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Research Article

Addressing Orthodontic Traction Obstruction via Corticotomy and Bone Augmentation Surgery

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ABSTRACT

The purpose of this paper was to evaluate clinical and radiographic outcomes of Corticotomy and Bone Augmentation Surgery (BAS) in patient with Orthodontic Traction Obstruction (OTO). A 26-year-old male with clinical manifestations of upper anterior tooth protrusion and increased interdental spaces, diagnosed with Class II malocclusion and skeletal Class II deformity. After 2 years of orthodontic treatment, the distal movement effect of tooth 13 was not satisfactory, so Corticotomy combined with BAS was performed. Two weeks after the operation, the interdental space between teeth 13 and 14 narrowed and the space closed at 8 weeks. At 12 months postoperatively, the teeth were well-aligned, the occlusion was stable. This surgical approach, by cutting the alveolar bone cortex to reduce resistance and increasing the density and height of the alveolar bone, accelerates tooth movement, improves treatment efficiency and stability and the patient is satisfied. It provides a new idea and method for the treatment of OTO.

Keywords: Corticotomy Surgery, Bone Augmentation Surgery Orthodontic Traction, Tooth Movement

1. Introduction

Orthodontic traction is a common clinical method for correcting malocclusions. However, in some patients, the thick alveolar crest and the abnormal anatomy in the radicular area often cause orthodontic traction to be impeded, prolonging the treatment cycle and affecting the therapeutic effect. Therefore, clinical and radiographic evaluations are required prior to orthodontic treatment to assess the difficulty of orthodontics and whether periodontal accelerated orthodontic surgery (PAOO) is needed[1-3]. Corticotomy surgery (COS) reduces the

elastic modulus of bone tissue by cutting the alveolar bone cortex, thereby reducing the resistance to tooth movement and accelerating tooth movement[4]. Bone augmentation surgery (BAS) can increase the thickness and height of the alveolar bone, providing a more stable bone tissue base for tooth movement[5]. The combined application of the two is expected to solve the problem of orthodontic traction obstruction caused by thick cortical bone. Kole[6] first described the application of corticotomy surgery in accelerating orthodontic tooth movement in 1959. In 2001, Wilcko, et al.[7] proposed the Accelerated Osteogenic Orthodontics (AOO) technique, which was later renamed Periodontally Accelerated Osteogenic Orthodontics (PAOO), also known as "Wilckodontics". This technique accelerates tooth movement by selectively removing cortical bone on the labial or lingual side. In adult cases, due to insufficient bone remineralization, BAS is usually performed at the target position of tooth movement to provide alveolar bone space[8]. In recent years, the application of COS in orthodontic treatment has attracted the attention of scholars.

Moreover, the combination of COS with other orthodontic techniques can improve treatment efficiency and aesthetics. Cassetta et al. reported a case of corticotomy combined with clear aligners, with a treatment completion time of only two months, significantly shorter than that of traditional methods[9]. This indicates that corticotomy alone or in combination with BAS can effectively solve the problem of Orthodontic Traction Obstruction（OTO）and also improve the stability and predictability of therapeutic effects. The purpose of this study is to evaluate the clinical and radiographic outcomes of corticotomy and bone augmentation surgery (BAS) in patients with orthodontic traction obstruction (OTO) and to explore the efficacy of corticotomy combined with BAS in patients with OTO caused by thick cortical bone, thereby providing new ideas and methods for clinical treatment.

2. Case Report

A 26 - year - old male patient visited the Department of Stomatology of our hospital due to upper anterior tooth protrusion and increased interdental spaces, seeking to improve aesthetics. The patient reported a history of upper anterior tooth protrusion for many years, intermittent bleeding during brushing, large interdental spaces in the upper front teeth, protrusion to the labial side, deep overjet and impaired occlusion and aesthetics, prompting a visit to the clinic. The patient's parents had no obvious dental abnormalities and the patient denied a history of systemic diseases. Extraoral examination revealed **(Figure 1)** that the face was basically symmetrical, with a convex profile, shallow nasolabial folds, short upper lip, deep mentolabial sulcus and tense chin muscles; normal mouth opening and no tenderness or clicking in the bilateral temporomandibular joint areas. Intraoral examination found that the patient had a complete permanent dentition, with Class III deep overjet (about 8 mm) in the anterior teeth, distal relationships in the first molars and canines, labial displacement of the upper anterior teeth and significantly widened interdental spaces in the anterior teeth, with no obvious gingival swelling **(Figure 2)**. Radiographic examination showed no obvious alveolar bone resorption, significant labial displacement of the incisors and deep overjet **(Figure 3)**. Periodontal examination revealed acceptable oral hygiene, no obvious plaque accumulation, slightly swollen gums, BOP(+), no obvious mobility, supragingival calculus(+) and no subgingival calculus, with PD 2-3 mm. The diagnosis was: (1). Class II malocclusion, (2). Skeletal Class II, (3). Deep overjet, deep overbite. The treatment plan included: (1). Oral hygiene education, (2). Extraction of teeth 14 and 24, (3). Orthodontic treatment, (4). Corticotomy combined with BAS, (5). Periodontal maintenance treatment.

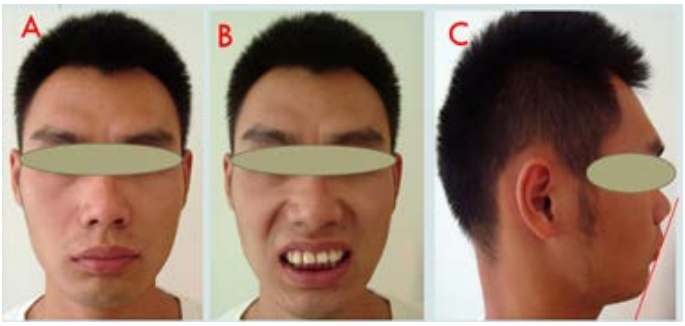

Figure 1: Extraoral examination: A and B show the frontal view and C shows the profile view. The face is symmetrical, with a convex profile, shallow nasolabial folds, short upper lip and deep mentolabial sulcus. No obvious clicking or tenderness in the bilateral temporomandibular joints.

Figure 2: Intraoral examination: Upper anterior teeth are labially inclined, with increased interdental spaces in the anterior region and a deep overbite of degree II. The canines and molars on both sides are in a distal position; there is a deep overjet of degree III. The lower anterior teeth have calculus of degree I and slightly swollen gums.

Figure 3: Radiographs: A. Panoramic view, B. Lateral view. The alveolar ridge is slightly flattened and the skeletal Class II malocclusion is present.

2.1. Orthodontic treatment

After oral hygiene education, teeth 14 and 24 were extracted and a full-mouth fixed orthodontic appliance was installed. After 1 year of treatment, the space between teeth 23 and 24 had significantly narrowed and the distal movement of tooth 23 had improved. However, the space between teeth 13 and 14 remained large and the distal movement of tooth 13 was

not satisfactory **(Figure 4)**. Mesial auxiliary mini-screws were placed on teeth 16 and 26 for traction. After 2 years of traction, the distal movement of tooth 23 was good and the labial line had significantly improved. However, the traction effect on tooth 13 was still poor, with a distinct root shape and obvious cortical bone resistance **(Figure 5)**. Since the space between teeth 13 and 14 could not be closed using mini-screws for traction, corticotomy combined with BAS was recommended to accelerate tooth movement and close the space between teeth 13 and 14.

Figure 4: Radiograph after 1 year of orthodontic treatment: Distal movement of tooth 23 improved, but the distal movement of tooth 13 is still not satisfactory.

Figure 5: Intraoral and radiographic views after 2 years of orthodontic treatment: The space between teeth 23 and 24 has closed, but the space between teeth 13 and 14 remains large, with obvious cortical bone resistance.

2.2. Corticotomy combined with bone augmentation surgery

At the 2-year of orthodontic treatment, corticotomy combined with BAS was performed to accelerate the distal movement of tooth 13. After obtaining informed consent, the local gingival mucosa was disinfected with iodine tincture and under local anesthesia with articaine hydrochloride, a papilla-preserving incision was made, with additional incisions mesial to tooth 12 and distal to tooth 15. A full-thickness flap was raised. Using a high-speed turbine, holes were drilled in the cortical bone between the roots of adjacent teeth, followed by longitudinal cuts. Spherical drills were used for dispersed drilling. After alveolar bone contouring, bone graft material was implanted. The gingival flap was repositioned and sutured with tension-relieving interrupted sutures **(Figure 6)**. Postoperatively oral antibiotics were administered and mouth rinsing with Xipaiyi was prescribed. On the day of surgery, elastic chains were applied to teeth 13 and 14 for orthodontic force application, with force renewal every 2 weeks. Oral hygiene was maintained. At 2 weeks postoperatively, sutures were removed, revealing good wound healing and narrowing of the space between teeth 13 and 14. By 8 weeks postoperatively, the space between teeth 13 and 14 had completely closed **(Figure 7)**.

At 12 months postoperatively, the teeth were well-aligned, the anterior occlusion was stable and the interdental papillae were slightly swollen **(Figure 8)**.The gingival inflammation improved significantly after local irrigation with 3% hydrogen peroxide and local scaling. The panoramic radiograph showed no significant alveolar ridge resorption **(Figure 9)** and the facial appearance had returned to normal **(Figure 10)**, with the patient being satisfied. The patient was advised to have regular periodontal maintenance treatments to maintain the health of the periodontal and dental tissues.

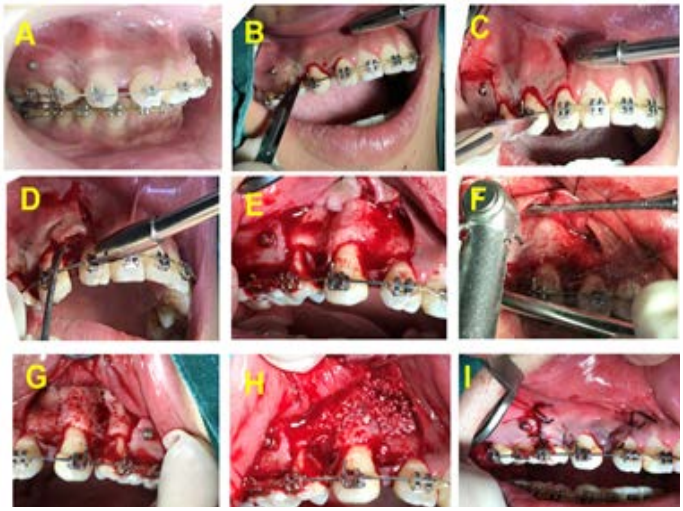

Figure 6: Procedure of Corticotomy Combined with BAS: A. Preoperative view; B. Internal bevel incision; C. Additional incisions; D. Flap elevation; E. View after flap reflection; F. Drilling with a turbine; G. After drilling; H. Bone graft placement; I. Interrupted suturing.

Figure 7: Postoperative intraoral views: A, B, C show the condition at 2 weeks postoperatively; D shows the condition at 8 weeks postoperatively. The blue arrow indicates the interdental space between teeth 13 and 14 and the red arrow indicates the space between teeth 23 and 24.

Figure 8: Intraoral view at 12 months postoperatively: The teeth are well-aligned, the occlusion is good and the interdental papilla is mildly swollen.

Figure 9: Radiograph at 12 months postoperatively: No significant alveolar bone resorption and the teeth are well-aligned.

Figure 10: Frontal and profile views of the face at 12 months postoperatively: The teeth are well-aligned, the occlusion is good.

3. Discussion

With the improvement of people's living standards and the enhancement of oral health awareness, an increasing number of patients hope to improve oral aesthetics and health through orthodontic treatment. There are those who suffer from periodontal health problems due to congenital malocclusion deformities, as well as those who experience anterior teeth flaring and tooth displacement caused by periodontal diseases or tooth loss. However, in adult orthodontic treatment, traditional orthodontic traction methods often fail to achieve ideal tooth movement due to thick cortical bone and may even lead to excessively long treatment periods. Therefore, finding an effective solution to this problem is of great importance.

In recent years, the application of corticotomy and guided bone regeneration (GBR) technology in orthodontic treatment has gradually attracted attention. In 2021, Brugnami F, et al.[10] found that this technology can significantly improve the regenerative capacity of periodontal tissues, break through the limitations of traditional orthodontic treatment and achieve more effective tooth movement and periodontal tissue repair. In addition, bone augmentation surgery(BAS) provides a more stable bone tissue base for tooth movement by increasing the thickness and height of the alveolar bone[11]. In clinical practice, this technology has been used to treat a variety of skeletal malocclusions. BAS can effectively improve the shape and thickness of the alveolar bone, providing a more stable bone tissue for tooth movement[12].

The application of corticotomy combined with BAS in orthodontic traction obstruction（OTO） has significant advantages. On the one hand, corticotomy reduces the elastic modulus of bone tissue by cutting the alveolar bone cortex, reducing the resistance to tooth movement, accelerating tooth movement and improving treatment efficiency[13]. On the other hand, BAS improves the thickness and shape of the alveolar bone, creating a stable bone tissue for tooth movement[14]. This combined application not only effectively solves the problem of OTO but also improves the stability and predictability of therapeutic effects[15]. In addition, the combined application can reduce postoperative complications and increase patient satisfaction[16]. Singh S, et al.[17] compared the efficacy of PAOO technology and traditional orthodontic methods in treating adult patients with bimaxillary protrusion and found that PAOO technology has significant advantages in accelerating tooth movement, shortening treatment time and improving periodontal tissue health.

In terms of mechanism of action, corticotomy initiates and accelerates the alveolar bone healing process by cutting the alveolar bone cortex, known as the regional acceleratory phenomenon (RAP). RAP is 2-10 times faster than physiological healing, usually starting a few days after injury, peaking at 12 months and lasting for 4 months[13]. Animal experiments have found that corticotomy can significantly accelerate cancellous bone metabolism[18]. Zhang Y, et al.[19] explored the important role of MicroRNA-21 in PAOO-assisted orthodontic tooth movement from a molecular biology perspective and found that it promotes alveolar bone regeneration and rapid tooth movement by regulating cell proliferation, differentiation and apoptosis.

We know that good surgical design and technical improvements are crucial for the success of combined surgical procedures. The use of minimally invasive techniques can reduce surgical trauma and postoperative complications[20]. At the same time, personalized adjustments to the surgical plan according to the patient's specific situation can maximize the surgical effect[21]. In addition, the application of computer-aided design and navigation technology can improve the accuracy and safety of surgery[9]. This technology has shown good results in a variety of complex cases, significantly improving therapeutic effects and patient satisfaction[22]. Munoz F, et al.[23] used the PAOO method, implanting a mixture of allogeneic bone and bovine bone and covering it with a membrane during surgery. The results showed that PAOO can increase the width of the maxillary alveolar bone and accelerate orthodontic tooth movement by 3-4 times without changing the state of the underlying bone. In this case, the patient's high bone density affected the speed of orthodontic traction. We referred to the Periodontally Accelerated Osteogenic Orthodontics（PAOO） technique. After flap elevation, we performed corticotomy and placed natural calcined bone material (without a periosteum) to activate bone remodeling. Orthodontic force was applied on the day of surgery for traction. We found that the distal movement of tooth 13 was significantly accelerated at 2 weeks postoperatively. Thereafter, force was applied every 2 weeks and by 8 weeks, the space between teeth 13 and 14 was completely closed. This indicates that corticotomy combined with bone augmentation (without periosteum) can significantly accelerate orthodontic tooth movement with stable therapeutic effects and no significant postoperative reactions were observed.

4. Conclusions

Corticotomy combined with BAS shows significant advantages in dealing with orthodontic traction obstruction caused by thick cortical bone. This combined application not only accelerates tooth movement but also improves the stability and predictability of therapeutic effects. Future research can focus on further optimizing surgical design and techniques

to reduce the occurrence of postoperative complications and improve the widespread clinical application and safety.

5. Acknowledgments

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6. Conflict of Interest

None.

7. Ethical Approval

All procedure involving participants were in compliance with the ethical standards of the institutional and national research committees, as well as the ethical standards of the 1964 Helsinki Declaration and its later amendments.

8. Author Contributions

TC-conceived the ideas original draft preparation and manuscript review; CJ and ZQ-original draft preparation; YW and CH-case collection; ZG and XW orthodontic treatment;HZ and RG-interpretation of data; XX and HR- conceived the ideas; TZ and XY-manuscript review.

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