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Case Report

Coronectomy of mandibular third molars with computer-assisted navigated system: A case report

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Abstract

The present case report describes a successful surgical case of coronectomy of a fully impacted lower third molar in close relationship with the Inferior Alveolar Nerve (IAN) that was trapped in the furcation roots of the lower third molar. It was associated with a dentigerous cyst. Dynamic Navigation (DN) was used to minimize iatrogenic injuries to the IAN. Coronectomy and cyst removal were successfully performed. High surgical accuracy was provided thanks to the dynamic navigation system that allows the surgeon to perform the procedures without direct vision during the surgery. No neurological damage or other intraoperative complications occurred. One month later, the patient reported a dental abscess to the left mandibular second molar without wound dehiscence which required antibiotic and endodontic therapy. After 2 years, no long-term postoperative complications were reported and follow-up radiographs showed complete bone mineralization. In conclusion, technological support of DN in Coronectomy seems to avoid IAN injury and reduce postoperative complications.

Introduction

Coronectomy is a surgical option for the treatment of high neurological risk third molars able to reduce iatrogenic nerve injuries [1]. The surgical protocol consists of the removal of the dental crown only, leaving the root undisturbed. This technique was tested in several randomized studies, and a systematic review concluded that coronectomy could be safely used for the treatment of third molars at high neurologic risk. Furthermore, this review suggested the need to improve surgical procedures to reduce the possibility of coronectomy failure [2].

The use of modern technology, specifically Dynamic Navigation (DN) used for implantology, could improve oral and extractive surgeries too [3] DN consists of a stereoscopic camera that detects in real-time the spatial relations of reference tools placed on the patient and on the surgical handpiece as well as software that pairs these with computed tomography images (CBCT). The stereoscopic camera therefore makes all the radiological structures appear in real time, with constant feedback with regard to 3D planning [4,5]. The application of DN in dentistry has improved thanks to the increasing availability of CBCT and the development of more manageable reference tools and software calibrated for dental purposes [6,7].

Moreover, it appears to be particularly helpful in rehabilitating atrophic jaws by avoiding graft procedures, with the insertion of zygomatic, pterygoid, or inclined implants. DN technology also seems to improve the accuracy of implant positioning, independent of the clinician's experience [5,8]. Recently, this technology enabled a dental student to successfully perform endodontic surgery through a minimally invasive approach [9].

In oral surgery, there are only two relevant case reports [10,11]. One retrospective review [12] regarding computer-assisted dental extractions is by Emery, et al. [12], focusing only on the removal of the M3M, and cases of displaced teeth or foreign body retrieval [10,13,14] where DN has been applied. DN was shown to be manageable and versatile in all components of these procedures with minimal discomfort for the surgeon [5].

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The present study reports one case of the Coronectomy of the third molar impacted and in close proximity to the mandibular canal, using the DN system to improve the accuracy of the procedure.

Case presentation

A 42-year-old woman was referred to the Unit of Oral Surgery of the Department of Biomedical and Neuromotor Sciences (DIBINEM) of the University of Bologna, Italy for the treatment of an impacted mandibular third molar. The study purpose and process were explained to patients and informed consent was obtained. The study was conducted in accordance with the Declaration of Helsinki and Strengthening the Reporting of Observational Studies in Epidemiology statement, and the study protocol was approved by the Ethics Committee Azienda Unità Sanitaria Locale Città di Bologna, Italy (Comitato Etico 12098, 2012). The patient reported recurrent pericoronitis requiring antibiotic therapy. Clinically, the third molar was deeply impacted with Pathological Probing Depth (PPD), complete with the presence of bleeding on probing (BOP) (Figure 1).

The panoramic radiograph showed a vertically impacted left lower third molar classified as IC grade according to the Pell and Gregory scale [15] (Figure 2).

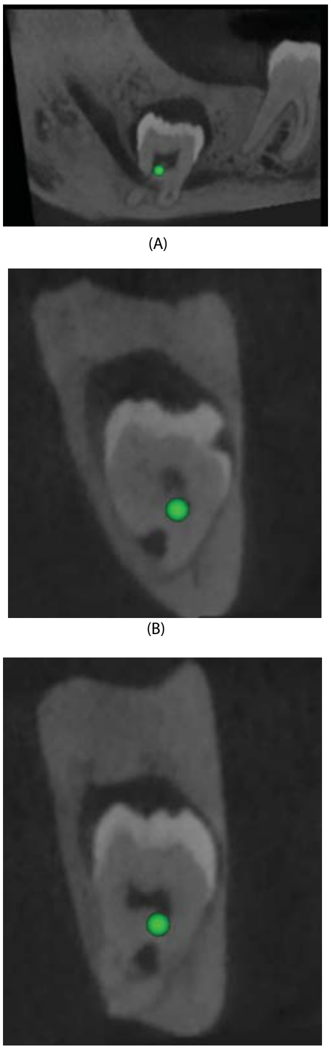
Panoramic radiographs also showed the presence of a dentigerous cyst and radiographic risk factor for alveolar nerve injuries [16,17]. CBCT examination showed the inferior alveolar nerve trapped in the furcation roots of the lower third molar. (Figure 3a-3c)

High neurological risk along with a few technical operative difficulties, and the resolute patient's request for a semi-invasive and rapid treatment corroborated the decision to perform coronectomy with the DN technology.

The ImplaNav (BresMedical, Sydney, Australia) navigation system was used and all stages of the operating protocol were performed. Preoperative CBCT scans were taken with a reference plate placed in the oral cavity (for dentate patients) containing fiducial markers (also called a marker plate [MP]). In a similar fashion to an impression tray, this reference plate was anchored to the dental arcade with a high-density impression

Figure 1: Preoperative clinical situation: unerupted left third molar.

Figure 2: Deeply impacted left third molar: preoperative orthopantomography radiographic situation.



(A)

(B)

(C)

Figure 3: Preoperative cone beam computed tomography situation: inferior alveolar nerve was trapped in the furcation roots of lower third molar (a,b,c).

material Ramitec; 3M ESPE, USA). The impression involved three healthy teeth, and the zone of anchorage was chosen by previewing the spatial interference of the MP with the surgical handpiece. After the CBCT scans were taken, the reference system was removed and stored, to be positioned in situ during the surgical procedure. The DICOM files were imported into the navigation software, enabling the assessment and mapping of the dental anatomy, mandibular canal pathway, and tooth crown, and following the position of the burr.

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On the day of surgery, after local anesthesia to block the IAN, the MP was again placed in situ; this time, however, the patient reference tool (RTp) was kept attached. The RTp consists of reflective spheres aligned on a support in a predefined geometric pattern in such a way that it can be localized by the firmware of an infrared digital camera [NDI], Waterloo, Canada), and segmented while in progress in the 2D images obtained from the frame. A second handle reference tool (RTh) was attached through an adaptable joint to the contra-angle handpiece and to the ultrasonic handle. This specific joint has a spherical connection that allows the surgeon to locate the camera wherever it is ergonomically comfortable, providing a direct view of the surgical field and, at the same time, the screen. In order to carry out the registration/calibration process, the operator exposed (for at least 3 s) the RTh attached to the handpiece of the camera that matched it with the RTp. Then, the fiducial markers on the MP were touched in sequence with a lancet drill (calibration tool) to enable the software to superimpose the surgical tips' position and axis to the 3D patient radiological image.

A mucoperiosteal buccal flap, with a releasing incision mesial to the second molar and a distobuccal one, was incised and raised. Then, the tracking array was placed so the surgeon could perform the planned surgical procedures for osteotomy and odontotomy with the navigation system guide (Figure 4). DN displayed the position of the rotating or ultrasonic tip on the computer monitor in real-time, overlaid with the CBCT images in the three spatial planes.

A circumferential ostectomy of the spongiosa was performed with the straight insert on the ultrasonic handpiece (Surgysonic Moto; Esacrom, Imola, Italy) to remove buccal bone; a crown section was accomplished via a spear bur, which was constantly tracked on the DN monitor. The section is performed in a bucco-lingual and mesio-distal direction. The dentigerous cyst was raised to the bone and removed using an alveolar spoon. The crown was gently fractured using an elevator inserted between the buccal bony crest and the tooth. The crown fragments were removed using only the forceps along the straight pathway toward the occlusal plane.

After the crown's removal, the remaining roots were reduced by at least 2 mms - 3 mms [18]. The grinding of the roots was performed using a round bur or a drill to make a smooth surface without dentinal or enamel spikes. A periapical radiograph was taken to control the crown section before suturing [19].

The post-operative migration of retained roots is a common and well-documented finding in literature [1,20,21]. The residual alveolus and roots were revised and irrigated with saline solution.

The surgery was carried out within 40 minutes, timed from the use of the first instrument to the completion of the suturing. After surgery, nonsteroidal analgesic medication was prescribed, to be taken only in case of pain and swelling. The patient was instructed to adhere to a soft diet for a few days, to maintain appropriate oral hygiene, and to rinse daily with a 0.2% chlorhexidine mouthwash. No immediate postoperative discomfort such as bleeding, swelling, or pain occurred. One month later, the patient reported a dental abscess to the left mandibular second molar without wound dehiscence which required antibiotic therapy. Root canal therapy was necessary for the left second molar. Three months later, no complications were recorded and the site completely healed. A year after the surgery, the soft tissue was completely healed, and bleeding on probing and probing depth was physiological. Two years after the surgery, a panoramic radiograph showed new bone formation distal to the second molar (Figure 5). The probing depth distal to the second molar was reported to be 3mm buccal, 3 mm medial, and 3mm distal (Figure 6).

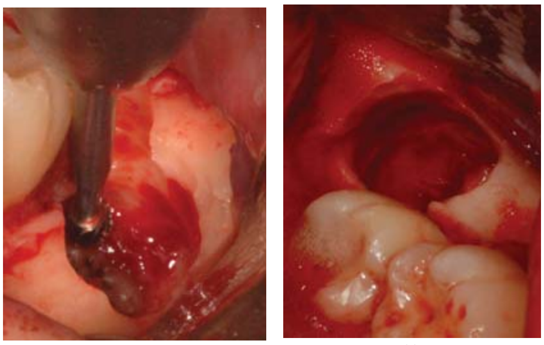
(A) (B)

Figure 4: Intraoperative procedures (a,b).

Figure 5: Postoperative orthopantomography radiographic situation 2 years later.

Figure 6: Postoperative clinical situation 2 years later.

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Discussion

The objective of this study was to describe the Coronectomy of complex mandibular third molars in close relationship with IAN, using in-office dynamic computer navigation.

Removal of deeply impacted lower third molars can lead to several temporary or permanent complications. One of the most embarrassing complications is IAN injury during the procedure, which may impair nerve function for an unpredictable period, or even permanently. Impairment of the IAN ranges from 0.1% to 5.3% [22] or up to 17% and the LN from 0.1% to 22% [23].

Coronectomy is a surgical option to avoid that outcome when there is a close relationship between tooth roots and the IAN, for the protection of the IAN [1].

In the presented case, this procedure showed to be quite beneficial not only for avoiding IAN injury but also for a possible fracture of the mandible, as the tooth occupied the angle mandibular. Every year for 5 years, the residual roots are checked with Orthopantomography.

DN technology can avoid IAN injury and reduce postoperative complications due to the precise control of the surgical tools in relation to the radiologic anatomy. In the reported case, the age of the patient (42 years), tooth position, morphology, and IAN position were considered risk factors for achieving these goals, with the possibility of protracted surgery time and postoperative complications. To our knowledge, this is the first description of using dynamic navigation for the coronectomy of third molars.

The majority of office-based computer-navigated surgery is performed for the placement of dental implants using static navigation. DN technology makes it possible to reduce the learning curve in implantology after a period of proper practice. It has been reported that it takes about 10 to 20 implant placements with DN technological support to optimize the surgeon's accuracy [12].

Thanks to the accessibility of cone beams, computed tomography has allowed oral and maxillofacial surgeons to utilize computer-assisted surgery in an office environment.

Golob Deeb, et al. [24] observed that novices obtained an implant positioning accuracy comparable to that of experienced operators within three attempts. Different studies have demonstrated better accuracy in implant positioning with a DN-supported insertion than with a freehand approach [25]. This can be helpful in general oral surgery. In a retrospective survey by Emery et al.1, covering the period between 2010 and 2014, the authors reported fewer complications after the extraction of M3Ms with DN technology. For this reason, increasing the use of this system, which is more sophisticated and manageable today, could be realistically considered. The same authors showed reduced surgical time with improved visualization of the surgical field, even though this was not scientifically demonstrated [12].

Importantly, the technology adopted by the present authors eliminated the requirement of cranial anchorage, thanks to a mini-implant placed in the premaxillary zone as the patient connection for both the reference tool and fiducial markers; this also allows the application of DN in totally edentulous patients. (Accuracy valuation using mini-implants remains to be conducted). The bearing of an extraoral fiducial MP avoids fiducial screw insertion in the jawbone, drastically reducing the invasiveness of the procedure. Optical array interferences are unavoidable drawbacks and point to the need for an observant operator and a well-trained surgical team. Another limiting factor of DN-supported extraction of third molars, as pointed out by Emery, et al. [12], is the inability to locate the tooth after it has been luxated because its position shifts from that in the presurgical CBCT. This could cause teeth to be dangerously dislocated and to lodge in inappropriate anatomical spaces.

The shortcomings of the system reported by Emery, et al. [12] are today overcome by less bulky instrumentation, as well as the reduction of the surgical tracking volume and the stability of the patient tracking array.

As in all surgical fields, new technology requires dental surgeons to consider a multidisciplinary approach that involves teamwork and implies the sharing of medical knowledge and information, as well as professional and technical competencies. Perhaps, increased costs and certain habitual changes have to be accepted. DN technology means much more time spent on surgical planning on a screen and keyboard rather than on the patient, changing surgical situations and ergonomic positions, improving teamwork, and taking better account of the diagnostic phase.

Conclusion

The technological support of DN in Coronectomy can avoid IAN injury and reduce postoperative complications. The DN system used in the present study resulted in a more manageable and ergonomic technology, thanks to the intraoral connection of both the reference tool and the fiducial marker.

Future clinical trials are needed to confirm the real advantages of DN technology in the domain of oral surgical procedures.

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