# Third mandibular molar and inferior alveolar nerve: a clinical case of a software elaboration

*Terzo molare mandibolare e nervo alveolare inferiore: un caso clinico di studio con elaborazione software*

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## ABSTRACT

### OBJECTIVES

*The aim of this article is to explicate the usefulness of the images elaboration with a software to evaluate the position of lower third molar and IAN and to show how this program could influence the treatment planning.*

### MATERIALS AND METHODS

*A first evaluation made on a panoramic radiograph shows positives signs of contact between tooth and nerve; for better assessment, a Dental CT Scan is prescribed. Through DICOM images acquisition and the software elaboration it is possible to carry out a 3D reconstruction of the anatomical site and a deepened study of the case.*

### RESULTS

*When positives radiograph signs of close relationship between lower third molar and IAN are found, there is the indication to prescribe a CT Scan and the use of a software reconstruction could be very helpful.*

### CONCLUSIONS

*The relationship between third molar and inferior alveolar nerve (IAN) could sometimes be very close. During surgical extraction IAN could be damaged from surgical instruments and tooth traction. The anatomic proximity between third molar and IAN should be investigated pre-operatively with appropriate radiologic techniques. The use of this software is*

## RIASSUNTO

### OBIETTIVI

Lo scopo di questo articolo è di dimostrare l'utilità di un'elaborazione d'immagine mediante l'utilizzo di un software con ricostruzione 3D per valutare la posizione del terzo molare inferiore e del NAI al fine di mostrare come il programma sia in grado di influenzare la pianificazione del trattamento.

### MATERIALI E METODI

Una prima valutazione è stata eseguita con una radiografia panoramica che rileva segni evidenti di contatto tra le radici dentarie e il nervo; per una migliore diagnosi è stata prescritta una Dental TC Scan. Mediante l'acquisizione di immagini DICOM e l'elaborazione software è possibile ricostruire un modello 3D del sito anatomico al fine di approfondire lo studio del caso.

### RISULTATI

Qualora siano presenti segni positivi di stretta relazione tra terzo molare inferiore e il NAI, sarebbe indicato prescrivere una TC: in tutti questi casi l'utilizzo di un software di ricostruzione può risultare molto utile.

### CONCLUSIONI

Talvolta il terzo molare inferiore e il NAI possono trovarsi in stretto rapporto; durante un'estrazione chirurgica il NAI può essere danneggiato dagli strumenti utilizzati o dalla trazione delle radici dentarie. La prossimità anatomica tra terzo molare e NAI dovrebbe sempre essere investigata con opportune indagini radiologiche.

*not always necessary, but it could be offering the possibility of an added value to the diagnostic phase that could minimize the risk of damages to the inferior alveolar nerve.*

**KEY WORDS**
- *Third molar extraction*
- *Surgery planning*
- *Software elaboration*
- *CBCT Dental Scan*
- *Inferior alveolar nerve*

L'utilizzo di un software non è sempre necessario, ma può offrire la possibilità di una valutazione aggiuntiva e approfondita alla fase diagnostica, minimizzando così il rischio di danni.

**PAROLE CHIAVE**
- Estrazione terzo molare
- Programmazione chirurgica
- Elaborazione software
- TC raggio conico Dental Scan
- Nervo alveolare inferiore

## 1. INTRODUCTION

The inferior alveolar nerve is the posterior-medial ramus of mandibular nerve, third branch of trigeminal nerve (fifth cranial nerve). It's a mixed nerve, with a big prevalence of sensitive fibres. Its sensitive component innerves alveolus, inferior teeth, gingiva, mucosa and the skin of chin and lower lip. The nerve enters in the mandible through the mandibular foramen, which is located near Spix spine, on the medial surface of the ascending mandibular ramus. It cross the mandible in the mandibular canal until mental foramen, where it splits into two terminal ramus: incisal and mental nerve[1]. Mental nerve usually emerges from the foramen between first and second premolar.

Third molar extraction is one of the most common procedures carried out by oral surgeons. Although the common complications after third molar extraction are edema, bleeding, superinfection, alveolitis, pain and swelling; the most serious and specific one is the neurosensory complication due to inferior alveolar nerve damage, which occurs with an incidence of 0,3% to 8,4%[2].

Some other less frequent causes of IAN injury could be: loco-regional anaesthetic injections for IAN block, endodontic treatments with overfilling of lower premolars and molars, malignant expansive lesions, metastases, mandibular fractures, local infections and pre-prosthetic surgeries[3].

The extraction of lower third molars is the primary cause of permanent nerve sensitive alterations of IAN, even more commune than implants positioning and orthognathic surgery[4], but fortunately, in most cases, this procedures implies little or no risk for the adjacent anatomic structure and is possible to carry out the extraction without risk of IAN injury.

An understanding of the possible mechanisms leading to nerve injury should reduce this occurrence[5].

The exact position of the mandibular nerve must be carefully investigated pre-operative, with a correct use of radiographic imaging techniques. Its anatomical relationship with third molar shoud be studied with an adequate software for images elaboration[4].

IAN canal's position compared to third molar's roots could be classified in lingual, inter-radicular, buccal or inferior. In some situation there is a direct contact between nerve and tooth, without bone tissue between them[6].

In this clinical case the ortophanoramic radiography shows radiographic signs of closed anatomical relation, that suggests an increase IAN damage risk[7]. The radiographic signs are: deflections of the root, narrowing of the root, diversion and narrowing of the canal. Prescription of a Dental CT Scan DICOM is mandatory and the relationship between nerve and third molar is investigated

with a dedicate software for imaging reconstruction.

## 2. MATERIALS AND METHODS

We analysed the imagine of one 46 years old female patient came to our observation requiring a valuation of the third lower left molar with a panoramic radiographic **(fig. 1)**. She reports only one episode of pericoronitis, resolved with a course of antibiotic. At the time of the visit, she was completely asymptomatic and there weren't any signs of inflammation.

The panoramic showed a close relationship between the third left molar and the IAN.

Therefore a CBCT Dental Scan with DICOM images was request to further assess the course of IAN and its relationship with the tooth.

The DICOM file was than elaborated with the software Nobel Clinician (Nobel Biocare, Kloten, Switzerland) which allows an accurate analysis of the relationship between the root and the mandibular canal. With this program is possible to mark the exact course of the nerve with a dedicated option call "nerve tool" which consent to highlight the exact path of the nerve thanks to a three-dimensional coloured reconstruction. In this way is possible to evaluate immediately the number, the correct anatomy, the dimension and
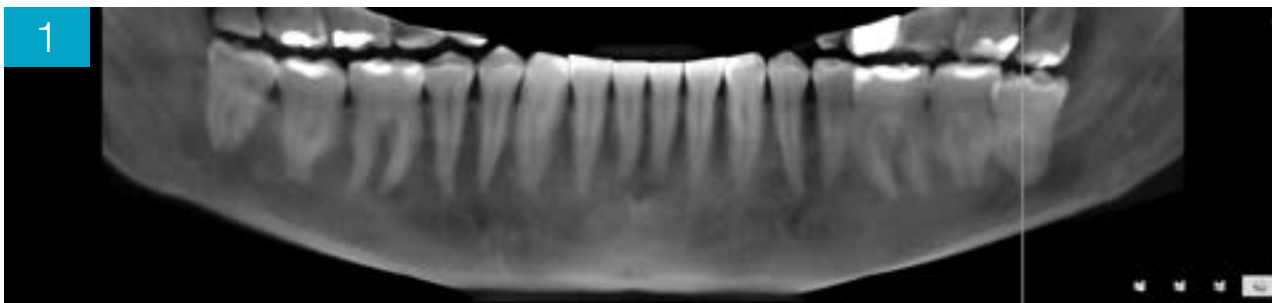
**Fig.1** Panoramic view, lower arch

the inclination of tooth's root as well as the dimension and the inclination of its crown and the extension of dental follicle. The relationship between tooth and nerve is now more evident and it is visibly easier and faster to identify it **(figg. 2a, b-3a-c)**.

The program also gives the possibility to make measurement of distances in millimetres and of angles in degrees.

The sections of the mandible can be analysed from different points of view, such as panoramic, axial or paraxial view.

The software also produces a three-dimensional reconstruction from the CT images **(fig. 4)** and it's possible to exam-ine it from different space's perspectives like vestibular, lingual, distal, medial, upper and lower view.
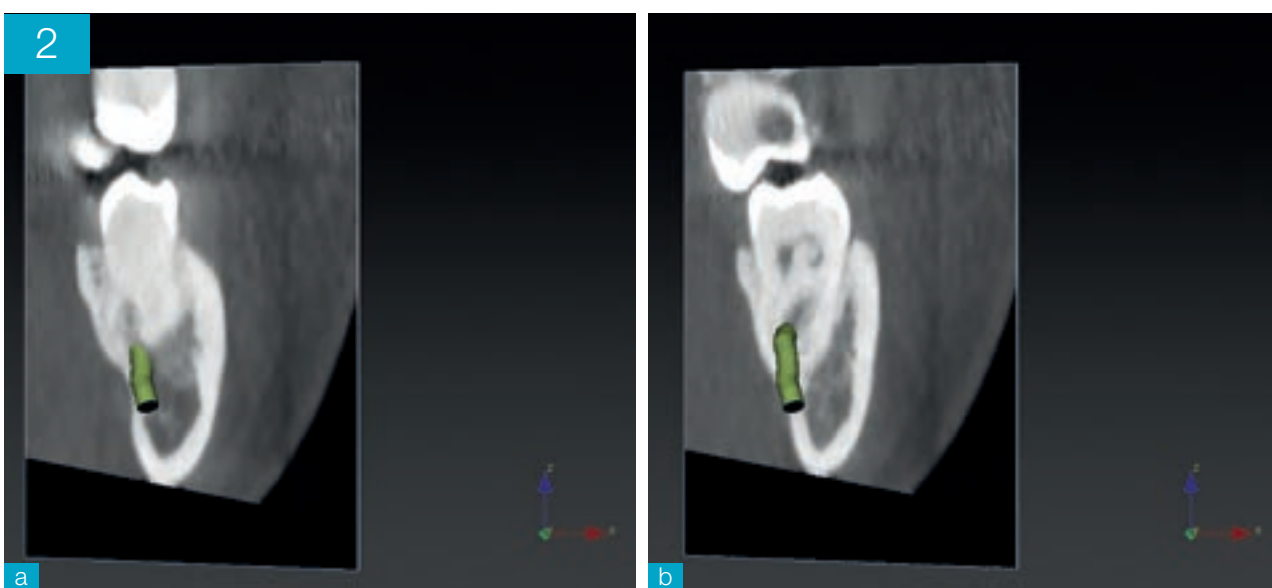
## 3. RESULTS

In this clinical case, thanks to the software elaboration, was possible to find out immediately, from the 3D reconstruction, that the tooth has three roots (two vestibular, one distal and one mesial, and one lingual) fused together in its apex regions and that the relationship between tooth and IAN was very close: the nerve runs exactly among the roots from distal to mesial.

The added value of this elaboration was an easier and faster comprehension of the risk-benefit assessment. Considering that the patient was completely asymptomatic and that the extraction would not, in this case, have been devoid of risks, we decided for a no-extractive solution.

## 4. DISCUSSION

Many studies analyze the possibility of IAN injuries during third inferior molar extraction based on the position of these two anatomic structures.

In 2013 W.P. Smith published a clinical study evaluating the removal of 1589



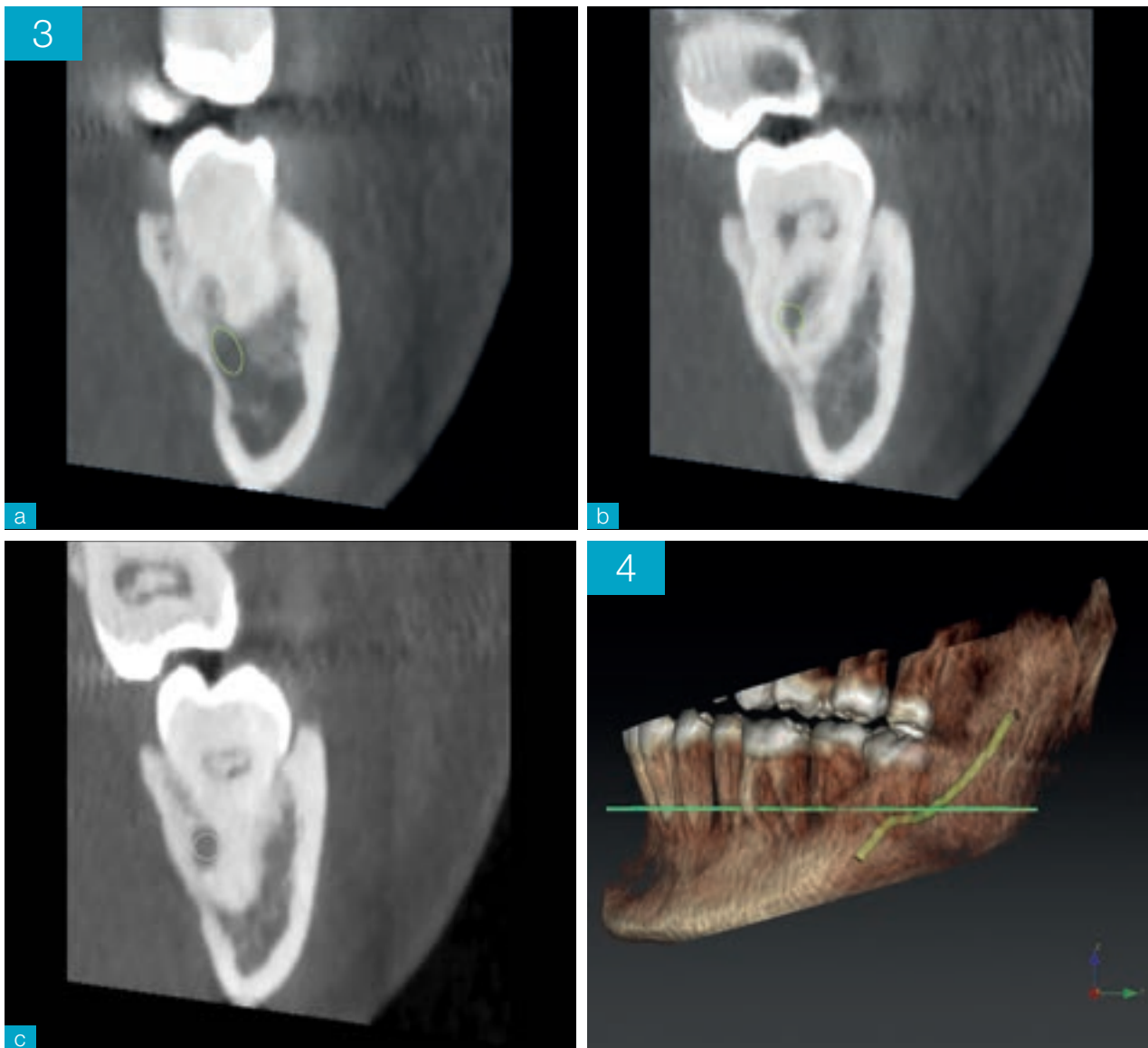**Figg. 2a, b** IAN 3D reconstruction

Figg. 3a-c Teeth and IAN relationship



Fig. 4 3D mandible reconstruction

third inferior molars in 1000 patients. Before the surgery, he classified the molars in 3 groups:

- distant from the canal. The space between the radicular third molar apex and the IAN canal is more than 1 mm;
- close to the canal. The tip of the root borders IAN canal without changes in radiologic features;
- intimate to the canal. Diversion of the canal or darkening of the root or deflected root apice.

In this study 466 teeth (29%) can be included in the group 1, 869 (55%) in group 2 and only 254 (16%) in group 3.
During postoperative course, 39 patients (3.9%) referred neurosensory disturbance and 7 patients (0.7%) a permanent neurosensory loss. The lowest incidence of neurosensory alterations is reported by group 1 (0.8%) and 2 (0.9%), the highest by group 3 (11%)[8].
From this study we can understand that there is a close correlation between distance IAN-tooth and risk of neurosensory disturbs after the surgery. For this reason, to avoid as much as possible postoperative symptomatology, it is fundamental knowing the distance from tooth and nerve: a depth radiologic investigation has always to be done.

EVEN IF THERE IS ONLY ONE **RADIOGRAPHIC** RISK MARKER, IT IS RECOMMENDED A CT FOR AN ADDITIONAL **INVESTIGATION** THAT ALLOWS TO VERIFY **3D RELATION** BETWEEN NERVE AND TOOTH. THE USE OF A SOFTWARE SEEMS TO BE IMPORTANT NOT ONLY FOR THE TRAINING OF YOUNG DENTISTS OR FOR THE EXPLANATION TO THE PATIENT, BUT ALSO IT IS AN ACCURATE INSTRUMENT FOR **REDUCING** THE RISK OF **IAN** DAMAGES

There are different radiographic techniques, but not all of them are ideal for this situation. Intraoral periapical radiograph is the smallest x-ray investigation used in dentistry; it implies superimposition of anatomical structures and so an improper view to analyze the relationship between IAN and molars. Orthopantomogram is usually the first choice to evaluate this condition, but it cannot give 3D information[9,10].

Rood and Shehab, in 1990[11], described different orthopantomographic signs to identify a possible tooth-nerve relationship:

- presence of radio-transparent stripe darkening the dental root due to the transition of mandibular canal in this area;
- interruption of the mandibular canal cortical bone by the crossing of third molar root. This situation can be identified with the radiographic discontinuance of cortical bone white line;
- abrupt change of mandibular canal direction caused by the presence of third molar root;
- narrowing of the IAN canal if there are third molar in contact or overlapped;
- deviation of the root (known as dilaceration) where the mandibular canal runs;
- narrowing of the root with a depression of dental structure due to the crosses of IAN;

- bifid apex with root darkening near the passage of IAN;
- superimposition of IAN canal and third molar root;
- dental roots are in contact with mandibular canal's roof[12].

There is no consensus in literature about direct manifestation of postoperative complications and relevance of one specific radiographic sign.

Even if there is only one radiographic risk marker, it is recommended to require a computed tomography (CT) for an additional investigation that allows to verify 3D relation between nerve and tooth[13].

Comparing with panoramic imaging, conventional CT is characterized by higher radiogenic dose and higher financial costs. Cone Beam Computed Tomography (CBCT) has been introduced to reduce radiogenic dose and costs.

The advantages of CBCT are well known[14]:

- x-ray beam limitation;
- image accuracy;
- rapid scan time;
- dose reduction;
- reduced image artifact;
- ideal display modes for maxillofacial imaging.

Another advantage derived from the use of CBCT is the possibility to identify bifid or trifid variation of mandibular canal. The prevalence of this anatomic alteration is different in the world and, for example, is reported that in Turkey the prevalence is about 46.5% of population[15], in Belgium 19%[16], in Taiwan 30.6%[17] and in Japan 15.6-65%[18]. A study published by Kang et al.[19] disagrees with another study by Oyuntugs et al.[20] about the prevalence of bifid or trifid variation in mandibular canal. The first one reported a prevalence of 10.2%, while the second one 22.6%. This discrepancy is due to the using of different imaging modalities. It has been demonstrated that conventional CT or CBCT help the individuation of this kind of alteration.

The use of a software that allows a 3D reconstruction of the relation between tooth and nerve seems to be important not only for the training of young dentists or for the explanation to the patient, but also it is an accurate instrument for reducing the risk of IAN damages. This study compares the planning with traditional radiologic imaging and the planning with a software 3D reconstruction, and shows a major accuracy of this planning and a reduced surgery risks.

## 5. CONCLUSIONS

Before performing the extraction of a lower third molar it is appropriate to execute a deep clinical and radiographic investigation. The first instrumental exam required is OPG. If it shows the presence of at least one signs of possible close proximity between the dental roots and IAN, it's necessary to prescribe a CBCT with a Dental Scan reconstruction.

In literature there is a general agreement that Dental CT Scan and CBCT are the most effective imaging techniques to detect the localization of IAN's canal and the exact crown and root's morphology of third molars.

With a software elaboration and DICOM files is possible to carry out 3D reconstructions; the program facilitates a lot the analysis of the cases.

It is not the aim of this article to suggest one particular software, anyway the authors believe that some characteristics of the elaboration phases are fundamental:
- highlight noble anatomical structures and its anatomical variants;
- have a 360 degrees views of the anatomical site, facilitating the analysis of the relationship between the third and second molar and IAN;
- take multiples scans of the area (coronal, transverse and sagittal) permitting to understanding for certain the anatomy of the roots, the number, its direction and the shape of its apexes;
- create a 3D mandibular reconstruction;
- make measurement of distances in millimetres and of angles in degrees;
- mime a bone's plastic using the function "cut", optimizing surgical planning;
- show to the patient the reconstruction, improving the communication.

In the last decade, 3D reconstruction software designed for the study of the jaws are being used more and more because they represent an excellent tool for daily practice, especially in challenging cases. The information derived by its elaboration are really very important: not only they simplify diagnostic phase, but also they can influence all treatment planning and for this they could reduce the risk of surgery complications.

In conclusion, we can say that the use of a software, able to carry out an imaging reconstruction, is not always necessary, but it could be offering the possibility of an added value to the diagnostic phase that could minimize the risk of damages to the inferior alveolar nerve. ∎

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# Long Abstract

## INTRODUCTION

The extraction of lower third molars is the primary cause of permanent nerve sensitive alterations of inferior alveolar nerve (IAN) and its incidence is more common than implants positioning and orthognathic surgery. An understanding of the possible mechanisms leading to nerve injury is then recommended to reduce this occurrence.

The position of the mandibular nerve must be investigated pre-operative with the use of radiographic imaging techniques and softwares for imaging elaboration. The IAN canal position compared to third molar's roots could be classified in lingual, inter-radicular, buccal or inferior and only in few cases there is a direct contact between the nerve and the tooth without bone tissue. Aim of this study was to propose the usefulness of imaging elaboration with a digital software to evaluate the position of lower third molar and IAN and to show how this program could positively influence the treatment planning.

## MATERIALS AND METHODS

The case of a 46-ys female patient requiring evaluation of the left third lower molar was selected for the study. The orthopanoramic x-ray showed a close relationship between the third molar and the IAN. A CBCT Dental Scan with DICOM images was request and the DICOM file was then elaborated with the software Nobel Clinician which allows an accurate analysis of the relationship between the root and the mandibular canal. Through DICOM images acquisition and software elaboration it was possible to obtain a 3D reconstruction of the anatomical site and better understand the IAN relationship with the third molar.

## RESULTS

In this clinical case the software elaboration allowed a 3D reconstruction showing that the tooth had three roots fused in the apex region and the nerve runs among the roots, from distal to mesial, revealing a close relationship. The advantages of this software analysis include the possibility to mark the nerve course, to measure distances and angles and to produce a 3D reconstruction.

## CONCLUSIONS

In conclusion, the relationship between third molar and IAN is crucial during third molars extraction. During surgery IAN could be injured due to surgical instrumentation and or tooth traction. The anatomic proximity between third molar and IAN should be investigated pre-operatively with appropriate radiographic techniques to avoid or reduce IAN damages. The use of CBCT in association to software imaging elaboration could offer additional valuable information to the diagnostic phase that could significantly minimize the risk of damages. The added value of this digital elaboration is an easier and faster comprehension of the risk-benefit assessment.

## CLINICAL SIGNIFICANCE

The extraction of lower third molars is the primary cause of permanent nerve sensitive alterations of the inferior alveolar nerve (IAN). The position of the mandibular nerve must be investigated pre-operative with the use of radiographic imaging techniques. However, the additional use of a software imaging elaboration allow a 3D reconstruction of the anatomical site providing the possibility to better understand the IAN relationship with the third molar. The added value of this digital elaboration is an easier and faster comprehension of the risk-benefit assessment.