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Skills and methods for the extraction of mandibular embedded wisdom teeth: Research progress

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Abstract: *Mandibular embedded wisdom teeth refer to the mandibular third molars that are completely embedded in the bone tissue and cannot erupt normally. Mandibular embedded wisdom teeth usually cause a series of complications such as deep periodontal pocket in the distal end, infection, distal bone loss, external root resorption of adjacent teeth, osteomyelitis, and cysts. Therefore, it is suggested that such mandibular third molars should be extracted as soon as possible by experts. At present, the operation of extracting mandibular embedded third molars is difficult, risky, with a high incidence of complications, and poor bone healing after surgery, which even aggravates the degree of some complications. More minimally invasive extraction methods are being studied by some scholars to better guide the healing of bone tissue, and modified flap methods, windowing methods, bone removal, and tooth separation methods have been proposed. This article takes the extraction of mandibular embedded third molars as an example, summarizes a series of modified extraction methods, and writes a review to provide a reference for clinical work.*

Keywords: *Mandibular embedded third molar; adjacent teeth; flap; window; suture*

1. Introduction

Extraction of mandibular impacted third molars is the most common surgery in alveolar surgery. The extraction of mandibular embedded third molars (Impacted Lower Third Molars, ILTM) usually requires a large range of flap turning, bone resistance grinding, and has a more complex relationship with nerves and blood vessels, which can easily lead to complications such as pain, swelling, limited mouth opening, infection, nerve injury, deep periodontal pocket in the distal end (probing pocket depth, PD), and distal bone loss[1,2]. 65% [3] of the mandibular third molars are close to the adjacent teeth (mandibular second molars, M2M). The traditional extraction method grinds the alveolar bone on the buccal side of M2M in the distal end, resulting in the loss of vertical bone mass in the distal end of M2M after surgery, forming a deep PD, which takes a long time to heal, repeats, and is difficult to recover [4-8]. With the development of minimally invasive extraction techniques, scholars continue to explore and improve the flap method, windowing method, tooth separation method, and suture method, and update minimally invasive extraction instruments [9]. This review summarizes several modified extraction methods to provide a reference for clinical work.

2. Surgical methods

2.1 Improved flap method

2.1.1 Envelope flap, triangular flap, Szmyd flap

The first step of ILTM extraction is to turn the mucosal flap to activate osteoclasts [6]. Some scholars have studied that the design of the flap has a certain impact on periodontal healing. Korkmaz [10] compared the effect of using triangular flap (3-cornered laterally rotated flap, LRF) and envelope flap (Envelope flap, EF) on periodontal healing when extracting ILTM. After 3 months of surgery, the PD using LRF was significantly smaller than EF, and the inflammatory reaction caused by LRF in the short term was more obvious. Muhtada Ahmad [11] used EF and Szmyd flap (Szmyd flap, SF) to extract ILTM. After 6 months of observation, it was found that the bone loss caused by EF flap was more obvious than Szmyd flap.

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2.1.2 Modified flap

The modified flap moves down 1-2mm on the basis of LRF, SF, and EF, completely retaining the continuity of the gingival tissue around M2M. The key to this modified design is to retain the continuity of the periodontal ligament around M2M and the integrity of the buccal attached gingiva, which can effectively reduce the risk of possible periodontal complications [13]. Tuğrul Kirtiloğlu [12] studied the recovery of the periodontal tissue in the distal end of the adjacent M2M after the modified SF and LRF flap extraction[16]. In the standard flap, 28.3% of the patients had PD of 5mm, and 51.7% of the patients had PD of 4mm. However, in the modified flap group, only 6.7% of the patients had PD of 5mm, and 36.7% of the patients had PD of 4mm, which significantly reduced the occurrence of periodontal lesions in the distal end of M2M [14, 15]. Kirtiloğlu [17] found that the plaque index and gingival index before and after surgery in the standard flap and modified flap were also similar, which indicated that the difference between the two incision designs in the early stage was not due to plaque accumulation, which may be related to the complete preservation of the gingival margin around M2M and the absence of sulcus incision.

2.1.3 Lingual flap

The modified design of the lingual basal flap was first proposed by Berwick in 2002 [18]. The lingual flap is incised from the gingival sulcus on the distal surface of the second molar, extending forward to the angled part of the distal buccal axis, and then obliquely downward, without exceeding the floor of the vestibular sulcus. It continues to extend along the anterior border of the mandibular ascending and turns backward and upward to make a smooth curved incision, reaching the height of the distal surface of the impacted tooth. The flap tip angle is about 60 degrees, and the length-width ratio does not exceed 3:1. After flipping up the lingual flap, it is suspended to the upper 1/3 of the mandibular folds with 4-0 sutures to fully expose the surgical area. In the postoperative stage, one stitch is used to fix the lingual basal triangular flap at the angular tip, and two stitches are used for each of the mesial vertical incision and the vestibular sulcus incision [19]. The impact of the lingual basal flap on the postoperative reaction of tooth extraction remains controversial. Due to differences in sample size and surgical methods among different studies, the results are inconsistent. Scholars such as Menziletoglu and Yolcu [20, 21] have found that the swelling reaction in the first week after the lingual basal flap is more evident compared to the buccal basal flap. Nevertheless, the lingual basal flap exhibits better initial sealing and stability of the wound, facilitating quicker mucosal healing and bone regeneration, reducing the treatment time and postoperative discomfort. Additionally, it effectively minimizes the risk of osteomyelitis and postoperative infections.

2.2 The improvement of the windowing method

The buccal windowing - lid flipping method was designed by Motamedi [22] initially, through lateral circular windowing. The method of buccal corticotomy (BC) [23] was proposed by Scolozzi, which performs block cutting on the buccal cortical bone plate under the premise of protecting the surrounding soft tissues. After the ILTM is extracted, the buccal cortical bone plate is completely reset, sealing the tooth extraction socket, supporting the soft tissues, and isolating the epithelial cells, which can guide the regeneration of surrounding bone tissues, thereby effectively reducing the damage to the periodontal tissues of adjacent M2M. The BC for extracting ILTM was studied by scholars such as Zhou Yangyifan [24] and Yang Huina [25], and it was found that BC can retain the integrity of the distal alveolar bone of M2M, providing sufficient support for the distal soft tissues of M2M, which is beneficial to the healing of postoperative wounds and reduces postoperative complications caused by bone defects, and reduces the probability of injury to the inferior alveolar nerve. However, due to the large range of flap turning during the buccal windowing process, the postoperative swelling is more obvious [25].

2.3 Extraction of ILTM through crown sectioning

The relationship between ILTM and the inferior alveolar nerve canal is close, which can easily cause inferior alveolar nerve injuries (IANI) [26-29]. Crown sectioning is a method of extracting the mandibular third molars that press on the inferior alveolar nerve canal. The crown of the mandibular third molar is initially removed, and the root is not removed for the time being. The remaining root is removed through a secondary surgery after the root moves upward or away from the nerve by means of orthodontic traction, micro-implant anchorage traction, and other methods [30,31]. It has been demonstrated in relevant studies that the use of crown sectioning can reduce the risk of IANI [32-34].

Scholars such as Carbonarea [35] have identified issues such as the slow movement speed of the root and the failure to achieve the expected results. Additionally, there are some shortcomings such as postoperative pain, swelling, infection, and jaw osteomyelitis. Therefore, when opting for this technique, its advantages and potential risks need to be thoroughly contemplated.

3. Improvement of surgical instruments

3.1 Painless anesthesia apparatus

With the continuous development of society, people's requirements for comfortable oral treatment are also increasing. The traditional injection technique not only causes puncture pain due to the need for needle puncture of the body tissue, but also the pressure pain generated by the injection flow rate is also an important reason. Therefore, the computer-controlled local anesthetic delivery system (C-CLADS) came into being. In 1997, a brand-new method of administering anesthetic drugs, the computer-controlled local anesthetic delivery system (C-CLADS), was introduced. In 1998, dynamic pressure sensing technology fundamentally changed C-CLAD [36]. Subsequently, various countries developed similar anesthetic systems. In 2007, Milestone developed the second-generation C-CLAD therapy device, the STA system (Single Tooth Anesthesia) [37] (also known as the painless anesthesia apparatus), which is widely used in clinical applications and can be used for all traditional intraoral injection techniques.

STA (Single Tooth Anesthesia, STA), that is, the computer-controlled local anesthetic transport system (C-CLADs), mainly consists of a computer-controlled host, a foot pedal with a tube, a handle, and a handle-matched needle. Among them, the automatically precisely controlled push rod is the core component. STA has multiple working modes and injection speeds, including STA, Normal, and Turbo modes, which are respectively suitable for anesthesia under the periosteum, under the mucosa, and in the soft tissue. The STA painless anesthesia apparatus can be applied in almost all fields of dental treatment. Most studies have reported that patients receiving painless local anesthetic injection devices have lower VAS scores, reduced pain, and have effectively solved the problem of injection pain. Liu Daohua et al. found that in patients with dental anxiety and cardiovascular disease, the application of the STA painless anesthesia apparatus can significantly reduce the heart rate of the experimental group compared with the traditional injection group, with significant effects, reducing the patient's sense of fear and pain and reducing the occurrence of cardiovascular diseases, making the tooth extraction process proceed smoothly.

3.2 Surgical knife

During the use of traditional surgical knives and electrosurgical knives, there is often a large amount of bleeding, and at the same time, it may lead to side effects such as thermal damage. However, with the in-depth study of laser technology, it has been found that hard lasers mainly composed of erbium-doped yttrium aluminum garnet (Er:YAG) lasers and neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers have significant advantages in the incision of gingival tissues. Specifically, lasers have the characteristics of antibacterial, anti-inflammatory, and minimally invasive, and can effectively stop bleeding. Among them, the wavelength of Er:YAG laser is 2940nm, which is a laser with surface absorption of tissue, and the penetration of tissue is relatively weak. Therefore, the wound formed after the incision of the gingival tissue is more regular, with less thermal damage and a thinner coagulation layer (only 47.9 ± 36.44 um). The wavelength of Nd:YAG laser is 1064nm, which has a high absorption capacity for hemoglobin. It has strong hemostasis during the cutting of gingival tissue. In addition, it can effectively expand the field of vision of the surgical area, making the operation more convenient. At the same time, because the Nd:YAG laser has a strong sterilization effect on periodontal pathogenic bacteria, it can effectively reduce the risk of incision infection during and after the operation.

3.3 Ultrasonic osteotome

The vibration frequency of the ultrasonic bone knife is 25 ~ 30kHz, which produces a small vibration with an amplitude of 60 ~ 210μm.According to the working frequency, the working mode of the ultrasonic bone knife can be divided into low frequency, high frequency and over frequency. When the vibration frequency exceeds 30 kHz, the vibration mode electronic control system of the host can force the equipment to suspend operation. This selective cutting function uses different operating

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frequencies for soft and hard tissues, and only cuts the mineralized structure-bone, but stops cutting when encountering nerves, blood vessels or other soft tissues. The invasive damage during cutting is less, the damage to the surrounding tissue is less, and the repair of the tissue can be promoted. During cutting, the release of oxygen ions can play a certain anti-corrosion role and will not cause bone necrosis near the cutting area. Ultrasound stimulates cells at work, promotes tissue metabolism, and promotes bone regeneration. When the high-speed turbine is used for osteotomy, a smooth surface will be formed around the bone. When the ultrasonic bone knife is used for osteotomy, an irregular rough surface will be formed around the bone, and more osteoclasts and osteoblasts on the rough bone edge work at the same time to promote bone regeneration.When the high-speed turbine cuts the bone, the working head will be heated, causing thermal damage to the bone tissue. However, the ultrasonic bone knife head produces less heat, so it can prevent bone tissue thermal damage during osteotomy. In the study of Berengo et al., the survival rates of osteoblasts and osteocytes around bone blocks made by bone chisel, circular saw, bone rongeur, turbine and ultrasonic bone knife were compared by tissue cytology analysis. It was found that ultrasonic bone knife and bone rongeur had the least damage to osteocytes.

3.4 Combined application of ultrasonic bone knife and high-speed turbine

Ultrasonic bone knife can accurately cut hard tissue, avoid damage to soft tissue, reduce postoperative inflammation, pain and other adverse reactions, and does not affect the healing of bone tissue. The improved 45-degree elevation impact pneumatic cutting mobile phone, the gas is dispersed from the head to the periphery, not sprayed in the surgical area, greatly reducing the probability of subcutaneous emphysema, the angle of the mobile phone head with surgical special lengthened crack drill to make it easier to penetrate the oral cavity internal operation. However, the preservation effect of bone tissue is poor, and the healing of bone tissue after tooth extraction is poor. High-speed turbines can quickly divide the crown to achieve the purpose of removing resistance. However, fever during rotation may lead to bone burn and necrosis, resulting in M2M distal bone defect. At present, the high-speed turbine combined with ultrasonic bone knife is used to remove the impacted third molar in order to reduce the operation time, reduce the postoperative reaction and improve the integrity of the extraction socket.

Huo Wenjing et al. used high-speed turbine combined with minimally invasive extraction knife to extract mandibular impacted teeth, which can shorten the operation time, reduce blood loss, reduce postoperative complications, and have high safety. Wu Jinan, Wu Changjing, Zhang Zhuo et al. studied the removal of impacted mandibular third molars by using a reverse-angle high-speed turbine combined with ultrasonic bone knife. By using the characteristics of small bone damage of ultrasonic bone knife and fast tooth separation of reverse-angle high-speed turbine, it can not only avoid the damage of soft tissues such as peripheral nerves and blood vessels caused by reverse-angle high-speed turbine, but also reduce the problem of joint discomfort caused by too long opening time caused by too slow cutting of tooth tissue by ultrasonic bone knife. Compared with the traditional crown splitting method, the minimally invasive tooth extraction method represented by high-speed turbine and ultrasonic bone knife has been widely used in clinical practice.

4. Conclusion

In summary, with the increasing development of minimally invasive tooth extraction techniques, scholars have broken through traditional tooth extraction techniques, continuously updated and developed new tooth extraction techniques, surgical approaches, incision methods, flap methods, window locations and sizes, suture methods, and the selection of instruments, so that patients can fully benefit. Toward a more minimally invasive, faster, lighter postoperative reaction, and fewer postoperative complications.

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