S. Nikzad DDS, MSc[1]
A. Azari DDS, MSc[2]
S. Sabouri MD[3]

Double Mandibular Foramina and Canal: Report of a Case with Interactive CT-Based Planning Software

The identification of the mandibular canal and its anatomic variations is of great importance in many branches of dentistry, especially in implant dentistry and prior to endosteal implant insertion. This knowledge is even more demanding when the mandible has been compromised by different degrees of atrophy and bone resorption. In this study we describe a rare case of double mandibular canal identified by three-dimensional imaging techniques during the process of diagnosis. It is concluded that mandibular canals may often be undetected during the diagnosing phase of implant treatment, and tomographic imaging is the only way to identify some of these distinctive features.

Keywords: Mandibular Nerve, Mental Foramina, Computed Tomography, Dental Implants

Introduction

The inferior alveolar nerve (IAN) is one of the most important anatomical features which may challenge the implantologist in choosing the best location for his/her implant positioning in the lower jaw. Some argue that the unintentional injuries to this vital anatomy do occur as a normal occurrence, even with the most careful preoperative planning and intraoperative techniques.[1] However, others consider these types of injuries very unsatisfying for the patient and account these complications as a fault and indemnity for the reputation of dental profession.[2] In the recent years, the higher incidence of IAN injuries, as a complication to implant treatment,[3,4] is becoming a major concern, and some studies indicate a complication rate not to be ignored.[5,6] Although the implantology is so affected by these complications, this very important anatomy may also become injured during injection,[7,8] minor and major oral surgery,[9-11] and endodontic treatment.[12]

In implantology, however, it seems that the most severe and lasting injuries are caused by the drill, and indeed most practitioners eventually learn by try and error that over-preparation of the surgical site may jeopardize the IAN and its accessories. The mandibular canal, which encloses the IAN, is usually considered as a single channel by many practitioners, enclosed by bony structure, forming an upward crumped curve. Radiologically, its appearance has been described as "a radiolucent dark ribbon between two white lines".[13] Although in many reference textbooks of anatomy, this structure is described as a single canal, there are several reports in the literature which clearly demonstrate the presence of a second [14-20] or even third mandibular canal [21] in many cases. It was proposed that identifying these structures enables the clinician to prevent potential complications that can sometimes have very serious consequences during surgery in

1. Assistant Professor, Department of Fixed Prosthodontics, Faculty of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.
2. Assistant Professor, Department of Prosthodontics, Faculty of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.
3. Assistant Professor, Department of Radiology, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Abbas Azari
Address: Department of Prosthodontics, Tehran University of Medical Sciences, Faculty of Dentistry, Quds St., Tehran, Iran.
Tel: +9821-2225-0734
Fax: +9821-2257-6968
Email: azari@sina.tums.ac.ir

Received June 24, 2007;
Accepted after revision November 11, 2007.

Iran J Radiol 2008;5(2):83-86

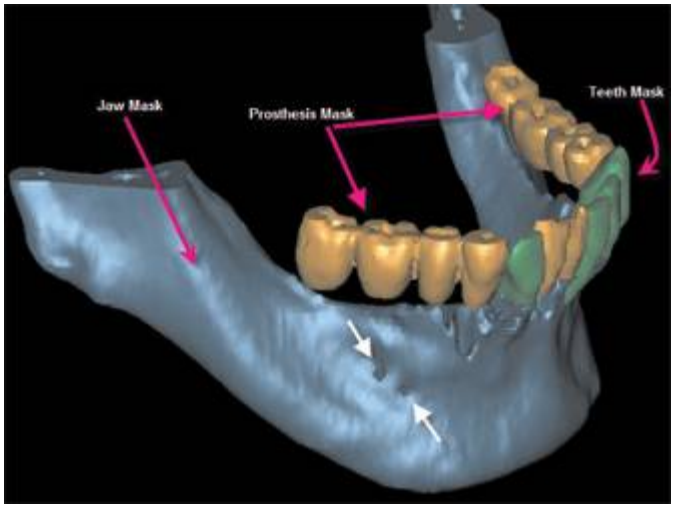

Fig. 1. The process of masking will provide the clinician with a fully masked and full-color 3D model which can easily be toggled on or off for a better view of the anatomical structure of interest.

the mandibular region. The incidence of this sometimes argued "rare abnormality", was reported from 0.08% to as high as 8%. [14,15,17,22] In some reports, a difference between different races has also been pointed out.[19] It is interesting that this type of anatomical variation is usually found out during radiographic jaw examinations for different therapeutical purposes. Until recently, all radiographic studies have utilized two-dimensional radiography, mostly panoramic radiographs. However, this type of two dimensional plain radiographs has no ability to precisely determine the exact course of the mandibular canal. It seems that emersion and then promotion of 3D medical imaging devices like CT and MRI makes it possible to see the anatomical structure "as a glass" and search the existence course of accessory mandibular canals and foramina exactly. The purpose of this article is to present a case report of unilateral mandibular accessory canals and foramina based upon an interactive CT-based program.

Case Presentation

A 44-year-old man attended for mandibular implant treatment. The patient was provided with a scannographic type appliance during the CT scanning procedure.

CT examinations were performed using a Q-speed Pro spiral CT scanner (GE Healthcare, Waukesha, WI) operated at 100 kVp and 87 mA. Overlapping 0.6 mm axial cuts were obtained through the mandible at 0.6 mm intervals in bone window. A planning line was drawn along the center line of the mandibular jaw arch. Images were then reconstructed into orthoradial (slice thickness 0.6 mm) and panoramic views (slice thickness 1.25 mm).

The axial slices retrieved from scanning are reformatted according to the protocols first advocated by Materialise Dental (Leuven, Belgium). The raw data in the form of DICOMs were sent out to a certified site for development and reconstruction purposes. There, the axial images were elaborately cleaned off from irrelevant anatomies (i.e. spinal cord, opposing teeth, metal scatterings etc.).The process is called "masking" and in this way the data can be viewed better for further diagnostic purposes. During this special procedure all non-important data were meticulously removed and an exact full-color 3D reconstruction of the jaw was prepared (Fig.1).

The reformatted and cleaned data were sent back to the clinic as a single file for virtual implant planning. This file was rendered to a special dedicated implant planning software program, Simplant ™ (Materialise Dental, Leuven, Belgium).

The presence of a double unilateral mandibular canal is documented by first opening the file in the proper software proper (Fig.1). Changing the position of reformatted images makes it possible to trace the course of the mandibular canal precisely and draw the exact pathway of the nerve. In this approach, it was shown that the right canal was divided into two separate canals at the posterior part of the mandible, then the two canals fused together in the middle and ended at the two separate foramina anteriorly (Figs.2A and 2B). These structures are demonstrated in different multiplanar reformats (MPRs), but a known limitation of MPR is that, visualized structures must be in the same plane, because an MPR cannot create an entire structure.

3D reconstruction model of the jaw will clearly demonstrate the trace of the canal in three dimensions (Fig. 3). By tracing the exact shape of IAN, it is now possible to precisely plan the implant location without the fear of traumatic injury to the nerve during implant osteotomy. This is demonstrated in figure 4. The orthopantomographic view of the patient's jaw after implant placement is shown in figure 5.

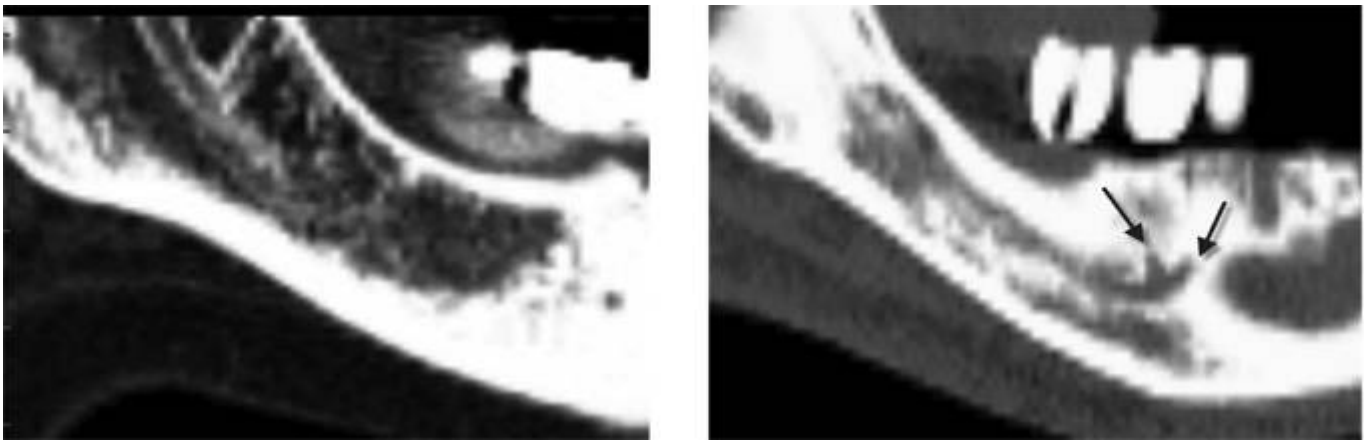

Fig. 2. Part of the panoramic reconstruction of the right mandible (thickness 1 mm) with two mandibular canals.

A. Division occurs in the mandibular posterior region.

B. Ends at the two distinct foramina anteriorly.

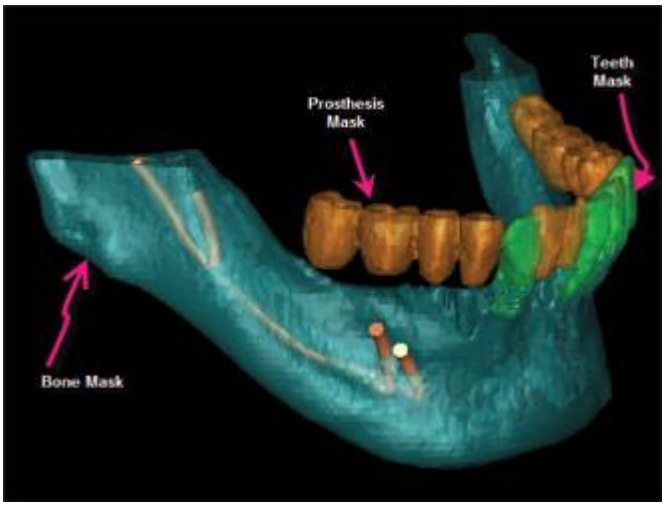

Fig. 3. The masked, full-color 3D model of the patient's jaw with the traced nerve.

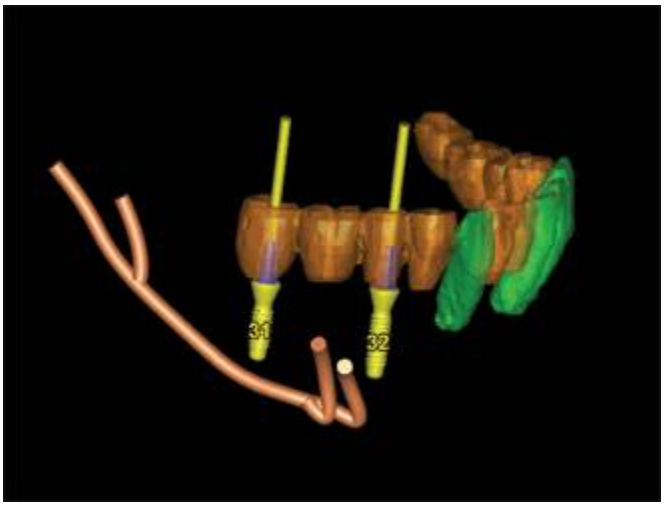

Fig. 4. The precise location of implants considering nerve location as well as bone encasement, implant paralleling, existing occlusion and bone density were performed by the aid of software. For the sake of clarity, the mask of the bone was toggled off.

Discussion

After about 30 years of experience, dental practitioners have really been convinced that implant treatment is one of the most successful treatment options for treating edentulous jaws. This high degree of success can even be higher by meticulous attention to so many diagnostically important anatomical features which can almost totally prohibit the potential of unintentional faults during surgical intervention. In order to achieve the best treatment, it is mandatory to use the best possible diagnostic aids.The technical advancement acquired in the recent years makes the procedure of implant treatment very precise, and actually prevents possible injuries to vital anatomic structures during surgery and implant placement. Interactive CT-based planning software programs are among the best and most useful utilities which provide the opportunity for clinicians to view the implant site like a glass. In this way the best possible width and height, bone density, and position regarding vital structures and occlusion are enclosed. It is obvious that knowledge of the anatomic variation of the mandible may be quite helpful in oral surgical procedures, prosthodontics, and other branches of dentistry. This may increase the success of certain interventions, and avoid surgical complications. Accordingly, consideration of the possible presence of interesting anatomic variations may help avoid common complications, such as nerve injury during routine procedures and may increase their success.

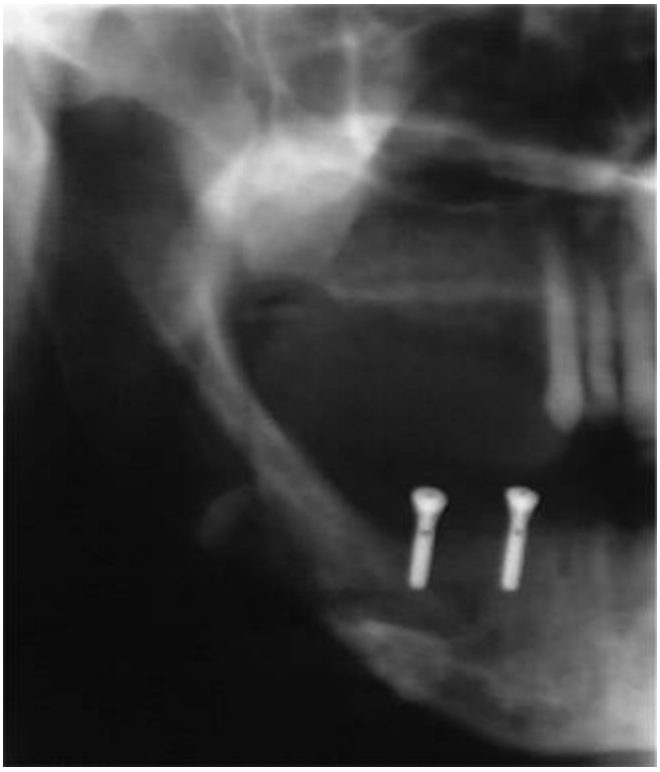

Fig. 5. The orthopantomographic view of the patient's right mandible after implant placement. Compare this view with the virtual one presented in Fig.4.Tooth No. 27 has been extracted surgically.

References

1. Hegedus F, Diecidue RJ. Trigeminal nerve injuries after mandibular implant placement; practical knowledge for clinicians. Int J Oral Maxillofac Implants 2006;21(1):111-6.
2. Worthington P. Injury to the inferior alveolar nerve during implant placement: a formula for protection of the patient and clinician. Int J Oral Maxillofac Implants 2004;19(5):731-4.
3. Kraut RA, Chahal O. Management of patients with trigeminal nerve injuries after mandibular implant placement. J Am Dent Assoc 2002;133(10):1351-4.
4. Rouas P, Nancy J, Bar D. Identification of double mandibular canals:literature review and three case reports with CT scans and cone beam CT. Dentomaxillofac Radiol 2007;36:34-8.
5. Bartling R, Freeman K, Kraut RA. The incidence of altered sensation of the mental nerve after mandibular implant placement. J Oral Maxillofac Surg 1999 Dec;57(12):1408-12.
6. Dao TT, Mellor A. Sensory disturbances associated with implant surgery. Int J Prosthodont 1998;11(5):462-9.
7. Haas DA, Lennon D. A 21 year retrospective study of reports of paresthesia following local anaesthetic administration. J Can Dent Assoc 1995 Apr;61(4):319-30.
8. Hillerup S, Jensen R. Nerve injury caused by mandibular block analgesia. Int J Oral Maxillofac Surg 2006 May;35(5):437-43.
9. Akal ÜK, Sayan NB, Aydogan S, Yaman Z. Evaluation of the neurosensory deficiencies of oral and maxillofacial region following surgery. Int J Oral Maxillofac Surg 2000 Oct;29(5):331-6.
10. Carmichael FA, McGowan DA. Incidence of nerve damage following third molar removal: a West of Scotland Oral Surgery Research Group study. Br J Oral Maxillofac Surg 1992 Apr;30(2):78-82.
11. Bataineh AB. Sensory nerve impairment following mandibular third molar surgery. J Oral Maxillofac Surg 2001 Sep;59(9):1012-7.
12. Grotz KA, Al-Nawas B, de Aguiar EG, Schulz A, Wagner W. Treatment of injuries to the inferior alveolar nerve after endodontic procedures. Clin Oral Investig 1998 Jun;2(2):73-6.
13. Worth HM. Normal radiographic appearances of the teeth and jaws and variations within the normal. In: Worth HM, editor. Principles and practice of oral radiologic interpretation. Chicago, IL: Yearbook Medical; 1963. p 207-12.
14. Nortje CJ, Farman AG, Grotepass FW. Variations in the normal anatomy of the inferior dental (mandibular) canal: a retrospective study of panoramic radiographs from 3612 routine dental patients. Br J Oral Surg 1977 Jul;15(1): 55–63.
15. Nortje CJ, Farman AG, de V Joubert JJ. The radiographic appearance of the inferior dental canal: an additional variation. Br J Oral Surg 1977 Nov;15(2):171–2.
16. Grover PS, Lorton L. Bifid mandibular nerve as a possible cause of inadequate anesthesia in the mandible. J Oral Maxillofac Surg 1983 Mar;41(3):177–9.
17. Langlais RP, Broadus R, Glass BJ. Bifid mandibular canals in radiographs. J Am Dent Assoc 1985 Jun;110(6):923–6.
18. Claeys V, Wackens G. Bifid mandibular canal: literature review and case report. Dentomaxillofac Radiol 2005 Jan;34(1):55–8.
19. Igarashi C, Kobayashi K,Yamamoto A, Morita Y, Tanaka M. Double mental foramina of the mandible on computed tomography images: a case report. Oral Radiol 2004;20:68–71.
20. Kaufman E, Serman NJ,Wang PD. Bilateral mandibular accessory foramina and canals: a case report and review of the literature. Dentomaxillofac Radiol 2000 May;29(3):170-5.
21. Auluck A, Pai KM. Trifid mandibular nerve canal. Dentomaxillofac Radiol 2005 Jul;34(4):259.
22. Wyatt W. Accessory mandibular canal: literature review and presentation of an additional variant. Quintessence Int 1996 Feb;27(2):111–3.