

Stability of Mandibular Irregularity Index With and Without PAOO: A Review



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Abstract

Periodontally accelerated osteogenic orthodontics (PAOO) is an accelerated tooth movement technique resulting in enhanced stability of treatment outcomes. Mandibular irregularity index was recently demonstrated to be significantly more stable at 10-years post treatment, and the purpose of this review article was to summarize current literature results. Under experimental conditions with and without PAOO, irregularity index at 5-years post treatment changed 0.4mm versus 2.8mm, and at 10-years, 0.9 mm versus 2.4 mm ($P=0.00$). The 10-year PAOO results were then compared to mandibular irregularity index changes from a comprehensive review of the scholarly literature; PAOO demonstrated 54% less change than patients orthodontically treated without PAOO and 40% less change than untreated subjects. While the 10-year PAOO change of 0.9 mm was more than twice the amount of change (0.41 mm) compared to fixed canine-to-canine retention patients, it is the only active treatment technique that significantly reduces mandibular anterior segment recording of post orthodontic outcomes.

Keywords: Irregularity index, PAOO, Stability, Mandibular crowding

Introduction

Long-term stability after orthodontic treatment is highly desirable, especially alignment of the mandibular anterior dentition as might be quantified by the irregularity index. Post orthodontic treatment stability is a vexing problem, and without permanent fixed retention, this issue has been a problem without a solution until recently. In 2014, long term stability of the mandibular anterior segment was shown to be affected by alveolar corticotomy and augmentation bone grafting (PAOO) [1].

Mandibular incisor crowding increases over time and there are no dependable predictors [2,3]. These two observations are so prevalent in refereed orthodontic literature they are regarded as consensus tenets. The amount of crowding change varies so greatly that increased crowding cannot be anticipated; this observation applies to untreated individuals [4-6]. Eighteen Swedish dentists with intact dentitions and no history of orthodontic or prosthodontic treatment were followed for 40 years from ages 20 to 60; the authors found a significant increase in Little's irregularity index (1.0 mm; $P=0.01$) [7]. Fifteen untreated adolescents and 18 untreated adults were observed over a span of about three decades and the rate of mandibular irregularity index increase was significantly greater in adolescents than in adults [8].

Mandibular anterior crowding increases are also well documented in post orthodontically treated samples. Richardson

[9] reported increases in irregularity index averaging 2.56 mm from 18 previous investigations ($n=1,117$) of extraction and non-extraction patients. Shah [10] reported mean post-treatment irregularity changes ranging from 0.6 to 4.88 mm after reviewing 29 studies ($n=1683$).

Little [11] used mandibular irregularity index to quantify the percentage of successful orthodontic treatment outcomes in the absence of permanent bonded retention. He designated an irregularity index score of <3.5 mm as representing clinically acceptable by Little et al. [12,13]; he demonstrated in orthodontically treated premolar extraction cases a success rate of 30% at 10 years post retention and only 10% at 20 years post retention.

Long term 20+ years of mandibular anterior segment stability after orthodontics has been demonstrated by Booth et al. [14] by placement of fixed permanent canine-to-canine retention. Fixed, uninterrupted retention is the only treatment strategy that assures irregularity index will not exceed 3.5mm, but it is a post treatment strategy.

Until recently, no active orthodontic treatment strategy has been shown to be effective at minimizing mandibular anterior recrowding. Makki et al. [15] recently reported mandibular irregularity index stability in PAOO subjects with incremental

increases of 0.4mm at 5-years and 0.9mm at 10-years. These small changes were in sharp contrast to non-PAOO groups at 5-years (2.8 mm, P=.000) and 10-years (2.4 mm, P=.000). None of the retention schemes in this study included long term fixed permanent retention.

These stunning results prompted a comprehensive literature review study by Ferguson et al. [16] comparing the PAOO irregularity index results with both orthodontically treated and untreated long 10-year outcomes. Treated outcomes were represented in the scholarly literature by 3181 patients in 53 publications; untreated subjects were represented by 1069 individuals in 23 articles. As described previously, irregularity index in 22 PAOO patients changed 0.9 mm in 10-years while non-PAOO treated patients changed more than twice as much (1.96mm) and untreated subjects changed 1.49 mm. Also reviewed in the article were irregularity index changes for fixed canine-to-canine retainer patients; there were 330 patients represented in four publications and average irregularity index change was only 0.41 mm. After comparing augmented corticotomy with the scholarly literature, it was concluded that PAOO is the only active orthodontic treatment strategy that results in post treatment mandibular anterior irregularity index stability [16].

Discussion

Why are augmented corticotomy results so stable? This is a reasonable question given the fact that post orthodontic treatment stability is so important to the profession. No other active treatment technique or procedure leads to mandibular anterior segment stability, so what is it about PAOO that distinguishes it from other techniques? PAOO includes minor surgery with a full thickness periosteal flap and intentionally scarring the alveolar cortex with a high speed surgical bur under copious irrigation [17]. The surgical trauma initiates an inflammatory healing response called regional acceleratory phenomena or RAP which increases tissue turnover [18]. Authors of the PAOO technique believe this increase in tissue turnover may be partly responsible for the loss of tissue memory [19]. Moreover, augmentation bone grafting increases the cortical thickness of the alveolar bone surrounding the dentition, and it is believed that increased cortical thickness reduces the risk of post orthodontic treatment recrowding [20,21].

Whether or not increased tissue turnover and/or increased cortical thickness reduce the risk of mandibular anterior segment instability is only speculation at this time. But circumstantial evidence suggests there is merit in believing these two factors enhance stability. The human body exists in an environment of mechanical stress (gravity, locomotion, etc.) Tissues maintain a certain level of tension, called prestress or tensional integrity, that may differ somewhat from individual to individual depending upon a host of factors including age, level of daily activity (athletic versus sedate), health (well versus ill), etc. These forces create a prestressed structural network that can sustain itself and, at the same time, can spontaneously accommodate perturbations [22,23]. The tensional readiness of body resets itself after the

invasive PAOO surgery and the local tissues likely are more reticent to change back to pre-surgery, prestress levels. Part of that reticence is likely due to the new tissue structure built from the local tissue turnover with different tensional integrity.

Augmentation bone grafting increases cortical bone thickness [24], and thin cortices have been reported as a risk factor in mandibular anterior segment recrowding [20,21]. In the absence of fixed retention, Rothe et al. [20] compared 10-year postorthodontic samples of minimal (3.5mm) and high (6mm) irregularity index. The authors measured mandibular inferior border cortices and, by a priori application to the alveolus surrounding the mandibular anterior dentition, concluded that patients with thinner mandibular cortices were at increased risk for mandibular anterior dental relapse. This finding was confirmed two years later in another study by the same investigative group [21].

Conclusion

One of the instability tenets of the mandibular dental arch is that irregularity index in the permanent dentition will increase with time. This has been shown to be true in the untreated and following orthodontic treatment, extraction or non-extraction, irrespective of gender and/or culture-ethnicity. The only "proven" way to prevent unwanted recrowding of the mandibular anterior segment after treatment is fixed retention. The only way to prevent mandibular anterior recrowding with active orthodontic treatment is by way of augmented corticotomy (PAOO).

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