CPQ Dentistry (2019) 1:4
Case Report

Unilateral Mandibular Neurovascular Plexus - CBCT Evaluation of an Intricate Unusuality

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Received: 09 September 2019

Published: 17 October 2019

Keywords: *Neurovascular Plexus; Mandibular Foramen; Mandibular Nerve; Accessory Foramina; CBCT*

Abstract

The following manuscript attempts to unravel the anatomic variations which are ascertained via imaging and clinical co-relational findings exhibiting the intricate presence of complex network of neurovascular plexus / nutrient canal plexus presumably pointing out to the ascribing factors which could have led to repeated failure of dental anaesthesia and extended bleeding during dental extractions in the past as documented in the patient's dental history. The cognizance of such distinctive anatomic intricacies is of immense clinical importance to the oral maxillofacial surgeons before proceeding with any interventional surgeries in the head and neck region.

Introduction

Anatomic science of human body has its own language, and the structure of which can be unravelled only by a veracious search of literature and excerpts from intricacies of the imaging and clinical co-relational findings. A fine network of neurovascular bundles and nutrient canals in the area lateral to the roots of the mandibular molar teeth are notably seen to be extending up into the ramus [1]. The components of the inferior alveolar neurovascular bundle (NVB), which is a major supplier of sensation and blood to the mandible via the mandibular canal, are arranged sequentially from superior to inferior as follows: vein, artery, and nerve [2].

Structural variations in the dental anatomy have been described to be diverse in many studies over past two centuries. The first mention of multiple canals was by Serres (1817) [3] which were confirmed by Robinson (1906) [4]. These variations develop at the later stages of third embryonic month persisting through adulthood. The mesenchyme of the mandible gives rise to a basal vein at the level below the inferior dental nerve and artery [5,6]. This leads to subsequent development of bony channels between the neurovascular structures causing separation from the main mandibular neurovascular bundle.

In the following manuscript, the author attempts to explore the mysterious anatomic variation of a complex intriguing CBCT investigation of a neurovascular plexus / nutrient canal plexus, hence making this manuscript of immense clinical significance for clinicians operating in the oral maxillofacial region along with emphasizing on adaptation of modified or certain specified local anaesthetic techniques in such patients.

Case Presentation

This case study describes a 64-year-old Saudi male, moderately-built, asymptomatic patient who was referred to the author in the department of oral and maxillofacial surgery at a tertiary referral centre for dentistry for extraction of periodontally compromised teeth with moderate to severe bone loss and teeth mobility as part of a comprehensive oral rehabilitation plan.

Clinical Findings

Patient's medical history was non-significant. Extra orally there was no obvious asymmetry of the face. On intra oral examination, there were multiple missing teeth in the mandibular arch with only remaining 41, 42, 45, 34, 35 & 36 teeth. The maxillary arch had a complete dentition except for the bilateral third molars which the patient gave history of being extracted over three decades back. Exodontia of the all the molars in maxillary and mandibular arches was planned due to the mobility caused as a result of severe bone loss secondary to periodontal disease. The patient's previous dental history involved multiple dental visits and also the repeated failure of dental anaesthesia. This intriguing past dental history kindled the author to instigate a comprehensive clinical examination followed by a detailed clinical interview so as to implement a systematic approach in providing the patient an efficient and a beneficial treatment plan catering to complete oral rehabilitation.

Investigations

Routine preliminary investigations such as an Orthopantomograph and complete mouth series intra oral periapical radiographs were performed followed by 3D CBCT scan evaluation.

Panoramic Radiographic Findings

An unusual scalloping and striations of the bone pattern in the left ramus of the mandible (Fig. 1) which did not co-relate with the normal morphologic features of the mandible were revealed. This instigated the need for further evaluation of mandible and the coronoid processes.

Figure 1: *Panoramic radiograph revealed unusual radio-opaque scalloping on the left ramus region with multiple parallel striations to inferior dental canal (black circle) which was absent on the right side*

Three Dimensional Cone Beam Computed Tomography (3D CBCT) Parameters

A 3D CBCT by Orthopantomograph OP300 scanner with technical parameters: image volume size 61 x 78mm, tube current 15mA, tube voltage 80kV, scan time 16s, exposure time 12s pulsed X-ray. The software used was DICOM On Demand 3D from Cybermed, USA, for image acquisition.

Analysis of the 3D reconstruction of this scan confirmed the structural alterations such as presence of accessory foramina with bony irregularities / striations (possible canals) on the lateral and medial aspect of the ramus of the mandible. There was the presence of a foramen in the anterior aspect of the ascending border of the ramus just below the coronoid process resembling a retromolar foramen but its location being higher than that of the actual retromolar foramen, an accessory foramen on the lateral aspect of the ramus (Fig. 2). Both distinctive radiographic findings were hinting at the fact that they are not consistent with the normal morphology of the mandible.

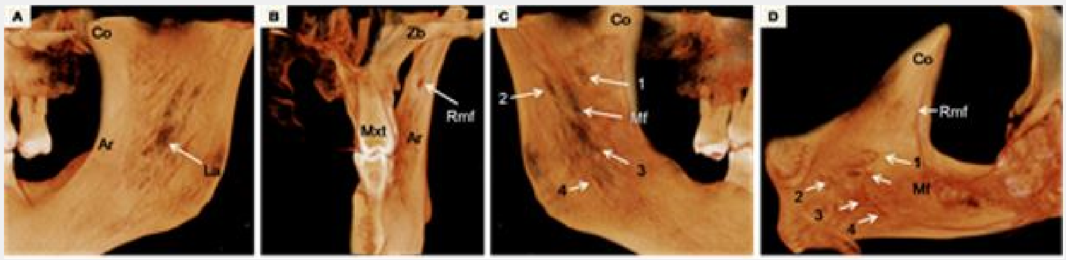

Figure 2: *3D CBCT scan images left side of ramus of mandible A showing Co coronoid process; Ar ascending border of ramus; La Lateral accessory foramen on ramus along with bony irregularities aspect showing Mxt maxillary teeth; Zb zygomatic botress; Ar ascending border of ramus; Rmf retromolar foramen C showing medical aspect of ramus Co coronoid process; Mf mandibular foramen; 1, 2, 3 & 4 multiple accessory foramina with bony strictions (possible canals) and irregularities on the lingual aspect D showing medical aspect from top Co coronoid process; Rmf retromolar foramen; Mf mandibular foramen; 1, 2, 3 & 4 accessory foramina*

Coronal section of the scan images revealed the presence of accessory foramina both superior and inferior to the mandibular foramen and mandibular canal along with presence of multiple canals encircling the inferior dental canal which is interspersed throughout the entire ramus of the mandible (Fig. 3). The largest of the accessory mandibular foramen was present antero-superior to the actual main mandibular foramen and was continuous with a canal in confluence to the main mandibular canal up to the level of the mental foramen region. The medial aspect of the mandible revealed a foramen exiting inferior to the main mandibular canal suggesting a branching of the inferior dental neurovascular bundle. It was captivating to find that the small accessory canals had their own separate course ending abruptly towards the centre of the body of the mandible.

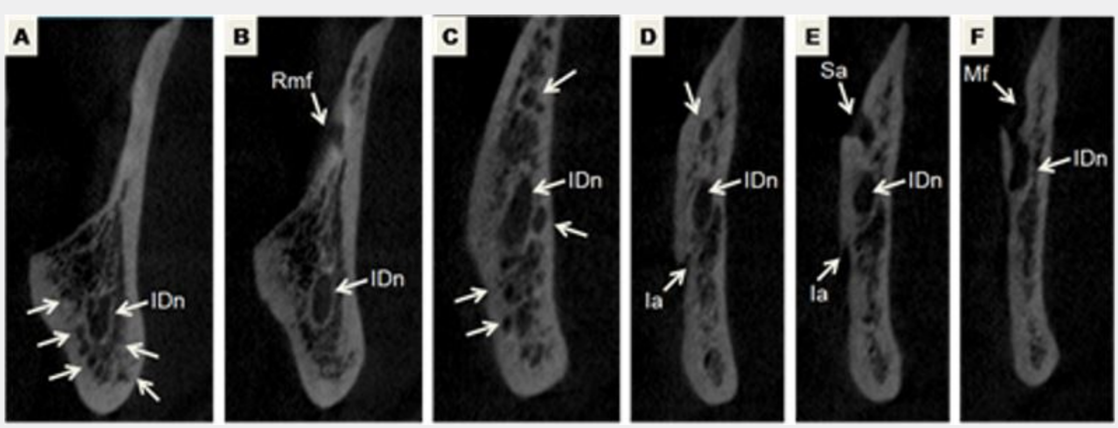

Figure 3: *Coronal section images of left side of ramus of mandible A – F antenor to postenor orientation showing IDn infenor dental nerve; unlabeled arrows multiple accessory nerve canals; Rmf retromolar foramen; la infenor accessory foramen on medial aspect of ramus; Sa Supenor accessory foramen on medial aspect of ramus; Mf mandibular foramen*

The axial section of the scan images unveiled the presence of a foramen on the anterior border of the ramus along with a canal in confluence, small accessory foramina exiting lateral and medial to the ramus (Fig.4). The sagittal section of the scan images ascertained the presence of the variations in the ramus of the mandible with the presence of retromolar foramen and its canal, multiple accessory foramina and canals running parallel to and few branching out from the main mandibular canal. The accessory canals appear to end abruptly at the level of the body of mandible just anterior to the second molar region (Fig. 5). The variations are suggestive of presence of complex network of neurovascular plexus presumably pointing to the ascribing factors, which could have led to repeated failure of dental anaesthesia and extended bleeding during dental extractions in the past as documented in the patient's dental history.

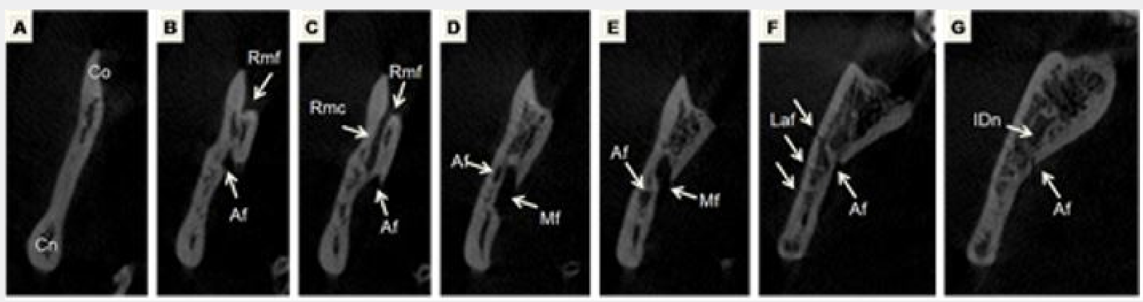

Figure 4: *Axial section images of left side of ramus of mandible A-G superior to inferior orientation showing Cn condyle; Co coronoid process; Af accessory foramen; Rmf retromolar foramen on anterior ramus; Rmc retromolar canal in ascending ramus; Mf mandibular foramen; Laf multiple accessory foramina on lateral aspect of ramus; IDn inferior dental nerve*

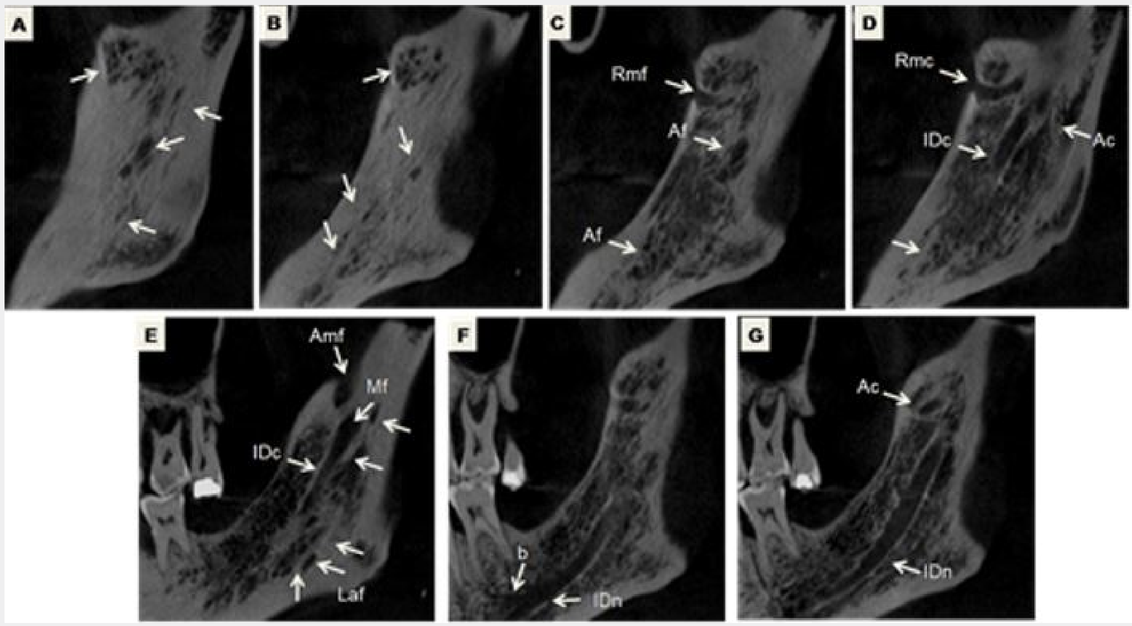

Figure 5: *Sagittal section images of left side of ramus of mandible A-G lateral to medial orientation A lateral accessory foramina; B foramina merging into accessory canals; C showing Rmf retromolar foramen on anterior ramus; Af accessory foramina; D Emc retromolar foramen and its canal in ascending ramus; IDc inferior dental canal; Ac accessory canal; E showing Amf accessory mandibular foramen; Mf mandibular foramen; Laf multiple accessory foramina on lateral aspect of ramus; F showing b anterior branching from the main mandibular canal; idn inferior dental nerve; G showing accessory canal and inferior dental nerve canal*

Discussion

The mandibular neural structures are a flexible interplay between neurovascular bundles and bony channels within the bone in typical pattern. The neurovascular bundle after entering the mandibular foramen, runs through the ramus of the mandible on the medial aspect to the angle and then proceeds further into the body of the mandible and finally end in the mental foramen. During this course, it is surrounded by the mandibular canal, which splits into incisive and mental canals respectively below the second premolar. However, the incisive canal moves on as a continuation of the mandibular canal to the anterior chin region [7], whereas the mental canal ends in the mental foramen. Beyond this division of mental canal, a single, well-defined canal could no longer be perceived below the central incisors [8]. It is speculated that the mandibular anterior teeth, interdental space and gums are supplied by the nutrient canals and fine branches emitted by the mandibular and the incisive canal. These nutrient canals vary in shape, size and direction containing the rami dentales and septales of the inferior alveolar artery and the rami dentalis of the inferior alveolar nerve [7] or so-called neurovascular plexus, allowing cross-innervations at the level of the mandibular midline and majority of the mandibular incisive canals terminate between first premolar and the canines [9].

The inferior alveolar nerve trunk has exhibited a branching structure suggestive of the upper limb brachial plexus. This plexus-like structure was the fragile network of the inferior alveolar artery. There were numerous communications between the individual components, including fine filaments to the auriculotemporal nerve both proximal and distal to its origin [10]. A second "plexus" was located between the mandibular canal and the roots of the mandibular teeth and was composed of small fine filaments which arose from the intra-mandibular plexus. These fine plexus network appeared to enter the roots of the teeth on their lateral surfaces as well as at the apices. The neurovascular plexus lies within a discrete canal running up to the mental foramen and seems to disappear distal to this point [10].

The pattern of distribution of the inferior alveolar nerve was classified into three types [1]. In Type 1, this arrangement the inferior alveolar nerve was a single large structure lying in a bony canal. The branches of supply to the canine and incisors were always found in a deeper (inner or posterior) position and were offshoots from a large branch of the main nerve given off just before it entered the mental foramen. The incisor plexus, while connected to the branches mentioned, was not the source of the dental branches. They clearly displayed thick down turning branches, from both the dental branches and from the incisor plexus, leading to foramina on the inner surface of the mandible opposite the premolar teeth. These foramina were described by Shiller & Wiswell (1954) [11] and provide a route for communication between branches of the mylohyoid nerve and the incisor plexus or the dental branches of the inferior alveolar nerve. Additional prolongations of the plexus can be traced to foramina, also described by Shiller & Wiswell (1954) [11], near the midline on the posterior aspect of the symphysis, either above- or below the genial tubercles. The undivided nerve was situated a little more inferiorly, and its branches to the teeth were arranged in a plexus between the nerve and the roots, instead of being direct offshoots to the roots, it seemed like the plexus gave off branches to the periodontal and gingival structures.

In Type 2, the nerve was situated substantially lower down in the mandible, some distance from the roots of the molars. The dental branches were given off more posteriorly and were consequently longer and more oblique in position that in type 1. The further course of the nerve was as described in type 1. While Type 3, the inferior alveolar nerve gave off two large branches posteriorly, which together could be regarded as equivalent to an alveolar branch, while the main continuation of the nerve occupied a more inferior position and continued, as in the other types, towards the mental foramen and the supply of the canine and incisor teeth.

These accessory communications could provide auxiliary innervations to the mandibular teeth and associated soft tissues and may be implicated in insufficient dental anaesthesia owing to the potential for collateral transmission of nervous impulses [12]. The mandibular nerve branches are known to exhibit high variations within the infratemporal fosse, as they travel to enter the mandible. In the infratemporal fossa the inferior alveolar nerve seems to originate from the posterior division of the mandibular nerve as 2 distinct branches or roots [13]. Hence for profound dental anaesthesia in this region should be alternated with a modified or specified different approach than the conventional Haldstead [14] method of inferior alveolar nerve block.

Conclusion

The following case presentation represents a compound entity by unravelling the anatomic variations of presence of intricately complex network of neurovascular plexus component. Galen describes plexus as -

"It is not a simple network but [looks] as if you had taken fisherman's nets and superimposed them. It is characteristic of this net of nature's, however, that the meshes of one layer are always attached to those of another, and it is impossible to remove anyone of them alone; for, one after another, the rest follow the one you are removing, because they are all attached to one another successively" in his book 'On the Usefulness of the Parts of the Body' [15]. As it is almost always better to be safer than sorry indicating that every oral maxillofacial surgeon should have the ability to fore see a cognizance of a possibility of existence of such an intricately distinctive anatomic variant before heading with any interventional surgeries in the head and neck region and adapt to modified or specific local anesthetic techniques for successful accomplishment of treatment protocol.

Acknowledgement

The author thanks the patient for his kind co-operation in the investigations and the consent rendered to illustrate the findings in the manuscript.

Compliance with Ethical Standards

All the findings were incidental and not planned procedural study. The patient was informed about the peculiar findings in him and an informed signed consent was taken with permission to use his data for research publication purposes.

Funding & Conflict of Interest

There was no funding for this study and the author declares that there is no conflict of interest.

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