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Abstract

Comprehensive orthodontic treatment usually takes 1–3 years to finish the details. The treatment duration depends on the complexity of treatment. Longer treatment times may increase the risk of root resorption, oral hygiene-related problems such as white spot lesion or dental caries, and periodontal destruction. Several methods, such as surgical-assisted procedures, drugs, and physical/mechanical stimulation methods, may accelerate tooth movement and shortened whole treatment time. This article reviews various surgical-assisted procedures and how the surgical method that can effectively shorten the treatment time. The advantages and disadvantages of various technique were also assessed.

Keywords

orticotomy; periodontally accelerated osteogenic orthodontics (PAOO); corticision; piezocision; micro-osteoperforations (MOPs); regional acceleratory phenomenon (RAP)

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SURGICAL METHODS TO ACCELERATE TOOTH MOVEMENT

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This article reviews various surgical-assisted procedures and how the surgical method that can effectively shorten the treatment time. The advantages and disadvantages of various technique were also assessed.

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INTRODUCTION

Patients frequently ask orthodontists about the duration of their orthodontic treatment. Currently, increasing numbers of methods for accelerating tooth movement have been proposed to meet the needs of patients and orthodontists.

Methods for accelerating tooth movement can be divided into four main categories including drugs, physical/ mechanical stimulation, PRP injection and surgical methods (Table 1):

The first category comprises methods that entail the use of drugs such as prostaglandins, parathyroid hormone, vitamin D, and relaxin.¹ These drugs had been reported to

increase the rate of tooth movement. Nevertheless, they have certain adverse effects. Using prostaglandin may increase the amount of root resorption.² The safe dose and effective release system for such drugs in clinical use must be further investigated.

The second category involves physical or mechanical stimulation. Because of their noninvasive nature, these techniques have become increasingly attractive to patients who seek rapid tooth movement. Several sponsored studies have claimed that the devices based on these techniques can shorten the treatment time.

The third category involves methods that entail platelet-rich plasma (PRP) injections. PRP has been widely used in dental surgery. Submucosal injection

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of PRP has been reported to be an effective method to accelerate orthodontic tooth movement. Such injection can simulate the effect of trauma without surgery and substantially reduce alveolar bone loss on the pressure side. The effect of accelerating tooth movement by a single injection can last for 5–6 months.³

The final category involves surgically assisted methods, such as corticotomy, periodontally accelerated osteogenic orthodontics (PAOO), interseptal alveolar surgery, corticision, piezocision, and micro-osteoperforations (MOPs). These methods cause trauma to induce the regional acceleratory phenomenon (RAP) to accelerate tooth movement.

In 1981, Frost found a correlation between the severity of surgery and the intensity of the healing response in relation to the acceleration of the bone turnover rate at the surgical site. This healing response is

known as the RAP.⁴

A histological study showed that selective alveolar decortication induced an increased turnover rate of alveolar spongiosa. This could result in a temporary decrease in bone density, a phenomenon called osteopenia. It enabled the tooth to move faster.⁵

This duration of RAP was temporary and could last for approximately 4 months.⁶ Another study indicated that in humans, the RAP begins within a few days after surgery, typically peaks at 1–2 months, and may take 6 to more than 24 months to subside.^{7,8} After the RAP subsides, the procedure should be repeated in cases that still require faster tooth movement.

In summary, the overall increase in bone turnover and temporary decrease in bone density caused by surgery can accelerate tooth movement.

Table 1. Various methods proposed to accelerate tooth movement.

| | |
|---|--|
| Drugs | Prostaglandin Vitamin D Parathyroid hormone Relaxin |
| physical/ mechanical stimulation | Electric current Vibration Low-level laser Therapeutic ultrasound Pulsed electromagnetic field |
| PRP injections | |
| Surgical methods | Corticotomy PAOO/AOO Interseptal alveolar surgery Corticision Piezoincision MOPs |

SURGICAL METHODS

Corticotomy

The procedure of corticotomy is to cut the bone surrounding teeth via flap elevation. It can increase bone remodeling and creates transitory state of osteopenia that reduces bone density, which causes less resistance to tooth movement. It can be used in En masse retraction, canine retraction, decrowding, molar uprighting, correction of a scissor bite, and rapid maxillary expansion.⁹

People who take corticosteroids bisphosphonates and nonsteroidal anti-inflammatory drugs or receive radiation therapy or have active periodontal disease, are the contraindications for corticotomy.⁹

Clinical studies have shown that using corticotomy to help canine retraction can reduce the treatment time by 28 ~ 33%, and can increase the rate of tooth movement by 2 ~ 3 times.^{10,11} However, corticotomy might engender marginal interdental bone loss, induces loss of the attached gingiva, infection, unfavorable changes in the appearance of the gingiva and associated with postoperative pain and swelling.

PAOO Method

In 2001, Wilcko developed a modified surgical method called PAOO.^{8,12} PAOO can be used in treating moderate to severe crowding, cases requiring expansion, reduced periodontal tissues, molar intrusion and open bite correction as well as to improve post-orthodontic stability. It can prevent the need of extraction and decrease the risk of dehiscence and fenestration.¹³

The surgical cuts created vertical grooves from 2 to 3 mm below the alveolar crest to 2 mm beyond the apices of the roots. And perform circular corticotomy to connect vertical cuts. Selective medullary penetration was performed to enhance bleeding. Bone grafts was placed in most areas that have undergone corticotomies. The volume of the graft material could be decided by the alveolar bone thickness and the direction of tooth movement.¹³

An immediate orthodontic force can be applied to the teeth. Initiation of the orthodontic force should not be delayed for more than 2 weeks after surgery.¹³

The duration of tooth acceleration is usually last for 4 to 6 months.¹³

PAOO can decrease treatment time and increases alveolar bone width and volume. The disadvantage of PAOO is similar to corticotomy.

Interseptal alveolar surgery

In 2007, Ren et al. conducted an animal experiment using the interseptal alveolar surgery and found that the speed of tooth movement was twice in the experiment side.¹⁴ Another human study found that the speed of tooth movement was about 1.6 times faster than the control side.¹⁵

The surgical procedure was made at the time of tooth extraction, and performed vertical grooving and oblique grooving inside the tooth extraction socket. It reduced the interseptal bone by 1 to 1.5 mm. If the inter-radicular bone was present, it should be removed together.

This surgery can shorten the treatment time in extraction cases without flap reflection or another separate surgical procedure. If some anatomic structure was present, such as low maxillary sinus or narrowed ridge, that might be difficult to improve tooth movement by this technique.¹⁵

Corticision

In 2009, Kim et al. proposed a surgical technique called corticision by performing flapless corticotomy transmucosally.¹⁶ This method is to create a vertical cut starting 5 mm from the papillary gingiva and up to two-thirds of the root length by a reinforced scalpel and mallet.

In an animal study, histologic findings showed that corticision could activate the catabolic remodeling in the direction of tooth movement. The overall effect of corticision reached the peak at the second months and drops at the third months.¹⁷

The surgical procedure is less invasive. However, it is not able to place grafts during the procedure. A single-site

corticision could not induce clinical or histologic changes.¹⁸

Piezocision

In 2009, Dibart used piezocision to accelerate tooth movement through trans-mucosal corticotomy without flap elevation. This method used a piezoelectric knife to cut bones from a small tissue opening. The knife can selectively cut the bone, thus preventing damage to adjacent soft tissue.¹⁹ If hard and soft tissue grafts are required, they can be placed by using a tunneling procedure.

This technique can reduce about half of the total treatment time. The attachment level and pocket depth change minimally, but gingival scar tissue was observed and remained in most cases.²⁰ In addition, the visibility of piezocision was inferior than corticotomy because of the small soft tissue opening. Thus, risk of iatrogenic root damage, devitalization of teeth and invasive root resorption must be paid attention.^{21,22} Nowadays, using a 3D-printed computer-assisted piezocision to guide the surgery could reduce the risk of root damage.²³

MOP Method

Micro-osteoperforations were developed by a commercial company. They claimed that placing three perforations cross through the cortical plate and enter to the cancellous bone in each interproximal alveolar bone can accelerate tooth movement.

In 2013, Alikhani et al. conducted the first human clinical trial of this method, and they reported that the application of MOPs can increase the rate of canine retraction by 2.3-fold.²⁴ However, a recent randomized clinical trial indicated that MOPs did not significantly increase tooth movements.²⁵

About the location of MOPs, study has indicated that if MOPs placed at 3 mm away from teeth would not increase the rate of tooth movement.²⁶ Although the bone density is decreased up to 4.2 mm, the principal effects did not extend to more than 1.5 mm away from the MOP.²⁷

This technique can be performed by orthodontists themselves, and was better accepted by most patients.

However, high-quality clinical evidence is required to investigate its effectiveness.

CONCLUSION

Surgical methods such as corticotomy and PAOO are relatively invasive procedures. They occasionally cause pain, swelling, and discomfort after surgery. Some minimally invasive surgeries were in current trend to reduce these complications. Thus, the interseptal alveolar surgery, corticision, piezoincision, and MOPs have been developed and gained increasing popularity. However, the MOP technique still requires more evidence to prove its effectiveness. With proper selection of surgical methods, we can shorten the orthodontic treatment time and prevent unexpected side effects.

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