

## Incidence and risk factors for nerve injuries in mandibular third molar surgery

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### Abstract

**Background:** The inferior alveolar (IAN), lingual (LN) and long buccal nerves (LBN) are the three terminal branches of the trigeminal nerve which are susceptible to injury during surgical extraction of impacted mandibular third molars. While it is not always possible to accurately predict the patients that will be affected with these complications, understanding and identifying the risk factors may allow the adoption of appropriate technique and expertise for specific cases. We embarked on this study to document the incidence and duration of injury to the inferior alveolar nerve (IAN), lingual nerve (LN) and long buccal nerve (LBN) following the operative removal of impacted mandibular third molars and to identify the associated radiographic and operative risk factors.

**Method:** Pre- and postoperative neurosensory tests were performed for seventy nine patients who had surgical extraction of unilateral impacted mandibular third molars to determine the incidence and duration of complicating nerve injuries. The risk factors for nerve injury were determined among the radiographic variables and documented operative events.

**Results:** The incidence reported were 6.6% for IAN, 2.6% for LN and 4.0% for LBN; all but one of the nerve injuries resolved within 2 weeks. Depth of impaction (Pell & Gregory Level C) and linguo-version were the significant risk factors for IAN and LN injuries respectively while no risk factors was detected for LBN injury. Some significant operative events were associated with nerve injuries

**Conclusion:** Nerve injury in third molar surgery can be predicted based on some radiographic risk factors and some unforeseen intraoperative events. Most of the injuries are transitory in nature.

**Keywords:** Nerve injury, Radiographic risk factors, operative risk factors, Third molar surgery

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### Introduction

The inferior alveolar, lingual and long buccal nerves are the three terminal branches of the trigeminal nerve which are susceptible to injury during surgical extraction of impacted mandibular third molars<sup>1,2</sup>. The Injuries result in dysfunctional symptoms such as paraesthesia, anaesthesia and dysaesthesia, the management of which could be very complex and sometimes unsatisfactory; resulting in permanent deterioration in quality of life<sup>3,4</sup>. Therefore, it is imperative that this operative procedure be undertaken with reasonable caution and professional prowess.

Though reported to be generally rare, the documented incidence of nerve injury following impacted mandibular third molar extraction ranges from 0.4% to 5% for the inferior alveolar nerve (IAN); 0.6%- 2% for lingual nerve (LN) and 0-0.27% for long buccal nerve<sup>5-9</sup>. These include cases performed by individuals of varying competence, using different techniques, under different settings and involving patients of diverse race and ethnicity. In our search of the literature, we observed a dearth of information on the incidence of nerve injuries associated with impacted third molar extractions in Nigeria.

While it is not always possible to accurately predict the patients that will be affected with these complications, understanding and identifying the risk factors may allow the adoption of appropriate technique and expertise for specific cases. Although some of the risk factors are observed intraoperative, majority can be easily identified during clinical and radiographic examinations. Although panoramic radiography is the recommended technique, sophisticated techniques such as, magnetic resonance imaging (MRI), tuned aperture computerized tomography (TACT), volumetric computerized tomography (VCT) and three dimensional reconstruction computerized tomography (3-D CT) have greatly enhanced the recognition of many of these risk factors in the developed world<sup>10,11,12</sup>. Apart from the limited or non-availability of some of these facilities, it is really impracticable to routinely request these

expensive and technically demanding investigations for dental extractions in our environment. Consequently, radiographic assessment for patients at the risk of this complication in Nigeria has largely relied on the periapical radiography which has a lot of limitations and shortcomings. Although a few private-owned facilities in Nigeria now have equipment for panoramic radiography, this is similarly fraught with shortcomings.

We embarked on this study to document the incidence and duration of injury to the inferior alveolar nerve (IAN), lingual nerve (LN) and long buccal nerve (LBN) following the operative removal of impacted mandibular third molars and to identify the associated radiographic and operative risk factors. We discussed our observations in the light of available information in the world literature.

## Patients and Method

The protocol for the study was approved by the Institutional Review / Local Ethics Committee and every participating patient gave an informed consent. Over a 12-month period 79 patients consented to participate in the study out of 102 patients who had impacted mandibular third molar extraction in our oral surgery clinic during the period. The participants were comprehensively examined and underwent complete pre- and post-treatment clinical neurosensory test by a modification of the technique described by Pogrel<sup>13</sup> and Miloro et al<sup>14</sup>. This was done to ensure that none of them had any clinical evidence of preoperative sensorineural deficiency of the inferior alveolar (IAN), lingual (LN) and long buccal nerves (LBN). The technique involved both objective and subjective tests. In the subjective test, the patients were asked to describe any change in sensation in the areas around the mouth and to compare with the unoperated side and the pre-op sensation at the operated side. They were to touch the spots where they perceived altered sensation which was documented by the examiner. The objective test, consisted of 3 components in our modification as opposed to the two described by the original authors. First, a cotton wool pledget was used to stroke the tested sites in a particular direction to assess for light touch and directional discrimination. Second, a pin-prick test was done to map out the areas of sensory loss and finally, a two-point discrimination test was performed using blunted points of a mathematical set divider.

Standard periapical radiographs of the impacted teeth were obtained and features which were previously implicated in the literature<sup>15</sup> such as; angular orientation of the tooth (Mesioangular, Horizontal, Vertical,

Distoangular, Transverse), depth of impaction (Pell & Gregory's Level A, B, or C), available arch space for the tooth (Pell & Gregory's Class I, II, or III), relative horizontal tilt of the tooth (Erect, Bucco-version, Linguo-version), proximity to the mandibular canal (Distant or Close), periodontal space (Normal, widened, obliterated), number of root (Fused, two, three), root favourability (favourable, unfavourable) were documented. The same surgical protocol was used for the extraction which involved the elevation of a three-sided buccal flap for access, the crestal periodontal fibres on the lingual side were carefully detached but no lingual flap was raised. Buccal guttering was performed using a rose-head surgical bur and after adequate osteotomy, the tooth was luxated using Coupeland's elevators Nos 1, 2, and /or 3. Crown sectioning was done using a surgical fissure bur when it was found necessary to effect tooth delivery. The extraction sockets were thoroughly irrigated, suctioned and swabbed dry to allow direct visualization for any exposed nerve or residual bony spicules. The flap was closed with 2 stitches of 3/0 black silk sutures. Every intraoperative event the operator considered notable was recorded; however, no intraoperative observation warranted the abandonment of procedure or exclusion of any patient. All extractions were carried out by a single operator who was a senior resident in the department.

Postoperatively, verbal and written instructions were given to patients and prophylactic antibiotics (Oral Amoxicillin 500mg 3 times daily for 5 days) and analgesics (Oral Piroxicam 20mg twice daily for 3 days) were administered. Any significant postoperative event was also documented. Patients were recalled for postoperative review on day 1, day 7 and day 14. Neurosensory examination was repeated for the inferior alveolar nerve, lingual nerve and long buccal nerve using the same protocol described above. Nerve function was coded normal or abnormal, when abnormal, it was documented as anaesthesia, paraesthesia or dysaesthesia.

The incidence of injury to the IAN, LN and LBN were determined serially over the postoperative days 1, 7 and 14. A multivariate regression of the radiographic variables was performed to determine the variables that constituted the most significant risk factors for injury to each of the nerves. Cases for which the operator documented significant intraoperative/postoperative events were specifically sorted out to find out if any of them had nerve injury probably resulting from the occurrence.

## Results

Seventy nine patients started the study of which four were excluded due to non compliance with follow up schedules. The four patients had turned up for review on postoperative day 1 but failed to show up subsequently. A summary of the periapical radiographic records of those who completed the study are presented in Table I.

On post-op day 1, the incidence of nerve injury observed were 6.6% (5 patients) for IAN, 2.6% (2 patients) for LN and 4.0% (3 patients) for LBN. There was significant improvement on day 7 with the LBN and LN injury rate reducing to 1.3% (1 patient) each, while the incidence of IAN injury persisted as 6.6% (5 patients). On day 14, there was complete recovery of IAN and LBN function while the incidence of LN injury persisted as 1.3% (1 patient) [Fig. 1]. The alteration in nerve functions presented as paraesthesia in 4/5 (80%) cases of IAN and 3/3 (100%) of LBN injuries. One of five (20%) IAN injuries and 2/2 (100%) of LN injuries presented as anaesthesia [Fig. 2].

To determine the risk factors for injury to each of the nerve, we performed a multivariate logistic regression using the radiographic variables in the models with injuries to each of the three nerves as the dependent variable. The significant predictors are depth of impaction [Level C] ( $P=0.034$ ,  $X^2=12.037$ ) for IAN injury and Horizontal tilt [Linguo-version] ( $P=0.047$ ,  $X^2=11.426$ ) for LN injury. On the other hand, no variable was significant for LBN injury.

When the documented intraoperative/postoperative events were reviewed with the incidence of nerve injury [Table II], it was noted that the patient with persistent lingual nerve anaesthesia had the lingual plate fused to the lingual surface of the root and was inadvertently fractured and luxated with the tooth. Notably, this patient had his impacted tooth in a linguo-version position. Also, 3/5 of the patients with IAN injury had extensive and deeper than usual bone removal (in the experience of the operator) and crown sectioning associated with significant intraoperative bleeding. The other 2 patients with IAN injury experienced persistent prolonged brisk bleeding from the extraction socket greater than 20 minutes without extensive osteotomy. One patient had an electric shock feeling along the lips during IAN block and another one required repeated/intermittent administration of local anesthetic agent in spite of clinical evidence of effective anaesthesia. One patient returned to the emergency ward later for significant secondary hemorrhage from the operation site. None of the latter three patients had nerve injuries on postoperative review.

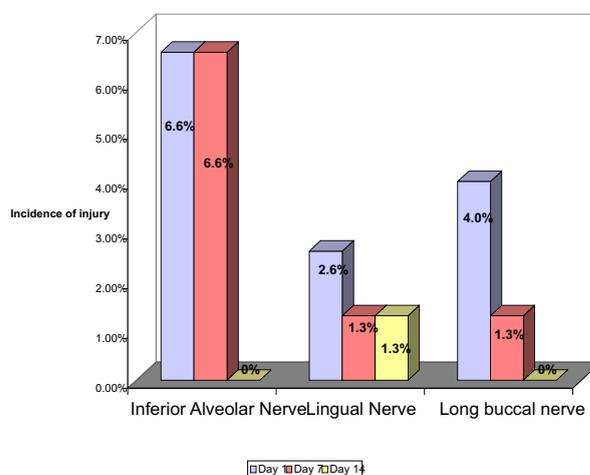
**Table I. Summary of radiographic findings in the study populations**

<b>Depth of Impaction</b>	<b>Proximity to IAN</b>
Level A: 51	Distant: 56
Level B: 21	Close: 19
Level C: 2	
<b>Arch space availability</b>	<b>Root favourability</b>
Class 1: 19	Favourable: 63
Class 2: 53	Unfavourable: 12
Class 3: 3	
<b>Angular orientation</b>	<b>Relative Horizontal tilt</b>
Mesioangular: 25	Erect: 64
Vertical: 20	Bucco-version: 3
Horizontal: 18	Linguo-version: 6
Distoangular: 12	
<b>Periodontal space</b>	<b>Number of root</b>
Normal: 70	One or Fused root: 3
Widened: 5	2 roots: 70
Obliterated: 0	3 roots: 2

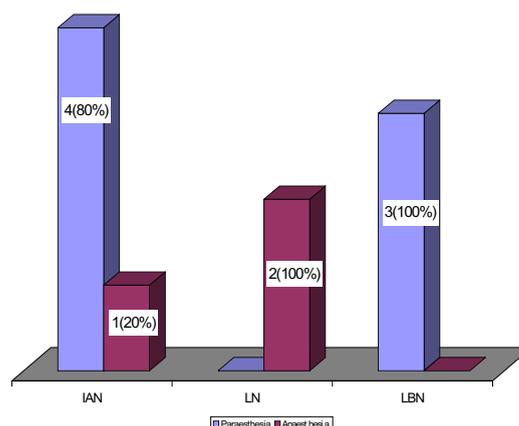
**Table II. Association of notable operative events with nerve injury**

Intraoperative/postoperative events related to nerve injury	Outcome
Fracture of lingual plate	- Lingual nerve injury
Prolong brisk intra-alveolar bleeding (2 cases)	- Inferior alveolar nerve injury
Extensively deep osteotomy + coronectomy (3 cases)	- Inferior alveolar nerve injury
Secondary haemorrhage from socket	- No nerve injury
Electric shock sensation during LA injection	- No nerve injury
Persistent sensation of pain in spite of clinical evidence of effective LA	- No nerve injury

**Fig. 1. Incidence of nerve injury**



**Fig. 2. Symptoms of nerve injury**



## Discussion

Nerve injury involving the IAN, LN and LBN is a known neurologic complication of third molar surgery. In Nigeria, there is general paucity of reports on this complication. In the present study we observed the incidence and duration of nerve injury following impacted mandibular third molar surgery, more importantly, certain risk factors were identified.

The reported incidence for inferior alveolar nerve injury is 0.4% - 5%<sup>5,6,7,8</sup>. The incidence in this study being 6.6% falls within the reported range. In the first postoperative day, all the patients presented with paraesthesia involving varying amount of area in the oral and perioral region including the lower lip, mentum and gingivae of the lower premolar/anterior teeth except one who had complete numbness around the lower lip. Although sensory abnormality in the oral region for any length of time is disturbing, it is much more agonizing when the symptoms persist as a permanent disability. Permanent sensory dysfunction is suspected when symptoms persists over 4 - 6 months without appreciable improvement<sup>18,19</sup>. None of the cases in this study persisted beyond 2 weeks resulting in zero percent incidence of permanent injury. The depth of impaction Pell & Gregory's level C was the significant risk factor for IAN injury in this study. Although this is previously documented<sup>16</sup>, the radiographic factor most strongly associated in the literature is the proximity of the root apices to the mandibular canal<sup>12,20</sup> which was not statistically significant in this study. This observation must be interpreted with caution considering the limitation of the 2-dimensional radiographic technique employed. When using 2-dimensional imaging modalities such as periapical or panoramic techniques, definite criteria<sup>21</sup> have been described for determining the relationship between the roots of an impacted molar and the neurovascular bundle however, some cases are still inevitably misjudged because of the inability to appreciate the radiographic picture in three dimensions. This is the basis for suggesting 3-dimensional techniques such as 3-D CT scan and Volumetric Computerized Tomography (VCT) to confirm suspected cases<sup>11</sup>. These modalities allow the surgeon to achieve a realistic impression of the overall patho-anatomic situation preoperatively<sup>11</sup>. Using these advanced techniques in selected cases where the panoramic radiographs suggested a risk to the neurovascular bundles, Maegawa et al<sup>12</sup> demonstrated that the bucco-lingual position of the canal relative to the roots is more important in determining the patients actually at risk in spite of proximity observed on two dimensional films. The mandibular canal could lie buccal, lingual or in-between the roots of the impacted molars.

They also noted that the absence/incompleteness of cortication around a mandibular canal exposes the nerve to greater risk and this was found to be more frequent with lingually placed canals and those between the roots. These are important impressions that could not have been appreciated on periapical radiographs and could account for the inability to clearly differentiate between the low risk and high risk cases when studies are based on 2-dimensional imaging techniques. Hence, a considerable number of roots thought to be close to the IAN and to probably predispose to injury in this study were not so found.

Most authors reported LN injury in third molar surgery accounting for 0.6% -2% of cases<sup>23</sup>, the incidence rate of 2.6% in this study compares with this. The lingual nerve provides general sensory supplies to the anterior two-third of the tongue, sublingual mucosa, floor of the mouth, and the mandibular lingual gingival. In addition, the special sensory supply for taste in the anterior two-third of the tongue is also carried by the nerve therefore; injury to the nerve could be very debilitating. Anatomical studies on patients<sup>22</sup> and cadavers<sup>23,24</sup> and also with the help of imaging technique such as magnetic resonance imaging (MRI)<sup>25</sup> have identified various risk factors that can cause injury to the lingual nerve in third molar surgery. These include six prominent factors<sup>26</sup>: 1. Close proximity or direct contact of the lingual nerve and the lingual plate in the third molar region, 2. Lingual flap retraction, 3. Linguo-version of the tooth, especially in distoangular impactions 4. Perforation in the lingual plate 5. Difficulty of the procedure 6. The operator's experience. Our finding in this study is that the linguo-version of the tooth was the predominant risk factor. Although it was impossible for us to study the preoperative position of the lingual nerve in relation to the lingual plate and the presence of lingual plate fenestration or dehiscence from a periapical radiograph, we neither palpate any bony deficiency in the lingual plate during clinical examination nor retract a lingual flap during the procedure. Hence, we do not think that any of the injuries resulted from these. However, it is not unlikely that the injured nerves were in close relationship with the lingual surface of the extracted tooth as reportedly found in many patients who have had chronic recurrent pericoronitis in whom resulting fibrosis often hold the nerve sheath bound around the alveolar crests<sup>26</sup>.

The incidence of long buccal nerve injury recorded in this study is unusually high being 4.0% compare to a 0.27% previously reported from our centre. Although

this complication is poorly reported, it is generally believed that the LBN is the least susceptible of the nerves and in the hand of an experienced operator; it is not expected to be so frequently injured. Previous studies have documented that comparatively low incidence of nerve injury occur with greater experience<sup>27</sup>. All the cases with LBN injury in this study presented as paraesthesia in the related buccal mucogingiva of the molar region which did not pose a major deterioration to the patients' quality of life, they all returned to normal by the second week after operation. Although no predisposing factor to LBN injury was identified in the study, the incision process, blunt trauma arising from the placement of flap retractor and extent of retraction has been suggested as a possible risk factor<sup>17</sup>. One paper did note long buccal involvement when the anatomical position was aberrant, i.e., coming off the IAN once it was already in the canal and coming out through a separate foramen on the buccal side of the mandible<sup>28</sup>.

Apart from radiographic factors, some operative variables such as surgical techniques, anaesthetic technique, surgeon experience, extensive ostectomy especially distal, crown sectioning, pain during root luxation, bleeding, exposure of nerves, primary closure of wound, and postoperative ecchymosis have been implicated<sup>20</sup>. We documented significant intra- and postoperative events that could possibly result in complications and correlated these with cases of nerve injuries observed. Deep and extensive ostectomy could have resulted in a breach of the lamina dura of the mandibular canal thus exposing the nerves to injury during coronectomy or luxation with dental elevators. This could account for the case of three patients with IAN injury who had extensive ostectomy and bleeding from the socket during surgery. Extensive ostectomy is sometimes required for certain deep impactions especially distoangular and where the root curvature is not favourable for easy delivery. In the same vein, two patients who had prolonged primary haemorrhage from the extraction site in spite of moderate bone removal turned out with IAN injury. Abnormally prolonged bleeding from an impacted molar extraction socket in a haemostatically normal patient is often associated with trauma to the inferior alveolar neurovascular bundle<sup>27</sup> or a vessel in an aberrant retromolar foramen<sup>29</sup>. Such trauma affecting the nerve sheath may be responsible for the injury recorded postoperatively. Furthermore, one patient who experienced lingual nerve anaesthesia sustained lingual plate fracture during tooth luxation whereby the plate which was fused to the lingual aspect of the roots got dislodged with the tooth. It is not unlikely for the lingual

nerve to have been traumatized in this experience. Although the anatomic position of the lingual nerve in relation to the retromolar and third molar region is variable<sup>22,23,24</sup>, inadvertent fracture of the lingual plate constitute a potential risk for injury.

There were other significant events recorded; a patient experienced electric shock sensation along the lip during inferior alveolar nerve block yet had no nerve dysfunction during postoperative reviews. Such sensation is said to occur when the nerve fibers is inadvertently barbed against the bone during injection for anaesthesia; it has been reported to result in nerve dysfunction post anaesthesia<sup>18</sup>. Another patient experienced periodic pain that required intermittent re-injection with local anaesthesia. Many possible causes for ineffective local anaesthesia are known<sup>30</sup>, the most likely cause in this case is aberrant anatomy of the IAN and the mandibular canal considering that objective and subjective evidence of IAN anaesthesia was repeatedly elicited in the patient. The likelihood of a retromolar canal in this patient was entertained. The retromolar canal is a rare anatomic variation found in the retromolar triangle, a small triangular shaped region posterior to the third molar tooth in the mandible. It has been suggested that the content of this canal originate from the mandibular neurovascular bundle before it enters the mandibular canal in which case anaesthetic agent deposited close to the mandibular foramen may not affect the nerve content of the retromolar canal which has been noted to give an unusual supply to the pulp and periodontium of the third molar tooth<sup>30,31</sup>. Injury to this aberrant neurovascular bundle could result in altered sensation and abnormal bleeding from the extraction site. Another patient had significant secondary haemorrhage that required admission for monitoring at the emergency ward. Secondary haemorrhage in this patient is explainable by the resurgence of severe pain post anaesthesia resulting in elevated blood pressure and reopening of local microvasculature in the operation site. The bleeding was arrested by ensuring adequate analgesia and local measure which involved the use of an argotone pack in the extraction socket held in place with a horizontal mattress suture of the surrounding soft tissue.

In the majority of cases, altered sensation is a transitory phenomenon<sup>20,33</sup>, when it persists beyond 6 months without any improvement the nerve is considered to be permanently injured<sup>18</sup>. All but one case of the injured nerves recovered completely within 2 weeks suggesting that most of the patients experienced

neuropraxic type of injury. The only case of persistent lingual nerve anaesthesia happened in a patient who sustained lingual plate fracture during the extraction and who may have had significant trauma on the nerve resulting in neurotmesis or axonotmesis. This has different implications in the management of the injured patients. While temporary nerve dysfunction may respond to vitamin and steroid supplements, permanent nerve damage often require extensive and expensive treatments such as microneurosurgery and /or low level laser therapy<sup>4,19</sup>. In addition to being expensive, the facility and expertise for these modalities of treatment is not available in our environment. The only patient with persistent nerve damage in this study was lost to follow up and the final outcome of the management could not be determined.

## Conclusion

In this study we identified depth of impaction (Pell & Gregory's level C), and linguo-version as the risk factors for IAN and LN injuries respectively. Certain important operative events such as extensive osteotomy and prolonged brisk bleeding from the socket also appear to be important factors associated with IAN injury while lingual plate fracture is associated with LN injury. No risk factor for LBN injury was discovered. The study supports the fact that nerve injury following third molar extraction is usually transitory in nature and patients often recover spontaneously and completely. The limitation associated with the use of 2-dimensional imaging for assessing impacted third molar was highlighted.

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