Mandibular Third Molar Impaction: Review of Literature and a Proposal of a Classification

Gintaras Juodzbalys¹, Povilas Daugela¹

¹Department of Maxillofacial Surgery, Lithuanian University of Health Sciences, Kaunas, Lithuania.

Corresponding Author:
Gintaras Juodzbalys
Vainiku 12
LT-46383, Kaunas
Lithuania
Phone: +370 37 29 70 55
Fax: +370 37 32 31 53
E-mail: gintaras@stilusoptimus.lt

ABSTRACT

Objectives: The purpose of present article was to review impacted mandibular third molar aetiology, clinical anatomy, radiologic examination, surgical treatment and possible complications, as well as to create new mandibular third molar impaction and extraction difficulty degree classification based on anatomical and radiologic findings and literature review results.

Material and Methods: Literature was selected through a search of PubMed, Embase and Cochrane electronic databases. The keywords used for search were mandibular third molar, impacted mandibular third molar, inferior alveolar nerve injury third molar, lingual nerve injury third molar. The search was restricted to English language articles, published from 1976 to April 2013. Additionally, a manual search in the major anatomy and oral surgery journals and books was performed. The publications there selected by including clinical and human anatomy studies.

Results: In total 75 literature sources were obtained and reviewed. Impacted mandibular third molar aetiology, clinical anatomy, radiographic examination, surgical extraction of and possible complications, classifications and risk factors were discussed. New mandibular third molar impaction and extraction difficulty degree classification based on anatomical and radiologic findings and literature review results was proposed.

Conclusions: The classification proposed here based on anatomical and radiological impacted mandibular third molar features is promising to be a helpful tool for impacted tooth assessment as well as for planning for surgical operation. Further clinical studies should be conducted for new classification validation and reliability evaluation.

Keywords: tooth impacted; molar, third; alveolar nerve, inferior; lingual nerve injuries; mandibular canal; classification.

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INTRODUCTION

In early 1954 Mead [1] has defined an impacted tooth as a tooth that is prevented from erupting into position because of malposition, lack of space, or other impediments. Later Peterson [2], characterized impacted teeth as those teeth that fails to erupt into the dental arch within the expected time. In 2004 Farman [3] wrote that impacted teeth are those teeth that prevented from eruption due to a physical barrier within the path of eruption.

According to Elsey and Rock [4] impaction of the third molar is occurring in up to 73% of young adults in Europe. Generally, third molars have been found to erupt between the ages of 17 and 21 years [5,6]. Furthermore, third molar eruption time have been reported to vary with races [5-8]. For example, mandibular third molars may erupt as early as 14 years of age in Nigerians [7], and up to the age of 26 years in Europeans [8]. The average age for the eruption of mandibular third molars in male is approximately 3 to 6 months ahead of females [9]. Most authors claim that the incidence of mandibular third molar impaction is higher in females [8,10].

Third molar eruption and continuous positional changes after eruption can be related not only with race but also with nature of the diet, the intensity of the use of the masticatory apparatus and possibly due to genetic background [11].

Impaction of mandibular third molars is a common condition related with different difficulty degree of extraction operation and risk of complications, including iatrogenic trigeminal nerve injury. The purpose of present article was to review impacted mandibular third molar aetiology, clinical anatomy, radiologic examination, surgical treatment and possible complications, as well as to create new mandibular third molar impaction and extraction difficulty degree classification based on anatomical and radiologic findings and literature review results.

MATERIAL AND METHODS

Literature was selected through a search of PubMed, Embase and Cochrane electronic databases. The keywords used for search were mandibular third molar, impacted mandibular third molar, inferior alveolar nerve injury third molar, lingual nerve injury third molar. The search was restricted to English language articles, published from 1976 to April 2013. Additionally, a manual search in the major anatomy and oral surgery journals and books was performed. The publications there selected by including clinical and human anatomy studies.

RESULTS

Aetiology

Many theories have been proposed owing to high incidence of mandibular third molar impaction. One of the most popular theory is insufficient development of the retromolar space [12,13]. Mandibular ramus growth is related to resorption at its anterior surface and deposition at its posterior surface, but in case of disbalance of this process, the mandibular third molars don’t get enough space to erupt [14]. Proper mandibular third molars eruption also depends on their favourable path of eruption. For example, if the tooth bud is medially angulated during the initial stages of calcification and root development the path of eruption will be unfavourable [15]. However, impaction of mandibular third molars can develop due to a decrease in the angulation of the mandible and an increase in the angulation of the mandibular plane [16]. Yamaoka et al. [18] found the relation between the root angulation and impaction: angulated roots were more common in impacted mandibular third molars as compared to erupted mandibular third molars. Some authors indicates other important third molar impaction causes: malposition of the tooth germ, hereditary factors [19], lack of sufficient eruption force for third molars, and the theory of phylogetic regression of the jaw size - insufficient mesial movement of the dentition of modern human due to lack of interproximal attrition [20,21].

Clinical anatomy

Mandibular third molar is situated at the distal end of the body of the mandible where is connection with relatively thin ramus. There is the region of weakness and the fracture can occur if excessive force will be applied during impacted wisdom tooth elevation without preliminary and adequate removing of surrounding bone [22]. The buccal alveolar bone in this region is thicker than the lingual. The external oblique ridge forms the buttress that reinforced the buccal plate. The lingual nerve often lies close to the cortical plate. There is high risk of lingual nerve damage using lingual split technique or elevating third molar flap medially to the distoangular recess [23]. Rood and Shehab [24] showed on panoramic radiographs that in most cases the roots of third molars are in close proximity to the mandibular canal. Furthermore, in some cases third molar roots can contact or penetrate into mandibular canal or they can be deflected. Close relationship of
the canal with the roots can evoke inferior alveolar nerve damage during the surgery [22].

**Radiologic examination**

The location and configuration of impacted third molar, surrounding bone, mandibular canal and adjacent tooth are important in imaging diagnosis for the proper surgical operation planning. Periapical radiographs have been used for many years to assess the jaws during impacted teeth surgery. Long cone paralleling technique for taking periapical X-ray is the technique of choice for the following reasons: reduction of radiation dose; less magnification; a true relationship between the bone height and adjacent teeth is demonstrated [25]. One of the shortcomings of the present method is the use of film. Since the film is highly flexible, literally and figuratively, its processing can be suboptimal and it often leads poor image [26]. During the last decade, many dental practices replaced the film with digital imaging systems [28]. Nevertheless, the biggest concern of periapical radiographs is that mandibular canal could not be clearly identified in the third molar region. Furthermore, the angulation of the periapical film can affect the perceived location of the canal with respect to the bone crest [28]. When a specific region that is too large to be seen on a periapical view, panoramic radiograph can be the method of choice. The major advantages of panoramic images are the broad coverage of oral structures, low radiation exposure (about 10% of a full-mouth radiographs), and relatively inexpensive of the equipment. The major drawbacks of panoramic imaging are: lower image resolution, high distortion, and presence of phantom images. These can artificially produce apparent changes thus may hide some of important vital structures [12]. For example, cervical spine images often overlap on the anterior mandible. Furthermore, it depicts a two-dimensional view of an intricate three-dimensional anatomic relationship and also fails to accurately project the buccolingual relation between the tooth and the inferior alveolar canal [30,31].

Cone Beam Computed Tomography (CBCT) have been advocated as method of choice than there is need to have a three dimensional view of the mandibular third molar and adjacent anatomical structures [32,33]. Ghaeminiya et al. [32] in prospective study evaluated the role of CBCT in the treatment of patients with impacted mandibular third molars (n = 53) at increased risk of inferior alveolar nerve injury. After reviewing the CBCT images, significantly more subjects were reclassified to a lower risk for IAN injury compared with the panoramic radiograph assessments. This change in risk assessment also resulted in a significantly different surgical approach (P < 0.03). Authors concluded that CBCT contributes to optimal risk assessment and, as a consequence, to more adequate surgical planning, compared with panoramic radiography. It was reconfirmed by study of Matzen et al. [33], where CBCT influenced the treatment plan for 12% of cases. Direct contact in combination with narrowing of the canal lumen and canal positioned in a bending or a groove in the root complex observed in CBCT images were significant factors for deciding to change treatment plan.

**Indications for mandibular third molar extraction**

According to the recommendations of National Institute of Health (NIH) [34] both impacted and erupted mandibular third molars with evidence of follicular enlargement should be removed electively and that the associated soft tissue should be submitted for microscopic examination. Impacted teeth with pericoronitis should also be extracted electively because of their known potential for repetitive infection and morbidity. Furthermore, third molars with non-restorable carious lesions and third molars contributing to resorption of adjacent teeth should be also extracted. Following indications for mandibular third molar extraction were highlighted by Koerner [35]: existing pathology or pain due to pericoronitis, periodontitis, periapical abscess, cysts or neoplasms, resorption of adjacent roots, and inflammation of the opposing soft tissue; aberrant positions in which the tooth is oriented buccally or lingually; preceding dental work with fixed or removable appliances; arch length discrepancy in cases when the impacted third molars are affecting the stability of orthodontic treatment. Lytle [20] added infection around the impaction; loss of bone around the impacted teeth; dental caries and damage of adjacent teeth; crowding of the dental arch; cysts and tumours associated with impacted teeth; pre-irradiation removal of impacted teeth; for prosthodontic reasons; and for chronic facial pain. The National Institute of Clinical Excellence (NICE) of England introduced guidelines relating to third molars surgery. These recommended against the prophylactic removal of third molars and listed specific clinical indications for surgery.

**Surgical extraction of impacted mandibular third molar and possible complications**

There are two main intraoral approaches for surgical removal of impacted mandibular third molars: one through the sublingual space and the other buccally through the entire mandibular thickness. There is also extraoral method from the submandibular space [36-38]. Sublingual access requires incision

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and elevation of a wide mucoperiosteal intrasulcular flap on the lingual side of the mandible, in the molar and premolar regions. Dissection of the mylohyoid muscle attachment is necessary to reach the impacted molar. The buccal approach requires the elevation of a wide mucoperiosteal flap localized around the molar–premolar region. An extensive osteotomy is made underneath the apical area of the mandibular teeth. However there are many modifications of flap techniques, including envelope flap, two sided flap, and comma shaped flap [39]. In every case the third molar flap should provide adequate visualisation of the surgical field.

After mucoperiosteal flap elevation excessive bone must be excised using bur before third molar extraction. In most cases there will be necessary to remove buccal and distal bone borders. In difficult cases the tooth should be sectioned with a fissure bur in a high-speed handpiece. The wound should be irrigated with cool sterile physiologic saline solution. After tooth extraction using elevator or forceps it is necessary to clean operation area and to suture the wound without tension [40].

The frequency and severity of untoward events associated with surgical procedures are influenced by multiple factors that may be related to the procedure, patient, and/or surgeon [41]. Complications related to mandibular third molar extraction can be classified to intraoperative and postoperative [2]. Intraoperative complications are as follows: mandibular fracture, damage of adjacent teeth, tooth or tooth fragments displacement into soft tissues and bleeding. In cases if the excessive intraoral force was applied or/and part of bone was removed, risk of mandibular fracture or damage of adjacent teeth is increased [2,40]. Tooth or tooth fragments displacement into soft tissues can occur in case of wrong operation technique [41].

The most serious and unpleasant iatrogenic complication that arise from third molar surgery is inferior alveolar and/or lingual nerve injury and neurosensory function disturbance. The incidence of inferior alveolar nerve injury according to different authors varies from 0.81% to 22% of cases [42-47]. 1% to 4% of patients are at risk of permanent injury [48]. Lingual nerve injury incidence was reported between 0.4% and 25% [49-53]. Inferior alveolar nerve injury can cause paresthesia to complete numbness and/or pain [54] in the region of the skin of the mental area, the lower lip, mucous membranes, and the gingiva as far posteriorly as the second premolar [55]. Furthermore this commonly interferes with speech, eating, kissing, make-up application, shaving and drinking [56]. The injury of the lingual nerve leads to numbness of the ipsilateral anterior two thirds of the tongue and taste disturbance [50].

Typical postoperative complications are pain, swelling, bruising, trismus [57], osteitis and surgical site infection [58].

Classifications and risk factors identification

In order to minimise number of complications during mandibular third molar extraction several classifications have been developed that are assessing the difficulty of surgical procedure and helping to create an optimal treatment plan. The most popular are Winter’s [59] and Pell and Gregory’s [60] systems who are classifying the inclinations and positions of the third molars based on the relation among the dental longitudinal axis, occlusal plane and ascending mandibular ramus. These systems have been extensively adopted and applied in clinical practice. However some authors claim that these scales have little value for predicting the degree of extraction difficulty, [61] mainly because these systems of classification introduce error of interpretation by the observer [62]. Later Peterson [2] proposed a modification of the Pell and Gregory scale that included a third factor, the angulation of the molar (mesio-angular, horizontal, vertical or disto-angular). Clinical studies showed that there is no doubt about the importance of individual parameters of mentioned above classifications. Chuang et al. [58] demonstrated in their study that the level of impaction is associated with an increased risk of inflammatory complications following third molar surgery. Carvalho and Vasconcelos [63] extracted 473 mandibular third molars for 285 patients and concluded that root number (P < 0.004 and morphology (P < 0.031), tooth position (P = 0.001), periodontal space (P < 0.004) and second molar relation (P = 0.001) were significant predictors of surgical difficulty. Authors mentioned that not all significant predictors of surgical difficulty should be considered indicators of complications. Akadiri and Obiechina [64] demonstrated in their study wisdom tooth depth angulation and root morphology as the most consistent determinants of extraction difficulty. Eruption status of the lower third molar is important risk factor for inferior alveolar nerve injury. Incidences of inferior alveolar nerve injury in fully erupted, partially erupted and unerupted lower wisdom teeth were 0.3%, 0.7% and 3.0%, respectively [65,66]. The risk of nerve injury is increasing with the depth of the impacted mandibular wisdom teeth [23,66]. It was demonstrated the relationship between pattern of impaction and inferior alveolar nerve injury. The incidence of nerve injury was highest in horizontally impacted lower wisdom teeth (1.7%), followed by distal impaction (1.4%), mesial impaction (1.3%) and vertical impaction (1.1%) [23,65,66].

In general the proximity of the mandibular third molar to the mandibular canal is considered a risk
factor for damage to the inferior alveolar nerve. This fact inspired further studies for the predictive radiographic parameters identification. Rood and Shehab [24] distinguished four radiographic indicators observed in the tooth root (darkening, deflection and narrowing of the root, and a bifid root apex), and the other three in the canal (diversion, narrowing, and interruption in the white line of the canal). Studies demonstrated that the most important parameters for inferior alveolar nerve injury prediction are third molar root apices inside or in contact with the mandibular canal [46,67-69]. Furthermore, the prevalence of post-extraction complications correlated with the absence of cortication around the mandibular canal. It was reconfirmed by Park et al. [70] in their retrospective cohort study (179 patients and 259 teeth) where the overall prevalence of paresthesia was 4.2%. In contrast, the prevalence of paresthesia in group involving an interrupted mandibular canal cortex was 11.8%. Ueda et al. [21] performed similar study (99 patients and 145 teeth) and showed that inferior alveolar nerve injury was observed in 7 of 145 cases (4.8%). All 7 cases exhibited absence of cortication. Leung and Cheung [72] in literature review demonstrated that 16.2% of the surgery with the inferior alveolar nerve injury was highest in distally impacted lower wisdom teeth (4.0%, P < 0.01), followed by horizontal impaction (2.8%), mesial impaction (2.4%) and vertical impaction (1.9%) [33,46,66]. The risk ratio of lingual nerve injury was 1.94 times more likely to occur if the lingual flap was raised than if it was not and 4.1 times more likely to occur if the lingual split technique was used in comparison with the buccal approach [72].

**Mandibular third molar impaction classification based on anatomical and radiologic features**

New mandibular third molar impaction and extraction difficulty degree classification based on anatomical and radiologic findings and literature review results is suggested (Table 1).

| Position of the mandibular third molar | Risk degree of presumptive intervention (score) |
|----------------------------------------|-----------------------------------------------|
|                                       | Conventional (0) | Simple (1) | Moderate (2) | Complicated (3) |
| Mesiodistal position in relation to the second molar – M and the mandibular ramus – R |
| Relation to the second molar - M | Crown directed at or above the equator of the second molar | Crown directed below the equator to the coronal third of the second molar root | Crown/roots directed to the middle third of the second molar root | Crown/roots directed to the apical third of the second molar root |
| Relation to the mandibular ramus – R | Sufficient space in the dental arch | Partially impacted in the ramus | Completely impacted in the ramus | Completely impacted in the ramus in distoangular or horizontal position |
| Apicocoronal position in relation to the alveolar crest – A and the mandibular canal – C (IAN injury risk) |
| Relation to the adjacent alveolar crest (from the uppermost point of the tooth) - A | Tooth is completely erupted | Partially impacted, but widest part of the crown (equator) is above the bone | Partially impacted, but widest part of the crown (equator) is below the bone | Completely encased in the bone |
| Relation to the mandibular canal (from the lowermost point of the tooth) - C | ≥ 3 mm to the mandibular canal | Contacting or penetrating the mandibular canal, wall of the mandibular canal may be identified | Contacting or penetrating the mandibular canal, wall of the mandibular canal is unidentified | Roots surrounding the mandibular canal |
| Buccolingual position in relation to mandibular lingual and buccal walls – B (LN injury risk) |
| Relation to mandibular lingual and buccal walls – B | Closer to buccal wall | In the middle between lingual and buccal walls | Closer to lingual wall | Closer to lingual wall, when the tooth is partially impacted or completely encased in the bone (A2 or A3) |
| Spatial position - S |
| Spatial position - S | Vertical (90°) | Mesioangular ≤ 60° | Distoangular ≥ 120° | Horizontal (0°) or inverted (270°) |

IAN = inferior alveolar nerve; LN = lingual nerve.
Classification of mandibular third molar impaction and extraction difficulty degree enables the clinician to determine the difficulty in removal of the impacted tooth, to choose optimal treatment and to avoid the majority of possible complications. This classification describes wisdom tooth relation to the adjacent anatomical structures: mandibular ramus, second molar, alveolar crest, mandibular canal, and the spatial position of the tooth. Wisdom tooth position assessment should be performed clinically and using CBCT and panoramic radiographic images. The tooth position according to the all aforementioned landmarks has not been completely classified yet. Proposed classification is determining mandibular third molar mesiodistal position (in relation to the second molar - M and the mandibular ramus - R), apicocoronal position (in relation to the alveolar crest - A, and the mandibular canal - C), buccolingual position (in relation to mandibular lingual and buccal walls - B) and spatial tooth position - S.

Risk degree of presumptive intervention is scored as follows:

- conventional extraction is determined, when all parameters are equal to score 0;
- simple, when at least one parameter is equal to score 1 and surgical extraction with coronectomy and/or sectioning of roots is determined;
- moderate, when at least one parameter is equal to score 2 and surgical extraction with coronectomy and/or sectioning of roots is determined;
- complicated, when at least one parameter is equal to score 3 and surgical extraction with coronectomy and/or sectioning of roots is determined. Extraoral approach can be indicated.

To make the classification more informative, each component of the indices (M,R,A,C,B and S) is described independently. For example, position, extraction difficulty degree of tooth 48 and risk of trigeminal nerve damage during surgery is described as follows: M1,R1,A2,C2,B1,S3 (Figure 1A, B). This description determines complicated extraction, because one of the parameters – S is equal to 3. Detailed explanation: crown is in contact below the equator to the coronal third of the second molar (M1), partially impacted in the ramus (R1), widest part of the crown (equator) is below the bone (A2), roots are contacting or penetrating the mandibular canal, wall of the mandibular canal is unidentified (C2), tooth is located in the middle between lingual and buccal walls (B1); horizontal spatial position (S3). Complicated extraction is anticipated and C2 value presumes moderate risk of inferior alveolar nerve damage.

There are some new approaches in assessing different anatomical and radiological parameters in the present classification. For example, the depth of tooth impaction in Pell and Gregory’s [60] classification was assessed according to the occlusal plane, but in some cases the crown of wisdom tooth is small in size and located below occlusal plane. However the tooth can be completely erupted and easily extracted. The assessment of tooth impaction (coronal position) should be evaluated from the alveolar crest, because the extraction difficulty is determined predominantly by the depth of impaction in the bone. Furthermore, it is necessary to highlight the lower landmark of the possible apicocoronal wisdom tooth position which is determined by mandibular canal. It was mentioned above that the proximity of the mandibular third molar to the mandibular canal is considered a risk factor for damage to the inferior alveolar nerve. In contrast, some previous classifications recommended assessing too many radiological parameters determining wisdom tooth roots relationship with mandibular canal. For example, Rood and Shehab [24] distinguished four radiographic indicators observed in the tooth

![Figure 1. A = Tooth No. 48 is classified as M1,R1,A2,C2,B1,S3 on the ortopantomograph. B = Impaction in horizontal spatial position index (S3) predicts complicated surgical extraction.](http://www.ejomr.org/JOMR/archives/2013/2/e1/v4n2e1ht.htm)
root (darkening, deflection and narrowing of the root, and a bifid root apex), and the other three in the canal (diversion, narrowing, and interruption in the white line of the canal). Latest clinical studies demonstrated that the most important parameters for inferior alveolar nerve injury prediction are third molar root apices inside or in contact with the inferior alveolar canal [46,67-69] and absence of cortication around the inferior alveolar canal [70-72]. This is why mentioned above parameters were included into inferior alveolar nerve injury risk evaluation assessment. In such cases clinicians should avoid apical pressure during root elevation or even to perform multiple sectioning of the tooth to reduce any stress to a root on elevation. CBCT scan should be also accomplished for detailed surgery planning in cases when C2 or C3 relation to the mandibular canal is expected on two-dimensional radiographs (Figure 2A, B). Some authors are recommending to perform coronectomy of impacted wisdom tooth if roots are surrounding the mandibular canal because there is high risk or inferior alveolar nerve injury [33,74,75]. In contrast, it was considered that in cases when wisdom tooth position is ≥ 3 mm away from the mandibular canal, there is no risk to damage mandibular canal during surgical extraction (Figure 3). Mesiodistal position is defined in relation to the second molar and the mandibular ramus. It is important to assess impacted tooth relationship to the second molar in order to avoid iatrogenic tooth traumatisation. The impaction degree of mandibular third molar in the ramus of mandible is associated with extraction operation difficulty score and postoperative complications manifestation. For example, high risk degree is registered when tooth is completely impacted in the mandibular ramus in distoangular or horizontal position (Figure 4). Buccolingual third molar position in relation to mandibular lingual and buccal walls is reflecting risk of lingual nerve injury. It was discussed previously that iatrogenic injury to the lingual nerve may happen during

![Figure 2.](image1.png) **Figure 2.** A = On orthopantomograph close contact between impacted right mandibular third molar and mandibular canal is suspected. B = More detailed view on the CBCT images reveals tooth penetration through the mandibular canal wall (C2) and moderate risk of inferior alveolar nerve damage.

![Figure 3.](image2.png) **Figure 3.** Roots of tooth No. 48 are ≥ 3 mm away from the mandibular canal (C0) on the orthopantomograph. There is no risk to damage inferior alveolar nerve during surgical extraction.
third molar surgery due to the anatomical proximity of the cortex region of the molar to the nerve [52]. Surgery on unerupted mandibular third molars was at higher risk (5.8%) of lingual nerve injury compared with erupted (0.3%) or partially erupted (2.0%) teeth (P < 0.0001) [66,73]. Thus the highest risk of lingual nerve injury was scored in case when the tooth is partially impacted or completely encased in the bone (A2 or A3) and is located closer to the lingual wall. Spatial mandibular third molar position is reflecting extraction difficulty degree especially in combination with other indices. For example distoangular or horizontal impacted tooth position in combination with deep impaction in the mandibular ramus, can be complicated case even for experienced clinician.

CONCLUSIONS

There are selected only the most informative parameters in presented herein classification, because it is impossible to reflect all important parameters, such as periodontal ligament width, soft tissue condition, patient characteristic, clinician’s experience, and et cetera in one classification which should be useful in daily practice. The classification proposed here based on anatomical and radiological impacted mandibular third molar features is promising to be a helpful tool for impacted tooth assessment as well as for planning for surgical operation. Further clinical studies should be conducted for new classification validation and reliability evaluation.

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The authors report no conflict of interest related to the present study.

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