Identification of bifid mandibular canals among Iraqi subjects using panoramic imaging system

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ABSTRACT
Background: Bifid mandibular canal is a rare anatomical variation that can be of considerable interest to dentist. The purpose of this study is to identify and classify specific anatomic variations of the mandibular canal suggested the term "bifid mandibular canals".

Materials and Methods: The courses of the mandibular canal in 319 panoramic images of Iraqi subjects were evaluated carefully and bifid mandibular canal was recorded when identified.

Results: The results revealed that 1.88% of the total sample was with duplication or division of mandibular canal.

Conclusion: The course and configuration of the mandibular canal should be carefully observed in different locations because it poses many variations. Bifid mandibular canal is rarely detected but it is important because of its clinical implications.

Key words: Bifid mandibular canal, mandibular canal, variations.

INTRODUCTION
Mandibular canal, or inferior alveolar canal, transmits the inferior alveolar nerve, a branch of the third division of the trigeminal nerve, and the associated vessels. The canal typically extends from the mandibular foramen to the mental foramen. (1)

The knowledge of the course of the mandibular canal and its anatomical variations is of great importance in certain surgical interventions, such as preprosthetic operations and the insertion of dental implants, and during the planning of removable dentures prepared in cases involving extensively atrophied mandibles. (2,3)

Bifid mandibular canals are often unrecognized. The detection of these anatomical variations is important because of its clinical implications. Special attention has to be paid in surgical procedures involving the lower jaw, such as extraction of an impacted third molar, dental implant treatment, and sagittal split ramus osteotomy (3,4), this anatomical variation and its presence can only be confirmed by volumetric imaging. (4)

However mandibular canals can be detected on panoramic radiographs. Nevertheless, as confusion is possible in using two-dimensional images. (5) Many authors have used panoramic radiographs to study the prevalence of bifid mandibular canal. (1, 6-16) but more precise information about the course of the canal can be revealed on cross sectional CT images perpendicular to the alveolar ridge can be used. (3, 5, 17-19)

MATERIALS AND METHODS
Total sample of 319 subjects (159 male and 160 female) were examined, they were attending Al-Karkh hospital in Baghdad, with age range (20-50) years old (Table 1) and referred to Radiology department for Panoramic Imaging. Planmeca Dimax3 Digital X-Ray machine was used and appropriate exposure factors were selected according to the user manual of the machine.

All participants were clinically healthy with no syndromes, clefts, or other malformations. Malocclusion type was not a criterion of sample selection, however, no sever malformations where included and all subjects had previous orthodontic, orthopedic or surgical treatment procedures. High quality images with respect to geometric accuracy and contrast was only studied.

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### RESULTS

Three types of duplication or division of the canal were identified unilaterally on six radiographic images, five of them were on the right side (two male & three female), their ages ranged from (20 to 29) years, and on the left side one image was identified (male aged 23 years). These six images represent 1.88 % of the total sample, males and females were affected equally, as illustrated in table (2).

#### Table 1: Classification of the study groups according to age and gender

<table>
<thead>
<tr>
<th>AGE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>20-29</td>
<td>54</td>
<td>55</td>
<td>109</td>
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<tr>
<td>30-39</td>
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<tr>
<td>40-50</td>
<td>52</td>
<td>52</td>
<td>104</td>
</tr>
<tr>
<td>TOTAL</td>
<td>159</td>
<td>160</td>
<td>319</td>
</tr>
</tbody>
</table>

The three main patterns of duplication found:

1. **Type I**: consisted of two canals originating from one mandibular foramen as seen in (Figure 1; A & B). It occurred in one male and in one female, thus, male to female ratio was (1:1). It represented 0.63% of the total sample and 33.33% of the duplication sample. (Table 2)

![A](image1)  
**Figure 1:** Type I double (bifid) mandibular canal, A: (original), B: (Magnified with contrast enhancement)

2. **Type II**: was seen radiographically as two mandibular canals of equal dimensions apparently arising from separate foramina in the mandibular ramus and joining together to form one canal in the molar region of the body of the mandible (Fig. 2; A & B). It occurred only in one male representing 0.31% of the total sample & 16.67% of duplication cases. (Table 2)
3. **Type III**: Bifid mandibular canal rise from one mandibular foramen then divided in two divisions ended in two separate mental foramina (Fig. 3). It was seen in three images unilaterally one male and two females, so it was the most common representing 0.94% of the total sample, 50% of duplication cases. (Table 2)

**Figure 3: Type III double (bifid) mandibular canal**

**DISCUSSION**

Bifid mandibular canal is a rare anatomical variation that can be of considerable interest to a dentist. This condition can lead to complications when performing mandibular anesthesia or during surgery of the lower third molar, orthognathic or reconstructive mandibular surgery, or placement of dental implants and prosthesis; bleeding and traumatic neuroma are possible complications. Therefore, awareness of this condition is important. (3)

Patterson and Funke (6) used panoramic and lateral jaw radiographs, identified a case of unilateral bifid mandibular canal with two mental foramina. Accessory mental foramen is an additional mental foramen which is situated near by the regular mental foramen, usually placed posterior to it, and probably it is related with race. (20-22)

In the same year, Kiersch and Jordan (7) also reported one case and noted that an osteocondensation image produced by the insertion of the mylohyoid muscle into the
internal mandibular surface, with a distribution parallel to the dental canal, may mimic a bifid mandibular canal.

A number of other cases were reported in the subsequent years. In 1977 Nortjé et al. (8) noticed that duplication or division of the canal was found via panoramic radiographs, in 0.9% (33 out of 3612) of the cases in otherwise normal patients.

In another study conducted by Grover et al, (9) only 0.08% bifurcation of the IAN was found in 5000 US Army recruits, aged 17 to 26 years.

Furthermore, Langlais and co-workers (10) evaluated routine panoramic radiographs of 6000 patients, and they found 57 (0.95%) cases of bifid inferior MC, 19 in males and 38 in females, whereas Zografos et al (12) has found three cases of bifid mandibular canal in 700 panoramic radiographs (0.4%).

On the other hand, Devito & Tamburús (15) found 7.85% of the studied cases with some type of bifurcation of the MC. In relation to its location, 41.83% of the MCs were bilateral high, while 32.09% were bilateral intermediate and 3.44% were bilateral low. 22.64% of the cases showed other variations.

By analyzing panoramic radiographs of 2012 patients Sanchis et al (1) reported that 0.35% of canals were bifid. All cases were registered in women.

A few years later, Auluck et al. (16) found that bifid MC existed in 5 panoramic radiographs (out of 6) cases of failure in mandibular anesthesia and trifid was noted in the remaining 1 case.

Karamifar et al, (2009) (13) reported two cases with bilateral bifid MC by examining their panoramic radiographs.

It seems that for accurate observation of the location and configuration of the bifid mandibular canals it is necessary to use cross-sectional images, taken perpendicular to the axis of the canals (26).

Naitoh et al (17,18) performed two studies, the first study when they used reconstructed computed tomography (CT) images to identify the bifid MC. They showed 4 (out of 5) sides had the bifid MC that possessed a short and narrow upper canal toward the distal area of the second molar while the remaining 1 side had a short and narrow lower canal toward the distal area of second molar.

In 2009 Naitoh et al, (18) reconstructed 122 two-dimensional images of various planes in the mandibular ramus region to the computer program using three-dimensional visualization and measurement software. Bifid MC in the mandibular ramus region was observed in 65% of patients and 43% of sides. Furthermore, they classified bifid MC into four types: retromolar, dental, forward, and buccolingual canals.

During examining the routine panoramic radiograph of a 45-years old man, had problems with accepting a removable lower denture, Miloglu et al (19) suspected bilateral duplicated mandibular canals. CT scans with axial, sagittal and coronal cross-sectional cuts perpendicular to the alveolar ridge were performed with cone beam computed tomography and confirmed this suspicion.

Chavez et al (23) suggested that during embryonic development there might be three inferior dental nerves innervating three groups of mandibular teeth. The canal to the incisors appeared first followed by the canal to the primary molars and subsequently canal to the permanent molars. These canals are directed from the lingual surface of mandibular ramus towards different tooth groups. The three nerves fuse together and form a single unified nerve in one canal. This theory would explain the existence of accessory canals resulting from lack of fusion of these canals.

Six radiographic images on the present study represent 1.88% of the total sample were with bifid canals. Inadequate anesthesia may be possible with any bifurcation type, but especially when there are two mandibular foramina such as type II case in the present study which might be considered as appropriate for the Type III classification by Nortjé et al (9), who considered this case to be the rarest type of duplication.

It is important for the dentist to be aware of the existence of a bifid mandibular canal so that he or she can choose a suitable technique for administering anesthesia (e.g., performing mandibular anesthesia at a higher level, the so-called Gow-Gates' technique). (24-26)

Once the multiple canals are identified, surgical procedures such as implant treatment involving the mandible can be modified to prevent pain, discomfort or even numbness during and after treatment. (27)

REFERENCES

Identification of bifid mandibular


