

## **SCHWARTZ APPLIANCE AND LIP BUMPER AS TREATMENT MODALITIES FOR MANDIBULAR CROWDING IN MIXED DENTITION**

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### **Abstract**

Dental crowding is the most common form of malocclusion. It is more pronounced in the mandible than in the maxilla and tends to increase with age. Depending on the degree of space deficiency and the age of the children the prevalence of dental crowding can be as high as 50%. Schwartz appliance and lip bumper have been widely used as an early treatment for increasing lower dental arch dimensions.

The aim of this review is to evaluate the scientific research about the efficacy of Schwartz appliance and lip bumper and compare the changes caused by the two appliances in addressing mandibular crowding in the mixed dentition.

A comprehensive literature search on the electronic databases: PubMed, Cochrane Library and Google Scholar was performed. Also, a search of the reference lists of included studies was conducted, to ensure comprehensive coverage of the literature. Search terms included "Schwartz appliance" OR "removable appliance" AND "lip bumper" OR "fixed appliance" AND "mandibular crowding" AND "mixed dentition" OR "early dentition". The search resulted in identifying several studies that met the inclusion criteria.

Results show that both Schwartz appliance and lip bumper can effectively improve mandibular crowding in mixed dentition, although the extent and type of changes produced by these appliances may vary. Schwartz appliance is more effective in increasing inter canine width, while the lip bumper has more effect on increasing the arch length. Patient compliance as well as treatment duration are important factors that can have an effect on the success of orthodontic treatment.

Schwartz appliance and lip bumper are effective in alleviating mandibular crowding, thus providing cost-effective and simple treatment in mixed dentition. The choice of the appliance should be based on the individual patient's needs and treatment goals. Further research is needed to evaluate and compare the stability and long-term effects of these two appliances as well as the need for further fixed orthodontic treatment.

**Key words:** Schwartz appliance, lip bumper, mandibular crowding, mixed dentition

### **Introduction**

Crowding has been noted as the most common malocclusion in mixed dentition. Usually is combined with a Class I molar relationship or a tendency toward Class II or Class III molar relationship [1].

According to NHANES III, a large-scale survey in the US, depending on the degree of space deficiency and the age of the children, the prevalence of crowding can be as high as 50%. Also, the percentage of children with excellent alignment decreases with age as the permanent teeth erupt, and especially worsens in the lower jaw for adults [2].

Having in mind this fact, there is no doubt that the treatment of this malocclusion is important.

Early orthodontic treatment tends to correct the existing or developing dentoalveolar, skeletal or muscular imbalances in order to create an improved environment before all the permanent teeth erupt.

Also, it is expected that early orthodontic treatment will reduce the need for second-phase treatment with fixed appliances, or at least will reduce the complexity and severity of future orthodontic treatment [3].

The etiology of crowding is most likely to be genetic in origin, but some local factors such as: early loss of deciduous teeth, retained deciduous teeth, developmental absence of teeth, unscheduled loss of permanent teeth, extra teeth and anomalies in tooth form or position may affect crowding [4]. Prediction of crowding during the early stage has been a goal in a few longitudinal studies. Samson and

Richards [5] evaluate if pre-eruptive tooth positions and dental arch perimeters can predict crowding changes. They suggest that due to individual variations in dentofacial pattern, no prediction of crowding in the transition from mixed to permanent dentition can be made.

Sinclair and Little [6] also did not find any associations or predictors of clinical value between various dental parameters and incisor crowding. Only the crowding in the deciduous incisors can be used as a possible predictor of the likely crowding that may be seen in the early permanent dentition. [4].

Also, several growth development studies have been conducted, evaluating the changes caused by the development. [7].

But, there is little data on the efficacy of early orthodontic treatment in mixed dentition regarding mandibular crowding and the stability of the achieved results. In order optimal treatment planning, changes in the arch due to growth and treatment should be considered. Mandibular crowding is of particular interest due to its anatomical structure and therefore has a different expansion mechanism than the maxilla. The expansion of the mandible is quite limited, mostly localized to the dentoalveolar complex and mainly causing tooth inclination. [3].

Due to these constraints the mandibular dental arch is a guide to determine the required changes in the maxillary dental arch. [8]. Schwartz appliance and lip bumper have been widely used as a treatment for increasing lower dental arch dimensions. Schwartz appliance is a removable appliance made of acrylic with an incorporated expansion screw for expansion of the dental arch and metal clasps used for retention.

Depending on the activation protocol, when activated once per week produce around 0.20 mm to 0.25 mm expansion in the midline of the appliance. It is indicated in mild to moderate crowding in the lower anterior region, especially if lingual tipping on posterior teeth is present. [1].

A lip bumper is a removable appliance, useful in patients with tight or tense buccal and labial musculature. It lies away from the dentition at the gingival margin of the lower central incisors. It acts by removal of the lip pressure on the lower anterior dentition, and the distal forces exerted at the molar abutment. The labial pressure on the lip bumper is estimated to range between 100 and 300 gm. Also, lip bumper holds the buccal musculature away from the vestibular surface of the teeth, thus allowing tongue pressure to act in increasing transverse arch dimensions. [9].

The appliance can be ligated in place and worn full-time, in contrast with the Schwartz appliance which highly depends on patient compliance.

The effect of the lip bumper is increasing the arch length, as well as up righting lower molars distally, which if not monitored closely can cause impaction of the second molar. [1]. Depending on the type of lip bumper used and its clinical manipulation, transverse widening also may occur [2].

The purpose of this review is to evaluate the current literature about the efficacy of the Schwartz appliance and lip bumper as well as compare the changes made from these two treatment modalities in addressing mandibular crowding in the mixed dentition. Greber [1] suggests that theoretically, from neuromuscular perspective, lip bumper creates more desirable treatment effect than Schwartz appliance, but clinically the Schwartz appliance offers predictable outcome and ease of clinical management. Another fundamental concern is the stability of early expansion of the lower arch.

This comes as a consequence of recurrent crowding in permanent dentition. [2].

## **Methodology**

A comprehensive literature search on the electronic databases: PubMed, Cochrane Library and Google Scholar was performed. Also, a search of the reference lists of included studies was conducted, to ensure comprehensive coverage of the literature. Search terms included ("Schwartz appliance" OR

"removable appliance") AND ("lip bumper" OR "fixed appliance") AND ("mandibular crowding") AND ("mixed dentition" OR "early dentition").

Inclusion criteria were that studies evaluate the efficacy of Schwartz appliance or lip bumper in addressing mandibular crowding in mixed dentition, studies make a comparison of Schwartz appliance and lip bumper or a comparison of each appliance to a control group, they are in English language and are available in full length. Studies were excluded if they evaluated the efficacy of other orthodontic appliance, they did not report data on mandibular crowding in mixed dentition and if they are case-reports.

## **Results**

### ***Efficacy of Schwartz appliance***

There is scarce evidence in the literature about the efficacy of Schwartz appliance in the treatment of mandibular crowding in mixed dentition. We identified three clinical trials that evaluate the changes from Schwartz appliance in treating mandibular crowding versus nontreated group.

In 2010 and 2011 *Tai et al.*[3, 10-11] conducted randomized controlled trials evaluating changes after treatment with Schwartz appliance using cone-beam computed tomography. The comparisons are made between expansion and non-expansion group in patients with mixed dentition.

Results show increase in the dental and dentoalveolar widths, with mandibular molar up righting, and no skeletal changes. Statistically significant changes in mandibular arch crowding and arch perimeter are observed before and after treatment with Schwartz appliance. Studies suggest that the appliance produce expanding of the mandibular alveolar processes in the level of the first molars, the deciduous molars as well as the deciduous canines.

There was increasing in the intermolar width for 5.41 mm at crown level and 5.90 mm in the width between deciduous mandibular first molar crowns. Mandibular molars after treatment were up righted to approximately  $-23^\circ$ , while it is suggested that the degree of buccolingual inclination of mandibular first molars is approximately  $-30^\circ$ . Except expanding the dental arch by teeth inclination, it is believed that the Schwartz appliance may cause alveolar process remodeling as well. However, the study shows no significant differences for the interwidth of the mandibular bodies, zygomatic bones, condylar heads, and antegonial notches.

Therefore, in cases where severe mandibular transversal discrepancies exists other treatment options should be considered.

*Shen et al.* [12] using a finite element study analyze the stress distribution and displacement of dentoalveolar structures between four different designs of mandibular screw expanders, from which the type A is the Schwartz appliance. The study shows that all expanders enlarged the arch dimensions. The Schwartz appliance caused highest levels of stress, mostly concentrated on the anterior teeth. It caused most tooth displacement, which was highest in the anterior region and decreased from the canines to the molars.

The greatest degree of transverse expansion occurred in the canines, followed with the premolars and then the first molars. Even though, Schwartz appliance caused greatest expansion, since the pattern of expansion is incompatible with the normal arch, study suggest its use with caution.

### ***Efficacy of lip bumper***

Lip bumper and its effect has been widely examined, but still the current literature lacks well designed randomized controlled clinical trials that investigate the efficacy of lip bumper versus control or other appliances. We identified several studies that investigate the treatment effects of lip bumper and few clinical trials that compare lip bumper with a control or Schwartz appliance in addressing mandibular crowding. Two systematic reviews on the efficacy of lip bumper were also identified. A key question is the mechanism of lip bumper in decreasing crowding, since the results of all studies advocate on the efficacy of lip bumper in decreased mandibular crowding. While some authors suggest that the decrease is

mostly due to incisor proclination and/or molar distalization, some suggest that the increase in arch width is the most contributing factor.

Several authors declare that the change in arch perimeter is mainly due to incisor proclination and distal movement of the molars or distal tipping of the molar crown.

*Bergersen* [13] evaluate the effect of lip bumper on molars and incisors in 61 subjects in a period of approximately two and a half months. Results show that distal movement on lower molars occurred in approximately 95% of subjects, with an average of 1 mm distal movement in the above-mentioned time. This movement was in correlation with the length of treatment and the amount of advancement of the bumper into the lower lip. Also, labial movement of incisors occurred in majority of patients.

This movement was independent of the treatment duration, but it was in correlation with the amount of advancement into the lower lip. The author did not find any correlation between distal movement of the molars and the jaw relation represented with the ANB angle, or the mandibular plane angle as measured to sella nasion line.

*Grossen and Ingervall* [14] show the effect from the lip bumper in treating mandibular crowding in 40 subjects aged 9-12 years. The study shows increasing in arch width and arch length. The arch length was increased as a result of incisor proclination and molar distal tipping. Also, the study measures the distance between MLP and point B in order to see if apposition of bone would appear if the pressure of the lower lip is eliminated from the front teeth, but no change was evident.

Other authors, support the hypothesis that the increase of transverse dimension of the mandibular arch is most responsible for alleviating mandibular crowding with lip bumper.

Study of *O'Donnell* [15] show that the lip bumper is effective in decreasing incisor irregularity. Study concludes that labial movement of mandibular incisors combined with increase in arch width are main contributors to space regaining. On the other hand, authors minimize the effect of molar distalization and tipping as a main effect from the treatment with lip bumper. In the study the proclination of incisors was  $4.37^\circ$ , mean distal movement of molars was 0.95 mm and distal molar crown tipping was  $4.37^\circ$ .

The mean arch width increased for 1.65 mm in intercanine level. Muscle adaptation is the main factor guaranteeing stability of results from lip bumper treatment. The study showed that there was no muscular adaptation to the appliance.

*Nevant et al.* [9] also supported the idea that the effect of lip bumper in increasing mandibular dimensions is mainly due to increasing transversal dimensions, rather than antero-posterior changes.

The study evaluated pre and post treatment cephalograms and study models of patients treated with lip bumper with two different construction methods and manipulation methods.

The study shows decreasing in Little Irregularity Index for both groups. The index decreased approximately 2.2 mm/year and the total arch length increased between 2.7 and 7.5 mm/ year. Also, there were changes in incisor antero-posterior position, molar distalization and arch width.

The construction of the lip bumper and the frequency of activation had effect of transverse dimensions and molar position. Incisor forward movement occurred in 75% of the patients approximately 1.4 mm/year, while the incisor apices stayed stationary. Molar roots moved mesial in both groups, while the molar crowns tipped distally. Distal movement was evident and more pronounced in the group with more frequent activation and lip bumper constructed with acrylic shields from canine to canine.

Study of *Osborn, Nanda and Currier* [16] use dental cast measurements and cephalometric radiographs to evaluate the dental arch changes after lip bumper treatment.

Results show that increasing the arch perimeter, was mostly due to increase in dental arch transverse dimensions rather than increase of the arch length. The mean increase in arch length was due to anterior incisor tipping. Molar distalization has been found to be minimal.

The results about the sagittal position of mandibular incisors are controversial between the studies.

Study of *Raucci et al.* [17] suggest that increasing the arch width primarily in posterior teeth is the main factor in decreasing crowding with using lip bumper.

The author concludes that there was no incisor proclination and therefore the arch length was not increased during the treatment with lip bumper.

The absence of a control group or use of 2D radiography have been proposed as factors that may have contributed in different results regard mandibular incisor position.

In order to overcome this a study by Griswold et al. [18] is analyzing mandibular incisor position after lip bumper therapy by using CBCT. Results suggest that with lip bumper therapy there is no proclination, protrusion or extrusion of mandibular incisors. The changes that have been observed during phase I treatment are mainly due to normal mandibular growth and development.

When it comes to the method of assessing treatment changes, the study of Davidovitch [19] is in correlation with the study of Griswold et al. [18].

Tomography data gave more precise information than the cephalometric ones. Also, the interobserver variability was higher with cephalometric radiographs that tend to measure clinical differences. A statistically significant differences, as well as much higher correlation was found when data derived from tomographic evidence than from a cephalometric evaluation [18].

In the literature there is little data on the comparison between treatment changes from lip bumper versus normal developmental changes in the mandibular arch. Our review identified only one prospective clinical trial that compare the treatment effects of lip bumper with nontreatment group in 34 patients during mixed dentition in 6 months follow-up [19].

Significant differences were found between treated and non-treated subjects in terms of incisor inclination, molar position, arch length and arch perimeter. The study highlights that the increasing of arch perimeter is mainly due to molar movement and transverse increase, while incisor proclination does not have a lot of effect.

There were significant differences in molar tipping between treated and non-treated group. In the treated group the study show, 6,31° of distal molar crown tipping, whereas the control group showed 2.1° of mesial molar crown tipping. There is also slight distal movement of the molar for 1.66 mm, while in the other group the molar has mesial movement of 0.65mm. Incisor proclination is six time greater in the treatment group (3.19° versus 0.5°) than the non-treatment group.

Arch width in the buccal region has been increased in the treatment group (second deciduous molars (+1.83 ±1.32 mm) and the permanent canines (+1.80 ±0.41mm). In contrary, the untreated group had reduction in transverse dimensions between the deciduous molars of - 0.33 ± 0.67 mm and the permanent canines for -0.25 ± 0.92 mm.

Also, there is little data on comparison treatment effects between Schwartz appliance and lip bumper. Only one study evaluates and therefore compares the mandibular crowding and dimensional changes caused by either Schwartz appliance or lip bumper in the treatment of mandibular crowding during mixed dentition [20].

The clinical trial is relatively small, including only 20 subjects in total and compares the pre and post treatment effects caused by the two appliances. In terms of crowding, both appliances showed to be able to reduce it at the end of treatment, with slightly different treatment durations. In the Schwartz appliance group the crowding was reduced for 3.5 mm and for the lip bumper group the crowding was reduced for 2.9 mm.

Statistically significant changes were observed in the intercanine width for the Schwartz appliance, while, the lip bumper registered no significant increase. Interpremolar and intermolar widths have been increased for both appliances, but the changes were higher for the Schwartz appliance compared with lip bumper.

The lip bumper treatment cause statistically significant changes in the arch length of 9.4 mm increase, while in the other group remained almost unchanged. The arch perimeter showed increase of 3.6 mm for the Schwartz appliance, while in the lip bumper was even slightly decreased.

For the purpose of the review, only two systematic reviews were identified [21,22] that aim to respond on the efficacy of lip bumper. They included only one and six studies respectively.

In the later [22], no meta-analysis was performed due to heterogeneity of the data from the studies. As a conclusion there is very low level of certainty regarding the effects of lip bumper therapy on the mandibular arch.

The post treatment effects of both appliances are inevitable. But, the question of long term stability and relapse after treatment that aims to increase mandibular arch length in mixed dentition has been raised years ago by Little, Riedel and Stein [23].

In their study that followed 26 patients up to 6 years out of retention discussed the changes in mandibular arch length and the stability of these changes after orthodontic treatment. The study finds that there is some relapse of mandibular arch length in both treated and untreated patients, consistent with constriction and crowding in the anterior teeth. Cephalometric data showed most changes occur by mesial movement of the molars and incisal tipping on the incisors.

A major concern in orthodontic treatment beside effectiveness of the treatment is its efficiency. It is of great importance the time of treatment duration for achieving desirable results. This would be beneficial for the clinician in order to timely terminate the treatment with the appliance, and desirable for the patient as well.

The study of *Murphy et al.* [24] investigated the time required for expansion using a lip bumper. The study suggests that 50% of the expansion happens in the first 100 days of treatment, and 90% of the expansion is completed by the first 300 days. Therefore, it is unnecessary for a patient in mixed dentition to have a treatment with lip bumper longer than 300 days. The maximum treatment time with lip bumper from the studies in this review was 2 years.

The clinical trials of Quinzi report treatment duration with Schwartz appliance for 18.8 months and for the lip bumper the treatment duration was 11.7 months [20].

## Conclusion

There has been an increased interest in increasing mandibular arch dimensions as a method to minimize the risk of tooth extraction in mild and moderate crowding during mixed dentition. The results from this review tend to increase the knowledge about the appliances and their effects on mandibular dental arch dimensional changes. The evidence from the literature show that Schwartz appliance and lip bumper are effective treatment modalities in mandibular crowding during the mixed dentition.

Literature suggest that Schwartz appliance is effective in alleviating crowding by expanding the dental arch especially in the incisor region. The appliance produces more dentoalveolar changes than skeletal changes during the treatment in the mixed dentition. Lip bumper show to cause clinically significant reduction in mandibular crowding during mixed dentition. Its effects are increasing the arch perimeter, by increasing the arch length and by the transversal changes.

Treatment duration and patient compliance are two important factors that determine the efficacy of an appliance. While the efficacy of Schwartz appliance is completely dependent on patient's compliance, the lip bumper can be fixed and thus not require patient compliance. That is one of the variables that may have an effect on treatment duration.

Besides the studies that evaluate the effect of appliance treatment, there is lack of randomized controlled clinical trials that investigate the efficacy of mandibular Schwartz appliance or lip bumper in the treatment of crowding in the mixed dentition. Further research on the topic is needed, especially in evaluating the stability of the results achieved and the need for second phase orthodontic treatment with fixed appliances.

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