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REVIEW ARTICALE

METHODS FOR ALVEOLAR RIDGE SOFT AND HARD TISSUE VOLUME INCREASE. NARRATIVE REVIEW

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ABSTRACT

Objective: The aim of the article was to compare orthotontic extrusion and regenerative surgery methods as methods for increasing the volume of hard and soft tissues of the alveolar process in the pre-implantation period.

Materials and methods: A search was carried out using electronic databases: Medline, Google Scholar,PubMed, EMBASE, Scopus.

Results: 58 articles were found and analyzed. Of these, 26 were clinical cases using orthodontic extrusion, 32 of them were clinical cases using regenerative surgical techniques.

Conclusions: Both orthodontic extrusion and surgical methods have been found to be effective in increasing the volume of hard tissue during the pre-implantation period, whereas surgical methods are less effective in improving soft tissue volume and very often require soft tissue plastic surgery.

The literature search also pointed to the lack of technical means and methods of carrying out the extrusion of teeth in cases of support deficiency.

There is a clear need to develop new techniques and devices for more controlled tooth extrusion.

***Keywords*:** alveolar ridge, soft and hard tissue, orthotontic extrusion , regenerative surgery

1. INTRODUCTION

Dental implantation has proven itself as a successful form of treatment for full and partial teeth absence. It has been shown that tooth loss leads to continuous progressive bone resorption and remodelling of the toothless areas. As a result, the bone at the site of the planned implantation may be severely deficient horizontally and/or vertically. In order to prevent resorption of the alveolar bone after tooth loss, it is often necessary to perform some tissue preparation before or after implantation to ensure a good aesthetic, functional and predictable long-term result for further prosthetic rehabilitation.

There are different techniques for soft and hard tissue augmentation before implantation. However, the primary stability of the implant is directly related to the volume of available alveolar bone and many studies have shown that dental implants should be placed in existing bone, while regenerative bone should not be relied upon as a primary support, just to provide coverage.

In addition to bone and soft tissue augmentation, Heithersay[1] and Ingber[2] described a "non-surgical" approach for preparing bone and soft tissue prior to implantation. This method is based on osteophysiological and orthodontic principles and was initially used to work on single teeth that are not subject to further restoration.

The advantages of this method include the correction of local intrabony defects, displacement of the gingival edge, and clinical elongation of the crown. [3,4] In addition, orthodontic extrusion was used for periodontally compromised teeth without periapical lesions to create favourable conditions prior to implantation.[5]

With slow orthodontic extrusion, the tooth moves 1-2 mm per month. With the use of weak and constant forces, all periodontal fibers remain intact, osteoid tissue is evenly deposited, and bone and soft tissues are formed.

However, the efficiency of these methods has not been thoroughly evaluated and compared.

Thus, the aim of this review is to identify studies that have studied either orthodontic extrusion or regenerative surgery prior to implantation and compare the biological, functional and aesthetic results of these two approaches.

MATERIALS AND METHODS

The literature search for this systematic review was carried out using a number of electronic databases, including **Medline, PubMed, EMBASE, Scopus** and **Google Scholar**, as well as through manual analysis of lists of relevant articles.

The search identified and fully analysed **58 publications** that met the inclusion criteria. Of these, **26 articles** described clinical cases of orthodontic extrusion and **32 articles** described the use of various regenerative surgical approaches.

In particular, the section on orthodontic extrusion included data from **26 publications**, including:

- **24 articles** were clinical case descriptions [6-18, 20-30],
- **1 pilot study** [19];
- **1 retrospective sequential study** of clinical cases [31].

The section on regenerative surgery included material from **32 publications**, including:

- **24 clinical case** descriptions [32,33-53],
- **6 clinical studies** [37,54-58],
- **2 randomized controlled trials** [59,60].

ANALYSIS OF ORTHOTONAL EXTRUSION METHOD

In this review 26 articles were analysed using orthodontic extrusion method. In most studies the patients were women, only in three studies were men [6-8]. Most of the clinical cases discussed were teeth frontal group, only one study discussed molar N.4.6 [9]. The most common cause of tooth removal was acute periodontitis (>40%).

As for orthodontic extrusion method, the most frequently used was the method using a brace system (13 cases from 26). In 9 studies, braces were installed only on one jaw [6,7,10-16], only in 4 cases on two jaws [18-21], in one - lingual braces [7], in another - ceramic braces [10].

One study used an individual interocclusal device[17].

In 4 studies, extrusion was carried out with hook and orthodontic arc [20,27,30,31]. One study used an intraoral device attached to the tooth and activated by a micrometer screw for removal of a bone fragment with ankylosed teeth [14].

Different methods were used to apply the extrusion force: in 5 studies, Ni-Ti arcs and a more apical attachment of braces on extruded teeth were used [22,13,23-25]; in one study, elastic bands from orthodontic hooks were used, SS and extrusion steps were used in 5 studies [20,26,29,30,7]; in one study Co-Cr was used from the beginning, after 3 months of β -titanium alloy [21]; one study used a SS arc with L-shaped loops [27]; one study used a TMA arc with T-shaped loops [11]; and one study used a power spring embedded in the root of the channel and an SS arc [31].

In most studies low extrusion force (<100g) was applied, in one study 150g force was used [31]. As for the extrusion coefficient, in most studies the extrusion was carried out slowly (on average 1mm/month), while in other studies no data were reported.

The frequency of observation in all studies varied from 2 to 4 weeks. The stabilisation period lasted from 1.5 to 6 months, depending on each study.

In most clinical cases, the volume of both hard and soft tissues was obtained (bone elevation 4mm; coronary displacement of the gingival edge 4mm; increase of keratinised gingiva volume 2mm, change of gingival biotype-increase of gingival thickness (clasp size) 0.7mm). Only one study performed subsequent bone grafting [11.]

In the majority of studies, immediate post-extraction implantation followed tooth removal, only in four studies implantation was delayed [17,25,7,21].

In all but two studies, complications did not occur; one study showed implant disintegration and gingival recession (0.2-5.7 mm) [19], while another study observed external root resorption and intermolar insufficiency [17].

ANALYSIS OF REGENERATIVE SURGERY METHOD

In this review, 32 articles were analysed using different methods of regenerative surgery. Directed bone regeneration (GBR) was performed in 22 studies [34-39,41-43,60,46,48,50-53,58,32;] bone grafting procedure was performed in 5 studies, in particular two studies used allogenic bone graft[47,33], while three other studies used intraoral autogenous bone grafts [55,44,57]; one study used xenogenic bone graft for sandwich osteotomy[56]; two studies performed alveolar distraction osteogenesis [45,49]; in one study, cylinders from the symphysis were used [40]; finally, in one study, an author's technique called 'socket schield' was developed [53].

As for the timing of implant installation, in most cases delayed implantation was performed and immediate implantation was performed only when it was clinically possible.

The patients' age ranged from 22 to 65 years, cases were selected with a single incisor of the upper jaw, that was not subject to further restoration (12-22) due to fracture of the root, trauma, not restorable tooth and root resorption. The observation period ranged from a minimum of 6 months to a maximum of 3 years, depending on each study.

All studies reported good results with improvement of hard tissues, but none of them gave quantitative data on the amount of regenerated bone. Regarding soft tissue changes, no studies reported data.

Complications reported in only seven studies: one study using a bone graft from the lower jaw symphysis reported four cases of paresis at the donor site immediately after the transplant operation [55], one study using alveolar distraction osteogenesis indicated lingual inclination of the dissected bone segment that occurred during one patient's distraction and postoperative infection in another patient [45], two studies using the GBR method reported early exfoliation of an e-PTFE membrane [48,58]. Finally, three studies reported implant disintegrations [37,59,54].

DISCUSSION

Analysing the literature, we can say that the causes of tooth removal are different, depending on clinical case. The most common causes of tooth removal are periodontitis, fractures, endodontic complications, injuries.

Studies have shown that the healing of the socket after extraction without installation of any material leads to resorption of toothless crest. In order to prevent the resorption of the alveolar crest, different methods of prophylaxis (preservation) of bone after tooth removal have started to be used. The method of prophylaxis involves filling defects with various bone plastic materials, to create good conditions for implantation. However, the method of prophylaxis does not increase bone level after removal, but only retains the original width and length of the alveolar crest, which in many clinical cases is insufficient for implantation.

In order to shorten the treatment time, we started using the method of immediate implantation. This technique has a number of advantages, because it reduces the number of surgical procedures and makes it possible to install a temporary crown on the implant (with primary stability of the implant 30N/cm and above), especially in aesthetic area. However, this technique also has a number of disadvantages, such as the higher risk of implant disintegration, unpredictable level of hard and soft tissues in the future, and difficulties in achieving implant stability.

In order to increase the alveolar crest, various techniques of regenerative bone-plastic operations were used. These include guided bone regeneration (GBR), the method of vertical and horizontal bone splitting, the use of allogenic or autologenous block transplantation, alveolar distraction osteogenesis. These techniques are suitable for use in different clinical situations, but have a number of deficiencies. For example, the removal of an autogenous bone graft from the intraoral region is traumatic for the patient, especially if the removal is from a symphysis of the chin or from branches of the lower jaw. The main disadvantages of the alveolar-distraction osteogenesis method are the lingual or palatal inclination of the dissection, the risk of fracture of the lower jaw and incomplete bone regeneration. The bone splitting method is effective for the alveolar crest of the upper jaw, but requires additional surgical intervention by GBR to maintain the height and width of the cheek bone.

Today, the most common method of increasing the alveolar crest is the GBR method. Allogenic or xenogenic bone materials are used for this method, as well as collagen, titanium or non-adsorbable membranes made of expanded PTFE with a titanium frame. With the correct implementation of this technique it is very effective to eliminate various bone defects on both upper and lower jaw. However, this method also has its disadvantages, the main ones being traumatic when removing a titanium membrane or membranes with a titanium carcass after expansion, infection of the mouth due to improper hygiene (especially in smoking patients), opening the wound due to the tension of the seams, as well as financial aspects, since the materials used are expensive.

It is also important to understand that periodontal biotypes influence implantation success. The thick biotype is more elastic and has a barrier function for the implant, while the thin biotype is more prone to gingival recession after mechanical or surgical manipulations. After the GBR method, as with all methods of alveolar crest augmentation, there is always a lack of soft tissues that need to be filled by the second surgical procedure.

Given all the complications of these methods and the specificity of some clinical cases, some authors have also used the method of orthodontic extrusion as a more atraumatic method of obtaining bone. It was used especially for aesthetic defects, in the absence of one or two teeth. The reasons for tooth removal in these cases were periodontitis. This method has many advantages, because it is less traumatic, the duration varies from 2 to 6 months, forms a good volume of firm tissues, and most importantly, soft tissues too. The disadvantage of the method is that for its application it is necessary to have a tooth that goes to the removal. None of the authors used this technique in patients with multiple adentia, which gives us an opportunity to analyse more possibilities of this technique.

Based on a review of the literature, this article will discuss methods of orthodontic extrusion and regenerative surgery with an analysis of advantages,

disadvantages, indications, contraindications and complications of each technique.

CONCLUSION

This review revealed a significant lack of data and evidence to determine which of the presented methods is best suited for tissue preparation prior to dental implantation, orthodontic extrusion or regenerative surgery.

There is a need for further improvement and scientific justification of innovative orthodontic approaches and designs that ensure high-precision and biomechanically controlled movement of teeth by the extrusion vector, especially in clinical situations with deficient supporting teeth.

The development of such solutions can significantly increase the predictability of treatment, minimise side effects and expand opportunities for orthodontic training as part of comprehensive implant rehabilitation.

Based on the results available, both orthodontic extrusion and surgical procedures are effective for hard tissue regeneration to plan further implantation, while not all methods can improve soft tissue volume and always require soft tissue surgery, as a second intervention.

Regarding orthodontic extrusion, this review has shown that this method is not widely discussed in the literature, although it can be widely used not only for elongation of clinical crowns, but also in implantation. The volume of firm and soft tissue obtained with orthodontic technique can be useful for aesthetic comfort and patient comfort.

It is obvious to search and develop new ways or devices helping to carry out more controlled and comfortable extrusion of teeth in cases of pronounced deficiency of supporting teeth.

DECLARATIONS

Competing interests

The authors declare no conflict of interest.

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