Clinical Note

Strategy to Remove Teeth Adjacent to Mesially Impacted Wisdom Teeth Based on a Geometric Analysis

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Abstract: The present study aimed to establish a strategy to accurately remove teeth adjacent to mesially impacted wisdom teeth. Geometric principles were applied to analyze the resistance of teeth adjacent to mesially impacted wisdom teeth before extraction, and the resistance of adjacent teeth was relieved. The traditional method used to extract mesially impacted wisdom teeth is the chisel technique, which has been gradually replaced by minimally invasive extraction because of its great degree of trauma. This study determined the cutting method, cutting line position, and cutting direction of mesially impacted wisdom teeth based on imaging data from panoramic radiographs under geometric guidance. In the case of a short cutting line, cutting and separation were completed within one attempt, the resistance of adjacent teeth was alleviated, and the surgical duration was shortened.

Key words: Cutting and separating tooth, Mandibular impacted wisdom tooth, Resistance of adjacent tooth, Strategy

Introduction

Because food tends to be fine nowadays, the human jaw gradually degenerates. The space available for tooth eruption is insufficient, resulting in wisdom tooth impaction. Impacted mandibular third molars are common; however, alveolar surgery for extraction of mandibular third molars, especially extraction of mesially embedded impacted mandibular third molars, is a complex procedure. Impacted wisdom teeth may lead to complications, such as pericoronitis, food impaction, and maxillofacial infection. Meanwhile, because impacted wisdom teeth are adjacent to the mandibular second molar, it often causes complications that affect the second molar, such as common dental root resorption, distal caries, and odontogenic cysts and tumors. Therefore, it should be removed as soon as possible. However, because of its complex anatomical structure, hidden position, partial or complete embedding in the jaw, it is difficult to remove. Furthermore, it may cause different levels of damage to the soft tissue and adjacent structures surrounding the surgical site, which may result in postoperative complications, such as pain, swelling, and restrictions in opening the mouth. This damage may cause feelings of anxiety in patients.

As research progresses, an increasing number of imaging indicators are being associated with the difficulty of extraction. Alleviating resistance via wisdom tooth extraction is one of the key steps that can be taken to avoid damage. There are three kinds of resistance associated with wisdom tooth extraction: soft tissue resistance, adjacent tooth resistance, and bone tissue resistance. Of these, the influence of adjacent tooth resistance is the greatest. Alleviation of adjacent tooth resistance can be achieved by separating crowns and removing bones. However, with respect to adjacent tooth blocking problems in patients with mesially impacted crowns, irrespective of the direction and height of impaction or the relationship of the mandible ramus, it cannot accurately describe this important resistance factor in the traditional classification.

Moreover, there is no accurate or simple evaluation strategy on how to remove resistance in adjacent teeth. In fact, the closer the relationship between the second and third molars, the more easily the second molar will obstruct the view during surgical extraction of the third molar, and the more likely surgery will be to damage the periodontium and root of the second molar, which makes tooth extraction difficult.

In this paper, we used simple geometry to analyze the resistance of adjacent teeth among different types of mesially impacted wisdom teeth, and applied different cutting methods to alleviate resistance from mesially impacted wisdom teeth using resistance analyses.

Methods

Cutting principles

In the case of adjacent tooth resistance being alleviated, the shorter the cutting line (i.e., the less tooth tissue removed), the better the outcome. This saves effort and shortens the surgical duration. After cutting and separation, the dislocation channel should be slightly greater than the maximum circumference of the dislocated part. After separation, if it is necessary to remove the crown, the buccolingual view of the crown should be of a slightly irregular inverted trapezoid or inverted conical, namely “top big, bottom small” to facilitate dislocation. When cutting, the lingual and mesial sides of the wisdom teeth do not need to be completely opened. An incision can be made to the enamel, and separation can be achieved using a dental elevator. This will avoid damage to the lingual side and deep tissue.

Alveolar bone around the impacted teeth should be resected as little as possible to reduce the height of the alveolar bone after impacted tooth extraction.
**Geometric model of impacted tooth dislocation**

**Fixed point**

A fixed point, \( a \), is made at the leading edge of the ascending branch of the distal neck of the wisdom tooth. Importantly, if the bone tissue covers the crown of the wisdom tooth, the bone needs to be removed to the distal dental neck. A fixed point, \( b \), is made at a high point of the distal second molar. A point, \( d \), is made on the occlusal surface of the distal wisdom tooth of the distal shape of the second molar, namely the starting point of cutting. Point \( c \), which is the range between the high point of the distal wisdom tooth and the distal dental neck of the wisdom tooth, is made according to the distance between \( a \) and \( d \). The \( c-d \) line is the cutting line. The \( a-b \) distance is the minimum distance of the dislocation channel.

**Principle of the dislocation channel**

When the distal part of the mesially embedded impacted tooth is dislocated, the distal part can be dislocated smoothly only if the \( a-c \) distance is less than or equal to the \( a-b \) distance. The \( a-c \) distance is less than or equal to the \( a-b \) distance when \( \angle a-c-b \) is greater than or equal to 60° according to the triangle geometry principle.

**Principle of the rotary channel**

There is an upward rotation when the distal part of the mesially impacted mandibular tooth is dislocated. Dislocation is completed when the longitudinal axis is in a vertical position. In this way, an arc-shaped dislocation channel is formed when the distal part of the impacted tooth is dislocated. The trajectory of distal dislocation of the wisdom tooth during rotation is an arc dislocation track based on \( a \) as the center and \( a-c \) as the radius. The distal part of the wisdom tooth can rotate and dislocate smoothly only if the arc with \( a \) as the center and \( a-c \) as the radius has only one intersection (intersection point \( c \)) with the \( c-b \) cutting line and the \( c-b \) extension line. That is, when \( \angle a-c-b \) is greater than or equal to 90°, there is only one intersection point between the arc with \( a \) as the center and \( a-c \) as the radius and the \( c-b \) cutting line and \( c-b \) extension line.

According to the cutting principles outlined above, from determining the dislocation geometry and the different types of mesioangular impaction, we propose several different methods for cutting and separation of mesially embedded impacted wisdom teeth.

**Determining the cutting line position**

**Oblique cutting**

Oblique cutting is a method of inclined cutting from the occlusion to the mesial neck. It is mainly suitable for mesially inclined impacted teeth and wisdom tooth extraction when the resistance in adjacent teeth is high but there is little root resistance. After cutting and separation, the distal part of the tooth is removed first, followed by the mesial part. At the fulcrum \( a \) during rotation, specifically at the leading edge of the ascending branch of the distal neck of the wisdom tooth, a fixed point, \( b \), is made at a high point of the distal second molar. Notably, if bone tissue covers the crown of the wisdom tooth, bone removal is required to the tooth neck. Point \( d \) is made on the occlusal surface of the distal wisdom tooth of the distal second molar, namely the starting point of the cutting line. Point \( c \) is made according to the distance between \( a \) and \( d \). The range of \( c \) is between the high point of the distal wisdom tooth and the distal dental neck of the wisdom tooth. The \( c-d \) line is the cutting line. With this approach, points \( b \) and \( d \) are fused at one point. The \( a-b \) distance is the minimum distance of the dislocation channel. The distal part of the wisdom tooth can be successfully dislocated from the dislocation channel only if the \( a-c \) distance is less than or equal to the distance from \( a \) to \( c-d \) (b). The trajectory of distal wisdom tooth dislocation is an arc dislocation trace with \( a \) as the center and \( a-c \) as the radius. Only if the arc with \( a \) as the center and \( a-c \) as the radius has only one point of intersection with the \( c-d \) cutting line (b), the remaining mesial part of the wisdom tooth will not affect the distal wisdom tooth dislocation trajectory. Meanwhile, when \( \angle a-c-d \) is greater than or equal to 60°, the distance between \( a \) and \( c \) is less than the distance between \( a \) and \( d \). Where the distance between \( a \) and \( c \) is less than the distance between \( a \) and \( d \), the width of the cutting gap may be increased or distal bone may not be removed properly when cutting, allowing the fulcrum \( a \) for distal shift to achieve this target. After cutting and separation, the distal part of the wisdom tooth is removed, followed by the mesial part (Figs. 1 and 2).

**Partial crown cutting**

The partial crown cutting method cuts the teeth slightly parallel to the long axis of the second molar from the occlusal side to the mesial side. It is mainly used for wisdom tooth extraction with mesioangular inclined impaction and low resistance in adjacent teeth. The starting position of the cutting line is the occlusal surface of the wisdom tooth. Its specific position is determined by point \( c \), which is the mesial break of the crown.

The leading edge of the ascending branch of the distal neck of the wisdom tooth is designated as point \( a \) (the fulcrum at the time of rotatory dislocation). A high point on the distal second molar crown is set as point \( b \). According to the distance between \( a \) and \( b \), point \( c \) is fixed on the mesial wisdom tooth. An extension line parallel to the long axis of the second molar is made from point \( c \) upward, and the intersection with the occlusal surface of the wisdom tooth is taken as point \( d \). The \( d-c \) line is the cutting line.

After cutting and separation, the mesial part of the crown is removed, followed by the distal part. At this point, distal and mesial resistance is alleviated, as is the resistance of the rotation channel. With distal dislocation, the distance between \( a \) and \( c \) is the turning radius of the dislocation. Therefore, the distance between \( a \) and \( c \) should be slightly smaller than the distance between \( a \) and \( b \) to facilitate dislocation (Fig. 3).
The vertical cutting method is used to cut the wisdom tooth from the distal side to mesial side of the crown, which is perpendicular to the long axis of the wisdom tooth. The high point of the distal surface of the crown of the second molar is point \(b\), and the leading edge of the ascending branch of the distal neck of the wisdom tooth is point \(a\). Point \(c\) is determined according to the distance between \(a\) and \(b\). An extension line parallel to the occlusal surface of the wisdom tooth is made from point \(c\) upward, and point \(d\) is at the intersection with the distal part of the wisdom tooth. The \(c\)–\(d\) line is the cutting line. After cutting and separation, the crown is removed first, followed by the root. When the root is partially dislocated, the distance between \(a\) and \(c\) is the turning radius, which should be less than the distance between \(a\) and \(b\) (Figs. 4 and 5).

**Longitudinal cutting**

The longitudinal cutting method is used to cut from the center of the
occlusal surface of the wisdom tooth in the direction of the root bifurcation. It is mainly suitable for extraction of wisdom teeth with high mesioangular impaction and a large root bifurcation. The cutting line starts at the center of the occlusal surface of the wisdom tooth (a) and cuts along the long axis of the wisdom tooth to the buccal tongue close to the root bifurcation (b). The connecting line from the center of the occlusal surface of the wisdom tooth to the root bifurcation is the cutting line.

After cutting and separation, the distal part and mesial part are removed, respectively. If there is bone resistance, bone is removed (Figs. 6 and 7). When the distal part is dislocated, point a is the intersection between the distal crown and distal alveolar bone. The dislocation channel is an arc dislocation access with \( a' \) as the center and \( a'-b \) as the radius. When the arc with \( a' \) as the center and \( a'-b \) as the radius has only one intersection, dislocation can be achieved smoothly. As a result, when \( \angle a'-b-a \) is 90° in preoperative measurements, minimum bone removal is guaranteed for distal dislocation.

**Crosscutting with lengthwise cutting**

The combination of crosscutting and lengthwise cutting is mainly suitable for extraction of wisdom teeth with middle low mesioangular impaction with large root bifurcation. First, the cutting line is determined using the cross-section method, and the crown is removed after tooth separation. Then, a second cut is made. The starting point of the second cut is the center of the root crown section, and the second cutting line is from this point to near the root bifurcation. The distal and mesial roots are removed after tooth separation (Fig. 8).

**Cutting depth**

The lingual osseous plates of wisdom teeth are very thin. Moreover, lingual nerves pass through the lingual submucosa. In addition, the inferior alveolar canal is located underneath wisdom teeth. During cutting procedures, if the crown is opened completely, there is a risk of damage to blood vessels and nerves if it is not precisely controlled. Therefore, only the most distal and buccal parts of wisdom teeth are completely incised during cutting, while the mesial and lingual sides can only be cut to the enamel; however, the depth of cutting is not easy to control. When cutting to a certain depth, a dental elevator can be inserted into the cutting gap. When gently turning the dental elevator, the tooth body can be

**Figure 5.** Preoperative X-ray film. Fig. 5a and Fig. 5b show wisdom tooth cutting and segmentation.

**Figure 6.** Point a is the starting point of the cutting line and point b is the breaking point at the root bifurcation. The dotted line is the incision line, and the dotted line is the bone removal section.
If it cannot be separated, the surgeon should continue cutting carefully until the crown is separated.

**Discussion**

Embedded impacted wisdom teeth cannot be easily rectified because of the operation direction and the force applied by the doctor. It is easy to damage periodontal tissue, which causes psychological stress and anxiety in patients. Moreover, the position of impacted teeth, their relationship with adjacent teeth, and the degree of tooth exposure are directly associated with the degree of difficulty in extraction, postoperative complications, and surgical duration. Payne first proposed the concept of “minimally invasive surgery” in 1985. Minimally invasive surgery can not only alleviate the trauma of patients, but it can also promote postoperative recovery.

Chisels, pliers, and hammers are common tools used in routine tooth extraction, which may cause fear in patients. Therefore, minimally invasive technology is increasingly used in the field of tooth extraction. Minimally invasive techniques of cutting and separation are commonly used to relieve the resistance of adjacent teeth when extracting impacted wisdom teeth. Notably, a clear analysis and pre-judgment should be made to assess the resistance in wisdom teeth before surgery. The whole procedure should be carefully controlled.

High-speed turbines are also useful as they have a strong drilling cutting force and good accuracy, and they are cost-effective and reduce labor. High-speed turbines have a light vibration and can eliminate the fear associated with hammers and chisels, and they can reduce or avoid intraoperative and postoperative complications. These tools have been widely used in the clinic.

Kaijin et al. highlighted that tooth separation is complex to master. Good preoperative design and accurate intraoperative processes are the key to remove teeth quickly and safely. With respect to different types of teeth, the most appropriate tooth separation method will differ. The key to tooth extraction is to remove resistance in all parts of the teeth. The position of impacted wisdom teeth and the relationship with mandibular branch, etc., the essence of these resistance factors is the change in number and quantity. Therefore, a direct decomposition analysis of resistance can intuitive and effective to judge the difficulties associated with tooth extraction.

At present, the minimally invasive tooth extraction method led by high-speed turbine drill has gradually replaced the traditional tooth extraction method represented by hammer chisel to remove the bone and
separate the teeth. However, many doctors are often unable to scientifically analyze the resistance of the near-middle obstructed mandibular third molar in the actual operation, resulting in cutting the separation of teeth for too long, causing the patient to open their mouths for too long and causing temporomandibular joint discomfort and other symptoms in the process of removing the near-middle obstructed mandibular third molar. At the same time, the probability of submucosal emphysema increases because of prolongs high pressure airflow impacting the soft tissues.

The main objective of this paper is to analyze the resistance of the extraction of the near-middle obstructed mandibular third molars in a scientific and geometric approach, and to develop a simple and rational plan for cutting the separation and debridement of the teeth to reduce the occurrence of the above complications.

In this paper, the author established a set of pre-judgment protocols that are both accurate and convenient to guide surgery. In clinical practice, some scholars\(^1,\)\(^2\) have observed that the human body is still in the growth period before the age of 25 years. Generally, if the periodontal ligament is healthy, alveolar bone will have good elasticity and a certain physiological toughness; thus, teeth are easy to remove. However, alveolar bone elasticity decreases with age, which may cause dental adhesion due to chronic inflammation of periodontal pulp. With respect to sex, male teeth are generally larger and bone density is also higher; thus, the teeth tend to be more stable. In addition, the lingual bone plate of embedded mesial impacted wisdom teeth is often thin with a certain degree of toughness. When the distal part of the tooth is dislocated, the rotation channel is dislocated towards the distal lingual side, which is a three-dimensional channel. Therefore, with the above cutting separation method, for patients less than 25 years of age, the arc with a as the center and \(a-c\) as the radius of the distal rotatory dislocation channel can slightly intersect the \(c-d\) line. The distal parts of wisdom teeth can be successfully dislocated using clinical procedures. This study is mainly based on imaging data, such as panoramic radiographs.

In conclusion, before the extraction of mesially embedded impacted wisdom teeth, the resistance of adjacent teeth with different types of mesially impacted wisdom teeth was analyzed according to panoramic radiographs. Moreover, a set of mathematical models of cutting and separation were developed under the guidance of the geometric principle to determine the cutting method, cutting line position, and cutting direction of mesially impacted wisdom teeth before surgery. In the case of a short cutting line, cutting and separation should be completed within one attempt, the resistance of adjacent teeth should be alleviated, and the surgical duration should be shortened. In clinical practice, procedures should be combined with examinations, particularly to examine the condition after the incision of the flap shall, which can then be further modified and the cutting line can be determined. It should also be determined whether bone should be removed and bone mass should be removed. In clinical practice, judgment errors may occur. In such cases, cutting can be performed multiple times according to the condition of the patient.

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Conflict of Interests

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

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