REVIEW ARTICLE

Orthodontics

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NEWER METHODS OF ORTHODONTIC RETENTION

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ABSTRACT

Over the past two decades, though the standards for retention have remained the same, the modalities to achieve it have undergone numerous changes. Retention maintains the teeth in their orthodontically corrected positions after the cessation of active tooth movement. The teeth have a tendency to return to their original position under the influence of periodontal, occlusal and soft tissue forces and continued dentofacial growth. Several authors have discussed the role of conventional retainers however much research has been conducted to experiment biological agents to aid in retention. Some of them are Osteoprotegerin, Bone Morphogenic Proteins, Bisphosphonates, Strontium, Low Level Laser Therapy and mechanical vibration.

INTRODUCTION

Reitan[1] was the first to describe the process of relapse. Many biological and mechanical factors dictate the rate of tooth movement in orthodontics. Similarly, this complex dynamic physiological environment also dictates the amount of relapse, after orthodontic treatment. The rationale for holding teeth in their treated position is to allow for reorganisation of gingival and periodontal tissues, minimise changes due to growth and permit neuromuscular adaptation.

Periodontal and gingival factors

When teeth are moved, the tissues in the periodontal ligament and gingivae remodel to the new tooth position. Boese[2] proposed that relapse in the first four weeks is largely due to the PDL fibres, and the gingival fibres thereafter. The tensile forces cause transseptal fibres to stretch, as demonstrated by increased collagenous protein turnover. Edwards[3], noticed that the rotational movements are brought about by stretching of collagen fibers. However, Redlich et al[4] reported that relapse is due to changed elastic properties of the stretched gingival fibres. The teeth therefore need to be held in position long enough for these fibres to adjust.

Occlusal factors

The gross occlusal interferences, displacing or premature tooth contacts and the abnormal loading of teeth may predispose the affected teeth to mobility which may contribute to relapse.

Soft tissue pressures and limits of the dentition

Teeth must be positioned in the neutral zone balanced between the tongue on the lingual and the lips and cheeks on the labial aspect. As Reidel[5] has proposed, the farther teeth are moved out of this zone, the more unstable they are likely to be. Changes in the arch form, in particular mandibular arch, results in increased risk of relapse.

Mechanical aids for retention

Retention can be achieved by various appliances. The Hawley retainer with its modifications is one of the most frequently used removable retentive appliance. The Essix thermoplastic retainer is also removable with esthetic advantages. For the fixed lingual retainer, a multistranded dead soft stainless-steel wire is bonded on the lingual surface of the anterior teeth. Fixed retention has its advantages since it does not rely on patient compliance, though it can make oral hygiene more difficult.

A promising strategy for maintaining anchorage and preventing relapse, may be the use of biological inhibitors of osteoclastic bone resorption. Described below are some agents that alter osteoclast activity and could be administrated locally or systemically to enhance post-treatment stability.

Bisphosphonates (BP):

Bisphosphonates are analogues of inorganic pyrophosphates. They are potent bone resorption inhibitors, generally prescribed for osteoporosis, Paget's disease and other bone metabolic disorders. They are of two types: nitrogenous and non-nitrogenous. Nitrogenous prevent protein lipidation. Non-nitrogenous induce osteoclastic apoptosis and inhibit protein synthesis.[6]BP act at three different levels: in tissue, cell or molecule:

a. They inhibit recruitment of cells towards bone surface.
b. They inhibit cell activity.
c. They reduce cell lifetime by inducing apoptosis.
d. They affect the process of mineral exchange during bone resorption. [7]

It was observed that topical or systemic application of BP decreases orthodontic tooth movement and reduces skeletal relapse after maxillary expansion or mandibular distraction.[8] Clodronate was shown to reproducibly inhibit the stress-induced expression of COX-2, PGE2, and RANKL in cultured human PDL-derived cells in a concentration-dependent manner. This is likely to indirectly prevent osteoclast formation and allow osteoclast apoptosis.[9] Kim et al investigated effects of alendronate on osteoblasts and on RANKL-induced differentiation of osteoclasts. They observed increased proliferation and differentiation of osteoblasts, and a potent inhibitory effect on osteoclast differentiation.[10]

Though BP provide an adjunctive retainer therapy in orthodontics there are concerns regarding bone resorption and risk of bisphosphonates related osteonecrosis of jaw.

Osteoprotegerin (OPG)

OPG is a soluble protein that inhibits binding of RANKL to its receptor and thereby prevents osteoclast differentiation and activation.

The efficacy of osteoprotegerin-Fc (OPG-Fc) for inhibiting post orthodontic relapse was examined for rat molars. OPG-Fc injections significantly diminished post orthodontic relapse from 63% of total movement in vehicle control rats to 31% in low-dose and 24% in high-dose OPG-Fc groups.[11]Schneider demonstrated that a single local injection of OPG-Fc effectively inhibited orthodontic relapse, with minimal systemic bone metabolic effects. These findings indicate that OPG-Fc is a safe and effective pharmacological agent for preventing relapse.[12]

The effect of local OPG gene transfer on orthodontic relapse was evaluated by Zhao et al. They found a decrease in number of osteoclasts and increase in bone mineral density and bone volume fraction.[13]

Keles et al[14] conducted a study to evaluate of the efficacy of pamidronate versus OPG in the inhibition of bone resorption and tooth movement. They concluded that OPG is more powerful

inhibitor of osteoclast recruitment and activity as BP act on active osteoclasts only, while OPG inhibits osteoclast formation and function.

Though OPG has potential advantages over BP there are concerns regarding development of anti- OPG antibodies that could neutralise endogenous antibodies.

Strontium

Strontium is an alkaline earth trace metal cation that has a high affinity for hydroxyapatite. It works by downregulating osteoclastogenesis by modulating the RANKL/OPG balancing system. Strontium exerts both anti-catabolic and anabolic effects on bone cells by stimulating bone formation via osteoblasts and inhibiting bone resorption by osteoclasts. It is, therefore, referred to as a "dual action bone agent".[15]

Munad et al[16] found that local injection of strontium inhibited alveolar bone resorption by affecting the formation and viability of osteoclasts. Hence local injection of strontium could be useful in retention.

Low-level laser therapy (LLLT)

Low level laser therapy is defined as laser treatment in which energy output is low enough so as not to cause a rise in the temperature of the treated tissue above 36.5ş C or normal body temperature. The mechanism of action depends on the ability of subcellular photoreceptors to respond to red and infrared wavelengths. LLLT also has biostimulatory effects such as stimulation of wound healing, collagen synthesis, and acceleration of bone remodeling during tooth movement.[17]

LLLT does not appear to prevent the biological relapse process, but delays redistribution of the Tartarate Resistant Acid Phosphatase-positive cells along the alveolar bone surface. LLLT application could aid in the remodelling process by increased bone formation and reduction of redistribution of osteoclasts from previous pressure areas, ultimately resulting in less relapse.[18]

Kim et al[19] studied the effects of LLLT on relapse and retention of rat molars and concluded that LLLT administered with retention facilitated collagen synthesis contributing to faster repair of damaged PDL tissue and better retention, while irradiation performed without retention in place would lead to an increased rate of relapse due to increased catabolic metabolism of collagen.

Saito et al[20]investigated the effects of LLLT on bone regeneration in midpalatal suture. They found that, LLLT can accelerate bone regeneration during expansion and that this effect is dependent on the total dosage, timing and frequency of irradiation which is in accordance with findings of Cepera et al[21]

Kim et al[22] investigated the effects of laser circumferential supracrestal fiberotomy (CSF) and LLLT on orthodontically rotated teeth in beagles. They concluded that Laser CSF is an effective procedure, causing no apparent damage to the periodontal structures, whereas LLLT on orthodontically rotated teeth without retainers appears to increase the relapse tendency.

CONCLUSION

Recent years have shown much interest and research in retention procedures with various methods. More experimental studies are needed to elucidate the role of biological agents in preventing relapse.

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