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# Bifurcation of the inferior dental nerve canal: an anatomical study

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**Abstract**

The aims of this study were to find the incidence of bifurcation of the inferior dental nerve (IDN) canal, to describe the characteristics of this variant, and to examine the sensitivity and specificity of dental panoramic tomography to identify it. We classified bifurcations by size and position relative to the main canal and the lower third molar using cone-beam computed tomography (CT) and dental panoramic tomography. In our study of 281 patients, 106 (38%) had bifurcations, and in one quarter, these were classified as large accessory canals. Bifurcations were most commonly found posterior to the lower third molar (n = 64, 57%) or within 2 mm of the roots of the third molar (n = 40, 38%). The sensitivity and specificity of dental panoramic tomography to identify all bifurcations was 11% (95% CI: 5.67 to 17.97) and 91% (95% CI: 85.58 to 94.68), respectively; this was 33% (95% CI: 15.63 to 55.32) and 94% (95% CI: 90.34 to 96.50), respectively, for large bifurcations. Our use of cone-beam CT suggested an incidence of bifid canals of 38%, with a variation in size and distribution in relation to the lower third molar. It also showed that the sensitivity of panoramic radiography to identify them was poor.


*Keywords:* bifurcation; inferior dental nerve canal; CBCT; DPT

## Introduction

Knowledge of bifurcation of the inferior dental nerve (IDN) canal is important as it offers possible explanations for the failure of anaesthesia, and for intraoperative bleeding, formation of a haematoma, and sensory disturbances after operation.[1] This is supported by studies that confirm that the canal contains a nerve bundle and artery.[1,2] The reported incidence of bifurcation of the IDN canal (also known as the mandibular nerve canal) has increased since the introduction of 3-dimensional imaging (0.08%–66%),[3] and many authors have concluded that cone-beam CT detects these, and other anatomical variations (such as a double mental foramen and lingual foramina),[1,4–7] better than dental panoramic tomography. Cone-beam CT gives a detailed, 3-dimensional image of the nerve canal and its surrounding tissues, and enables identification of a bifurcation. It also shows the direction of the accessory canal. Although panoramic radiography is most commonly used to assess mandibular third molars, its ability to show bifurcations of the IDN canal is poor.[3]

The distribution of bifid canals, particularly in the third molar region, can be confusing because several different classification systems are used. Initially, panoramic imaging, which takes into account the position of the bifid canal in relation to the mandibular third molar, was used,[8] but

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more recently, cone-beam CT has been used to classify its direction.[9] Previous classification systems have limited use in oral surgery, as some are based on two-dimensional images, and others include anatomical landmarks that are not always present in the field of view.

The aims of this study therefore were to find the incidence and describe the characteristics of bifurcation of the IDN canal, and to classify bifid canals using a universal system for oral surgery (specifically lower third molar surgery). We also compared the sensitivity and specificity of panoramic radiography with those of cone-beam CT to identify them.

## Material and methods

We studied consecutive adult patients who presented to the Oral Surgery Department of Guy's Hospital, UK, and had a cone-beam CT between January 2010 and October 2011. In all cases cone-beam CT was done for two main reasons: the initial panoramic tomogram showed "high-risk" features that suggested close association of the third molar to the IDN canal, or gross disease in the posterior mandible (such as a large dentigerous cyst), or both. Patients with images indicative of disease that distorted or displaced the IDN canal, were excluded, as were those without a third molar or a corresponding panoramic tomogram. For patients with bilateral images, one side was randomly selected for examination.

We used the 3D Accuitomo (J Morita, Kyoto, Japan) cone-beam CT apparatus with a tube voltage of 90 kV, tube current of 4 mA, and exposure cycle of 17.5 seconds. The imaging area was a $4 \times 4$ cm cylinder that provided isotropic cubic voxels with sides of roughly 0.125 mm. The projection data were converted by imaging software (i-Dixel, J Morita) into axial, coronal, and sagittal planes. Images that were too pale or too dark were excluded to prevent inaccurate interpretation. All scans were viewed using volume rendering to allow full rotation of the image for more accurate interpretation.

Of the 357 cone-beam CT images available, 76 were excluded, leaving a study group of 281 patients (108 men and 173 women, mean (range) age 31.5 (14–79) years).

### *Incidence and characteristics of bifurcation of the IDN canal*

Two examiners were trained to identify bifurcations of the IDN canal on dental panoramic tomograms and cone-beam CT by a consultant in dental and maxillofacial radiology. To evaluate interobserver agreement, the examiners independently assessed 50 cases before the study, of which about half showed evidence of bifurcation. Inter-rater reliability was estimated by consistency (Pearson's $r$) and consensus methods (Cohen's kappa), and both approaches produced a coefficient of 1.0, which indicated excellent reliability.

Bifurcations were classified by size, site, and direction.

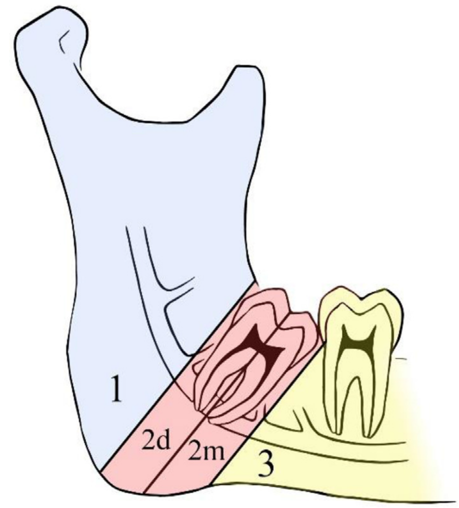


Fig. 1. Distribution of bifid canals arising from the inferior dental nerve canal in relation to the lower third molar. The locations of the canals can be described as type 1, type 2d, type 2m, and type 3.

### *Size*

The size was classified according to the diameter of the accessory canal. An accessory canal was regarded as large if its diameter was greater than, or equal to, 50% of the main canal. It was regarded as small if this was less than 50%.

### *Site*

The site of the bifurcation in relation to the lower third molar was recorded (Fig. 1). A distance of 2 mm from the surface of the root was chosen, based on the diameter of a surgical fissure bur commonly used in third molar surgery.

### *Direction*

The direction of the accessory canal was also noted in relation to the main IDN canal. Bifurcations producing accessory canals that entered directly into the apex of a root were not classified.

Figs. 2–4 show this classification system using cone-beam CT.

### *Ability of panoramic radiography to identify a bifurcation of the IDN canal*

A total of 281 corresponding panoramic tomograms were independently assessed for bifurcation of the IDN canal. The data were compared with cone-beam CT and tested for sensitivity and specificity.

### *Statistical analysis*

We calculated the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios with the