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Evaluating a Methodical Approach to Lingual Nerve Protection during Third Molar Surgery Using a Standardized Step-by-Step Procedure: A Retrospective Analysis

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Abstract: The aim of this study was to assess the methodical protection of the lingual nerve via the use of a standardized step-by-step procedure in the surgical extraction of the lower third molar. A 5-year retrospective analysis of surgical third molar surgery conducted by third-year oral surgery specialty program students was performed in the oral surgery department of Policlinico Umberto I in Rome, from 2017 to 2022. All surgeries were carried out using a standardized step-by-step procedure to protect the lingual flap during the surgery. Every patient underwent a review on the initial postoperative day, and subsequently, one week after the surgery, coinciding with the removal of the sutures. During each postoperative visit, thorough examinations were conducted to assess any sensory nerve impairment of the inferior alveolar, lingual, or mylohyoid nerves. None of the cases reported postsurgical lingual nerve injury; there was zero incidence of lingual nerve paresthesia or dysesthesia. The systematic application of lingual flap protection proved to be an effective and reproducible approach for the surgical removal of lower third molars without raising the risk of lingual nerve sensory impairment, regardless of the operator's experience.

Keywords: nerve injury; lingual nerve; third molar extraction; mucoperiosteal flap; mandibular third molar; lingual nerve injury; lingual nerve protection

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1. Introduction

Surgical removal of impacted lower third molars is frequently indicated, and it is the most common surgical procedure in dentistry. The traditional approach for surgically extracting lower third molars typically involves raising a buccal flap, removing buccal bone, which can be performed with (LF+) or without (LF) lingual retraction, and tooth sectioning. The proximity of the lower third molar to several vital structures, including the lingual nerve, poses potential complications. The lingual nerve is particularly susceptible to injury during lower third molar surgery, which can significantly impact a patient's quality of life, leading to both physiological and psychological disturbances [1]. Lingual nerve injury (LNI) can result in complications such as altered touch and taste sensations, neuralgia, and impaired swallowing and speech [2].

The lingual nerve (LN) is a branch of the mandibular division of the trigeminal nerve [3]. It provides somatosensory innervation, such as sensations of pain, temperature, and pressure, to the mucous membrane. The LN innervates the anterior two-thirds of the tongue, the lingual gingiva of the mandibular teeth, and the mucosa of the floor of the mouth [3]. Approximately 1 cm below the point where the inferior alveolar nerve and LN diverge, the LN is joined by the chorda tympani nerve [4]. The path of the LN varies between individuals. A study by Pogrel et al. found that, in twenty cadaveric heads, the LN was situated between 1 and 7 mm from the lingual plate of the lower third molar [5].

This highlights the potential risk of lingual nerve injury when a lingual flap is retracted due to the varying locations of the LN.

Lingual nerve injury (LNI) following the removal of third molars is typically transient, with studies indicating that spontaneous recovery occurs in about 60% of cases within three months and 35% of cases within six months [2]. If LNI persists beyond six months, the likelihood of spontaneous recovery diminishes significantly, and the injury may be considered permanent [6].

In the literature, the incidence of third molar removal ranges from about 0 to 23%, depending on the technique and instruments used [7]. The most commonly reported statistically significant risk factor in the literature is the reflection of a lingual flap, the removal of bone, the sectioning of the tooth, and the experience of the operator, as well as the anatomic variations in the lingual nerve, but authors are not always in agreement with each other about its etiology, risk factors, and incidence [7,8]. The association between lingual nerve injury (LNI) and the extraction of third molars depends significantly on the anatomical relationship between these structures. Many studies highlight the closeness between the lingual nerve and the third molar surgery site [9–13].

A relevant controversial topic linked to LNI is the application of surgical techniques of elevation and lingual flap protection to prevent LNI [14–17]; according to the results obtained with surgical protocols developed in the United States, surgery with the elevation of only one buccal flap has spread further [14]. The debate regarding whether or not and how lingual flap protection could impact the incidence of lingual nerve injury (LNI) remains unresolved [18–23].

The aim of this study was to evaluate the efficacy of the methodical protection of the lingual nerve via the use of a standardized step-by step procedure during third molar surgical extraction by last year's students of the oral surgery specialty program.

2. Materials and Methods

A 5-year retrospective analysis of surgical third molar surgery carried out by third-year oral surgery specialty program students was conducted in the department of oral surgery of Policlinico Umberto I in Roma, from 2017 to 2022.

The inclusion criteria for the study encompassed lower third molars requiring flap reflection and surgical extraction, while cases associated with pathological conditions such as cysts or tumors were excluded from consideration. All the third molar surgeries were performed by a third-year oral surgery student with the supervision of an experienced senior surgeon.

All the surgical extractions included in the study involved a full-thickness buccal flap reflection, a full-thickness lingual flap reflection and protection (LF+), osteotomy, and odontotomy.

The patients were interviewed and examined. X-ray examinations were carried out for each patient, either via an orthopantomogram (OPG) or CBCT.

Routine preoperative laboratory tests (on full blood count, blood clotting tests, glycemia, azotemia, and creatinine) and a cardiologic visit with an electrocardiogram were carried out. The patient was informed of the risks and benefits of the surgical intervention. Informed consent was obtained, and the surgery was scheduled.

A standardized data sheet was completed, including the name, age, gender, side of the operation, state of eruption, cause of extraction, angulation, depth of the lower third molar, tooth division, and lingual nerve injury.

The orientations of the lower third molars were categorized from the radiographs in accordance with Winter's classification [24] into vertical, horizontal, mesioangular, or distoangular. Other patterns were classified as aberrant. The depth of the tooth was classified as position A, B, or C in accordance with the classification of Pell and Gregory [25].

A step-by-step procedure aimed at protecting the lingual flap to prevent lingual nerve injury was taught to oral surgery students during their first two years of the oral surgery program. The essential part of the program was anatomical cadaveric dissection, allowing

them to deeply understand the anatomy of the retromolar area while exploring the relation of the lingual nerve and the third molar (Figure 1), and a simulation of the intervention was carried out with the aid of a plastic model. Deep knowledge of the retromolar anatomy of the mandible is mandatory.

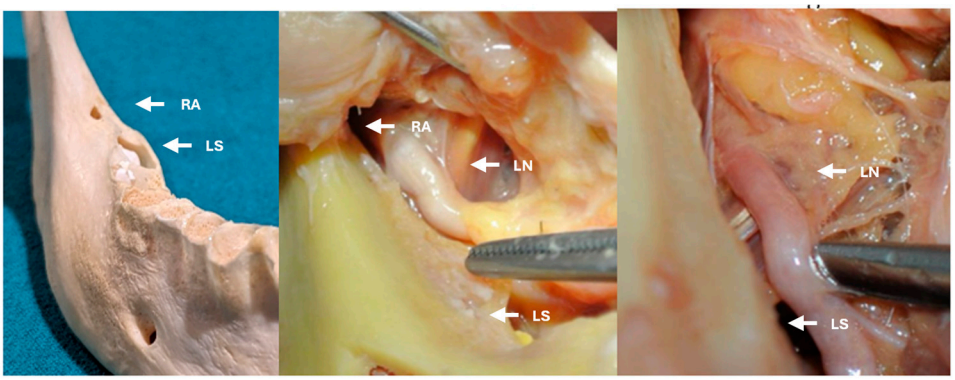

Figure 1. Anatomical dissection of retromolar area performed by students. RA: retromolar area; LS: lingual side; LN: lingual nerve.

The standardized procedure to protect the lingual flap from the harmful action of rotary instruments is composed of 4 steps:

Step 1: Design of a vestibular full-thickness flap.

Flap incision is carried out at the buccal site, respecting the anatomy of the retromolar area using a three-sided flap, also known as Ward's incision, with the distal relieving incision positioned buccally to avoid damage to the lingual nerve. The distal relieving incision is made 45 degrees to the distobuccal cusp of the lower third molar or the middle of the distal surface of the second molar in the case of a full impacted third molar. From there, an intrasulcular incision of the second molar is made; before the mesial papilla, a vertical incision line is made obliquely into the mandibular vestibule, with a variable length according to the area to be exposed. This vestibular releasing incision was carried out as a standard procedure for all patients to ensure adequate exposure for all patterns of impaction (Figure 2A).

Step 2: Full-thickness elevation of the buccal flap.

The elevation of the buccal flap starts from the mesial vertical releasing incision and extends to the retromolar trigone area (Figure 2B–E).

Step 3: Full-thickness elevation of the lingual flap.

Delicate full-thickness reflection of the lingual flap starts from the most distant part of the distal releasing incision of the vestibular flap (Figure 2E). This procedure avoids perforation or partial dissection of the lingual flap due to the tension at the insertion point in the retromolar area. The reflection of the lingual flap can extend to the intrasulcular part of the second molar, and it is aimed at exposing the initial margin of the lingual zone (Figure 2F). The elevation proceeds from the retromolar area to the lingual zone; the retractor must maintain contact with the bone throughout all stages of detachment. Close contact with the bone surface allows for optimal flap elevation without tearing the periosteum, which is crucial to avoid complications. A key point is the change in the inclination of the bone from the buccal to the lingual area of the retromolar region. This important step is demonstrated clearly using a human jaw model (Figure 3). During buccal and retromolar elevation, the tip of the elevator is in close contact with the bone, and the concave inner portion of the elevator faces downward (Figure 3A–C). When transitioning to the lingual area, the tip of the elevator remains in close contact with the bone, but the concave inner portion of the elevator faces upward (Figure 3D–F).

Step 4: Protection of the flap

Protection of the flap is achieved by using the internal part of the retractor in contact with the bone, and a delicate reflection is performed either by the operator or the assistant,

moving the distal part of the instrument from the vestibular to the lingual side. It is crucial to gently reflect and keep the internal tip of the retractor in contact with the lingual bone margin (Figure 4).

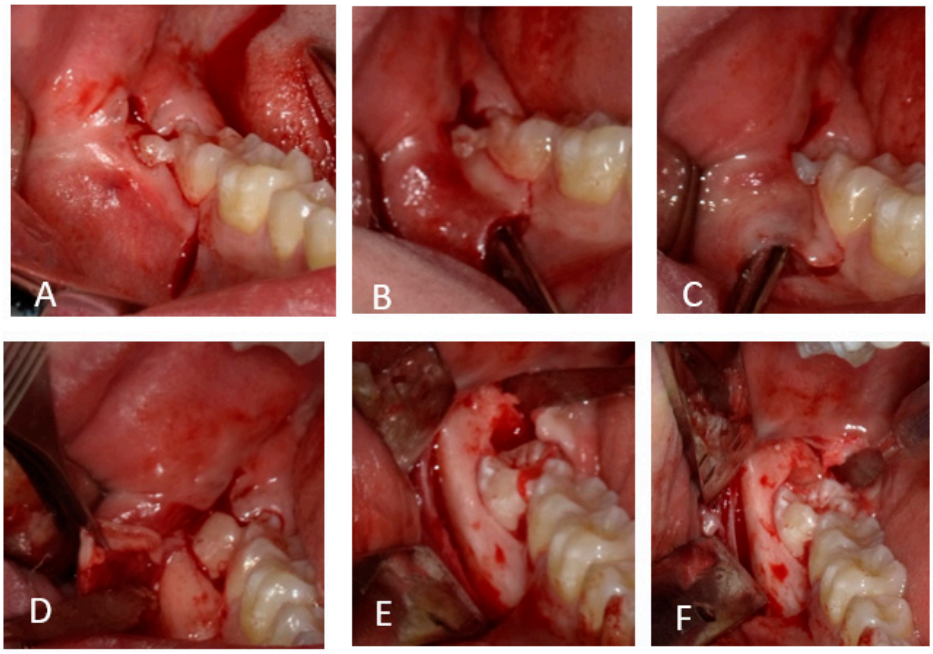

Figure 2. Design and reflection of a full-thickness flap to protect the lingual nerve. Design and reflection of a full-thickness flap to protect the lingual nerve. Design of a vestibular full-thickness flap (**A**); full-thickness elevation of the buccal flap (**B**–**D**); full-thickness elevation of the retromolar area and the initial portion of the lingual area (**E**); reflection of the lingual flap (**F**).

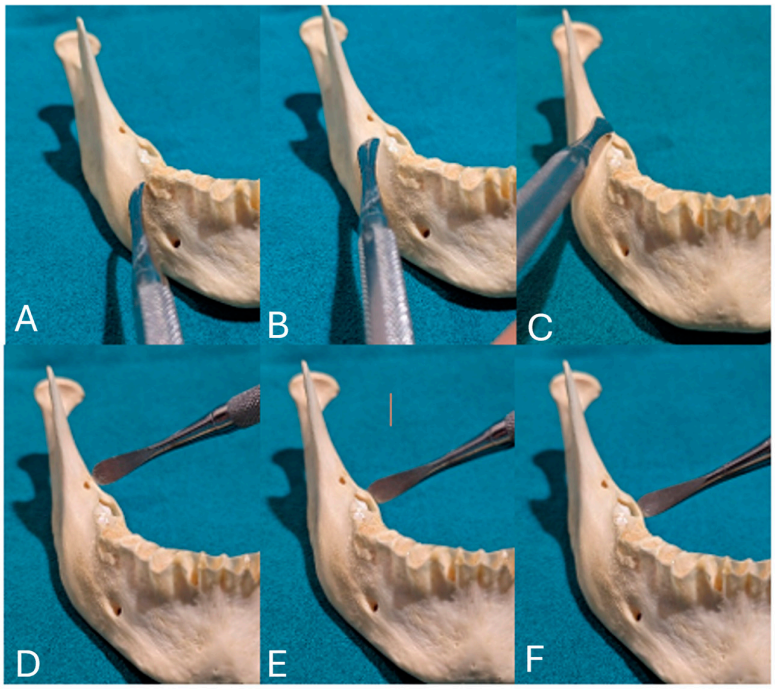

Figure 3. Close contact of the retractor to the bone and the change from a vestibular to lingual inclination in the retromolar area. Note how during the buccal (**A**,**B**) and retromolar flap elevation (**C**), the concave inner portion of the elevator faces downward. When moving to the lingual area (**D**), the tip of the elevator stays in close contact with the bone, while the concave inner side of the elevator is oriented upwards (**D**–**F**).

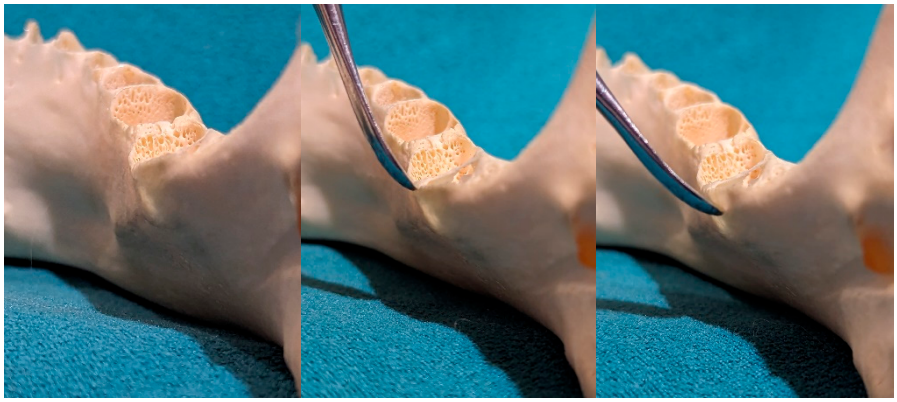

Figure 4. Inclination of the retractor in the final position in the lingual area.

Once the mucoperiosteal flaps were mobilized and protected, a round surgical bur was used to remove the bone and section the tooth depending on the position and inclination. Following tooth extraction, the socket underwent debridement, and primary wound closure was performed using gentle, non-traumatic sutures. Special attention was paid to avoid taking more than a 3 mm section from the lingual mucosa just distal to the lower second molar, preventing inadvertent entrapment of the lingual nerve by the suture.

Every patient underwent a review on the initial postoperative day and, subsequently, one week after the surgery, coinciding with the removal of the sutures. During each postoperative visit, thorough examinations were conducted to assess any sensory nerve impairment of the inferior alveolar, lingual, or mylohyoid nerves.

In the context of evaluating sensory nerve function in the lingual nerve, each participant was queried about any sensations of tingling or numbness in their tongue. To establish the presence or absence of sensory impairment in the lingual nerve, a more objective evaluation of nerve injury was conducted. This assessment adhered to the procedures outlined by Ferdousi and MacGregor [26], as well as those employed by Mason [17] and Blackburn [27].

The assessment encompassed the following criteria:

1. Light touch sensitivity;
2. Tactile discrimination ability;
3. Pain perception awareness;
4. Two-point discrimination while in motion.

3. Results

In total, 453 lower third molars from 305 patients were extracted.

The age of patients ranged from 18 to 45 years with a mean of 31.5 years. Among the 305 patients, 200 (65.6%) were men and the remaining 105 patients (34.4%) were women (Table 1).

Three hundred surgical sites (66.2%) were on the right side while 153 (33.8%) surgical procedures were performed on the left side. In total, 185 teeth (40.9%) were partially erupted, and the remaining 268 (59.1%) were fully covered (Table 2).

Regarding the angulation of the impacted lower third molars, the most common pattern of impaction was mesioangular (36.8%). The aberrant patterns of impactions were the least common, being present in only twenty cases (4.4%), eight of which were lingually angulated while the remaining twelve cases were horizontal and buccally tilted (Table 1).

All lower third molars included in this study required reflection of a buccal flap and buccal bone removal, and possibly distal bone removal. Tooth division was required in almost half of the cases (78.4%) (Table 1).

The majority of the impacted teeth (84.5%) were in position A or B according to Pell and Gregory's classification.

Suturing of the buccal flap was performed in all cases by placing one suture just distal to the lower-second molar. In addition, some surgical procedures required additional suturing of the distal and/or the vertical releasing incisions. None of the cases reported wound dehiscence.

None of the cases reported postsurgical lingual nerve injury; there was zero incidence of lingual nerve paresthesia or dysesthesia (Table 3). There was no increased risk of lingual nerve paresthesia or dry sockets, which were identified. Given the absence of lingual nerve injuries, only descriptive data analysis was conducted.

Table 1. Demographic data of the patients.

Number of Patients	Age Range (Years)	Mean Age (Years)	Male Patients (%)	Female Patients (%)
305	18–45	31.5	65.6%	34.4%

Table 2. Distribution of lower third molars according to the side, state of eruption, angulation, and tooth division.

Side of Operation	Number	Percentage
Right	300	66.2
Left	153	33.8
TOTAL	453	100
State Of Eruption	Number	Percentage
Fully Impacted	185	40.9
Parzially Erupted	268	59.1
TOTAL	453	100
Angulation	Number	Percentage
Vertical	88	19.5
Horizontal	108	23.8
Mesioangular	167	36.8
Distoangular	70	15.5
Aberrant	20	4.4
TOTAL	453	100
Tooth Division	Number	Percentage
Tooth Divided	355	78.4
Tooth Not Divided	98	21.6
TOTAL	453	100

Table 3. Results of LNI.

Total Lower Third Molars Extracted	Total Patients	LNI
453	305	None

4. Discussion

The surgical extraction of impacted lower third molars is the most prevalent surgical intervention in dentistry and undoubtedly the most frequent cause of lingual nerve damage.

The iatrogenic damage observed in lingual nerve injury (LNI) represents a noteworthy event of legal and medical importance [28].

Several etiologic factors, anatomic or surgical, and direct and indirect, have been addressed.

Direct factors directly cause nerve injury, such as local anesthesia injection, incision and flap design, manipulation of the lingual flap, bone removal, lingual bone splitting, tooth division, and suturing. Indirect factors, on the other hand, elevate the risk of lingual nerve injury either by rendering the nerve more vulnerable to damage or by complicating the surgical procedure. These factors encompass the anatomy of the lingual nerve, type of

anesthesia employed, stage of eruption, and angulation and depth of the lower third molar, as well as the proficiency of the operator [29,30].

Thorough knowledge of lingual nerve anatomy and topography is crucial to avoid iatrogenic nerve damage or at least to lower the risk of nerve injury. According to Al-Amery et al., lingual nerve spatial localization ranges widely from individual to individual, as well as in the same individual, in areas from the third molar region to the submandibular gland [31].

The concept of normalcy in anatomy is considered relative. Understanding anatomical variables is crucial not only for addressing diagnostic challenges but also for developing surgical procedures [32].

According to Patryk Ostrowski's metanalysis, the LN was found to be locate below the lingual/alveolar crest in 77.87% of cases, above the lingual/alveolar crest in 8.21% of cases, and in direct contact with the lingual plate in 37.61% of examined nerves [33].

Injuries to the lingual nerve during surgical procedures involving the third molar region necessitate a thorough investigation of its typical course and notable variations. Reports indicate a varied incidence (ranging from 0 to 62%) of direct contact between the lingual nerve and the alveolar wall of the third molar [33–38].

It commonly travels on the periosteum on the medial surface of the mandible and finds itself opposite the posterior root of the lower third molar. At this location, it is covered solely by the gingival mucoperiosteum and is bound closely to the lingual plate of the mandible.

This anatomical course can also be observed clinically, in those cases in which an accidental laceration of the periosteum occurs during incorrect management of the lingual flap (Figure 5).

The lingual periosteal laceration does not directly harm the lingual nerve but poses an indirect risk because it hampers the possibility of complete detachment of soft tissues from the lingual mandibular plate.

Some studies suggest that the prevention of LNI through the detachment of the lingual flap is essential to avoid the harmful action of rotary instruments on the lingual soft tissues that may occur during odontotomy or osteotomy [29].

In our study, 453 surgical extractions of impacted third molars were performed using the surgical technique involving lingual flap retraction (LF+). None of the cases reported post-surgical permanent lingual nerve injury; there was zero incidence of lingual nerve paresthesia or dysesthesia.

However, there are contrasting opinions in the literature.

Among the proponents of the LF technique, several authors stand out, but the most significant study was conducted by Robinson and Smith in 1996. They suggested that the LF technique comes with a lower incidence of LNI compared with the LF+ technique [38].

More recently, Pichler and Beirne [30] assessed the incidence of and spontaneous recovery from lingual nerve injury following surgical techniques: the buccal approach with lingual flap retraction (BA+) and the buccal approach without lingual flap retraction (BA−). The results indicate a prevalence of permanent LNI of 0.60% for BA+ and 0.20% for BA−, with a temporary LNI prevalence of 0.60% (BA−) and 6.40% (BA+). In line with Robinson and Smith's findings, they concluded that the use of a lingual nerve retractor during third molar surgery is associated with a higher incidence of temporary and permanent nerve damage.

A more recent literature review [39] similarly examines how retracting and safeguarding the lingual flap could influence the occurrence of lingual nerve injury (LNI) during third molar extraction, compared with protocols that do not involve manipulation of lingual tissue.

In particular, 11 studies were considered (Table 4). From the literature analysis, the outcomes were compared by analyzing the mean incidence values and standard deviations of lingual nerve injury (LNI) reported by the studies, distinguishing between the sample treated with LF+ (3886 surgeries) and that treated with LF (5938 surgeries). For the

LF+ group, the mean incidence of temporary LNI was 2.98 ± 0.03%, and for permanent LNI, it was 0.1 ± 0.003% (Figure 2). In contrast, the LF group had a mean incidence of 1.92 ± 0.02% for temporary injuries and 0.49 ± 0.006% for permanent injuries.

In contrast to previous literature, and consistent with our study, the findings from this review suggest that the LF+ technique reduces the risk of lingual nerve injury during mandibular third molar extraction. Additionally, retracting the lingual flap improves access to the surgical site, potentially simplifying the procedure. Occasionally, patients may experience paresthesia, likely due to traction pressure from the retractor, but such damage is typically temporary, with full recovery occurring within 2 to 6 months.

In agreement with our study, the most recent systematic review and meta-analysis by Joshua Lee et al. [40] examines studies on patients who underwent surgical extraction of the lower third molar using the buccal approach without lingual flap retraction (BA−) and with lingual flap retraction (BA+). The incidence of permanent nerve injury was 0.18% with BA− and 0.07% with BA+.

These conclusions contrast the widely held belief that the surgical approach involving only the buccal flap better preserves the integrity of the lingual nerve compared with the LF+ technique.

It is clear that the primary challenge in reaching definitive conclusions stems from the multitude of possible interventions, which results in a high number of variables that are nearly impossible to account for simultaneously [23].

This notion is bolstered by the observation that studies with similar designs frequently present significantly different or conflicting outcomes, indicating unclear management of intervention variables that could potentially pose a risk factor for lingual nerve injury (LNI). One factor that may have contributed to the propagation of the theory, now disproven, that the use of LF+ increases the risk of LNI, is the lack of randomization in the analyzed samples. In several studies, the use of a lingual retractor was left to the clinician's discretion. This practice could have introduced bias since lingual retraction might have been employed more frequently in challenging cases that inherently carried a higher risk of lingual nerve injury (LNI), regardless of whether or not lingual retraction was formally documented. Another limitation was the variability in the type of lingual retractor utilized across articles, with some studies failing to specify the type used. This variability introduced potential bias [41,42].

We propose a systematic, step-by-step standardized procedure for all surgical extractions of the lower third molar, enabling trained surgeons to perform every phase safely. This technique ensures adequate exposure and protection of the surgical field, reducing the risk of LNI.

Properly learning the described technique and adherence to all operational steps are conducive to protecting the lingual nerve, especially during the phases of odontotomy and bone removal, which, as described in the literature, increase the risk of LNI [43].

Safety can be achieved by correctly detaching a full-thickness lingual flap without lacerating the periosteum. Maintaining periosteal integrity during lingual detachment ensures nerve protection. To achieve proper flap detachment, it is imperative to keep the separator in direct contact with the bone throughout all stages described in the technique. Direct contact of the separator with the bone allows for the surgeon to follow the mandibular plate's natural inclinations, resulting in a change in the tool's axis inclination from the vestibular to the lingual plate, as illustrated in Figure 6.

Table 4. List of all the included studies with the year of publication and reported incidences (%) of temporary or permanent injuries to the inferior alveolar nerve related to the type of intervention (LF+/LF). Abbreviation: LF: lingual flap; LNI: lingual nerve injury. Petroni G et al., 2021 [39].

L	First Author	Year	Technique	Temporary LNI (%)	Permanent LNI (%)
1	Shad	2015	LF+	8.94	0
			LF	2.63	0.5
2	Jerjes	2010	LF	1.8	1.6
3	Jerjes	2006	LF	6.5	1
4	Pogrel	2004	LF+	1.6	0
5	Malden	2002	LF+	1.4	0
6	Gargallo-Albiol	2000	LF+	2.11	0
			LF	0.63	0
7	Robinson	1999	LF+	3.33	0
			LF	0.9	0
8	Appiah-Anane	1997	LF	0.2	0
9	Chiapasco	1996	LF+	0.05	0
10	Robinson	1996	LF+	6.9	0.8
			LF	0.9	0.3
11	Walters	1995	LF+	0.5	0

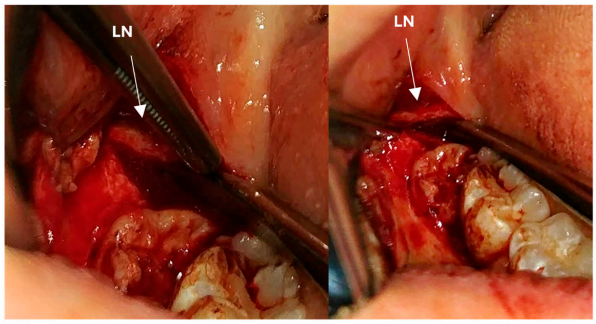

Figure 5. Details showing the course of the lingual nerve (LN), following an accidental laceration of the periosteum.

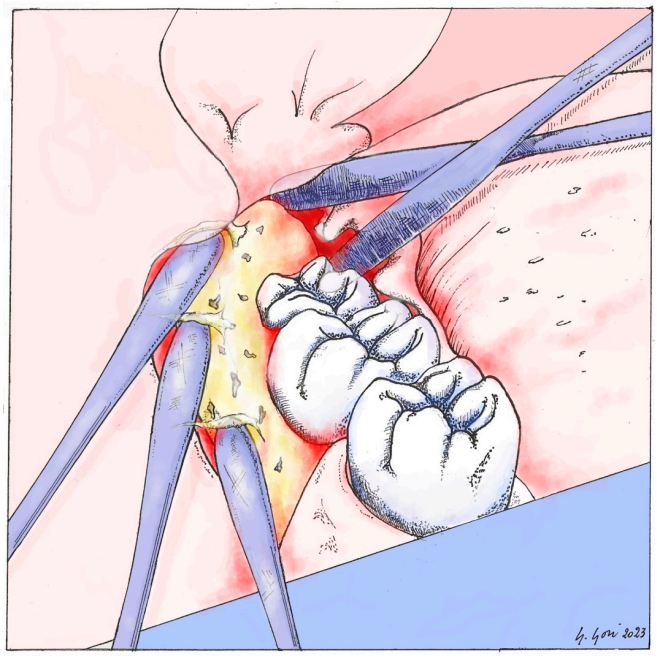

Figure 6. Dynamic detachment of the full-thickness flap (Guido Gori).

5. Conclusions

This study shows that there is no incidence of temporary lingual nerve injury (LNI) following surgical extraction of the lower third molar when performing full-thickness lingual flap elevation in accordance with specified steps.

Based on the successful application of this methodical approach, it appears that it can be safely employed for the surgical extraction of lower third molars under local anesthesia. This protocol proved to be a standardized and reproducible approach for the surgical removal of lower third molars without raising the risk of lingual nerve sensory impairment. However, more large-scale and standard investigations should be considered in further studies to improve the evidence in support of this conclusion. Surgeons should always perform lingual flap elevation cautiously and only after undergoing adequate surgical training.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent was obtained from the patients to publish this paper.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflicts of interest.

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