Tactics in interceptive orthodontics during primary and mixed dentition

ABSTRACT
The prime objectives of interceptive treatment are to minimize the extent of developing malocclusion and to address psychosocial factors. A systematic program of interceptive orthodontic treatment during the primary and mixed dentition phase is more effective than doing nothing to improve malocclusions in the short term. Although a second phase of treatment may be required in most cases, interceptive procedures can produce acceptable results and reduce the severity of malocclusion. The outcomes will have been achieved at a younger age and the child’s social and psychological well-being will be enhanced before adolescence. Today, many interceptive procedures that are included in public health measures aim at reducing the burden of malocclusion in underserved populations and as a strategy for increasing access to orthodontic treatment when resources are limited. This paper overviews various interceptive possibilities in the primary and mixed dentition stages and their management approaches in light of the existing evidence.

Key words: Dentition, mixed; Orthodontics, interceptive

Introduction
Interceptive orthodontics includes procedures to restore normal occlusion once malocclusion has started to develop. Interceptive orthodontics may be defined as any treatment procedure that eliminates or reduces the severity of developing malocclusion, as this may reduce the need for, or simplify, further treatment. The prime objectives of interceptive treatment are to minimize the extent of developing malocclusion by maintaining midline, prevent development of full unit Class II molars and minimize crowding, prevent trauma to the incisors, and address psychosocial factors. In addition, interceptive procedures can be perceived as useful ways to improve a patient’s self-image, eliminate destructive habits, facilitate normal tooth eruption, and improve some growth patterns. Although the procedures often do not produce finished orthodontic results without a second phase of treatment in permanent dentition, several studies suggested that systematically planned interceptive treatment in mixed dentition might contribute to a significant reduction in treatment need between the ages of 8 and 12 years, often producing results such that further need can be categorized as elective.

A systematic program of interceptive orthodontic treatment during the mixed dentition phase is more effective than doing nothing to improve malocclusions in the
short term 7. Certain long-term studies demonstrated optimal stable results after starting treatment (interception) at early mixed dentition, justifying the burden of treatment compared with a single-phase treatment during permanent dentition 8,9.

Today, many interceptive procedures which are included in public health measures aim at reducing the burden of malocclusion in underserved populations and as a strategy for increasing access to orthodontic treatment when resources are limited 10. Most patients who receive interceptive orthodontic treatment do not have all of their orthodontic problems addressed. However, interceptive treatment can reduce the need for comprehensive treatment in the population and eliminate malocclusions considered to be potentially compromising to the dentition (Fig 1). The purpose of this article is to review the various interceptive possibilities in the primary and mixed dentition stages and their management approaches in light of the existing evidence.

**Approaches in primary dentition**

Developing Class III malocclusions are clinically expressed as anterior crossbites in the primary dentition. They can be dental, functional, or skeletal in origin. Cephalometric radiographs can be helpful in making the distinction between dental and skeletal problems. It was recommended that dental anterior crossbite in the primary dentition must be corrected when identified to allow for normal dental development and more favorable skeletal growth 11-13. Inclined planes and removable acrylic appliances can be used for correction of dental anterior crossbite. Chin cups and facemasks can be used to treat skeletal Class III malocclusions 14-17.

The vast majority of unilateral posterior crossbite in primary dentition are the result of a bilaterally constricted maxillary arch with a functional shift. Bilateral constriction of the maxillary arch leads to premature contacts on closure (typically in the canine area) and a functional shift to one side, which allows for maximum interdigititation of the arches. One important diagnostic feature of unilateral posterior crossbite resulting from bilateral maxillary constriction and a functional shift is that patients typically have a midline discrepancy in centric occlusion. A common approach includes selective grinding of the primary canines, but equivocal evidence exists. A longitudinal study by Kurol and Berglund 18 demonstrated that 64% of identified posterior crossbites in primary dentition could be corrected with selective grinding. However, in this report 19, spontaneous

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**Figure 1** Interceptive possibilities

![Interceptive possibilities diagram](image_url)
correction occurred in up to 45% of the untreated patients. In another study, Thilander et al. 19 found that complete correction of posterior crossbite using selective grinding could only be achieved in 27% of children. Other options for treatment involve use of either a fixed appliance (W-arch, quad-helix) or a removable appliance with an expansion screw.

Treatment to correct Class II malocclusions can be initiated in the primary dentition, although there is little documentation in the literature regarding the long-term effectiveness of treating this type of malocclusion in young children 20. The vast majority of treatment decisions for Class II malocclusions are made in mixed and early permanent dentition phases. The long-term clinical outcomes of treatment to correct anterior open bite and deep bite are not well documented. Also, mechanical intervention in primary dentition for correction of tooth size–arch length relationship problems is generally not recommended 21.

Abnormal habits in primary dentition include sucking behaviors, atypical swallowing patterns, mouth breathing, and bruxism 22. Early discussion of these habits with parents or guardians of infants and toddlers should include the role of the mouth in infantile exploration, pacifier use (safety and hygiene issues), and the effects of digit-sucking 23,24. Preliminary evidence suggests that juvenile bruxism is a self-limiting condition that does not progress to adult bruxism 25.

The premature loss of primary teeth due to caries, trauma, ectopic eruption, or other causes may lead to undesirable tooth movement of primary and/or permanent teeth, including loss of arch length. Arch length deficiency can produce or increase the severity of malocclusions, with crowding, rotations, ectopic eruption, crossbite, excessive overjet, excessive overbite, and unfavorable molar relationships 26. Space maintenance may be considered in primary dentition after early loss of a maxillary incisor, when the child has an active digit habit. An intense habit may reduce the space for the erupting permanent incisor.

**Approaches in mixed dentition**

The orthodontic problems commonly encountered in mixed dentition are divided as either dental or skeletal in origin. Dental problems predominantly include management of tooth size–arch length discrepancy and dentoalveolar corrections in Class II and Class III malocclusions. Skeletal problems include maxillomandibular discrepancies associated with Class II and Class III malocclusions.

**Tooth size–arch length discrepancy**

**Space management**

Early loss of a deciduous canine is the single most important indicator of developing crowding. In moderate crowding, starting treatment just at the end of the mixed dentition stage and maintaining leeway space facilitates non-extraction treatment. This is the gold standard treatment period 27. Importantly, leeway space makes it possible to treat mixed-dentition patients who appear to have crowding, but do not actually have tooth size–arch length discrepancy. Gianelly 28 found that management of leeway space alone may resolve the crowding problems in more than 80% of orthodontic patients. Moyers et al. 29 also found an average gain of 2.5 mm of space per side in the mandibular arch and that of about 2 mm per side in the maxillary arch, if the permanent first molar position is maintained during the transition to the permanent dentition. Gianelly 30 hypothesized that tooth size discrepancies can be resolved using a non-extraction approach that includes the placement of one or more holding arches in late mixed dentition (Fig 2). A transpalatal arch can also be used, either as a passive appliance to maintain the position of the upper molars or as an active appliance to rotate and torque these teeth, which often improves the sagittal molar relationship in the process 31.

**Figure 2** Lingual holding arch in mixed dentition
Lip bumpers
Lip bumpers maintain leeway space. Based on the available studies of lip bumper–only treatment, arch length increases by an average of 2.2 mm, 4.7° of tip back in mandibular molars, and 3.6° of proclination in the mandibular incisors. Because lip bumpers also disrupt the equilibrium of the buccal musculature, intercanine and intermolar widths increase 1.9 and 3.1 mm, respectively. The anterior teeth spontaneously move into the space that is created and maintained, resulting in an average of 3.2 mm decrease in incisor irregularity 32,33. The clinical concern with lip bumpers is not their effectiveness, but their relapse potential and long-term stability 33.

Serial extraction
Serial extraction is used much less now than a generation ago because it is hard to be absolutely certain that crowding in early mixed dentition is severe enough to make the extraction decision at that time. However, in extremely severe crowding, there are studies showing that serial extraction can reduce the duration of later comprehensive treatment, so it can be efficient for carefully selected patients 34,35.

Transverse expansion
Patients with mild-to-moderate crowding (3-4 mm) can be managed effectively with rapid maxillary expansion (RME), especially those whose mandibular posterior teeth are initially tipped lingually. Orthopedic expansion of the maxilla via RME can be achieved with an expansion device in early mixed dentition, with or without prior mandibular dental ‘decompensation’ with a removable Schwarz expander. Hyrax (Johns Dental Laboratories, Terre Haute [IN], USA) is a type of rapid maxillary expander made entirely of stainless steel and does not include palatal acrylic, so is considered more hygienic by many practitioners. The expansion screw is placed in the palate in close proximity to the palatal contour. Buccal and lingual support wires are added for rigidity. Activation of the screw in young growing patients involves two turns per day for 4 to 5 days, followed by one turn per day until expansion is achieved 36. The changes are produced primarily in the underlying skeletal structures rather than by the movement of the teeth through alveolar bone. After the palate has been widened, new bone is deposited in the area of expansion so that the integrity of the mid-palatal suture is usually re-established within 3 to 6 months.

Another approach is to use a slow expansion appliance (quad-helix expander, W-arch, removable appliance with expansion screw) and lingual arch for approximately 6 months. The mandibular lingual arch is adjusted at each visit during the first 6 months until ideal alignment of the incisors is obtained. The lingual arch must be kept at the incisal third of the teeth to correct incisor crowding and rotations. Little or no forward pressure is exerted on the mandibular incisors unless these teeth are initially positioned lingually. The lingual arch is designed to hold leeway space to resolve mandibular crowding 37.

The quad-helix appliance is fabricated from 0.038-inch stainless steel wire and soldered to the bands. The lingual wire should contact the teeth involved in the crossbite and extend no more than 1 to 2 mm distal to the banded molars to eliminate soft tissue irritation. Activation at point 1 produces posterior expansion, while that at point 2 produces anterior expansion (Fig 3). The lingual wire should remain 1.0 to 1.5 mm away from the marginal gingiva and palatal tissue 36.

Class II therapy
With regard to treatment of Class II malocclusion, various studies have demonstrated greater growth response when treatment is initiated during late mixed dentition 38,39. However, the evidence is equivocal. Although patients receiving phase 1 treatment can have better skeletal and dental changes than those who do not, no differences were
found in skeletal and dental outcomes between those treated in single phase (i.e. phase 2 only) and in both phases. Because most studies on Class II malocclusions in the past 10 years have provided equivocal evidence for the benefits of early intervention, perhaps patient preferences should guide the clinician’s decisions on when to begin treatment. If skeletal growth indicates that the child is physically ready for orthodontic intervention, the clinician must ask, “Is the child psychologically ready?” For children who can define their malocclusions and understand how they will be corrected and their role in this process, one can assume that they are psychologically ready. These children, and especially their parents, expect treatment to improve not only the child’s occlusion and mastication, but also their appearance and social acceptance.

The choice of appliance therapy in developing Class II malocclusion depends on the nature and site of the problem. Headgear therapy is a reliable method of molar distalization and restraining of maxillary growth without negative effects. Short-term treatment effects of preorthodontic trainer or eruption guidance appliances showed marked dentoalveolar changes with smaller but significant skeletal effects.

**Headgear: Kloehn-type appliance**

Kloehn-type headgear (GAC International Inc., Central Islip, New York, USA) uses a cervical neckstrap and a facebow to produce distal force on the maxillary teeth and maxilla en bloc, aiming at altering maxillary size and position. Another application is to change an end-to-end molar relationship to Class I by moving the upper molars distally, either by tipping both molars distally or by bodily movement. Extraoral force via a facebow to the molars is the most effective and straightforward method (Fig 4). The following ‘force prescription’ for headgear to restrain maxillary growth in patients with Class II problems is considered optimal: force of 250 to 500 g total (half that per side), force direction slightly above the occlusal plane (through the center of resistance of the molar teeth), and force duration for at least 12 hours per day. The teeth should move at the rate of 1 mm/month, so a cooperative child would need to wear the appliance for 3 months to obtain the 3-mm correction that would be a typical requirement in this type of treatment. It must be kept in mind that both orthopedic (skeletal) and orthodontic (dental) effects will be produced from use of this force prescription. Sometimes, extraoral force is used with the aim of promoting tooth movement alone, in which case the force levels should be lighter and the duration of wear longer.

**Preorthodontic trainer**

The preorthodontic trainer is a functional device used in children aged 4 to 10 years. The appliance is intended to initiate Class II orthopedic therapy at an earlier age and to correct functional problems of soft tissues, so as to correct the interposition of the lips between dental arches, atypical swallowing, and the centripetal thrust of the cheeks upon the dental arches; to discourage oral respiration; to avoid bruxism; and to favor the action of the external pterygoid and thus encourage the active push of the mandible. The trainer is claimed to encourage transverse bone growth by acting as a ‘shield’ for the cheeks and bringing about muscular relaxation and correction of a skeletal Class II malocclusion by an active mandibular force (Fig 5). By distancing the lower lips from the dental alveolar arch, the trainer is claimed to prevent malposition of the tongue and lower lip during

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**Figure 4** Headgear

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swallowing, thus solving the associated dental open bite. A study by Usumez et al. 48 demonstrated that preorthodontic trainer application induced mainly dentoalveolar changes that resulted in a significant reduction of overjet and can be used with appropriate patient selection.

**Functional appliance**
Functional appliances utilize, eliminate, or guide the forces of muscle function, tooth eruption, and growth to correct a malocclusion. They help to harness the differential mandibular growth to correct Class II malocclusion. The main application of a functional appliance involves treatment of a patient with the following characteristics: Class II Division 1 malocclusion with mandibular retrusion, average or reduced lower facial height, upright or retroclined lower labial segment, and well-aligned arches 49. In many cases, functional appliances are helpful to achieve some antero-posterior correction for a severe Class II malocclusion prior to comprehensive fixed appliance therapy with or without extractions. The changes produced by any conventional appliance include skeletal changes, such as restraint or redirection of forward maxillary growth, optimization of mandibular growth, forward movement of the glenoid fossa, and increase in lower facial height. Dental changes are lingual tipping of upper incisors, labial tipping of lower incisors, inhibition of forward movement of the maxillary molars, and mesial and vertical eruptions of the mandibular molars. Twin block (designed by William Clark) is the most common appliance used today (Fig 6).

**Eruption guidance appliance**
The eruption guidance appliances (Occlus-o-Guide; Ortho-

Tain Inc., Bayamon Gardens, Puerto Rico) are considered a combination of a functional appliance and a tooth positioner (Fig 7). The Occlus-o-Guide places the mandible forward to correct the Class II relationship and acts as a tooth positioner because it is constructed of an elastomeric material that can produce minor tooth movement. The Occlus-o-Guide is prefabricated in 13 different sizes to fit 95% of patients 50. This appliance is indicated for patients with Class II malocclusions associated with deep overbite and overjet during early mixed dentition and follows the same indications as most
functional appliances. The Occlus-o-Guide is an effective method to restore normal occlusion and eliminate the need for further orthodontic treatment 51.

**Class III therapy**

Class III malocclusions are often seen with maxillary retrognathia, mandibular prognathia, or a combination of both. Also, Class III malocclusions occur in association with the whole range of vertical patterns. Maxillary protraction is an emerging paradigm in the early management of skeletal Class III malocclusion. Protraction facemask therapy has been advocated for early treatment of Class III malocclusions with maxillary deficiency. The dental and skeletal effects of this appliance are well documented in the literature 52,53. Accurate diagnosis and understanding of the individual growth pattern is crucial for determining the proper timing of Class III treatment. Optimal treatment timing for facemask therapy is in the deciduous or early mixed dentition periods 54,55. Early treatment with a facemask allows for favorable sutural response, elimination of any centric occlusion–centric relation discrepancies, and improvement in facial profile and self-esteem 36.

**Facemask**

For children with anteroposterior and vertical maxillary deficiency, the preferred treatment is to move the maxilla into a more anterior and inferior position, which also increases its size as bone is added at the posterior and superior sutures. The facemask exerts a forward force on the maxilla via elastics that attach to a maxillary appliance. To resist tooth movement as much as possible, the maxillary teeth should be splinted together as a single unit. The maxillary appliance can be banded, bonded, or removable. A removable plastic splint that covers the occlusal surfaces of the teeth is often satisfactory. Force of 300 to 400 g per side for 12 to 14 hours is the usual protocol 36. The common side-effects of facemask therapy include forward movement of the upper incisors, as well as downward and backward rotation of the mandible (Fig 8).

**Chin cup**

Inhibiting mandibular growth has proven to be almost impossible. The major effect of a chin cup is downward and backward rotation of the mandible, which decreases anteroposterior projection of the chin by making the face longer. There is some evidence that a chin cup is more effective in children younger than 7 years than the same treatment used at an older age 56. Unfortunately, despite efforts to modify excessive mandibular growth, many of these children ultimately need surgery, and the chin cup treatment is essentially camouflage. This type of treatment is appropriate with normal or reduced lower anterior face height, but is contra-indicated for a child who has excessive lower face height (Fig 9).

**Management of some common malocclusions**

**Deep overbite and intra-arch alignment**

A common approach for treating a deep overbite in the mixed dentition is the biteplate. However, these appliances depend on good patient compliance. A less compliance-
Dependent approach might be the wider use of partial fixed appliances with intrusion arches. The main indications for intervention include persistent soreness palatally from the mandibular incisor impingement, when the malocclusion is more complex and associated with more severe skeletal components, particularly for girls who have earlier skeletal maturation.

**2 x 4 Appliance**

The typical fixed appliance for mixed dentition treatment is a ‘2 x 4’ arrangement (i.e. 2 molar bands, 4 bonded incisors). This appliance can advance, retract, intrude, or extrude incisors, and it works in three planes of space. When a fixed appliance includes only some of the teeth, archwire spans are longer, large moments are easy to create, and the wires themselves are springier and less strong. This can provide some biomechanical advantages. For example, intrusion of teeth is easier with long spans of wire that keep forces light and allow the appropriate moments to be generated. However, the wires are more prone to breakage and distortion. Simple multistrand stainless steel wires and looped stainless steel configurations are more effective to use with the 2 x 4 system. The 2 x 4 appliance appears to be deceptively simple to use but, in reality, it could be difficult and therefore must be used with considerable care.

**Utility arch**

A utility arch can be used to intrude, tip, or reposition either the maxillary or mandibular incisors but, with the limited anchorage provided by only the first molars, posterior teeth can be expected to move as well. The archwire is stepped away from the occlusal plane to eliminate distortion from interference with food during chewing. This appliance is versatile and effective in reducing overbite by relative intrusion, but it can be difficult to control and often produces unwanted reciprocal movements. A lingual arch to reinforce the anchorage is usually needed.

**Removable biteplate appliances**

This appliance can be used for patients who have less-than-normal eruption of the posterior teeth (which is usually associated with reduced face height). An anterior biteplate is incorporated into a removable appliance so that the mandibular incisors occlude with the flat plane lingual to the maxillary incisors. This approach prevents the posterior teeth from occluding and encourages their eruption, which may take several months. The appliance must be worn on a full-time basis during this phase of treatment. The posterior eruption is hard to regulate and, once the proper vertical dimension has been established, the biteplate must continue to be worn, otherwise the anterior teeth will erupt and the deep bite will return.

**Crossbite**

The presence of an anterior crossbite limits lateral excursions. This can cause enamel wear/occlusal trauma and mandibular displacement. Management includes pushing the teeth over the bite with an upper removable appliance comprising Z-springs or an anterior expansion plate and capping of the posterior segment teeth for disocclusion. Stability of the result depends on good overbite. A utility arch (protraction) can also be used to advance the anterior teeth and establish a good overbite by extrusion of the anterior teeth. A 2 x 4 archwire approach can also be used to provide any mix of facial tipping and lingual root torque to bring the maxillary incisors out of crossbite.
The treatment decision for posterior crossbite in mixed dentition is made on a case-by-case basis and includes consideration of the following factors: presence or absence of lateral mandibular shift, degree of skeletal discrepancy, and degree of posterior tooth compensation in each arch. The most common treatment modality is to separate the mid-palatal suture with RME. Even if transverse discrepancy results from a broad mandibular arch, it is better to expand the maxilla. Other appliances include the quad-helix, transpalatal arch, crossbite elastics, and expansion plates 61.

**Skeletal open bite**

Children with excessive face height (e.g. with a skeletal open bite or long face syndrome) generally have a normal upper face and elongation of the maxillary and mandibular posterior teeth, which accounts for the steep mandibular plane and the large discrepancy between posterior and anterior face height. The ideal interception for these patients would be to control all subsequent vertical growth so that the mandible would rotate in an upward and forward direction. The most effective approach to growth modification involving vertical excess and a Class II relationship problem is a combination of extraoral force in the form of high-pull headgear and a functional appliance with posterior bite blocks to anteriorly reposition the mandible and control eruption 62. Concomitantly, mild clenching exercises can be initiated 5 times a day for 1 minute. Nevertheless, there are no evidence-based conclusions for the management of vertical dysplasia in the primary or mixed dentition phases 63.

**Tactics for ankylosed primary teeth**

With a permanent successor in a normal position, the expected future development of an ankylosed deciduous molar should be a 6-month delayed shedding compared with the normal shedding time 64,65. Extraction of the ankylosed deciduous molar is thus unnecessary. However, by the time the companion permanent tooth on the opposite side of the mouth is ready to erupt, the ankylosed tooth should be extracted and the underlying permanent tooth uncovered if necessary.

With the permanent successor missing, spontaneous exfoliation is not likely. However, root resorption might continue, and an impaired vertical position might occur due to the ankylosis. This development might be slow after the age of 12 or 13 years. The problem is predicting which ankylosed molars will, with time, have good bone support, minimal infraocclusion, and good roots. One recommendation is to accept the situation or, with moderate loss of height, restore occlusal height. With severe infraocclusion, extractions are recommended as early as possible to enable spontaneous mesial migration of permanent molars. Thus, with early ankylosis and infraocclusion, a serious negative development can be expected, and extraction of these ankylosed deciduous molars with the successor missing must be considered 66.

**Interception of maxillary canine impaction**

If left undiagnosed and untreated, an ectopic maxillary canine will move farther medially, with the impaired position leading to more difficult orthodontic treatment. The risk of incisor root resorption will also increase 67. Therefore, early diagnosis is essential. The patient should be examined by the age of 8 or 9 years to determine whether the canine is displaced from a normal position in the alveolus and to assess the potential for impaction. The indicators are as follows: lack of canine bulge in the buccal sulcus by the age of 10 years, over-retained primary cusps (beyond the age of 13 years and have no significant mobility), asymmetry in the exfoliation, and eruption of the right and left canines. The range for eruption time is 9.3 to 13.1 years. Canines are palpable from 1.0 to 1.5 years before they emerge. The absence of canine bulge after the age of 10 years is a good indicator that the tooth is displaced. The interception includes judicial extraction of the deciduous canine between the ages 10 and 13 years and radiographic follow-up for 12 months to monitor eruption 68. This has been found to be effective for palatal impactions in almost 80% of patients 69. Rapid maxillary expansion, followed by a transpalatal arch combined with extraction of the deciduous canine, has also been suggested as an effective option for treating patients in the late mixed dentition phase with palatally displaced canines 70,71.

**Ectopic eruption of permanent first molar**

Ectopic eruption of the permanent first molar occurs because of the molar’s abnormal mesioangular eruption path, resulting in impaction at the distal prominence of
the primary second molar’s crown. Ectopic eruption of permanent molars is classified into two types. There are those that self-correct or ‘jump’ and others that remain impacted. In 66% of patients, the molar jumps 72, A permanent molar, which presents with part of its occlusal surface clinically visible and part under the distal side of the primary second molar, normally does not jump and is of impacted type. No treatment can result in early loss of the primary second molar and space loss. Elastic or metal orthodontic separators can be placed to wedge the permanent first molar distally. For more severe impactions, distal tipping of the permanent molar is required 72,73.

**Interception of oral habits**

A child's well-being can be affected by oral habits and an individualized approach to the management of various oral habits is recommended. Oral habits are associated with dentoalveolar and/or skeletal deformation in some patients. Changes that can occur to the dentoalveolar structures may include anterior or posterior open bite, interference of normal tooth position and eruption, alteration of bone growth, and crossbites. Treatment modalities to control these habits may include patient and parent counseling, behavior modification techniques, myofunctional therapy, and appliance therapy 74-78.

**Conclusions**

The timing of interceptive treatment is critical. A thorough knowledge of craniofacial growth and development is necessary, and the proposed treatment should be of benefit when the permanent teeth are erupted. The positive point with interceptive management is that the treatment outcomes will have been achieved at a younger age than with full treatment, and the child’s social and psychological well-being will be enhanced before adolescence. Interceptive treatment is an effective strategy for reducing the severity of malocclusion and, in some patients, it can eliminate the need for future orthodontic treatment.

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**References**