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LINGUAL NERVE INJURIES DURING ORAL SURGERY PROCEDURES: VIEWS AND PERSPECTIVES

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ABSTRACT

Lingual nerve being one of the most important nerves within the oral cavity, it is very often injured during some oral surgery procedures. The clinical presentation of lingual nerve injury, its epidemiology, predisposing factors, and anatomy are explored to identify those patients at risk for developing neuropathic pain. Moreover, lingual nerve presents a variable anatomical location and is very often injured during mandibular third molar surgery due to trauma from an inferior alveolar nerve injection; incision, intubation in general anaesthesia; lingual flap retraction, bone removal and instrumentation; tooth sectioning; tooth elevation; and suturing. Due to its importance when it comes to guarantee the correct oral surgery procedures, this work aims to identify any factors that could aid the surgeon in preventing or minimizing the risk of lingual nerve injury during some oral surgery. The research which sustains this review was implemented on databases from PubMed (R), PMC and B-on, and the inclusion criteria were papers written from 2000 until 2019, that included clinical trials, case reports and revision articles, and whose subjects were humans and ought to have been written in English language. From the articles gathered, we were able to obtain a general vision of the frequency as well as of the severity of lingual nerve injuries and the most common ways of treating them. Oral surgery, namely third molar removal, is responsible for a high number of lingual nerve injuries. The piezosurgery may be advantageous when doing osteotomy and the raise or retraction of a lingual flap presents no advantage. The coronectomy emerged to avoid lingual nerve injuries. The time to repair the injured nerve should be as quickly as possible and the neurography presented the biggest success percentage, although in the lingual nerve case there may be an association with neuroma formation. Nevertheless, results should be interpreted with extreme caution because of the considerable heterogeneity of the data and the considerable influence of several anatomic and surgical variables that were closely related, but difficult to analyze independently.

KEYWORDS: Lingual nerve; oral surgery; lingual nerve repair; lingual nerve reconstruction.

1. INTRODUCTION

The knowledge of the topographic anatomy of the lingual nerve and the retro molar region is essential for the choice of the most appropriate surgical technique and, consequently, the prevention of the lingual nerve trauma and adjacent structures. Regarding lingual nerve anatomic location, after passing along the lingual bone plate of the mandibular body, the lingual nerve turns medially towards the tongue, usually at the level of the first and second root of the third mandibular molar. The lingual nerve carries general sensitive fibres, as well as gustative and sensitive fibres, via chorda tympani, for the tongue. Lingual nerve lesions may cause impact on speech, taste, deglutition, food competence, social interaction and pain perception.Lingual nerve lesion may cause tongue bite, feeling of burn on the tongue, changes on the speech pattern and/or alteration on the perception of food and drink taste (Pichler and Beirne, 2001).

In addition to typical symptomatic chronic pain, also nerve damage is induced by local anaesthesia (Renton *et al.*, 2010). Most lesions of the lingual nerve result in sensory alterations, which are transient and recover spontaneously over time (Cheung *et al.*, 2012; Renton *et* *al.*, 2012; Bagheri *et al.*, 2010). The lingual nerve may be localized above the alveolar bone, within the gingival tissues (up to 17.6%) or may be, directly, in contact with the bone over the third molar area (up to 62%). Consequently, there is no doubt about the lingual nerve being highly vulnerable in that region. The removal of the third inferior molar is the surgical procedure more commonly associated to lingual nerve disability (Tojyo *et al.*, 2019; Pippi *et al.*, 2017; Boffano *et al.*, 2012). As regards surgical considerations, it must be considered that the lingual nerve is one of the two nerves most injured during oral surgery with the other being the inferior alveolar nerve. To date, several procedures have been thought to cause lingual nerve damage, including mandibular resection, extraction of a third molar tooth, operations on the salivary glands, excision of tumours, and lingual flap retraction. An increase of second molars implants has also increased the risk of injury to the nerve. However, the lingual nerve most commonly gets damaged during inferior alveolar nerve block injections and third molar tooth removals. Potential mechanisms for preventing lingual nerve injury during third molar surgery include avoiding lingual flap elevation and conducting tooth sectioning. Injury to the lingual nerve most often are temporary, resulting in hyperaesthesia, hypoaesthesia, and/or dysaesthesia in the anterior two-thirds of the tongue. Several reports indicated that the nerve typically repairsitself, after damage, within six months (Fagen and Roy, 2019; Bataineh and Batarseh, 2017).

2. Development

2.1. Lingual Nerve Injuries

The inferior alveolar and lingual nerves are related to dental practice, as they are constant targets of anesthesia used in the treatment of inferior teeth, as well as the proximity of their path to the surgical region of extraction of the inferior third molars. Céspedes-Sanchez et al. (2014) reported a direct relationship between the position of the extracted tooth and the incidence of lesions of the inferior and lingual alveolar nerves, as well as the patient's age, intraoperative nerve exposure, the access technique for extraction of the inferior third molar and sometimes the surgeon's inexperience. Radiological examination is useful to assess nerve damage and to decide on the appropriate surgical technique to apply. In view of the above, Olsen et al. (2007) indicated that ultrasound can be used to visualize the lingual nerve, since some consequences inherent to this nerve include the burning sensation at the moment of anesthesia (~40% of patients) and continuous pain (8-15% of patients) (Biglioli *et al.*, 2015). In a study carried out in thirty-five patients who had a partial or complete lesion of the lingual nerve and underwent exploratory surgery and direct neurorrhaphy, all patients presented a good recovery of sensation in the tongue. In this study, patients who experienced pain preoperatively experienced complete relief from pain symptoms. These results allowed us to conclude that an early microsurgical approach is the most appropriate choice for the treatment of lingual nerve injuries (Biglioli*et al.*, 2018). Pedersen et al. (2018) carried out a study on the prevalence of injuries in the inferior alveolar and lingual nerves during the extraction of the third molar, showing that the injuries in inferior alveolar correspond to 39%, while30% correspond to injuries in lingual nerve, due to the removal of the inferior wisdom tooth. Hartman et al. (2017) analyzed intraoral neurophysiological changes in patients with unilateral lingual lesions. Results proved lingual nerve injury in patients with peripheral dysfunction, with the consequent loss of sensory function for stimuli mediated by small or large fibers. Pogrel et al. (2006) wrote about suggested causes of lingual nerve injury which include local anaesthetic injection, scalpel used to make the initial incision, use of the bur during bone and tooth removal, accidental crushing of the nerve, or excess tension from retraction, inadvertent stretching of the nerve, fracture of a sharp piece of bone from the lingual plate of the mandible, dental instrumentation, suturing of the wound, either by direct trauma from the needle or compression by the suture, medicaments coming into contact with the nerve, either during the primary surgery or in the treatment of any subsequent dry socket or other condition.

2.2. Lingual Nerve and Regional Anaesthesia

Until today we are not able to provide precise information about the lingual nerve lesion during local anaesthesia. In fact, in clinical practice it is, often difficult or even impossible, to extrapolate from a possible lesion of the inferior alveolar nerve, since it is not clearly specified if the local anesthesia was followed by surgical procedures (Pippi *et al.*, 2017). Sambrook and Gross (2011) calculated a 1/27415 risk of injury to the lingual or inferior alveolar nerves due to regional block anesthesia. Likewise, Pogrel et al. (2000) reported an injury incidence from 1/160571 to 1/26272 (a probability that, during a life time work, at least one patient appear with a nervous trauma due to local anesthesia. Harn and Durham (1990) (cited by Pogrel *et al.*, 2000) reported a hypothesis of ~3.62% of lingual nerve trauma when a block anaesthesia of the mandibular nerve was performed. Also, according to the same authors, dysesthesia, which is a very incapacitating sensory alteration, occurs more frequently after injury, due to local anesthesia (34%) and not after surgical procedures (8%) (Pogrel *et al.*, 2000). Due to a considerable anatomical and functional variation from lingual nerve, it is usually difficult to prevent lesions. Nevertheless, it seems preferable to use needles of lesser diameter, as well as not use high concentrations of local anaesthetics, as well as avoid multiple injections (Moore and Haas, 2010; Gaffen and Haas, 2009 and Garisto *et al.*, 2007). Local anesthetics such as prilocaine (4%) and articaine (4%) appear to be associated with an increased risk of causing paresthesia with the inferior alveolar nerve block (7.3% and 3.6% higher, respectively) (Gaffen and Haas, 2009; Olsen *et al.*, 2007). Garisto et al. (2010) suggested that paresthesia occurs more commonly after the use of local anesthetic formulations

(≥ 4%). More recently, Sambrook and Goss (2011) stated that direct injury by a needle is unlikely, considering that the damage is more likely to be due to neurotoxicity and/or interference with nerve vascularization; patients suffering from this complication suffer considerable distress and feel injured, so referral to a specialist is recommended. Costantinides et al. (2016), in an observational, unicentric study on 534 patients who underwent third molar surgery, concluded that since general anaesthesia is a perioperative variable that seems to significantly increase the risk of developing inferior alveolar and lingual nerves lesions, when treating patients that request general anaesthesia, they must be adequately informed that an higher incidence of post-surgery sensory disturbances is expected. Hillerup and Jensen, in 2006, studied 54 injuries by injection, and concluded that block anesthesia causes more lingual nerve injury than inferior alveolar nerve injury. Unlike most mechanical injuries after surgery, injection injuries were not followed by a course of spontaneous improvement of neurosensory and/or gustatory function. This may indicate neurotoxicity as a central aetiological factor.

2.3. Lingual Nerve and Suture

A suture, popularly known as surgical stitches, is a type of connection used by healthcare professionals, including surgeons, doctors and dentists, to hold the skin, muscles, blood vessels and other tissues of the human body together, after being sectioned by an injury or after surgery. Pogrel and Le (2006), considered that injury might occur from suturing of the wound, either by direct trauma from the dental needle or compression by the suture. However, there are no data on the incidence of lingual nerve injury caused by a suture placed at the surgical site, as a possible risk factor for lingual nerve injury, by direct trauma to the needle or by "strangulation" during the knot tying. Chossegros et al. (2002) considered the needle insertion up until 3 mm from the gingival margin of the lingual flap. According to the same authors, protection of the lingual nerve is not necessary for inferior third molar germectomy.

2.4. Lingual Nerve and the Third Mandibular Molars

The third mandibular molars removal is, probably, the most performed procedure in oral and maxillofacial surgery. For instance, in the United Sates, about ten million teeth are extracted from approximately five million individuals every year. Some reported reasons for third molar removal include the risk of impaction associated with caries, pericoronitis, periodontal defects in the distal surface of second molars, odontogenic cysts and dental crowding (Lee *et al.*, 2015). Whenever indicating extraction of third molars, dentists should have a justifiable reason, one that takes into account future treatment planning from an orthodontic, surgical, periodontal and/or prosthetic point of view. However, despite the aforementioned reasons, the third molar removal is the surgical procedure most associated with the lingual nerve lesion. Conversely, than inferior alveolar nerve, the lingual nerve position cannot be determined with panoramic radiography, what makes bigger the tendency for the occurrence of damages (Pippi *et al.*, 2017). Different methods have been proposed to evaluate lingual nerve running, such as MRI, ultrasounds, or radiographic imaging with radiopaque landmarks placed inside or alongside the lingual nerve. About 75% of the lingual nerve injuries can occur due to the removal of inferior third molars, presenting a prevalence between 0.6% and 0.2% of the lesions (Biglioli *et al.*, 2018), being the most utilized technique the bone removal from the buccal side (called Buccal Approach), using a rotating cutting device (bur) and the "Lingual Split-bone Technique" in which a osteotome and a hammer are in order. Due to the high risk of lesion during inferior third molar surgery, several techniques were created and studied, in order to try reducing the probability of nerve damage. Nevertheless, the effect of some surgical procedures is not clear yet, as the use of surgical devices to protect the lingual nerve during the mandibular third molar removal (Céspedes-Sánchez *et al.*, 2014; Pogrel and Goldman, 2004). For instance, Queral-Godoy et al. (2006), in a retrospective study of extractions of inferior third molars corresponding to 24 extractions, found an impairment of lingual nerve of 0.5%. Also, Valmaseda-Castellón et al. (2000) removed 1117 inferior molars in 946 patients and concluded that anatomical factors such as lingual angulation, surgical manoeuvres such as retraction of the lingual flap or vertical tooth sectioning, and surgeon experience, increased the risk of lingual nerve damage. More recently, Ge et al. (2016), in a study carried out in 91 patients, with 110 deeply impacted mandibular third molars, reported that among deeply impacted or completely impacted inferior third molars are related with the type of lingual nerve position. Injury to peripheral branches of the trigeminal nerve, namely the lingual and inferior alveolar branches, is a known complication of third molar surgery. Surgeons should inform patients preoperatively of this risk as part of the informed consent process and closely monitor any patients postoperatively who present with hypoesthesia or dysaesthesia. It is essential that surgeons document the extent of the injury and do some basic tests of neurosensory function in the postoperative period.

3. Surgical Procedures

Exploration and repair of the lingual nerve can only be accomplished through an intraoral approach. Visual magnification is not required for the gross dissection of the lingual nerve, but microsurgical dissection and neural anastomos is require the use of magnifying loupes or an operating microscope with fiberoptic lighting. The quality of the sensory improvement is related to the age of the patient, the timing of surgery, the extent of the neural injury, and the quality of the repair (Salvatore, 2001). Surgical intervention for a damaged inferior alveolar nerve is not usually indicated but may be undertaken, for instance: if the nerve is completely divided and the severed ends are misaligned; if a bony fragmented has compressed the mandibular canal; or if the patients suffer from persistent neuropathic pain. In contrast, after lingual nerve injury, if sensory tests demonstrate no neural recovery within 3-4 months, exploration of the injury site and microsurgical repair of the damaged nerve is indicated. There is a wide range in the reported frequency of lingual nerve injuries during third molar removal, with 0.2-22% of patients reporting sensory disturbances in the early post-operative periods and 0-2% permanent disturbance. A prospective study undertaken by Renton et al. (2005) reported the factors reflecting the surgical skill (i.e. lingual plate perforation) and the difficulty of the extraction were the stronger predictors of temporary and permanent lingual nerve injury. Surgery should therefore be offered to all patients with lingual nerve injury who show few signs of spontaneous recovery.

3.1. Lingual Flap

In a literature review conducted by Bataneh and Batarseh (2017), was reported the incidence of lingual nerve lesion, by comparing three different techniques. Authors showed that the technique that presented higher injuries incidence was the "Lingual Split Technique" (15%). Meanwhile, the use of a bur and the raising of a "Lingual Flap", resulted in a 11% incidence of lesion. "Envelope-Type Flap" was reported as the most used technique for the removal of the third molar (Bataineh and Batarseh, 2017). However, other flap designs have been proposed and discussed in the literature. Jakse et al. (2002) compared two different flap designs to remove 60 third mandibular molars fully impacted. There were performed thirty operations using an envelope flap and the other thirty used a modified three-sided flap, where was made an incision perpendicular to the angle of the line distobuccal of the second molar, obliquely to the mandibular vestibule. They concluded that the modified triangular flap presents a lesser post-operative wound, than the envelope flap. This study confirmed the evidence that the design of the flap in inferior third molar surgery primarily influences wound healing. The modified triangular flap is significantly less conducive to the development of wound dehiscence. Nageshwar (2002) proposed an unconventional incision, shaped like a comma, which was based on an inverted buccal flap, the base of which was positioned distolingually in relation to the impacted third molar. Of the 50 patients who were operated on using this type of flap, the author stated that no paresthesia of the lingual nerve or any other morbidity occurred, thus, suggesting that the new incision design was preferable, although it may initially require some practice. Suarez-Cunqueiro et al. (2003) carried out a prospective clinical study to compare two flap designs (marginal and paramarginal) used during impacted third molar surgery. They found no advantage in using the paramarginal flap instead of a traditional marginal flap. Lingual nerve damage following third molar surgery remains a clinical problem. Pogrel and Goldman (2004) used a technique that raises a lingual flap in addition to a buccal flap and places a specially designed lingual retractor to ensure that the lingual nerve is held out of the surgical field. 250 patients were treated by this method and only 4 cases presented transient lingual paraesthesia, so it was conclude that the lingual retraction for third molar removal improves access to the surgical site and can simplify third molar removal. Pichler and Beirne (2001) compared the results from surgeries of their inferior molars with 3 surgical techniques: the buccal approach with lingual flap retraction, the buccal approach without lingual flap retraction and the lingual split technique with lingual flap retraction, in relation with lingual nerve injuries. The "Lingual Split-Bone Technique" presented a lingual nerve injuries incidence of ~10%. Nevertheless, the incidence decrease to 0.6% when the retraction of the lingual flap was avoided. It was concluded that the use of a lingual nerve retractor during third molar surgery was associated with an increased incidence of temporary nerve damage and was neither protective nor detrimental with respect to the incidence of permanent nerve damage. More recently, Moor and Haas (2010) reported that persistent paresthesias, after dental treatment, are rarely reported and are more frequent due to surgical trauma, with lingual nerve being the most affected. The vast majority of these complications are transient and result in complete recovery (up to ~ 1 year). However, it is generally accepted that paresthesia that lasts more than 6 to 9 months is unlikely to fully recover. Mavrodi *et al.* (2015), when considering the influence of two different surgical techniques on the difficulty of impacted inferior third molar extraction, concluded that the application of elevators on the buccal surface of the impacted tooth, the lingual elevation of the tooth and its extraction with a lingual inclination is a safe technique. The appropriate application of the elevators on the buccal surface of the tooth can impressively reduce the duration of the procedure, the need for excessive bone removal and even tooth sectioning.

3.2. Piezosurgery

The ultrasonic-lancet is a surgical device able to cut out hard tissue with precision and to facilitate the cleavage of solid interfaces. Piezosurgery uses microvibrations of intermediate frequency generated by a piezoelectric transducer and applied to titanium nitride-hardened or diamond-coated inserts. With its vast range of inserts, it finds many applications in oral and maxillofacial surgery, such as nontraumatic dental avulsions, root surfacing and bone defect debridement, or cyst removal. It also proposes a simplified protocol for the sinus lift surgery. It offers a true revolution in the bone grafting surgery by allowing precise and nontraumatic graft harvesting. Although its brute efficiency may be less than that of the rotating systems, it remains adapted perfectly to the accomplishment of the majority of oral surgeries, yet, for an experienced practitioner may slow the surgery down in some cases because is less invasive than conventional instrument (Ge *et al.*, 2016).

The “Lingual Split Technique” for the removal of the third inferior molar, was first proposed by Kelsey Frey, in 1933. This technique, according to its opponents presents a potential damage to the lingual nerve, can produce excessive haemorrhage from the lingual soft tissue, makes possible sublingual or parapharyngeal space infections and oedema on the proximity to the air way. Yeah (1995), cited by Ge et al. (2016) proposed a simplified split-bone technique, that tapp the chisel into the tooth´s lingual periodontal space and proceeding lingually and distally to separate the lingual plate from the tooth, but can increase the operating time up to 2 or 3 times then the buccal approach. The authors concluded that the lingual split-bone technique using piezosurgery is an effective and minimally invasive approach for lingual positioned bony impacted third molars extraction. As lingual position type occupies the largest portion in deeply or fully impacted mandibular third molars, this technique can be widely applied. Also, this technique allowed a reduction in the operating table time and in the morbidity incidence requires a very good tactile sense and a big experience from the operator. Ge et al. (2016) did 110 surgeries in 89 patients, in which a piezosurgery apparatus was used to perform the “Lingual Split Technique”. Authors obtained a success of 100% on the removal of third molars. Also, there were reported no intra-operatories complications. The occlusal and lingual portion of the alveolar bone, was adequately removed with this technique, allowing this way a faster and easier luxation and extraction of the tooth, using a lingual direction; this way the surgical method became easier, avoiding coronal or radicular sections, which allowed for a decrease of surgical time and the avoidance of possible ways of harming the second molar. Piezosurgery has prominent advantages over the conventional osteotomy instruments, which are a clean and precise cut as well as the protection of soft tissues in complex anatomical areas. Another of the positive points from the piezosurgery use was the constant irrigation and the oscillatory tip to allow a better evacuation of the surgical field debris what at the end would allow for a better visibility and consequent bigger safety in performing the surgery (Leclerq *et al.*, 2008).

3.3. Coronectomy of the Third Inferior Molar

Coronectomy is a procedure in which the tooth crown is removed, but not the root complex. Several studies, included in a meta-analysis, indicated that this method is superior to the complete removal, as far as the incidence of nervous lesions is concerned. The most frequent complications were infection (2.8-17.3%) and the necessity of root removal (0-6%). The procedure in question consists of applying local anaesthesia, after that, do a mucoperiosteal flap and bone removal to allow access to the area. The crown would be, latter, divided along the junction between enamel and cement, using a fissure bur. If necessary, an additional cut, buccolingual, can be done, for a possible removal of the crown, in cases where the space is limited. In order to reduce the stress applied to the root complex, after crown removal, the root surface is softly inferiored 2 to 4 mm below the bone margins, using a round bur, removing all the enamel and dentine points.

A total of 231 coronectomies of third mandibular molars, located close to the mandibular canal, were evaluated after a 5.7 years follow-up period. During this period only three of the cases resulted in a inferior alveolar lesion, in other words, only 3.1% of the cases resulted in a nervous lesion (Pedersen *et al.*, 2018). Monaco et al. (2019), in 116 coronectomies, reviewed in a 5-year follow-up, showed that after the third year no complications were observed. No cases of neurologic lesions, and no cases of late infection of the retained roots were found at 5 years, and was found a low rate of immediate postoperative complications. These studies indicated that third molar coronectomy, can reduce the nervous lesion risk, compared with the full removal of the tooth. On the other hand, this procedure raises questions and possible problems, like the incidence of late migration of the root complex, development of late pulp necrosis, the increase in antibiotic utilization and the risk of more complicated infection or osteomyelitis (Renton *et al.*, 2005).

Renton et al. (2005) studied 128 patients who required operations on mandibular molars. The length of the follow-up was about 2 years, which for the assessment of delayed eruption of the root fragments is not sufficient as this process may continue for up to 10 tears. It seems, according with theses researchers, that coronectomy reduces the incidence of injury to the inferior alveolar nerve without increasing the risk of dry socket or infection. More recently, Leung and Cheung (2015) did a prospective study on long term morbidities after inferior third molars coronectomy. After 612 inferior third molar coronectomies in 458 patients they concluded that inferior third molar coronectomy is safe in long term.

4. Lingual Nerve Recovery

4.1. Recovery Time

The lingual nerve plays an important role in several functions, including gustatory sensation and contact sensitivity and thermo sensitivity. Misdiagnosed conservative treatments for lingual nerve injuries can induce the patient to consequential mental disability. After continuous observation and critical diagnosis of the injury, in cases involving significant disruption of lingual nerve function, microneurosurgical reconstruction of the nerve is advised (Fujita et al., 2019). The time for repairing after occurring lesions of the inferior alveolar and lingual nerves is a controversial matter and the results are different (Kushnerev and Yates, 2015). In a study of 33 surgically treated patients, significant improvements in mechanosensory function were reported. Better results were found for lingual nerve surgery, two or three weeks after the injury occurred. In contrast, they were able to resolve symptoms 2 years after the occurrence. Renton and Yilmaz (2012) concluded that the recommended time for exploratory surgery would be a period between three and six months after the lesion first occurred. Already in the study by Bagheri et al. (2012), 81.7% of the patients with inferior alveolar nerve lesion had a functional and sensory recovery. Also, Bagheri et al. (2009), observed that the faster the repair the better results are observed, and a lesion with 9 or more months showed a higher risk of non-getting better. In general, they observed a decrease of 5.8% in the chances of improvement, for each month the repair was postponed. Another study involving 64 patients with a lingual nerve lesion showed that the ones who underwent surgery, in a period up to 90 days, got a 93% success rate in function and sensation, while only 68.9% of success was obtained when the lesion was present for more than 90 days. The early repair was statistically associated with a functional and sensory recovery, with a risk rate of 2-3, P=0.02 (Susarla *et al.*, 2007).

Erakat et al. (2013) have demonstrated that the injury to surgery interval is the most significant prognostic factor in the repair of lingual nerve injuries. The use of the collagen membrane demonstrated a greater level of SFR compared with those treated without the use of the membrane. However, the results from the collagen conduit were not statistically significant. Also, Tay et al. (2008) concluded that the immediate nerve repair for transacted nerves during oral and maxillofacial surgery may be a feasible option, but requires the availability of a microsurgeon, instrumentation, and operating-room time. According to Biglioli et al. (2015), the surgery to repair the lingual nerve should be performed no later than 12 months after iatrogenic nerve damage. The ideal time is during the first few weeks after symptom onset. Hillerup and Stoltze (2007) studied 46 patients with damaged lingual nerve, who were monitored at different intervals after surgery. Most lingual nerve injuries exhibited a significant potential for recovery, but only a few patients made a full recovery with absence of neurogenic symptoms. The recovery rate was highest during the first six months. Recovery was not influenced by gender, and only slightly by age. Patients should be monitored repeatedly for at least 3 months, and not operated on until neurosensory function no longer improves, and is less than what might be rendered by microsurgical repair. Also, Rutner et al. (2005) undertook a retrospective study to investigate the clinical outcomes from the microsurgical repair of lingual nerve injuries, and concluded that microsurgical repair of lingual nerves provides moderate to significant improvements in clinical sensory function and is a useful option in treating affected individuals , especially when implemented soon after injury. According to all authors previously mentioned Ziccardi (2011) stated that early repairs defined as those completed before 10 weeks after injury appeared to do better than late repairs.

4.2. Reconstructive Methods

There are several techniques to repair nerve lesions. Unfortunately, there is no way of effectively get externally an image of the nerves; this way, it is necessary an exploratory surgery, as well as which treatment to perform while the patient is on the operatory table. As a result, most of the studies included variable results as for to conclude what was the best method to nerve repair. Ducic and Yoon (2019) suggested that primary tension-free repair should be performed in inferior alveolar and lingual nerve reconstructions when possible. If a bridging material is to be used, then processed nerve allografts and autografts are both superior to conduits and non-inferior to each other. In addition, allografts do not have the complications related to autograft harvesting such as permanent donor site morbidity. Toyo et al. (2019) attempted through the analysis of clinical data to investigate the aetiology and determine the risk of severe iatrogenic lingual nerve injuries in the removal of the mandibular third molar. After the study they concluded that the distoangular impaction of the mandibular third molars in female patients aged between 30-50 years may present higher risk for severe lingual nerve injury during the removal of mandibular third molars.

4.2.1. Direct Suture / Neurorraphy

Peripheral nerve can have inflammatory, traumatic, metabolic, toxic, genetic and neoplastic diseases, which develops different types and grades of nerve lesions. Avoiding suture tension in peripheral nerve coaptation seems to be a clinical dogma for many decades, although experimental data are weak and clinical practice shows good functional outcome after peripheral nerve repair by direct coaptation under reasonable tension, defined by local anatomic feasibility and the use of specific and suitable material. In clinical practice, one of the choices to avoid donor nerve morbidity is the side-to-end or end-to-side neurorrhaphy. In view of the above, many studies have been developed. For instance, Bagheri et al. (2009) concluded that microsurgical repair of peripheral branches of the trigeminal nerve injured by maxillofacial trauma produced significant improvement or complete recovery. These results compare favourably with the microsurgical repair of peripheral trigeminal nerve injuries resulting from other causes. Also, Kim et al. (2011) studied the introduction of inferior alveolar nerve defect repair method that does not require a nerve graft. Using this technique and 10-0 nylon epineural sutures, they successfully achieved some nerve repairs for gaps ≡ 10 mm in size. According to Bagheri et al. (2010), the great advantage of this technique is that a moderate nerve defect can be anastomosed without a nerve graft when direct closure of the nerve segment is impossible without tension.

In fact, Bagheri et al. (2012) concluded that microsurgical repair of a nerve injury resulted in a successful restoration of an acceptable level of neurosensory function in most patients. These studies have been continuous over the years, but many past works have already highlighted this issue. For example, Robinson et al. (2000) used, exclusively, excision of the neuroma, mobilization of the stumps, and direct reposition with epineural sutures. Although none of the patients regained completely normal sensation and there was no reduction in the number with spontaneous paraesthesia or pain, their observation showed that lingual repair is effective in most patients, suggesting that this treatment should be offered to all those who show few signs of spontaneous recovery after injury.

Pogrel (2002) concluded that microsurgery can provide a reasonable result by improving sensation in the inferior alveolar and lingual nerves. Patients with dysesthesia have less favourable outcomes compared with anaesthesia patients, and early surgical intervention in patients with localized pain. Patients with painful traumatic neuropathies that are chronic (> 1 year) are not likely to benefit from surgical treatment. More recently, Biglioli et al. (2015) described that surgery of a nerve injury should be performed no later than 12 months after iatrogenic nerve damage. According to the authors, the ideal timing is during the first few weeks after symptom onset. Also, pharmacological support is necessary when patients experience pain for longer than 1 year or the pain recurs after an unsuccessful microsurgical intervention. Antiepileptic drugs are the most effective, though they are potentially associated with poorly tolerated side effects. Drug dosage and combination should be managed by neurologists to maximize therapeutic effect (Biglioli *et al.*, 2018).

4.2.2. Reconstruction with Autogenous Grafts

In general, the graft is unnecessary for the lingual nerve repair if the nerve path is sinuous enough to be mobilized without tension, however, it is, occasionally used (Bagheri *et al.*, 2010). Pogreland and Maghen (2001) used an autogenous graft from a saphenous vein to treat lingual nerve lesions in 15 patients. The repair of the lingual nerve in 3 cases, where the interval between the nerve ends was 5 mm or less, resulted in some sensation lap. However, in 7 cases, in which the interval was between 5 and 14 mm, it was observed that no recovery of sensitivity was achieved. According with these authors it appears that a vein graft can form a physiologic conduit for nerve regeneration. The results are more successful with shorter a gap, which indicates that the vein acts like a barrier membrane. The lack of success with a long lingual nerve gap repair may be because the vein is collapsed or kinked by movement of the tongue. From the three patients in a gap inferior to 5 mm, one of them got a good recovery and the other two obtained a slight recuperation. No recuperation at all was achieved on the seven patients with a gap superior to 7 mm. Therefore, vein grafts should not be used for long lingual nerve continuity defects. Miloro et al. (2015) studied the question of to graft or not to graft, and concluded that a graft repair of the lingual nerve provides superior long-term (> 2 years) objective and subjective outcomes compared with direct repair. This might be because of the lack of tension at the repair site, more freedom with nerve stump preparation, and the addition of neurotropic and neurotrophic factors from the donor nerve graft at the site of injury to augment neurosensory recovery.

More recently, Verweij et al. (2017) reported that the lingual nerve reconstruction can be a successful therapy in patients experiencing pain after iatrogenic nerve injury. A lingual nerve lesion can cause invalidating neuropathic pain that is sometimes resistant to non-invasive therapy. Nerve repair can reduce otherwise untreatable pain significantly and deserves a place in the armamentarium for the treatment for this devastating disease. Iwanaga and Shane (2019), in a study in 12 fresh-frozen Caucasian cadaveric heads, found that is feasible to reroute the buccal nerve to the lingual nerve. Such technique might be used for patients with lingual nerve injury for patients without any sensation of the tongue. According to these authors clinical studies are now necessary to validate this procedure.

3. DISCUSSION

Lingual nerve is a branch of the posterior trunk of the mandibular nerve given off in the infratemporal fossa, coursing close to the lingual aspect of the mandible at the region of the third molar. It carries general sensation to the mucosa of the anterior tongue, mandibular lingual gingiva and the floor of the mouth and also receives the chorda tympani nerve that provides taste and parasympathetic innervations to the anterior two thirds of the tongue and the salivary glands. Several previous studies have shown inconsistent data on the position of the lingual nerve at the third molar region, which implies more studies about it, in order to minimize its possible injury. Karakas et al. (2007) reported a mean vertical distance of 9.51 mm which differed from a study by Miloro et al. (1997) who found a mean of 2.75 mm in which using magnetic resonance imaging to visualize the nerve. Several factors can influence this difference, being ethnicity the major factor, due to race heterogeneity and lack of data. Knowledge of lingual nerve anatomy is of supreme importance to dentists and maxillofacial surgeons. Most of lingual nerve injuries result in sensory changes, which are transient and with rapid recovery over time (Bagheri *et al.*, 2010; Cheung *et al.*, 2010).

Also, lingual nerve injury may be related to the variant anatomy in the course of the nerve and use of different surgical techniques resulting in significant morbidity to the patient and potential medico-legal repercussion to the surgeon. So, data on the lingual nerve are especially useful to new practitioners since it has been shown that inexperience on the part of the practitioner is an important factor leading to lingual nerve injury. True frequency of lingual nerve injury remains controversial and current publications give the considerable variation of 0.2% to 22% (Loescher *et al.*, 2003). Approximately 75% of lingual nerve injuries occur due to third molar removal with almost all involving osteotomies and tooth resections (Biglioli*et al.*, 2018). Renton and Ylmaz (2012) gave more emphasis to the surgical procedure, stating that surgery alone results in significant decreases in the neuropathic area and improving mechanosensory function. The lingual nerve is always at risk of iatrogenic lesions during several surgical procedures, mainly, the third inferior molar removal, suturing and mandibular anaesthetic block (Biglioli *et al.*, 2018; Sittitavornwong *et al.*, 2017). According with Sittitavornwong et al. (2017), the lingual nerve has been found 10 to 17.6% of the time at the level of the alveolar crest or higher at the mandibular third molar. The same authors reported that the lingual nerve contacted the lingual plate of the third molar in 62% of 256 patients. Only few studies claim that suturing can be a risk factor for lingual nerve lesion, by needle direct presents a not so big post-operatory wound consider safe the needle insertion up about 3 mm from the graft gingival margin. Also, the use of lingual flap retraction has been implicated in nerve injury during third molar extraction (Oghenemavwe *et al.*, 2010) though Lata and Tiwari (2011) reported that lingual nerve injury could occur without lingual flap retraction.

Several types of lingual flaps were created and evolved, each one with its supporters. Along the years there has been countless opportunities for ideas exchange: that the technique presenting higher incidence of lesion was the “lingual split technique”, that, performing the lingual flap retraction is not beneficial but rather a cause for increasedincidence of lesion (Bataineh and Bataseh, 2017; Amorim Gomes *et al.*, 2005; Pichler and Beirne, 2001), that the modified triangular flap, than the envelop flap (Jakse *et al.*, 2002), that the paramarginal flap does not present better results than the conventional marginal flap, being the former who presented a bigger tendency for opening a wound (Cunqueira *et al*., 2003), that the lingual flap protection was unnecessary (Gargallo-Albiol *et al.*, 2000) and that to elevate or retract the lingual flap was not beneficial but rather a factor for occurrence of lesion (Bataneh, 2001), in spite of the “lingual split technique” being the one which showed higher lesion incidence, the use of piezoelectric devices was proposed, decreasing this way the lesion incidence, making once again this technique viable (Ge *et al.*, 2016). Another technique, or procedure, for third mandibular molars removal is the Coronectomy; this method is superior to the complete tooth removal, in relation with the nerve lesion incidence (Pederson *et al.*, 2018). In contrast this procedure raises questions and possible problems, like the incidence of late migration of the root complex, development of late pulp necrosis, increase on antibiotic use and the risk of more complicated infections or osteomyelitis. Being the lingual nerve in risk of infection so many times, the causes of lesion, as the repairing methods are quite debated. Like the ideal times for recovery, being the results mixed (Kushnerev and Yates, 2015) some authors defend that the surgery must be done within a period of three and six months (Renton and Ylmaz, 2012), one year (Bagheri *et al.*, 2012) and up to 10 weeks (Pogrel, 2002).

Regarding neurorrhaphy, the repair of lingual nerve injuries is traditionally performed via direct neurorrhaphy or, in the case of excessive tension or a segmental defect, with a nerve autograft. In the case of autogenous grafts, they are generally unnecessary for lingual nerve repair, because of the nervous tract is so sinuous that can´t be mobilized without tension (Bagheri *et al.*, 2010).

4. CONCLUSION

Being the third lower molars removal the surgical procedure with major lesion index it is, by consequence, the most studied, giving raise to countless techniques to perform its removal by Lingual Split Technique, who is indicated by several studies as the one with higher injury rate, the piezosurgery, which showed to be advantageous, being able to turn viable the execution of the Split Bone Technique, the coronectomy, which presented in some studies as the procedure with bigger success index in avoiding lingual nerve lesion, but in contrast presents a late radicular migration, as well as the development of the late pulp necrosis, the increase in antibiotic use and the risk of more complicated infections or osteomyelitis. The studies indicate the retraction or raise of a lingual flap did not show any advantage and, in contrast contributed for the increase in lingual nerve lesion incidence. Regarding the time to repair the injured lingual nerve, the authors indicate that the sooner this procedure is performed, the greater is the probability for recovery. The nerve reconstruction can be achieved by several methods, being neurorraphy the one who presented the biggest success percentage, but in contrast, with the lingual nerve this procedure is associated with neuroma formation.

This paper focuses on an issue that comprises many factors and variables, and for that we suggest further studies on this item should be conducted.

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