

Functional Appliances : An Insight

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The load of patients visiting the orthodontic practice comprise mostly of Class II malocclusion. Pancherz reports high frequency of mandibular retrognathism amongst these Class II malocclusion. In these cases, the use of functional appliances for mandibular growth stimulation has been an appealing perspective in growing patients.¹

The term "functional appliance" refers to a variety of removable appliances designed to alter the arrangement of various muscle groups that influence the function and position of the mandible in order to transmit forces to the dentition and the basal bone. Typically these muscular forces are generated by altering the mandibular position sagittally and vertically, resulting in orthodontic and orthopedic changes.² The objective of functional appliances is to stimulate mandibular growth and correct the sagittal misalignment by bringing the condyles forward and downward within the glenoid fossa^{3,4} as well as remodelling the condyle and glenoid fossa, causing anterior rotation of the mandible and consequently projecting it forwards.⁵ It is also a well-established fact that functional appliance therapy brings about long-term changes in oral volume and volume of the upper pharyngeal airway. This may result in a reduced risk of developing long-term impaired respiratory function in children.⁶

Considering this the functional appliance can affect by the following ways either working in tandem or solo:

1. Maxillary growth restrictions and redirection (both skeletal and dentoalveolar components).
2. Mandibular growth (both skeletal and dentoalveolar components).
3. Overjet correction through a combined maxillary and mandibular orthopedic effect with maxillary incisor lingual tipping and mandibular incisor labial tipping
4. Remodeling changes in the temporomandibular joint (articular eminence, glenoid fossa and at the condylar head).
5. Changes in neuromuscular anatomy and function.

This can only be achieved if the treatment is instituted at the right time.

Correct timing for intervention

The efficiency of functional treatment for skeletal Class II malocclusion is critically dependent on the timing of intervention especially for removable appliances. It is usually advised that the functional appliance therapy be instituted before adolescence. A constant dilemma sustains this issue though, if institution of Functional Appliance therapy be pre-pubertal or pubertal.

Baccetti et al in a study on Twin blocks concluded that the optimal timing for Twin-block therapy of Class II disharmony is during or slightly after the onset of the pubertal peak in growth velocity. When compared with treatment performed before the peak, late Twin-block treatment produces more favorable effects that include: (1) greater skeletal contribution to molar correction, (2) larger increments in total

mandibular length and in ramus height, and (3) more posterior direction of condylar growth, leading to enhanced mandibular lengthening and to reduced forward displacement of the condyle in favor of effective skeletal changes.⁸

Pavoni et al state that when treatment is initiated before puberty, Class II correction was mostly confined to the dentoalveolar changes, with significant improvements of both overjet and molar relationships. On the other hand, treatment with the outset at puberty produced significant long-term improvement of sagittal skeletal relationships, which were mainly sustained by mandibular changes.⁹ Kevin o'Brein in a multi centre -RCT study concluded that the mean age to institute the FA therapy is 12.4 years. Kurt Faltin regards CVMI II to be the ideal stage for delivery of Bionator FA.¹⁰

A meta-analysis of RCTs and CCTs assessed the short-term skeletal (mainly supplementary mandibular growth) and dentoalveolar effects of removable functional appliances for the treatment of Class II malocclusion during the pre-pubertal or pubertal growth phase. It concluded that functional treatment by removable appliances may be effective in correcting Class II malocclusion with relevant skeletal effects if performed during the pubertal growth phase. Skeletal effects of functional treatment were seen at the mandibular level and consist mainly in mandibular elongation and increase in ramus height, although dentoalveolar effects were detected even in pubertal patients.¹¹

Change in Mandibular length

The influence of functional appliances on mandibular growth is a controversial issue. The primary question is whether treatment with a functional appliance can induce a clinically significant increase in mandibular growth that would create a better looking face than traditional orthodontic therapy. McNamara evaluated their own results obtained in laboratories and concluded that on long term basis, a maximum of 5% to 15% increase in mandibular length can be expected.¹²

It was found that mandibular length increased by 1.1mm per year. Typically, functional appliances obtain the average 6-7 mm of correction needed for the resolution of Class II malocclusion through a combination of orthopedic (30% to 40%) and dentoalveolar (60% to 70%) effects.¹³ Lorenzo Franchiet al noted that there was a significant long-term mandibular change (Co-Gn) (3.6 mm over the controls) associated with improvements in the skeletal sagittal intermaxillary relationship, overjet, and molar relationship (___3.0-3.5 mm). Also treatment instituted during the pubertal peak was able to produce significantly greater increases in total mandibular length (4.3 mm) and mandibular ramus height (3.1 mm) associated with a significant advancement of the bony chin (3.9 mm) when compared with treatment before puberty.¹⁴

A meta analysis conducted by Adriana Santamaria-Villegas, et al. to evaluate the effect of removable functional appliances on mandibular length in patients with class II

with retrognathism showed that all removable functional appliances, aiming to increase mandibular length, are useful and showed a slight increase in mandibular length (Co-Gn and/or Co-Po).¹⁵

Changes in Condyle Glenoid fossa complex

The mandibular condylar cartilage plays a primary role in the growth and development of the oro-facial complex. Thus, a deficient growth of the condyles may result in mandibular retrognathia, also referred as skeletal Class II malocclusion. Growth at the condyles is characterized by condrogenic, proliferative, and hypertrophic layers of condylar cartilage presenting at the distal aspect of the condyle which eventually effects an increase in total mandibular length.¹¹ Skeletal correction of Class II malocclusions with mandibular retrognathia involves jumping the bite with the assistance of functional appliances. Experimental studies by Voudouris et al. have reported CGF remodeling at the condyle and the glenoid fossa which correlated with decreased postural EMG activity during the experimental period.¹⁶ Voudouris and Kufteinc showed that displaced condyle from condylar fossa leads to extrinsic signals from tissues surrounding it which serve as stimulus to the fibrocartilage on the head of the condyle to undergo growth modification following growth of soft tissues.¹⁷

Research at the molecular level provides some insight on the process of enhanced cellular growth and genetic alterations in the cells in condylar cartilage which when subjected to altered environment, send signals to cause mesenchymal cell differentiation in the articular layer in chondrocytes, which proliferate and mature into hypertrophic cells. Insulin-like growth factor 1 (IGF-1), fibroblast growth factor 2 (FGF-2), and their receptors (IGF-1r, FGFr1, 2, 3) show enhanced expression. Alteration in mandibular posture, might to a certain extent contribute to changes in proliferative activity of condylar cartilage.¹⁸ New bone formation was preceded by increased neovascularization indicated by increased expression of vascular endothelial growth factor.¹⁹

Conclusion:

The wide popularity and brilliant clinic performance of functional appliance makes it the appliance of choice for the treatment of Class II malocclusion. It can thus be concluded that in the last 138 years a lot of understanding in respect to the physical, biological and clinical aspect of the functional appliances has been gained and refined. After reviewing and comparing research work it can be concluded that case selection followed by appropriately customized appliance design, timing of treatment institution, favourable growth and diligent follow up can account for successful and satisfactory results with functional appliance therapy.

References:

References are available on request at editor@healtalkht.com