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Nerve damage resulting from oral surgery and medical legal implications

ABSTRACT

Aim During oral surgery and implantology in particular, nerve damage can occur. This event falls in the group of iatrogenic injuries and may lead to medical litigation.
Case description Two cases of legal dispute subsequent to lower alveolar nerve damage after implant surgery are reported.
Discussion and conclusion In relation with the cases, a detailed analysis of the most common causes of such injuries is presented, as well as the diagnostic techniques and possible treatments are proposed. In addition, the various procedures leading to the evaluation of biological damage are illustrated.

Keywords Nerve trunks injuries; iatrogenic injury; medico-legal diagnosis; medical litigation attorney.

INTRODUCTION

A nerve injury resulting from oral surgery represents a complex adverse event, for both the patient and the surgeon, that falls within the group of iatrogenic injuries; this term defines a harmful event caused by medical procedures or occurring as a result of surgery (1).
The incidence of these injuries in the literature varies, depending on the authors and the surgical technique performed, from 0.2 to 43.5% (2). The incidence is much higher in case of implant placement, reaching values close to 44% (Table 1).
Among symptoms, prevail those in the sensory area, represented by hypo-, hyper, paraesthesia and anesthesia, followed by the biting of the cheeks, loss of saliva and fluids while drinking, difficulty in speech, stagnation of food in the oral vestibule etc (3). Moreover, a reactive depression very frequently shows on top of these symptoms, worsening the clinical picture. The sensation, often only subjective, to have a "twisted mouth", triggers a series of difficulties to live an ordinary social life and may lead to an attitude of closure to the outside world. It is a natural evolution

Incidence of nerve injuries in dental surgery[2]	Neodent
Lower alveolar nerve damage after wisdom tooth surgery	0.2-7.1%
Lingual nerve damage after third molar surgery	0.0-24%
Lower alveolar nerve/mental nerve damage after implant surgery	1.7-43.5%
Permanent damage after one year	5-15%

Table 1 Incidence of nerve damages in oral surgery[2].

of this clinical picture to look for the "guilty" and therefore to start legal action, often supported by a compensation request disproportionate to the damage.
We here report two cases that developed in this direction.

CASES DESCRIPTION

First case report

A 20 years old male patient, upon advice of an osteopath and in order to improve his sport performance, went to a dentist for the extraction of all the four impacted third molars (fig. 1).
During the operation, performed under local anesthesia in a private office, the four teeth are removed: the upper ones first, followed by the mandibular ones. At the end of the operation, the patient failed to close his mouth and the oral surgeon, thinking that this was the result of a dislocation of the jaw, performed three times the reduction maneuver for dislocated jaw. Not succeeding with this procedure in solving the problem, the surgeon took an orthopantomogram which showed two mandibular fractures with involvement of the corners of the jaws (fig. 2).
The patient was referred to a hospital, where ferulae and intermaxillar locking for the containment of the fractures were applied,

Fig. 1 First case report: preoperative orthopantomograph.

Fig. 2 First case report: postoperative orthopantomograph. The bilateral fracture at the corners of the jaws.

with a 30 days prognosis. After about one month, the jaw locking had recovered and after about another month the ferulae were removed and physiotherapy commenced, in order to rehabilitate the patient; the treatments allowed the subject to recover a good mouth opening, although occasional sensation of numbness and tingling in the tongue remained.
The legal dispute that arose was solved by the professional insurance of the surgeon.

Second case report

The patient, a female subject about 55 years old, came to our observation for a partial consultation in view of a lawsuit.
In 1980 she had undergone prosthetic rehabilitation supported by 5 Shalom's electro-welded needles in the upper maxilla and of 12 in the lower jaw (fig. 39. About 20

Fig. 3 Second case report: preoperative orthopantomograph.

Fig. 4 Second case report: postoperative orthopantomograph. A fragment can be seen in the mandibular canal, left side.

years after their placement the needles, being mobile, were removed by another surgeon, and a third surgeon placed three screw-type osseointegrated implants in premolar and first molar upper left zone. The panoramic radiograph shows two fragments of needles resulted visible in the mandibular right canine and in the second left premolar and first molar area: they seemed to be related to the strong hyperesthesia in the third left branch of the trigeminal area, limited to the area between the mandibular foramen and the mandibular symphysis.

TC performed in June 2006 showed the presence in the left mandibular canal of an implant fragment - visible also in the orthopantomograph - about which the report stated "... it is confirmed the presence in the left lower jaw of the remnand of an implant in the mandibular canal".

DISCUSSION

The management of an iatrogenic injury to the nerve trunks must consider several issues: what should be the correct clinical approach, how to make a correct diagnosis, what medical and surgical treatments can be performed and how to quantify the biological damage.

Clinical considerations

The surgical areas most frequently affected by neurological complications are those involving the third molars and those connected to implant dentistry (4). In both cases, a number of predisposing factors that must be carefully taken into account may be highlighted.

In the surgery of the eight tooth, particular importance relies on the anatomy of the mandibular canal and its variables (5, 6), and it is worth bearing in mind that a bifid channel can be present at a rate between 0.08% and 0.9% (3). The exact definition of the intrabony position of the impacted tooth is essential to determine the surgical approach both in drawing the flap and in the choice of ostheotomic lines, that should always be carefully planned on the basis of the radiographic findings (7). An orthopantomograph is normally sufficient for this purpose (2, 8, 9), even if in very doubtful situations a spiral CT can be required (10). Much more complex it is to define the course of the lingual nerve, and therefore the safest approach to an impacted lower wisdom tooth is always the vestibular one (11, 12). Particular attention shall be paid while using the rotating instruments (13-15) and in flap retraction on the lingual side (16), so as to protect the nerve without causing injury by compression with the retractors (2, 17). While suturing, it is possible to entrap the lingual nerve, and it is therefore necessary to proceed very carefully also in

this stage (2).
The time of anesthesia has a significant role as well, since mandibular nerve lesions (12) can develop (0.15% -0.54% of injuries) for direct nerve injury, both during the injection and during the retraction of a deformed needle, or for intraneural bleeding (18); the anaesthetic toxic (19) effect must be considered too; it was observed that 54% of cases can be attributed solely to Articaine, compared to 19% of Lidocaine and 7% of Mepivacaine (18). Articaine is therefore referred as the most neurotoxicant molecule among those available.
As it is proven that the surgeon's experience plays an important role in the incidence of nerve damage (the risk to cause a nerve injury increases 4 times in the case of a young surgeon), therefore his/her age is a sign of greater or lesser experience, and so it is considered as a predisposing factor (20, 21, 22). It will be therefore appropriate for younger dentists to operate initially only the most simple impacted third molars to avoid the imputation of imprudence. In this type of surgery the young age of the patient represents normally an advantage, because young patient are faster in the healing processes and the bone tissue is more elastic and abundant; in relation to the sex of the patient, some studies suggest that the hormonal influences in women may be an element of risk (23). Genetic factors, that can not be determined but that seem to play a positive or negative predisposing role in development of a nerve injury, are present as well (2). In implant surgery, in addition to problems about the course of nerves, design and execution of flaps, control of rotating instruments etc., it is opportune to focus on two specific elements: the quantity and quality of available bone structure (1). Although implants are often placed in young and partially edentulous subjects, most commonly they are inserted in elderly and fully edentulous patients, with reduced bone thickness. It is well known that in old age healing processes are slower, the bone is scarce and sclerotic and alveolar nerve's surfacing is frequent. In implant surgery it is always advisable to observe the safety distances of 2 mm from the top of the channel and of 3 mm from the mental foramen (4, 24).

Diagnosis of nerve damage

The diagnostic process takes place in two stages, an early and a late one: the first, when disorders appear, is based on symptoms reported by the patient (2); if there are still sensations caused by mechanical stimuli to the lower lip or to the chin, connected to the lower alveolar nerve, or to the tongue for the lingual nerve, it can be assumed that part of the fibers of the affected nerve remained intact and healing is possible (25). The more the affected area is limited, the better is the prognosis. In cases where the patient experiences a spontaneous paraesthesia, the possibility of a neural activity departing from the site of the lesion should be considered. A third possibility is the complete anesthesia of the nerve.
The clinician should refer the patient to periodic controls, in order to determine whether the damage may be the result of compression-induced anesthesia, that heals spontaneously in three months, or of the section of nerve, with slower healing time and that may require surgery (25).
If an injury is suspected, a second phase of diagnosis, based on more complex and articulated investigations consisting of clinical examinations and instrumental tests, will be necessary.
The clinical tests can be performed easily in a private office, but have the limit to provide a subjective assessment of the damage, based

on patient's feelings and may be affected, due to this element of subjectivity, by a possible fraudulent attitude of the patient.
The tests that can be performed in a private office are listed in table 2a. Tests must be carried out in a peaceful environment with the patient relaxed and blindfolded. Instrumental tests (Table 2b) need specific equipments, available in neurology departments, with the advantage of providing recordable, reproducible and objective data on the neurosensory variability, allowing the surgeon to plan treatment strategies and assess location and extent of the nerve injury.
In order to test the integrity of the lingual nerve, the taste test is used: it consists in asking the patient to recognize the flavor and intensity of different solutions based on sodium chloride, citric acid and quinine hydrochloride (2). Another test of gustatory sensibility is the electrogustometry (or electrogeusometry): with the application of a single-phase electrical stimulus of 500 mA over an area distant 1 cm from the tip and 1 cm from the midline of the tongue, the test determines the threshold stimulation that brings the patient to receive a tingling or a metallic taste (2). The trigeminal somatosensory evoked potentials (TSEP) are used to assess the integrity of the inferior alveolar nerve or of the lingual nerve. The test begins from the side certainly healthy, in order to determine the normal threshold values of painful and tactile sensitivity. For alveolar inferior nerve at least two stimulator electrodes are inserted in the skin area of theaffected side of the lower lip, while for the lingual nerve an electrode on the tip of the tongue is enough; the receiver electrodes are placed on the scalp in the somatoesthetic area corresponding to the

	Diagnostic tests
	2a - Tests that can be performed in a private office
Slipping Direction	Sliding a nylon monofilament or horsehair (Von Frey filaments) on the skin: the patient must recognize the direction of movement[2, 25]
Light Touch	Application of a force of 2g to 5g through a blunt tip probe[26, 27] to assess the sensitivity of mechanoreceptors associated with $\alpha\beta$, fibres[2]
Pin Prick Sensation	Calibrated stimulation of 150 g[50] using a common anesthetic needle mounted on a orthodontics dynamometer. The needle will stimulate the skin in rapid succession and the patient will say whether acute and punctiform pain is perceived[26], therefore indicating the sensitivity of nerve's free endings associated with the Aδ fibers[2]
Two Point Discrimination	A pair of 0.8 mm probes, applied simultaneously on the skin at a distance ranging from 2 to 20 mm. The clinician will find the shortest distance to which the patient can distinguish the individual touch of each probe. The value of this distance varies, depending on the authors, from 4 ± 2 mm to 14 mm[22, 26, 27]. The test is used to assess the integrity of large diameter myelin fibers connected to quickly adapting receptors
Hot and Cold Thermal Stimulation	Placing a heated probe (about 45 °C) or a cotton pellet soaked in ethyl chloride onto the skin of the patient, and analyzing the reactions of the patient to stimuli[17, 27-29]
Electrical Stimulation	Application in the region of the mandibular foramen of increasingly intense electrical single pole stimulations of short duration (0,2-0,5 ms), until perceived by the patient
	2a - Tests that can be performed in the private office
Blink Reflex	Bilateral winking following a unilateral stimulation of the supraorbital nerve[30]. The electrical activity is recorded with electromyography of orbicular muscle of the eye. The blink reflex can be induced by stimulation of other branches of the trigeminal nerve, such as the infraorbital and mental nerve
Somatosensory evoked potentials	The evoked potential (EP) is a variation of an electrical part of the central nervous system in response to a stimulation of a member of the afferent sensory system[31]

Table 2 Diagnostic tests.

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	Initial stage therapy
Anti-inflammatory drugs	Control the oedema formation
Proteolytic enzymes	Stop the clot and facilitate the hematoma absorption
Vitamins of B group	Neurotrophic activity; to accelerate the nerve repairing processes
C and E group vitamins	For the prevention of post-traumatic ischemia, protecting vascular structures so as to limit the cellular damage
Antibiotics	Prevent bacterial infections
	Restorative stage therapy
Naftidrofuryl	Vasodilator, its effects are more evident on arterioles of the nerve trunks
C and D groups vitamins	Promote the process of intraneural angiogenesis
Ozone i.m.	Hyperaemic function response to a stimulation of a member of the afferent sensory system[31]
Magnetotherapy	Modulates the activity of ionized molecules in the ischemic area
Laser therapy	Affects on mechanoreceptors and on $\alpha\beta$, fibres
Hormones	Stimulate regeneration of the nerve structure
	Late stage therapy
Anticonvulsants drugs	Control central origin pain
Associations of tricyclic antidepressants and psychotropic agents	
Analgesic gel	Locally applied prevent or delay pain

Table 3 Treatment options for nerve injuries.

sensitivity of the face.

Therapy of nerve damage

For the treatment of nerve damage different medical or surgical options are available, depending on the pathological variations and symptoms reported by the patient.
The therapy focuses on the medical treatment of symptoms, metabolic and physical support therapy, and magnetic field and laser therapy (2). Drug therapy varies depending on the period of healing of the lesion, so defined: initial stage, next to trauma; restorative stage, within the first month; and late stage, when stabilization of symptoms occurs (Table 3).

Surgical treatment

Surgery is aimed at restoring the continuity of the nervous trunk involved, with the objective of recovering the functionality or to reduce the symptoms until they regress to a more acceptable hypoesthesia.
The main surgical techniques, that should be performed by an experienced surgeon, are: decompression, neurorraphy, nervous tissue graft and nerve stump intubation.
The decompression is performed in case of nerve compression caused by an external (implant fixture or root fragment) or internal (neuroma) compression agent and consists in its surgical removal. The indications to neurorraphy, graft and intubation are listed in Table 4.
Surgical treatment is contraindicated in case of neurapraxia, which heals spontaneously in 4-6 weeks and the injury does not break the anatomical continuity, and when the damage lasts for more than two years with pair turning from peripheral to central and permanent.
As for the time of intervention, if it is true that the earlier the operation the better the healing process, it is also true that over time

Indications to neurorraphy, nervous tissue graft and intubation
Suspect or certainty of neurotmesis
Anesthesia, disesthesia or paresthesia persistent at 3-6 months from the moment of trauma, with significant psychological repercussions for the patient;after wisdom tooth surgery
Hypoaesthesia causing serious discomfort to the patient: bites of the tongue and taste alteration (for the lingual nerve) or difficulty in speaking, eating and drinking (for the inferior alveolar nerve);
Pain relieved by block anesthesia to nerve (sign of peripheral lesion);
Worsening of symptoms
Amputation neuromas or in continuity and clinically evident
Bridling of nervous trunk for scar tissue resulting from phlogosis

Table 4 Nerve injuries that can be trated with surgery .

nerve handling improves, for the presence of a thickened parafascicular tissue due to spontaneous healing of the lesion. A late intervention, however, requires a more extensive resection followed by the coaptation of nerve stumps under stress, with possible formation of neuromas and the need to perform grafts to restore the continuity of the neural structure (32).
The best solution would be a compromise timing of the intervention from 3 to 6 months after the iatrogenic injury (2, 33, 34).

Medical legal assessment of the damage

The occurrence of damage to neural structures caused during oral or implant surgery is often the cause of a medical dental lawsuit: the legal duty of the forensic scientist is to determine whether the dentist is liable for malpractice by and there is a causal link between the objective and subjective elements, also evaluating active behaviors or omissions suspected of having caused the injury (35). An injury to the mandibular branch of the trigeminal nerve, given the nature of the nerve fibers involved,

Permanent damage	Points of disability
Chewing deficit from lesion of the trigeminal	Up to 5
Sensory deficit from injury of the trigeminal	Up to 5
Total peripheral paralysis of the facial nerve (unilateral)	Up to 18
Disorders of gustatory function up to ageusia	Up to 5

Tab. 5 assessment of biological damage.

causes symptoms of sensitive nature, mainly hypoesthesia, disesthesia or anesthesia in the area of the nerve involved. Generally the problem is heals within 6-12 months, but in some cases, the disease lasts over time and becomes permanent.
In Italy the tables adopted by the Ministerial Decree of 12 July 2000 can be taken as a reference (Table 5).
The lingual nerve receives the sensory perceptions of the tongue and to a lesser extent of taste sensitivity, and when injured hypogeusia can occur. Ageusia (complete lack of taste perception) cannot occur as a result of iatrogenic injuries in dentistry, as the main nerves responsible for this function (facial, glossopharyngeal, vagus) are outside the sphere of oral surgery.
The ramus of the mandible is also equipped with a minimal motor component, and therefore the nervous damage can cause a minor motor deficit of chewing muscles, bite of the lips and cheeks, loss of saliva, accumulation of food in the inferior oral vestibule and mild dysarthria. In respect to this, a reference table are reported and can be used as guideline. With regard to the inferior alveolar or the lingual nerve, if only disturbances to sensibility remain, the damage depends on age, sex or loss of saliva. For the insensibility due to injury of the lingual nerve, the biological damage can be 2%. Should this happen to a person who has special work (e.g. sommelier), the damage to his/her specific working capacity could be

very significant. In fact, the capability to work could be compromised if not completely stopped.
As always, it is of paramount importance the consent of the patient to be treated, and this must be achieved in stages prior to any intervention, especially when surgery is involved.
The operator must inform the patient about his/her disease, diagnostic and therapeutic options, prognosis, the outcomes of treatment or in the event of non-intervention, the advantages and possible issues (art. 30 of the Code of Ethics).
In case of diagnostic or therapeutic procedures that can involve risks to the physical integrity of the patient, an informed consent document, preferably written, should be obtained as required by art. 32 of the Code of Ethics. The need for consensus is founded in the Constitution of the Italian Republic, where Article 13 states that "personal liberty is inviolable" and Article 32 states that "no one can be forced to a specific medical treatment if not for provisions of law". The consent is therefore an essential element for the treatment.

CONCLUSIONS

In oral surgical practice implant placement and third molar extraction are very frequent and the presence of peculiar anatomical conditions or the occurrence of technical errors may lead to injuries to the lower alveolar and lingual nerves. This type of injury is one of the most severe complications that may occur as a result of oral surgery, both for the physiological changes that ensue and for the medical and legal implications that may arise. The symptoms that may develop are mostly of transitory nature, but, in relation to the severity of the lesion, a permanent damage may also occur. To avoid the first, but especially the latter possibility, the operator shall carefully analyze the case with a preoperative evaluation aimed at assessing adverse conditions and risk factors, and then plan a surgical treatment as safe as possible. In order to obtain precise details on patient's anatomy, for the surgery of impacted wisdom teeth orthopantomograms are essential and the CT are recommended in case of doubt, while in implant surgery the CT is an indispensable aid. Despite compliance to procedures and safety standards, there are elements such as individual response that are not influenced and that may be underlying to neurological damage.
In the event of injury, the operator should be able to perform a diagnostic investigation through the clinical examinations mentioned in this article and must refer the patient to a specialized health professional for appropriate instrumental examinations. The underestimation of symptoms must be absolutely avoided, as it may lead the patient to think that the dentist does not believe him/her; this behavior can be interpreted by the patient as indifference or insensitivity; this attitude is often the cause of the compensation demands by the patient. It is asvisable instead to reach, through appropriate analysis, an careful diagnosis that allows to start immediately the most suitable treatment. It is not justifiable under any circumstances to ignore the problem and lose precious time before starting a therapy that could at least bring an improvement.
Lacking a standard protocol for the management a iatrogenic injury, the suggestion is to start pharmacological treatment as soon as possible (2), with the aim of reducing the symptoms and stimulate the regeneration of damaged fiber. The patient must undergo monthly controls to assess the healing process through the

clinical diagnostic tests. In some cases the problem is solved within 6-12 months, in other cases the damage becomes permanent. In the absence of signs of improvement, some Authors (32, 33, 34) suggest to perform surgery, but in practice it seems that very few patients accept this treatment. The clinician is required to provide all information and explanations to the patient, so that he/she can fully understand the operation they will undergo, with all the advantages, disadvantages and possible complications. A good insurance finally allows the surgeon to deal calmly with claims of compensation resulting from a lesion. The awareness of having done everything possible in order to avoid the occurrence of complications before, and to improve the recovery after the surgicak treatment, may also help the surgeon to deal comfortably any lawsuit.

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