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REMOVABLE ORTHODONTIC THERAPY - CLINICS OR/AND SCIENCE

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Summary

Class II malocclusion is one of the most common orthodontic problems in our population, and the most consistent diagnostic finding is mandibular skeletal retrusion. There are many treatment approaches for the correction of this malocclusion with varying degrees of scientific support. In the last twenty years, functional appliances were widely used for correction of sagittal intermaxillary relationship in children, but mostly in Angle Class II treatment. One of the most controversial topics in orthodontics relates to the effectiveness of functional appliances on mandibular growth. Much of the debate about Class II treatment centres on the possibility of permanently increasing mandibular length, because an underdeveloped mandible is a common cause of Class II malocclusion.

Functional appliances based their wide application on the hypothesis that they stimulate growth modification, which is only possible in patients with adequate growth amount, or potential, to correct maxilomandibular relationship, which is the reason why they should be used before or during adolescent growth spurt. Functional appliances encompass a range of removable and fixed devices that are designed to alter the position of the mandible, both sagittally and vertically, to induce supplementary lengthening of the mandible by stimulating increased growth at the condylar cartilage. The results of the new, relevant studies state there is no evidence that functional appliances significantly increase horizontal growth when evaluated in the long term, and that most of the correction of the malocclusion is due to dentoalveolar changes with a small but statistically significant amount of skeletal effect. Despite of this there are some indications for their application with successful results

Key words: functional orthodontic appliances; malocclusion.

INTRODUCTION

Class II malocclusion is one of the most common orthodontic problems, and it occurs in about one third of the population [1,2]. The most frequent diagnostic

cephalometric finding in Class II maloccusion in Croatian population is bimaxillary skeletal retrusion with dominance of mandibular retrusion [3].

Contemporary treatment approaches address the chin as the important part for profile attractiveness. People frequently seed orthodontic therapy because of facial disharmony; straighter profiles and more prominent chins are preferred esthetically over retruded chin positions [4]. Possible mechanisms for improving AP chin position include: increase in mandibular size, repositioning of the glenoid fossa, and counterclockwise or forward rotation of the mandible.

Three commonly used methods of Class II correction have been: 1) Extraction therapy with headgear and Class II elastics, 2) Nonextraction headgear treatment and 3) Functional appliances.

One of the most controversial topics in orthodontics relates to the effectiveness of functional appliances on mandibular growth. A wide range of functional appliances aimed to stimulate mandibular growth by forward posturing of the mandible is traditionally indicated in these patients [5]. Functional appliances encompass a range of removable and fixed devices that are designed to alter the position of the mandible, both sagitally and vertically, to induce supplementary lengthening of the mandible by stimulating increased growth at the condylar cartilage. In the 1970s and '80s there was an increase in the numbers of papers published in refered journals supporting functional appliance stimulated mandibular growth. Many studies performed on animals have demonstrated that skeletal mandibular changes can be produced by posturing the mandible forward, but the effect on humans are more controversial [6,7]. The question of whether the effect of mandibular forward positioning appliances in increasing mandibular growth in animal studies can be reproduced in humans has been widely addressed by many, with inconsistent findings. Many of the reports concerning growth effects of functional appliances have been characterized by poor methodology, or are simply anecdotal case reports. The problem has been recognized and acknowledged by the profession, with steps taken to rectify the situation. Evidence shows that favourable growth responses are not always achieved with functional therapy; some authors reported increases in overall mandibular length, and changes in the amount of condylar growth, but others believe that mandibular length cannot be altered by such therapy [8-10].

The studies reporting a positive effect on mandibular growth still leave this question unanswered due to characteristics such as lack of a control group, clinically minimal effect and patients being retained with a mandibular positioning appliance [11].

The clinical significance of a measured increase in mandibular length needs to be considered in terms of forward chin positioning. The increase in length may be

negated by clockwise mandibular rotation. For example, in the studies of McNamara et al. [12], despite giving an increase in mandibular length, the Frankel appliance did not increase anterior chin projection compared with the control, although the Herbst appliance did demonstrate this effect.

It has been claimed that most of the correction of the malocclusion is due to dentoalveolar changes with a small but statistically significant amount of skeletal effects [13,14]. There are also controversies concerning the effects of functional appliances on the maxilla. Many studies indicate that forward growth of the maxilla might be inhibited, but others stated that there is no appreciable effect on the position of the maxilla [15,16].

All of these conflicting claims could be attributable to retrospective study designs of methodologic limitations such as small samples, inadequate or no control group, dishomogenity of the groups for sex an age at the start of therapy, and different lengths of treatment [17]. In addition, there is a lack of long-term studies on the effect of functional appliances to evaluate the stability of skeletal changes because of the great difficulties in recruiting patients after treatment.

REVIEW OF THE LITERATURE

To date, very few RCTs on treatment outcomes of functional jaw orthopedics have been published in the orthodontic literature. A systematic review on the efficacy of functional appliances on mandibular growth by Chen et al. [18] analyzed the relevant literature from 1966 to 1999, and were limited to randomized clinical trials (RCTs). RCTs have been recommended as the standard for comparing alternative treatment approaches. The results of their study were inconclusive.

Illing et al. [19]. and Keeling et al. [20] have undertaken prospective randomized clinical trials of Class II appliances, as well as Ghafari et al. [21], but the conclusion was that activators do not bring about an increase in mandibular growth.

Based on randomized clinical implant study of 25 patients followed longitudinally for 1 year Araujo et al. [22] concluded that bionator therapy: alters the direction but not the amount of condylar growth; produced greater than expected posterior drift of bone in the condylar and gonial region; and displaces the mandible anteriorly but limits the amount of true mandibular forward rotation that would normally occur.

Illing et al. [19] in their clinical trial examined the responses to treatment with Bass, Bionator and Twin Block appliances. The treatment and control groups consisted of patients with mandibular retrusion. None of the appliances were successful in increasing either the SNB angle or the forward projection of pogonion, compared

with the control group. Of the three appliances, the Bionator and Twin Block gave an increase in mandibular length (or mandibular displacement), as measured from articulare to gnathion, compared with the control.

La Haye et al. [23] in their study evaluate the effect of extraction headgear and Class II elastics, nonextraction headgear, and Herbst treatment, and conclude that methods commonly used to correct Class II skeletal malocclusions produce no significant improvements in AP chin position, and that skeletal Class II correction in growing adolescents results primarily from maxillary growth restriction or inhibition. Validating previously established mathematical models, approximately 80% of the variability in AP movement of the chin can be explained by true rotation, AP and vertical condylar growth, and AP movement or drift of the glenoid fossa. True mandibular rotation is the most important determinant of AP changes of chin position.

In the most recent study, Perillo et al. [24] performed a meta-analysis of articles (from 1966 to 2009) to verify the mandibular changes produced by the Fränkel-2 (FR-2) appliance during the treatment of growing patients with Class II malocclusions when compared with untreated growing class II subjects. Meta-analysis showed that the FR-2 was associated with enhancement of mandibular body length, total mandibular length and mandibular ramus height. Despite the heterogeneity among studies for all the considered linear measurements, they stated that the FR-2 appliance had a statistically significant effect on mandibular growth. They advocate that the evidence-based approach to the orthodontic outcomes of FR-2 appliance is needed, by selecting and comparing groups of children with the same cephalometric characteristics with and without treatment.

The aim of the systematic review by Cozza and colleagues [25] was to assess the scientific evidence on the efficiency of functional appliances in enhancing mandibular growth in Class II subjects. The survey covered the period from 1966 to 2005 and included: randomized clinical trials (RCTs), prospective and retrospective longitudinal controlled clinical trials (CCTs) with untreated Class II control. Among 704 articles, four were RCTs and 18 CCTs. Two-thirds of the samples in the 22 studies reported a clinically significant supplementary elongation in total mandibular length as a result of overall active treatment with functional appliances. The amount of this growth was significantly larger if the functional treatment is performed at the pubertal peak in skeletal maturation. But, it was interesting that none of the 4 RCTs reported a clinically significant change in mandibular length.

The aim of the study of Marsico and colleagues [26] was to analyze the current literature for the best evidence (RCTs) about the efficacy of functional appliances on mandibular growth in the short term. Electronic searches identified thirty two

articles that fulfilled the specific inclusion criteria and were identified as potentially appropriate randomized clinical trials to be included in this meta-analysis. Only four articles, based on data from 338 patients with Class II malocclusion in the mixed dentition were selected for the final analysis. The results of the meta-analysis from the random-effects model showed a statistically significant difference of 1,79 mm in annual mandibular growth of the treatment group compared with the control group. They concluded that skeletal changes were statistically but unlikely clinically significant.

In the most recent meta-analysis performed by Marsico et al. [26] they investigated the current literature with best evidence (RCTs) about the efficacy of functional appliances on mandibular growth. They included only articles that reported the anatomic condylion (they excluded studies that used articulare because its location is determinate by mandibular position). This meta-analysis showed that the treatment resulted in a change of skeletal pattern; however, these effectively small increases of the mandibular length, even if statistically significant, appear unlikely to be very clinically significant. These data seem to support recent reports that 2-phase treatment has no advantages over 1-phase treatment. However, several benefits must be attributed to the early treatment of Class II malocclusion with functional appliances; prevention of trauma to maxillary incisors associated with a large overjet, interception of the development of dysfunction, psychosocial advantages for the child during an important formative period of life, stable dentoalveolar correction, and improved prognosis and shorter duration of treatment with fixed appliances.

LENGTH OF TREATMENT: One versus two phase treatment

Class II malocclusion can be treated according different treatment protocols according to the characteristics of the problem, such as anteroposterior discrerpancy, age and patient compliance. Both 1-phase and 2-phase treatment protocols are considered effective approaches for correcting a Class II malocclusion [27,28]. The 1-phase treatment begins after the emergence of the second molars with fixed appliances associated with Class II intermaxillary elastics and extraoral appliances, and the 2-phase treatment start in the mixed dentition with functional appliances, and is followed by a second phase with fixed appliances for completition of the treatment. The choice of a specific treatment protocol is based on the benefits of treatment, and its effectiveness in correcting several aspects of the malocclusions, especially the occlusal characteristics.

Early, or phase I, orthodontic treatment refers to treatment that precedes the conventional treatment protocol in which brackets and bands are placed on perma-

nent teeth. This early treatment begunn during either the primary or transitional dentition to intercept malocclusions in a manner that will ultimately lead to a better, more stable result than that which would be achieved by starting treatment later. The goal of many clinicians who provide early treatment is to reduce the time and complexity of fixed-appliance therapy. Whether early treatment is beneficial for orthodontic patients is still controversial question.

In cases where functional appliances are utilized, the patient usually requires further therapy with fixed appliances. Although early functional appliance therapy has been reported to decrease the time in fixed appliances (phase 2), the total treatment time is generally increased over that for fixed appliances only.

Recently, the results of three randomized clinical trials specifically designed to address these important issues were published [20,21,29].

Tulloch and colleagues [29] studied benefits of two-phase vs. one-phase Class II treatment. In this randomized clinical trial, children with a moderate to severe Class II malocclusion assigned to one of three groups: headgear treatment, bionator treatment or an observational group in which no treatment was performed. The results suggested that treatment with either headgear or bionator can improve the relationship of the jaws in most children (76 percent), although there was substantial individual variation noted in both treatment groups, as well as in the untreated control group. The second phase of this study was designed to test whether these changes represented long-term differences. At the end of treatment, they did not found significant differences among the three groups in regard to their skeletal relationships, and occlusions. It appears, from these results that, on average, the skeletal changes that occur with early treatment are not sustained. The improvement in jaw relationships seems to represent a period of accelerated growth rather than a permanent change. These authors concluded that for children with moderate to severe Class II malocclusion, early (phase I) treatment followed by conventional orthodontics later (phase II) does not produce skeletal or occlusal relationships that differ substantially from those produced by phase II treatment alone.

As reported by Ghafari and colleagues [21] who conducted another randomized clinical trial of the effectiveness of early Class II treatment, it seems to be just as effective in late childhood as it is at an earlier age. Keeling and colleagues [20] reported findings from a similar randomized clinical trial. Their data showed that both headgear and bionator treatments in preadolescent children can result in short-term skeletal changes. One year after completion of treatment the skeletal changes were stable, but the some of the dental movements relapsed.

On the basis of these three ongoing clinical trials we can conclude that both the one or two- phase treatments are effective in correcting the Class II malocclusion.

This correction is due to both a skeletal and dental change. These studies do not support the claim that a favourable effect on skeletal growth patterns is limited to two-phase orthodontic treatment. In fact, these and other recent studies suggest that as long as the patient is treated while he or she is still growing, the time at which treatment begins may not make a difference in the success of the Class II correction. We can conclude that a later-stage treatment approach is preferable because of the advantages accompanied with the reduced treatment time.

Tulloch et al. [28] also compared one and two-phase treatment, and concluded on the basis of the two-phase randomized trial that early treatment (phase 1) followed by later comprehensive treatment (phase 2- Fixed appliance therapy), on average, does not produce major differences in the jaw relationship or dental occlusion, compared with later one-stage treatment. Although favourable skeletal changes were noted in the functional appliance group following phase 1 therapy, the changes were not maintained. This finding agrees with previous that also failed to demonstrate any benefits in terms of skeletal change with early phase 1 therapy. The study of Keeling et al. [20] concurred with that of Tulloch et al. [28] in that functional appliances brought about some favourable skeletal change following phase 1 treatment. The change in mandibular length was greater in the functional group than the control and amounted to a little less than 1 mm per year.

The purpose of the study performed by Cancado et al. [30] was to compare the occlusal outcomes and the efficiency of 1-phase and 2-phase treatment protocols in class II/1 malocclusions. They have two groups of patients, one comprised 78 patients treated with 1-phase treatment protocol and the second group comprised 61 patients treated with 2-phase treatment protocol. The initial and final study models of the patients were evaluated by using the peer assessment rating index. They found similar occlusal outcomes between 1-phase and the 2-phase treatment protocols, but the duration of treatment was significantly shorter in the 1-phase treatment protocol group. They prefer the 1-phase treatment of Class II Division 1 malocclusions.

In terms of practical clinical applications, a lack of significant skeletal change with functional appliances does not diminish their use in correcting overjets. The appliance is still a useful orthodontic tool for correcting Class II malocclusions. For a patient who has a severe retrognathic profile with a deficient chin where surgery may be required, the use of a functional appliance is unlikely to change the long-term surgical needs. However, in many cases favourable profile changes can occur. The overall facial profile is the result of skeletal, dental and soft tissue contributions, so improving dental relationships may result in an improved profile due to more favourable soft tissue drape. In Class II division 1 pattern patient with lower lip habit the reduction of the overjet using functional appliance can result in a substantial

improvement in facial aesthetics, without altering the skeletal base relationship. After reduction of the overjet, the lower lip can rest and function in front of the upper teeth [31].

CONCLUSION

On the basis of available evidence, it cannot be concluded that functional appliances are effective in stimulating and increasing mandibular growth. Although favourable growth changes have been reported following phase 1 therapy they are generally not substantial and long-term stability appears to be poor. Evidence suggests the modest skeletal changes revert with time.

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Sažetak

Mobilna ortodontska terapija – kliničko iskustvo i/ili znanost

Anomalije Klase II i njihova terapija su jedan od najčešćih ortodontskih problema u našoj populaciji , a dijagnostički nalaz većinom ukazuje na skeletni retrognatizam mandibule. Postoje brojni terapijski pristupi za liječenje te malokluzije s različitim stupnjem znanstvene podloge. Zadnjih dvadeset godina terapija funkcionalnim napravama postala je opće prihvaćeno sredstvo za terapiju sagitalnih međučeljusnih nepravilnosti u djece, no ipak se najčešće koriste u korekciji Klase II po Angleu. Jedno od najkontroverznijih pitanja u ortodonciji danas odnosi se na učinak funkcionalnih naprava na rast mandibule. Većina debata o učinku terapije Klase II odnosi se na mogućnost trajnog produženja mandibularne dužine, jer je upravo nedovoljno razvijena mandibula glavni uzrok te anomalije.

Funkcionalne naprave temelje svoju široku upotrebu na hipotezi da se radi o terapiji modifikacijom rasta, koja je moguća jedino kod pacijenata kod kojih je preostala dovoljna količina, tj. potencijal rasta sa željom da se isprave međučeljusni odnosi utječući na rast te ih je stoga najbolje koristiti prije ili tijekom adolescentnog ubrzanja rasta. Funkcionalne naprave obuhvaćaju velik broj mobilnih ali i fiksnih naprava koje su dizajnirane kako bi promijenile položaj mandibule, sagitalno i vertikalno, te proizvele dodatno produženje mandibule stimulacijom rasta kondilarne hrskavice. Rezultati novih istraživanja ukazuju da nema dokaza da funkcionalne naprave dugoročno značajno povećavaju horizontalan rast mandibule, te da se glavnina ispravljanja malokluzije događa zbog dentoalveolarnih promjena s malim, statistički značajniim, ali klinički inferiornim skeletnim učinkom. Usprkos tome i danas postoje indikacije za njihovu upotrebu koje dovode do zadovoljavajućih rezultata.

Ključne riječi: funkcionalne ortodontske naprave; malokluzija.

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