case report

SURGICAL EXTRACTION OF LOWER THIRD MOLARS: DIAGNOSTIC TESTS AND OPERATIVE TECHNIQUE IN THE PREVENTION OF INFERIOR ALVEOLAR NERVE INJURY. CASE STUDY

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SUMMARY

Surgical extraction of lower third molars: diagnostic tests and operative technique in the prevention of inferior alveolar nerve injury. Case study

Increased knowledge and technical refinement have broadened the limits of outpatient oral surgery; however, these changes have at the same time led to a greater number of complications and poor outcomes and, accordingly, to legal action for professional responsibility. Oral surgery represents 10% of all actions, and almost all of these are attributable to exodontic surgery, of which around a third are related to inferior alveolar nerve injury following the extraction of lower third molars.

The aim of this case study is to suggest operative technical strategies in accordance with a correct clinical-diagnostic pathway in order to prevent neurological complications involving the inferior alveolar nerve subsequent to lower third molar extraction. Cases should be carefully selected and surgical intervention undertaken solely when genuinely necessary. The patient should be informed of the risks, the methods and the possible results of the treatment. These are the bases for correct indication, along with a sufficient diagnostic path and a good level of communication between operator and patient.

Key words: trigeminal nerve injury, computerized tomography, third molar extraction.

RIASSUNTO

Chirurgia estrattiva dei terzi molari inferiori: accorgimenti diagnostici e di tecnica operatoria nella prevenzione delle lesioni del nervo alveolare inferiore. Casistica

L'aumento delle conoscenze e l'affinamento delle tecniche se da un lato ha ampliato quelli che sono i limiti della chirurgia orale ambulatoriale, contestualmente ha condotto ad un aumentato numero di complicanze e insuccessi e, in modo speculare, di contenziosi per responsabilità professionale. La chirurgia orale rappresenta il 10% di tutti i contenziosi e la quasi totalità di questi eventi è imputabile alla chirurgia exodontica, di cui circa un terzo è costituita da lesioni del nervo alveolare inferiore a seguito di estrazione di denti del giudizio inferiori.

Scopo della presente casistica è quello di suggerire accorgimenti di tecnica operatoria in funzione di un corretto iter clinico-diagnostico al fine di prevenire complicanze neurologiche del nervo alveolare inferiore in occasione di interventi avulsivi di ottavi inferiori. Sarebbe opportuno selezionare accuratamente i casi e intervenire chirurgicamente solo quando vi è una reale necessità. Il paziente deve essere informato dei rischi, delle modalità e delle possibilità di risultato del trattamento. Queste sono premesse fondamentali per un'indicazione corretta, insieme, ovviamente, a un sufficiente percorso diagnostico e a un buon livello di comunicazione tra operatore e paziente.

Parole chiave: lesione del nervo trigemino, tomografia computerizzata, estrazione dei terzi molari.

Introduction

Inferior alveolar nerve damage is a rare but serious complication associated with a number of dental procedures. Oral surgery represents 10% of all actions, and almost all of these are attributable to exodontic surgery, of which around a third are related to inferior alveolar nerve injury following the extraction of lower third molars. This injury occurs with equal frequency in implantology, and more rarely following endodontic (orthograde and retrograde) procedures or nerve block anaesthesia (1).

Lower third molar extraction is one of the most frequently performed procedures in odontostomatological and maxillo-facial surgery. Lack of space in the retromolar region is the most common cause of retention/impaction of the lower wisdom teeth; around 84% of individuals aged twenty present with retained lower third molars (2).

The frequency with which third molar extraction is performed leads inevitably to an increased risk of damage to nerve structures, in particular the lower alveolar nerve. The operation may prove particularly subject to investigation, even in the most expert hands, due to the anatomical position, the difficulty of visual and tool access, morphological variability of the impaction and the equally variable relationships with adjacent structures (3).

The indications for impacted third molar extraction seem obvious in the presence of pathologies, such as recurrent pericoronitis, caries of the lower second and third molars, parodontitis of the third and/or the second molar, radicular reabsorption of the settimo, chronic facial pain not due to any other cause, or other associated pathologies (cysts, tumours, supernumerary teeth, etc.). There may also be indications of an orthodontic or prosthetic nature, but the fact remains that most lower third molars, impacted or otherwise, remain asymptomatic for the entire life. This therefore raises the problem of preventative extraction, in the absence of associated pathologies or symptomology, especially where there is a risk of iatrogenic inferior alveolar nerve injury (3-5).

Surgical anatomy

The inferior alveolar nerve crosses the entire length of the mandibular canal and, in the premolar region, divides into its two terminal branches, the mental nerve and the incisive nerve. Its intramandibular course runs obliquely in a cervicocaudal and medio-lateral direction. The position of the lower teeth, especially the third molar, in relation to the mandibular canal and its contents is of particular importance. The relationship of the root tips to the canal may take the form of contiguity, with a bony septum separating root and canal, or of continuity where the periodontium of the lower third molar is in direct contact with its content: this condition may explain the pain of a neuralgic type which often arises following the extraction of the tooth or during inflammation of the periodontal ligament (6, 7).

From a spatial point of view, four different arrangements may be identified (6).

The most frequent situation is that in which the base of the alveolus of the third molar is in contact with the roof of the canal: a fine lamellar diaphragm may separate the two compartments, or the periapical connective tissue of the lower third molar is in direct contact with the contents of the canal.

In a large number of cases there is no spatial relationship between these structures: this occurs when the mandibular body is relatively high and the dental roots are of average length.

A third situation involves a closer and more complex relationship: in standard x-rays the roots are shown to extend beyond the level of the mandibular canal, although it is quite rare for them to meet. In this case the lower third molar may be lingually inclined and its roots exceed the canal on the buccal incline; vice versa, the opposite situation is found.

In rare cases root complex is positioned in part on the vestibular side and in part lingually, thus becoming intimately connected with the contents of the canal. When the root tips of the two sides are fused, the vascular-nervous bundle crosses a channel within the root complex. There are therefore evident complications involved in extraction in the presence of this anomaly.

Eziopathogenesis and physiopathology of nerve damage

The pathogenic mechanisms at the basis of nerve damage during the extraction of the lower third molar may be broadly divided into two categories:
– mechanical: compression, strain, trauma, laceration, partial or total section of the nerve branch by rotating instruments, levers, pliers, endo-alveolar *curettage* devices, etc.;
– thermal: due to the use of high-speed rotating instruments without cooling.
The consequent anatomical and functional injuries are described in Seddon's classification which, on the basis of the extent of the anatomical damage, recovery time and prognosis, recognises three categories of nervous damage: neuropraxia, axonotmesis and neurotemesis. This distinction proves extremely useful for the diagnosis of nerve damage, and for gauging the possibility of functional recovery and the need or timing of possible microsurgical treatment (8-10).
Neuropraxia consists of a temporary block in nervous conduction without anatomical damage mostly following mechanical trauma of a mild nature, such as compression or prolonged traction of the nerve branch. Usually the sensory disturbance disappears within around four weeks and there is no need to intervene to repair the injured structure (8-10).
Axonotmesis is a more serious form of nerve damage caused by excessive traction or compression of the nerve. From the anatomo-pathological point of view, edema, ischemia and demyelination may be present; the continuity of the nerve structure is maintained but some axonal continuity may be interrupted. Patients report reduced sensitivity in the affected area – hypoesthesia – often accompanied by paraesthesia or dysesthesia; slow recovery of sensitivity begins around 5 to 11 weeks after the initial nerve damage and continues for the following 10 to 12 months. Microsurgical intervention is not generally necessary, except in cases of persistent neuropathic pain (8-10).
Neurotmesis is the most severe form of nerve injury and consists of a complete interruption of the nervous structure, affecting both the axon and the myelin sheath. In order for sensitivity to be recovered, often only very partially, timely microsurgical intervention is needed to bring together the sectioned nerve ends. The prognosis depends largely on the rapidity of intervention, the extent of the damage and the location of the nerve structure, whether intraosseous or in the soft tissues (8-10).

Diagnostic tools

Where there is a clear risk of biological damage, the planning of a third molar extraction in close spatial relations with the inferior alveolar nerve requires an accurate medical history, a precise clinical examination and, principally, a timely radiological examation. Furthermore, prior to any medical treatment, the patient must be correctly informed and valid consent obtained.
In dentistry, two traditional forms of radiographical examination are routinely used: endo-oral x-ray and orthopantomography. The endo-oral x-ray is the most commonly used tool, as it is easy to use and provides good definition. However, it is subject to three main limitations: the image may be partially distorted, especially if badly positioned; it enables the examination of a limited area only; and is difficult to carry out in the region of the lower third molar as the positioning of the film is poorly tolerated by patients. Orthopantomography, on the other hand, enables information regarding both dental arches to be displayed on a single x-ray, and is fast and simple to carry out, but does not provide a solution to the problems of distortion, which may be from 25% to 30%. Furthermore the principal limitation of both radiographical techniques is that they render two-dimensional images and do not provide in-

formation on the depth of the structures under examination. They do not permit an examination of the relative positioning of the roots of the lower third molar and the mandibular canal from the buccolingual side, other than by means of the "tube shift" technique using endo-oral x-rays, and in any case they do not provide information on possible anomalies relating to the number and shape of the roots (for instance, apical hooks) (11-13).

The most precise images and multi-dimensional information may be obtained using CT and the appropriate software, such as Dentascan. In relation to anatomo-morphological studies of this type, this examination makes a decisive contribution to surgical risk assessment and to the planning and choice of the most appropriate extraction techniques to be employed. Unlike two-dimensional endo-oral x-rays and orthopantomography, the multi-plane transversal mandibular sections that may be obtained secondarily (panorex and paraxial or cross-section), without volume artefacts and with a ratio of 1:1, show the correct and and exact spatial positioning of the anatomical structures under examination. However, the standardized use of CT involves significantly higher costs both in economic and biological terms compared with traditional radiographical diagnostic examinations and is therefore to be performed only when judged necessary (11-13).

Finally, when prescribing the examination the surgeon must indicate the width of the interspaces between the paraxial and parorex sections, which should not be greater than 1 mm. Otherwise anatomical risk factors, such as apical hooks close to the canal, may be off-section and therefore missed by the operator.

Materials, methods and results

The case study illustrated takes into consideration all the extractions of lower third molars in which conventional x-ray examinations (orthopanoramic and endo-oral periapical) showed that the root structures overlapped with or had a relationship of continuity with the mandibular canal. Some patients were presented for observation by other colleagues; others autonomously chose our structure. A CT dentascan of the lower dental arch was prescribed for all patients to obtain a more detailed three-dimensional view of the root morphology and the position of the teeth in relation to the inferior alveolar nerve. All the procedures were carried out in the Department of Clinical Odontostomatology at the Institute of Clinical Dentistry at the University of Rome "Sapienza" from 2005 to 2007.

A total of 50 surgical extractions were carried out, involving 29 patients, of whom 13 were male and 16 female, aged between 20 and 64 years and with an average age of 31.9 years.

In all cases extraction was clearly indicated, inasmuch as current pathologies were present: 35 elements (70%) were the cause of recurrent episodes of pericoronitis, 7 (14%) were affected by invasive caries disease, 5 (10%) were the cause of periodontal problems affecting the second molar, 2 teeth (4%) had induced distal caries of the second molar, and finally, one element (2%) was associated with a complex odontomatosis damage.

58% (n = 29) of the lower third molars extracted were in a condition of osteomucous impaction; 22% (n = 11) in osteomucous semi-impaction; 10% in bone impaction; 6% (n = 3) in mucous semi-impaction and 2% (n = 1) in mucous impaction. Of these, 68% (n = 34) were mesially tilted, 14% (n = 7) were distally tilted, 10% were positioned vertically and 8% (n = 4) were horizontal.

The post-extraction findings confirmed the number of roots illustrated by the CT dentascan: 32 elements (64%) had fused roots, 16 (32%) had 2 roots, just one element (2%) had 3 roots and another (2%) 5 roots. 10 teeth (20%) had apical hooks.

A careful examination of the pre-operative CT dentascans enabled an assessment of the root structure in relation to the mandibular canal from the vestibular-lingual side: 46% (n = 23) had roots tilted lingually in relation to the canal; 28% (n = 14) rested on the roof; 12% (n = 6) were in

a vestibular position; 8% (n = 4) had non-fused cross roots below the canal; 4% (n = 2) had roots positioned in part lingually, and partially on the roof; 2% (n = 1) were positioned in part in a vestibular direction and partially on the roof.
All the extractions were performed surgically and carried out under local-regional anaesthetic, using surgical protocol and standardized equipment.
The surgical technique involved the opening of a mucoperiosteal flap using a intrasulcular bayonet incision, starting from the retromolar region and flanking the crown of the second molar in a distal-vestibular direction, and finishing with a vestibular exit in the mesial direction of the fornix. After retracting the tissue on the vestibular incline, the mucous membrane on the lingual side was carefully detached using the bevelled edge of a periosteal elevator. This latter was used on this incline for the protection of the tissues and the lingual nerve during the phases of osteotomy and odontotomy. To perform the osseous breach, carried out in all cases but one (2%), a rose cut bur or straight fissure/crosscut bur was used with abundant irrigation, to save lingual bone and periodontal tissue of the second molar.
The odontotomy, carried out in the presence of undercut placement and divaricated roots, was performed using a turbine mounted tungsten carbide rose cut bur. This operation was unnecessary in only 12% (n = 6) of cases, while in 62% (n = 32) a simple odontotomy was required and in 26% (n = 13), a multiple odontotomy.
Patients underwent antibiotic treatment beginning the day before the procedure and for five days thereafter; anti-inflammatory treatment for three days; cortisone treatment for three days administered orally in graduated doses, apart from the first dose of 4 mg of desametasone administered via intramuscular route.
Out of this select sample of extractions at risk of nerve damage, post-operative changes in sensitivity were present following only 3 procedures (6% of all extractions performed): in two of these, the clinical picture was resolved spontaneously within around four weeks and probably consisted of a form of neuropraxy; one patient, however, reported a prolonged sensation of a paresthesic and hypoesthesic nature affecting half of one lip, which lasted for around ten months.

Discussion

The data regarding the 50 procedures carried out show how important it is to obtain a preoperative diagnosis using traditional x-ray examinations alongside more sophisticated techniques which are in any case now widely available. CT dentascan examinations enable an excellent assessment of the position of the root structure in relation to the mandibular canal, and hence the adoption of techniques and extractive manoeuvres which preserve the integrity of the nerve structure.
This study takes into consideration only those cases in which the extraction of the affected elements was clearly indicated due to the presence of disease or symptoms. However, the extraction of lower third molars for purely prophylactic purposes is extremely controversial, especially when there is a serious risk of nerve damage, as in the sample under consideration here.
A number of references attest to the level of uncertainty on this issue. In 1997 the ADA provided this rather ambiguous indication: "after consideration of the individual circumstances, the dentist must decide whether to treat or monitor the impacted/unerupted tooth". In 1998 the American Academy of Paediatric Dentistry decreed that "third molars, judged to be potential or actual problems, should be considered for specialist treatment". In the same year, the American Academy of Oral and Maxillo-Facial Surgery declared categorically that "all impacted teeth are pathological and surgery is the treatment of choice". In 1999 the NICE (National Institute for Clinical Excellence) in the United Kingdom stated that there was a lack of scientific evidence to support the preventive extraction of impacted third molars unaffected by pathological conditions. In the absence of such conditions the treatment program for third molars should be standard. The build-up of plaque constitutes a risk factor but alone does not justify resorting to surgery; a first episode of

pericoronitis, if not particularly serious, should not be considered a surgical indication although second and subsequent episodes would fall into this category (15).
This study does not aim to indicate which is the best approach to the problem, but rather proposes a more rational assessment of the risk-benefit ratio. In the sample presented, the benefits derived from extraction were decidedly superior than the risk of neurological complications.
The relevant protocol indicates the opening of a intrasulcular bayonet flap incision, enabling the affected area to be widely exposed, thus facilitating excellent visual and instrumental access; however this has the disadvantage of greater edemigenous reaction in the postoperative phase.
An osseous breach was performed in almost all the dental elements involved, enabling broad luxative movements and the elevation of the roots from the nerve structure. Odontotomy was necessary in the great majority of cases, due not only to undercut placements but also to reduce the number of luxative manoeuvres and the consequent use of compressive force or stretching. There were multiple cuts in the dental element, especially in the cases involving deep impaction (total osseous and total osteomucous), least favourable positioning (horizontal, mesially tilted, distally tilted) and the most anomalous morphology (more than one root, divaricated roots, cross roots, apical hooks). Sections were not carried out in full, so as not to bring the rotating tool too close to the nerve structure thus avoiding accidental cuts or overheating; the residual dental septum was then fractured using back and forth luxative movements of the dental fragments obtained.
The suitable luxative manoeuvres were chosen on the basis of the vestibular-lingual positioning of the roots indicated by the CT dentascan: luxation of the crown in a vestibular direction and a evelating motion in the case of lingually positioned root structure; vice versa in the case of vestibularly positioned roots.
If the third molar rests on the roof of the canal, a elevating motion is to be used to distance it from the latter, with the aid of a sufficient breach in the bone and an adequate odontotomy in the case of horizontal, mesially-tilted and distally-tilted elements (7, 14).
Particular care is to be taken in the presence of apical hooks: the elevation of the dental element without a preventive movement away from the radicular curve of the canal may lead to traction and stretching of the nerve and even to the tearing and partial or total section of the latter.
Roots positioned in part vestibularly and in part lingually in the canal render the situation more complex: in these cases, the odontotomic cut is incomplete and is concluded with the fracture of the residual dental septum, and must lead to the separation and independent avulsion of the individual roots.
Fortunately there were no cases present in this study of tunnel roots, or rather cross roots with fused apices below the canal: in this case, it is advisable to induce the fracture and separation of the dental bridge positioned between the apices using delicate luxative manoeuvres to divaricate the roots (7, 14).
In spite of all the cautionary provisions undertaken throughout the procedures, three cases of nerve damage arose in the most surgically complex situations: there was one case of probable axonotmesis, which was resolved within approximately one year, following the extraction of a mesially-tilted 3.8 presenting in osteomucous semi-impaction with five cross roots (three lingual and two vestibular) with a lingually tilted hook on the mesio-vestibular root (Figs. 1, 2 and 3); two cases of neuropraxy, which disappeared after four weeks, following the extraction of a 4.8, presenting in deep osseous impaction and horizontally positioned on the roof of the canal (Figs. 4, 5 and 6), and of a 3.8 presenting in osteomucous semi-impaction, distally angled, vestibularly positioned fused roots and a significant apical hook curved around the floor of the mandibular canal (Figs. 7, 8 and 9). In the first case, the luxative force of the compression used to extract all three roots and possible stretching with an injury caused by the hook most probably led to the disruption of the axon fibre; in the second case, compression forces due to the luxative manoeuvres used, along with a post-operative oedema, probably gave rise to a temporary disruption of

Figure 1
Case 1: pre-operative ortopanoramic view.

Figure 3
Case 1: tooth's sections.

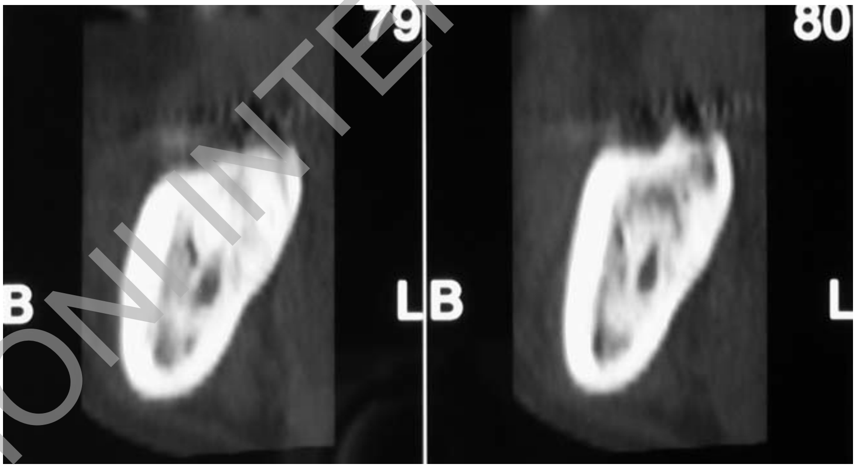

Figure 2
Case 1: pre-operative CT dentascan cross-sections.

nervous conduction without anatomical damage; a similar clinical picture was present in the third case, presumably following the stretching of the nerve caused by an apical hook.

Conclusions

Inferior alveolar nerve injuries are among the most severe complications that may emerge following the extraction of lower third molars, in terms of both the functional sequelae and the medico-legal repercussions. Although the current case study and

Figure 4
Case 2: pre-operative ortopanoramic view.

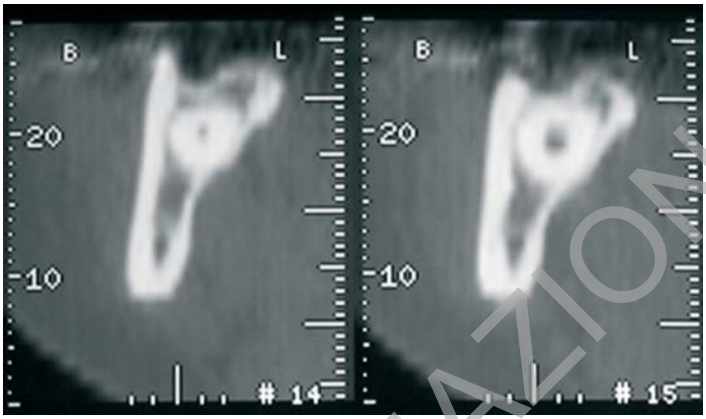

Figure 5
Case 2: pre-operative CT dentascan cross-sections.

Figure 6
Case 2: the extracted tooth.

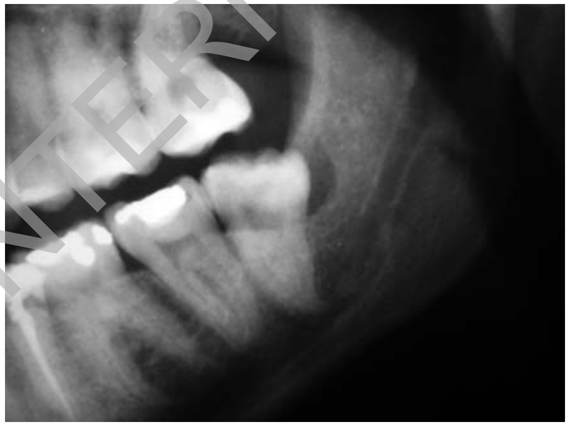

Figure 7
Case 3: pre-operative ortopanoramic view.

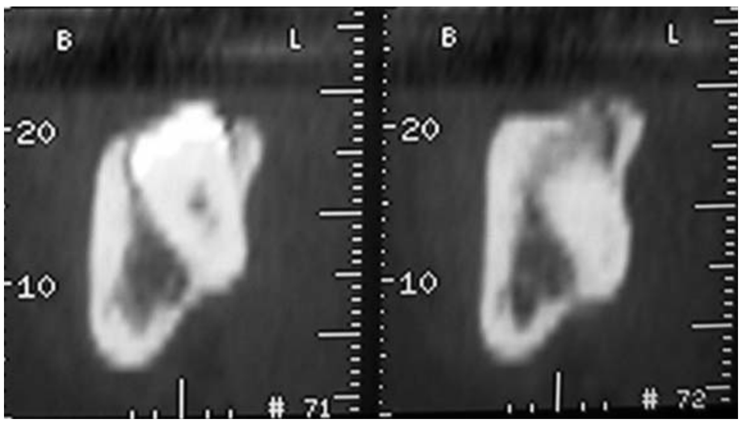

Figure 8
Case 3: pre-operative CT dentascan cross-sections.

Figure 9
Case 3: the extracted tooth.

the others present in the literature (3, 9, 10) demonstrate that the incidence of this outcome is rare compared to other complications, the risk of iatrogenic nerve injury is always present.
Oral surgeons now have an additional diagnostic tool aside from the traditional x-ray examination: CT dentascan. Precise three-dimensional assessment of the relationships between the lower alveolar nerve and the dental element enables an evaluation of surgical risk and the selection of the most suitable operative technique. On the other hand, it is true that close relationships of contiguity or continuity with the canal, aggravated by deep impaction, anomalous root morphology and unfavourable positions of the teeth, it may be practically impossible to avoid minor neurological sequelae.
Furthermore, even in the case of minimal risk of iatrogenic nerve injuries, it is imperative to inform the patient in detail of the possible consequences of such a procedure and to obtain valid informed consent.

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