**EVALUATION OF ANTILINGULA AND MANDIBULAR FORAMEN IN 3D CT SCAN IMAGES FOR MANDIBULAR OSTEOTOMIES**

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**ABSTRACT**

Sagittal split osteotomy of mandible has been performed routinely for correction of mandibular prognathism, retrusion, mild open bite, and asymmetry. One of the big objections to the sagittal split technique is the likely damage to the inferior alveolar nerve. Antilingula is an important landmark in mandibular ramus osteotomies, however it is a highly variable landmark. The purpose of the study is to examine the geometric relationships of mandibular foramen and antilingula in relation to sigmoid notch and deepest concavity of anterior border of ramus using 3D Computed Tomographic data. The values obtained from this study can be of significant use in performing mandibular osteotomies with much confidence by the surgeon.

**INTRODUCTION**

In 1954, Caldwell and Letterman first proposed to use 'antilingula' as the reference for the entrance of the IAN, which was defined as 'a very slight rounded prominence on the lateral surface of the ramus that can be used to identify the mandibular foramen on the mesial side.' (2) The antilingula has since been referred to as being located near the mandibular foramen. This guideline has been used by many surgeons in performing medial horizontal osteotomy. Several reports suggested that the medial horizontal osteotomy should be 'just above the mandibular lingula', and should be extended as far back as possible from the tips of the mandibular lingula. The presence of antilingula and its relationship to the true lingula and the mandibular foramen is highly variable in the literature, and sometimes it is hard to recognize the true lingula due to a poor surgical field of vision, musculotendinous attachment and morphological variants. (3)

Hogan and Ellis concluded that the use of this term for marking the location of ramus osteotomies was illogical and that the antilingula was the musculotendinous apparatus that attaches to the portion of the mandible rather than to the entrance of the Inferior alveolar nerve (IAN). (4) A large amount of compression and stretching force exerted on the neurovascular bundle was found in cases where there was minimal vertical distance between antilingula and mandibular foramen. (3)

The knowledge of the mandibular anatomy as well the inferior alveolar nerve course through the mandible canal is of great importance for the dental surgeons, especially those planning to perform Orthognathic surgeries. An accurate imaging technique might be required to give a detailed form of the mandible including the position of the mandible foramen in relation to the sigmoid notch. (5)

Bilateral sagittal split ramus osteotomy has a very important step of a horizontal bone cut in the ascending ramus, specifically in the area located between the sigmoid notch and mandible foramen. Performing an osteotomy too far superiorly above the mandibular foramen may induce a fracture line in purely cortical bilaminar zone which increases the chances of bad split. (3) Smith *et al* anatomic cadaver study of the mandibular ramus found that fusion of the buccal and lingual cortex of the ramus occurs only in 2% below the lingula. It is recommend that the medial horizontal cut be at or just above the tip of the lingula because a higher cut may be associated with an increased difficulty in splitting or incidence of unfavourable fracture. (5) The most obvious changes in all IAN parameters (latency, amplitude and conduction velocity) and
the highest risk of nerve injury occurred during preparation on the medial side of the ramus. Most importantly, surgeons are unable to operate at the osteotomy site effectively when the exact location of the mandibular foramen and the course of the IAN is not known.(6)

Three-dimensional (3-D) studies in medicine began in the early 1970s presented by Ferencz and Graco.(5) MIMICS software is an image-processing package with 3D visualization functions that interfaces with common scanner formats. It is an interactive tool for the visualization and segmentation of CT images. Measurement with the MIMICS program is a measurement on both 2D and 3D images by identifying landmarks points on a 3D reconstructed model or on CT-scanning images. This method is quite accurate and a comfortable method in comparison with 2D or other measurement methods in the past.(7)

Materials and methods

Inclusion Criteria

CT Scans of Patients with age between 18-40 years old male or female reporting to Department Of Oral and Maxillofacial surgery, Sri Venkateshwaraa dental college diagnosed with mandibular horizontal excess or deficiency, planned for bilateral sagittal split ramus osteotomy.

Exclusion Criteria

Scans with poor image quality or dentofacial deformity around the ramus are excluded. Patients under 18 or over 40 years old with an unidentifiable mandibular second molar position, which is considered a surgical guiding landmark, are also excluded.

Six male patients and four female patients planned for mandibular osteotomies were included in the study. 3D reconstruction of the obtained CT data is done using Materialise Interactive Medical Image Control System (MIMICS) software.

Template for Measuring the Distance Between Different anatomical Reference Points in 3D scan Images

<table>
<thead>
<tr>
<th>Anatomic reference points considered for evaluating mandibular anatomy in 3D scan images</th>
<th>Right side (in mm)</th>
<th>Left side (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-antilingula(A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antilingula –anterior border(B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-mandibular foramen(C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular foramen-anterior border(D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antilingula –mandibular foramen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(horizontal)(W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antilingula–mandibular foramen(vertical)(H)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular canal-Alveolar crest at coronal section (E)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular canal-buccal plate at second molar(F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular canal-lower border at second molar(G)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

The mean distance from anterior border of ramus to mandibular foramen and antilingula were 15.50mm and 15.11mm respectively. The minimum and maximum distances were 14.08-18.01mm for the mandibular foramen and 11.16-18.83mm for the antilingula. The average horizontal distance between antilingula and mandibular foramen did not differ significantly (0.65mm). But the value ranges between -3.20 to 3.97mm. The average distance from the sigmoid notch to the mandibular foramen and antilingula were 17.30mm and 14.23mm respectively. The value ranges between 11.31-21.85mm for the mandibular foramen and 9.26mm- 16.63mm for the antilingula. The average distance from antilingula to mandibular foramen in vertical direction was 3.01 mm. It ranges from 0.0mm to 6.75mm.
DISCUSSION

The antilingula is a bony tubercle on the lateral surface of mandibular ramus. However, it is not always present or obvious. Christopher H. Martone has found that only in 44% of cases antilingula was identifiable. In our study, we have identified the mandibular foramen in all the patients in the CT scan. But Antilingula was not dissected intraoperatively in our patients, since it may result in extensive masseteric muscle stripping and may compromise the vascularity of the osteotomized segments as well as it would produce extensive swelling post operatively.

The importance of the location of the mandibular foramen in regard to the SSRO lies in both horizontal and vertical dimensions because of the placement of horizontal medial ramus osteotomy. The distance from the ascending ramus to the distal surface of the mandibular foramen is important because the horizontal medial ramus osteotomy must extend to or beyond the posterior aspect of the mandibular foramen to preserve the IAN and facilitate the SSRO, yet minimize the potential for any unfavorable condylar fracture. The distance vertically measured from mandibular foramen to coronoid notch where the osteotomy is done is important.

Performing an osteotomy too far superiority, above the mandibular foramen, may induce a fracture line in purely cortical bilaminar bone, inducing this fracture induces an unfavorable sagittal split. To reduce injuries to the inferior alveolar nerve during surgery, knowledge of the anatomic location and course of the mandibular canal is imperative.

MIMICS is the standard software for 3D image processing and editing based on scanned data. The software can translate multitude image modalities including CT, MRI and Micro CT into complete 3D model very easily and quickly. It can process any number of 2D image slices. It has powerful automatic and manual segmentation tools for gray value images.

In this study the relationship between antilingula and the mandibular foramen in vertical and horizontal dimensions is found using 3D CT scan data, vertical measurement ranges from 0 to 6.75mm and the horizontal measurement ranges from -3.20 to 3.97mm. This is in accordance with other studies. These values suggest antilingula shows a high degree of variance and cannot be used to locate the mandibular canal on the medial side of the ramus during BSSO.

In our study, we have identified the mandibular foramen with minimal dissection on the medial aspect of the mandibular ramus. None of our patients had encountered bad split or direct nerve injury complication intra operatively. The average distance between the buccal cortex and the mandibular canal was 6.42mm.

CONCLUSION

Average anatomical measurements from the literature will not be useful to make osteotomy during SSRO, since there was wide range of variation in the anatomical position. It is better to take CT scan and assess the nerve position in every individual cases rather than taking average measurements and also the antilingula is not a reliable landmark to assess the position of the mandibular foramen.

Conflict of Interest

None

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References