and outer bony surfaces of mandible in dentate and edentate mandibles*.
Tableau 5.
Distances entre le canal incisif (IC) et les surfaces osseuses de mandibules dentées et édentées.

		Region of section			
Mandible	Distance	P1	C	I2	I1
Dentate	IC/buccal side	4.7	5.8	4.9	5.7
	IC/lingual side	5.5	4.2	3.7	4.5
Edentate	IC/buccal side	5.5	5.3	4.7	4.8
	IC/lingual side	4.3	4.3	5.0	5.8

* Mean values in mm.

In regard to its position, the incisive canal was, on the whole, situated more lingually, which was especially characteristic of the frontal segment. This was less marked in edentate mandibles (Tab. 5).

DISCUSSION

The presented results concerning the morphometric analysis of the MC position in the mandible are generally in accordance with already published data (Schroll, 1975; Reich, 1980). However, it is interesting to note that the schematic presentation of the MC in the mandibular corpus, made only on the basis of its relationship to the outer and inner side of the mandible, gives a wrong picture of its position (Obradovic et al., 1991). In fact, due to lateral displacement of the lingual bony plate in the molar region, the MC is also buccally placed in this region although it is closer to the lingual surface of the mandibular corpus. In other words, the MC is on the whole placed buccally in its horizontal part, even where it is closer to the lingual mandibular surface.

Morphometric analysis of the MC is especially important for the planning of different oral surgical procedures in the mandibular ramus and corpus. For example, every recommended osteotomy of the ramus in orthognathic surgery, as one of its main principles, has the safety of the neurovascular bundle during operation (Moos, 1985). Also, every surgical procedure in the mandibular corpus, including simple or surgical tooth extraction, bears the danger of the MC content injury. This especially refers to the enucleation of great bony lesions in the mandible, which may be in direct contact with the MC content or may even push it aside (Fig. 3).

For the everyday dental surgery practice, of special importance is the fact that the MC can be positioned very high in the atrophic mandibular body, with the mental foramen at its occlusal surface (Fig. 4). Such a position of the foramen sometimes prevents a total denture to be made without previous surgical reposition.

Finally, the position of the mandibular or the incisive canal has to be kept in mind during implantation procedures because the injury of their content undoubtedly discredits the success of the operation. By careful preoperative planning, this complication can be overcome.

Fig. 3: A large keratocyst of the mandibular ramus which displaced the MC lingually and downwards.
Fig. 3: Un kératokyste de la branche montante qui a déplacé le CM lingualement et vers le bas.

Fig. 4: The mental foramen situated at the crest of the resorbed mandibular corpus.
Fig. 4: Le foramen est situé sur la crête du corps mandibulaire résorbé.

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