# A SURVEY OF POSTERIOR CROSSBITES TREATED WITH A FIXED W-ARCH EXPANSION APPLIANCE

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ABSTRACT

Posterior crossbite; dental, functional or skeletal, is a common orthodontic finding in children. The incidence has been reported to range between seven and ten percent.

Several appliances are available to treat this type of malocclusion. The W-arch expansion appliance is one of these. It has been demonstrated that this appliance is capable of correcting posterior crossbites, but the exact mechanism by which it accomplishes this correction has not been established. It is felt that opening of the midpalatal suture in young children or tooth tipping in young and older children may be the main mechanism of maxillary expansion.

Fifteen children, ten girls and five boys, who were treated with the fixed W-arch expansion device, were studied to determine the effectiveness of the appliance. A control group of seven children was used for comparison purposes.

Eighty percent of the treated cases developed a normal occlusion while all of the untreated cases developed crossbites.

It was shown that the W-arch expansion appliance has the ability to correct existing posterior functional or dental crossbites in children.

Starting treatment early in the child's life appears to result in normal eruption of the bicuspids and molars.

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# INTRODUCTION

One of the most common orthodontic problems observed in a pedodontic practice are anterior and posterior crossbites. Both types of crossbites impede the normal development of occlusion and frequency may cause the mandible to swing forward and/or laterally. Such mandibular aberrations, according to Jenkins,[22] can be of etiologic significance in disorders of the temporomandibular joint.

Functional posterior crossbite appears as unilateral lingual crossbite with a mandibular deviation upon closure. The crossbites are significant in that a deflective occlusal contact may prevent terminal closure of the mandible along the centric relation arc. The resulting displacement of the condyle may alter the equilibrium between form and function and may be a factor in the development of temporomandibular joint disorders.[33]

For the above and other reasons that will be discussed later, it may be important that posterior crossbites be treated early to prevent possible loss of bone growth and to re-establish proper muscle balance before deteriorating effects become well established. If the primary dentition is in crossbite, invariably the eruption of the permanent teeth will follow the same pattern[25] due to loss of maxillary bone and muscle imbalance caused by the patient attempting to accommodate the crossbite.

The purpose of the present study, is to re-evaluate the cases of posterior crossbite treated with a fixed W-arch appliance in the Graduate Pedodontic Department of the School of Dentistry at the University of Oregon Health Sciences Center, and to determine: a) the effectiveness of the W-arch expansion appliance in the correction of posterior crossbite; and b) that early treatment of posterior crossbites prevent this malocclusion on the permanent dentition.

## REVIEW OF THE LITERATURE

Occlusion is constantly changing. Occlusion in the course of evolution was influenced chiefly by transformation in form, modification in pattern, and changes in position of teeth singly and collectively.[12] In modern man the dentition presents two primitive features of significance. One is that the teeth of the upper jaw or maxilla still overhang those in the lower jaw, and the other, that the teeth in occlusion interlock and alternate. However, while the first statement is entirely true, the secondly is only partly so. In other words, while all the upper teeth overhang all the lowers, not all of them alternate and not all of them interlock.[16] [12]

A critical analysis of dentitions in man and anthropoids made by Hellman[16] reveals the fact that occlusal relationships between the teeth is attained by four kinds of contacts. In other words, when the jaws are brought together and the teeth of the one are in opposition with those of the other, there are four different ways in which they touch each other. They are as follows:

"1. Surface-to-surface contact: In normal occlusion of the incisors and cuspids, the lingual surfaces of the upper incisors and cuspids come into contact with the labial surfaces of the lowers. Each tooth in the maxilla also makes contact with two in the mandible.

2. Cusp point and cusp fossa contact: This involves the occlusion of the cusp point of the mesio-lingual cusp of any upper molar with the central fossa of the like lower molar.

3. Ridge and groove contact: As the triangular ridge extending from the tip to the base of the mesio-distal cusp of an upper molar and the buccal groove on the homologous lower molar.

4. Ridge and embrasure contact: The triangular ridge of the buccal cusp of the upper first premolar and the interdental embrasure on the buccal side between the lower first and second premolar."

By taking into account the number of various kinds of contacts, the assumption is that an adult human dentition to be in normal occlusion must have all these factors of occlusion in exact relationship. Moreover, taking in consideration the normal form and total number of teeth and cusps, one hundred and thirty-eight factors of occlusion which should make exact contact in a dentition with normal occlusion.

The type of occlusion in man is shown to be represented by a masticatory apparatus with an average of approximately 90% perfect and a standard deviation of approximately 6%, this means that 90% minus 6%, or 84%, is as much representative of the type of occlusion in man as is 90% plus 6%, or 96%. The average it may be said, represents the "normal" and the range of variability the type.[16] [17]

Studies on the various phases of individual development, the human dentition is as much subject to influences of growth now as it was to influences of differentiation in its making. But while phylogenetic simplification influenced just the number of factors of occlusion, individual development influences occlusion as a whole. Clinch,[7] reveals the fact that at birth there is considerable variation in relationship of mandible to maxilla. On a group of 400 babies, at birth, the mandibles of 74, or 18.5%, were too far back in their relationship to the maxilla. Of course, occlusion is really not directly involved since the teeth are not present. When teeth are present, ratios between individuals with dentitions in normal occlusion and those with dentitions in malocclusion are of interest. The striking thing about them is that ratios of this sort are not constant. They vary with age. Hellman, [17] reports in a study of 1,013 children, 593 boys and 420 girls, at the average age of five years, when the deciduous

dentition is still fully present, the occlusion is normal in 68.5% among boys and 70.6% among girls. As age advances, there is a constant decrease in normal occlusion and an increase in malocclusion. By the time girls are eight years old and boys nine and ten years old, there is a complete reversal of this ratio. The normal in occlusion reaches the low level of approximately 17% in boys and 19% in girls. At fifteen, 38.5% of the dentition among boys and 41.7% in girls are in normal occlusion. When adulthood is reached, at the age of 21 years and the full complement teeth is present, the dentitions are in normal occlusion in 26.5% among males and 32% in females. It is thus obvious that occlusion of the teeth varies with age.

Since age is just a time scale for measuring development, it is also reasonable to assume that the occlusion of the teeth is closely linked to those processes which account for growing up.

The dentition in the course of individual development is subject to certain vagaries which have some effect on occlusion. They are:[27] [29]

1. Differences in the time of eruption of the teeth among individuals with normal occlusion and malocclusion.
2. Differences in total length of time required for the completion of the entire dentition.
3. Differences in order of sequence followed by the erupting teeth.
4. Differences in growth of the alveolar process and jaw bones accompanying the eruption of the teeth.

In order to diagnose a developing malocclusion, the clinician must have thorough knowledge of normal occlusion at any given time during the growing years. A normal primary dentition exhibits certain easily recognized characteristics. Brown,[2] makes a very simple but concise description of these characteristics. He points out that:

> "The arches usually are ovoid in shape, the overbite is shallow, the axial inclination of the incisors is almost vertical, there may be spacing between all teeth and there is a straight-line relationship between the distal surfaces of the second primary molars (flush terminal plane). There may be an excess in arch space mesial to the maxillary cuspids and distal to the mandibular cuspids (primate spaces).
>
> As the child with arch space approaches the time for the eruption of the first permanent molars, the arch perimeter decreases so that the primary incisors are almost end-to-end. In some children a mesial step develops as the mandibular molars. This allows the first permanent molars to erupt into a solid Class I occlusion which reduces the chances of loss of arch length if primary molars are lost prematurely. In most children, however, the flush terminal plane persists during the period of the mixed dentition, and the permanent molars remain in an end-to-end relationship until the primary molars exfoliate.
>
> When the permanent mandibular lateral incisors erupt in a child with normal arch spacing, the primate spaces distal to the primary cuspids close since the cuspids are forced distally. The maxillary primary cuspids will also move distally at this time in order to maintain normal cuspid interdigitation. Spacing between the permanent maxillary anterior teeth is common during the period of the mixed dentition, and often the spaces will not close completely until after the eruption of the permanent cuspids."

According to Lo and Moyers,[27] in their study in 236 younger children, the combination of eruption sequences of 6 1 2 4 5 3 7 in the maxilla and 6 1 2 3 4 5 7 in the mandible provides the greatest incidence of normal molar occlusion or molar relationship. However, no one doubts that malocclusion can manifest itself in the deciduous dentition.[29] Little is known of its significance, and predictions based upon observation at this age are still very uncertain. For this reason, it is felt that longitudinal studies

are required to correlate malocclusion of the deciduous dentition with subsequent development of the permanent dentition. Since the subject is too vast to be covered in this project, only one aspect of the subject has been selected, namely buccolingual malrelations of the posterior teeth. This includes both cross-bite (lingual occlusion) and buccal occlusion.

Wood[43] [25] defines cross-bite as an abnormal buccal, labial or lingual relationship of a tooth or teeth of the maxilla or mandible or both, when the teeth of the two arches are closed in occlusion. It may include one or more teeth and it may be unilateral or bilateral, nevertheless, the term "scissors bite" is preferred to define the buccal malrelation of the posterior teeth just to differentiate it from the abnormal lingual relationship of the maxillary to the mandibular posterior segments, more commonly known as posterior cross-bite.

Moyers[32] defines posterior crossbite as a failure of the two dental arches to occlude normally in lateral relationship. This may be due to localized problems of tooth position or alveolar growth, or to gross disharmony between the maxilla and mandible. He classified it on an etiologic basis as dental, muscular and osseous.

Dental crossbite, says Moyers, involves only tipping of teeth, is localized, and does not affect the size or shape of the basal bone. The midlines will coincide in opening and diverge when the teeth are in occlusion. In other words, the asymmetry of the dentoalveolar arch is normal, besides the abnormal posterior malrelation of the teeth in occlusion.

Muscular crossbite involves muscular adjustment to tooth interference, and Moyers points out that the dental and muscular crossbites are clearly distinguished by the required treatment. In one (dental), teeth must be moved; in the other (muscular), the adjustments can often be gained by occlusal equilibration. Both dental and muscular types require occlusal and muscular adjustments to complete their correction.

In the osseous type, a third etiologic base, gross mediolateral disharmony of the craniofacial skeleton is present. This may be due to inherited growth patterns or because of trauma. Aberrations in bony growth may give rise to crossbites in two ways; asymmetrical growth of the maxilla or mandible which are most difficult to treat, and lack of agreement in the widths of the maxilla and mandible, in which the muscles shift the mandible to one side to acquire sufficient occlusal contact for mastication.

Leighton[26] shows in his study of 550 cases, that crossbites may arise as a result of a skeletal discrepancy or of an unfavorable balance of force causing lingual inclination of upper teeth or buccal inclination of lower teeth. An imbalance of buccal-lingual forces before the ages of five years, Leighton points out, is most likely to be caused by sucking habits, which at this stage can be indulged in for long periods of the day as well as the night.

Mathews[29] divided the posterior crossbites into two general classifications: anatomic and functional. In the anatomic type the mandible will not deviate from the midline upon closure, and is truly unilateral. The etiology, according to him, is due to a narrowing of the buccal alveolar process on a lateral segment of the maxilla, or very infrequently, a corresponding widening of the mandibular arch on the same side. This

type of posterior crossbite is very uncommon in comparison as those of a functional nature, in which the jaw deviates from the midline either to the left or right during the final few millimeters of closure. This type is bilateral in nature, since the width of the maxillary arch is insufficient for the maxillary teeth to correctly occlude with the teeth of the mandibular dental arch. In other words, it occurs as a result of insufficient maxillary overjet in the lateral segments of the dental arches. King[24] describes it as an unsatisfactory cusp tip-to-cusp tip situation encountered when the patient closes in centric relation. Then, in an effort to secure interdigitation, the mandible deviates to one side as acquired centric occlusion or "convenience bite" is assumed. This deviation appears as a unilateral lingual posterior crossbite. McDonald,[34] as Moyers, classified it on an etiologic basis as skeletal, dental and functional. His concept of skeletal crossbite is very similar as Mathews[29] point of view. He bases the definition in a discrepancy in the structure of the bone of the mandible or the maxilla. In the dental type McDonald states that there may be no irregularity in the basal bone but that the problem is due to a faulty eruption pattern. He defines the functional crossbite on the basis of mandibular shift into an abnormal but more comfortable position in centric occlusion. In this type there is no evident discrepancy in the upper and lower midline when the mandible is at rest.

Higley,[19] as Moyers[32] and Mathews,[29] analyzed the importance of the position of the midline in the diagnosis of the crossbite. He states that midline discrepancy does not always reflect mandibular malposition, but may be the result of tooth drift or shifting around the line of the mandibular dental arch, and advises to perform a differential diagnosis to determine the exact cause of the malposition or deflection of the mandible.

If deflection is detected while the jaws are in complete closure, Higley says:

> "ask the patient to open slowly, if the mandible swings back to and continues to open in the midline it is tooth interference, joint disease of the tumor type, arthritis, or a foreign object in the glenoid cavity. If the mandible swings even more off center as opening increases, the cause is joint disease of the ankylosis type."

Nevertheless, Kutin and Hawes,[25] in their study of 515 children, state that the midline between the opposing incisors is not an absolute indicator of the lateral position of the mandible with respect to the maxilla. Midline discrepancy might be due to several factors in addition to mandibular displacement. This may be arch asymmetry, aberrations in the sequence of tooth eruption and tooth loss, and the discrepancy of tooth size between the maxillary and mandibular arch.

Chaconas,[4] however, states that the first clue as to whether the condition is a true unilateral crossbite or in fact a bilateral problem, is to observe the midlines. Wertz[42] also advises that a differentiation must be made between a true unilateral crossbite in which the midlines coincide and a unilateral crossbite due to lateral mandibular displacement in which bilateral maxillary constriction is most often present. McDonald,[34] as others, emphasizes the importance of the midline as a diagnostic aid to determine the severity of the maxillo mandibular malocclusion. He supports the evidence that if there is a midline discrepancy that remains constant both at rest position and when the teeth are in occlusion, then the condition is more serious and is indicative of a skeletal deformity.

With the eruption of the deciduous teeth, a functional posterior crossbite can be established. Horowitz and Hixon[20] describe the genesis of the clinical entities called mandibular shift, false centric, and dual bite; when erupting opposing teeth approach each other in such a way that only their prominences, or cusp tips meet when the mandible is elevated in

its centric relation path. When heavy chewing forces are used, this creates nociceptive stimulation to the teeth and supporting structures because the forces are concentrated but not well distributed. This results in activation of protective reflexes that move the mandible into a position of greater comfort and stability.

Some suggested etiologic environmental factors which are responsible in producing posterior crossbite include: maxillary crowded teeth, where the stress of the crowding is not absorbed in the anterior region os the bicuspids may collapse and assume a lingual version. About 90% of the posterior crossbite in children can be attributed to interferences in the deciduous cuspid areas[3] or when the upper and lower arches may not be equally wide and, therefore, cannot close in centric without cuspal interference. Other reasons are insufficient arch length which can result in a tooth or teeth deflected lingually during eruption, sensitive and traumatized teeth or loose primary teeth that cause a lateral shift of the mandible during centric closure, ectopic eruption of the permanent first molar, resulting in the premature loss of the second primary molar, subsequent loss of space, and the eventual buccal or lingual eruption of the second bicuspid.[31][3][25][24]

Agreement about factors responsible for effectively producing maxillary arch narrowing, are not yet well established, but many investigations have focused on possible pernicious environmental influences. For instance: Thompson[40] says that lateral shift of the mandible may occur as a result of a thumbsucking habit. But the interrogation that arises here is, how is it that asymmetrical malocclusion can result from a habit that is employing an abnormal force equally on both maxillary buccal segments? The possible answer to this question is that the narrowing of the maxillary arch is symmetrical, but in order for the maxillary teeth to occlude with the normal

mandibular arch, the mandible shifts either right or left, and the teeth occlude in crossbite. Maxillary narrowing is also present in a high percentage of cases with congenital cleft palate, in which the cleft lip may or may not be present. Logan and Kronfeld,[28] observed that underdevelopment of the jaws, and irregularities of the teeth were frequently associated with early surgical treatment to correct congenital clefts of the upper jaw and lips. Gainsforth,[10] on the other hand, sustains the concept that in this case the patient does not have enough bony structure needed to oppose the natural forces exerted from the buccal surfaces of the teeth by lip pressure, cheek pressure and atmospheric pressure.

Higley,[19] feels that:

> "a stomach sleeping posture produces extraneous pressures, which result in maxillary constriction."

Nevertheless, with regard to sleeping position, it is well known that the infant does not lie in one position during sleep, but moves about at frequent intervals. According to Salzmann,[37] the movements are largely involuntary and are produced by nervous reflex in order to obviate pressure interferences with circulation. Higley[19] further states that some children like to place the arm or hand under the head while sleeping, thus adding to the force produced by the postural position. The result is a maxillary dental arch too narrow for its opposing mandibular arch.

In prolonged retention of the deciduous maxillary molars, the permanent bicuspids generally erupt lingually from the correct position in the arch. They erupt lingually because the roots of the primary molars fail to reabsorb and the erupting bicuspids take the path of least resistance.

According to Moyers,[32] skeletal factors associated with posterior crossbite include gross mediolateral disharmony of the craniofacial skeleton produced by aberrations in the bony growth of the maxilla or mandible in which there is either an asymmetrical growth of the two or a lack of agreement in widths caused by insufficient lateral growth of the maxilla or an overgrowth of the mandible. Nevertheless, the stability of the lower arch width is very high. There is relatively little change in mandibular intercuspid width from age nine to adulthood. In many instances, an alternative explanation of the cause would be to admit the possibility of the maxillary arch having a congenital deficiency in the width relative to the mandible. Even though, the narrowing of the maxillary arch is usually bilateral, the convenience swing is habitually to one side. Prolongation of this abnormal relationship can cause permanent changes in tooth position, in the alveolar bone, and possibly in the temporo mandibular joint growth centers.

Posterior crossbite is a condition which may appear in all three stages of the dentition: deciduous, mixed and permanent; however, it is in the deciduous and mixed dentition where I am going to center my attention. Miller,[31] in a population of 2,695 children aged between two and a half to six years old, found that 135 had posterior unilateral or bilateral crossbites, resulting in an incidence of 5%. Infante[21] computed the prevalence of posterior crossbite in 543 children with Class I molar occlusion and between two and a half to six years of age. He found a higher incidence among the population from the middle class than the sample from the lower class. He also found that girls had greater incidence of 4.7% compared to an incidence of 7.1 in 680 children with Class I and Class II molar relation. Popovich and Grainger[36] report a prevalence of 9% in children with an Angle Class I occlusion and 4% in those with a Class II molar occlusion. Woodside[44] in 1,194 Canadian children aged three to

twelve years, reports an incidence of 7%. Kutin and Hawes[25] in their study of 515 children between age three to nine report a prevalence of 1:13 or 7.7% in the primary and mixed dentition, and Kelly[23] reported an incidence of 8% in a study of 7,417 children between the ages of six and eleven. Most of the epidemiologic data available does not differentiate between the various possible forms of posterior crossbite, i.e., dental, skeletal or functional. The reported incidence usually falling between seven and ten percent indicates that posterior crossbite is not an uncommon finding in children.

Opinions regarding the proper timing for treatment, have changed over the years. Researchers[1][30] have shown that when the position of the primary teeth are changed under the effect of orthodontic forces, the developing permanent tooth buds beneath these primary teeth, tend to follow them and erupt into the changed positions. Because of this movement of the tooth buds there is now accepted for several clinicians that posterior crossbite, whether skeletal, dental or functional, should be treated as early as it is practical to do so. Correction may also reduce sequelae such as interference of normal development and growth of the dental arches and possible warping of the alveolar ridges, possible deterioration of the periodontum from abnormal occlusal forces and food impaction because of faulty tooth position. Pain caused by muscular spasm due to an abnormal lateral shift of the mandible during centric closure, has also been observed.[2][25][28][34] Posterior crossbites usually are not self-correcting and untreated primary dentition is followed by a permanent dentition in crossbite.[25][8] On occasion, as an exception, a posterior functional crossbite in the deciduous dentition is corrected spontaneously upon change of dentition, but for the most part, the clinician should expect the deciduous crossbite to be repeated in the permanent dentition unless

correction is instituted. Once the posterior crossbite has been identified the professional has several choices of treatment. Numerous appliances fixed and removables, have been utilized in the treatment of inter-arch width discrepancies due to a narrow maxillary arch. Among the fixed are: the Haas,[13] the rapid palatal expander, Porter of W-arch, the quad-helix which is a modification of the Wards appliance who first added two distal coils (bi-helix) and later two mesial coils, thus producing a W shaped quad-helix palatal expander device. The Coffin spring[5] and the minne expander are two of the removables maxillary expanders. Some of them have been tested to observe the orthopedic force distribution in the craniofacial complex.

In regard to this concept, Chaconas and Caputo[6] report that:

> "Stresses produced by the fixed appliances, were concentrated in the anterior region of the palate, progressing toward the palatine bone. The Haas, minne expander and hyrax appliances, produced stresses that radiated superiorly along the perpendicular plates of the palatine bone to deeper anatomical structures such as the lacrimal, nasal and malar bones, as well as the pterygoid plates of the sphenoid. Similar stress characteristics were seen within the removable appliance. The quad-helix proved to be the least effective orthopedic device. Although the effects of palatal separation were seen with increased activation, this appliance primarily affected the posterior teeth."

Harberson,[15] in his study regarding the effect of the Porter or W arch appliance on the midpalatal suture, reports that in eight of the ten cases treated, there was radiographic evidence of midpalatal suture opening. To correct a posterior skeletal crossbite in patients with mixed and permanent dentition up until the age of 16 to 18 years of age. A rapid palatal expansion screw is usually employed.[9] The objective of this appliance is to increase the transverse width of the maxillary dental arch at the apical base with minimal concomitant movement of the posterior teeth within

the alveolus.[18] The first permanent molars and the first permanent bicuspids, if present, are the teeth to which the appliance is attached. The screw thread is such that each represents an opening of 0.2 to 0.5 mm. Treatment time depends on the amount of expansion desired and the frequency of daily activations tolerated by the patient. The midpalatal suture opens and then is held open by the screw until it fills in with bone, this period of time is approximately three months of rigid stabilization in order to allow sutural readjustment and dissipation of accumulated residual forces at the contiguous articulations of the maxilla.[13][18][9]

Treatment of a posterior crossbite, resulting from a functional shift of the mandible, may be carried out by equilibration of the patient's occlusion with a wheel-shaped diamond stone. It may be done by grinding the buccal surfaces of the cusps of the mandibular molars and cuspids toward the lingual, and the lingual surfaces of the cusps of the maxillary molars and cuspids toward the buccal. If the crossbite can be attributed to interferences in the deciduous canine areas, selective grinding of these teeth may correct the malocclusion and no additional therapy is required.[39][2]

Most dental unilateral or bilateral crossbites involving one or more teeth can be successfully treated with occlusal equilibration and the W-arch appliance. The fixed W-arch appliance, a modification of the Porter appliance, acts as an expansion device which produces buccal tipping of the maxillary teeth. It is possible that the increased maxillary width could result from either buccal tipping of teeth, opening of the midpalatal suture or a combination of both. Because this type of device produces minimal midpalatal suture opening and basically uses tooth tipping type of action, it should not be considered in the correction of posterior crossbites of skeletal origin. In those cases the rapid palatal expansion technique is one of the most common choices. The degree of maxillary arch narrowing present

in functional posterior crossbites, suggests that light tooth tipping forces are appropriate for expansion, and the W-arch appliance has been reported for this purpose.[24] The technique to follow using this type of device is adapting preformed bands to the most distal teeth involved in the crossbite, and a 0.036 or 0.040 inch wire is contoured to the arch. The appliance should be activated by making slight opening of the palatal loop with corresponding adjustments in the molar loop area. The activation of the appliance before cementation usually is in the range between 6 to 12 mm. The activation of the wire should be performed every three to four weeks until the crossbite has been corrected,[34] which in the majority of the cases is between the 6 and 12 weeks after the appliance is placed in the mouth. It is allowed to remain as a passive retaining device for three to six months after completion of treatment. The purpose of retention is to stabilize the teeth in the new position. This goal is not limited to stabilize the teeth in the new location in the dental arch, but to get an adequate balance and harmonious equilibrium of the teeth in the oral environment. In regard to the stability of the dental arch after the retention, Haas[14] reports 100% success in the correction of posterior crossbites using a palatal expansion appliance. Kutin, et al.,[25] using a removable acrylic expansion device mentions a high degree of stability of the maxillary dental arch after removal of the appliance.

The W-arch has the advantage of being relatively hygienic and well tolerated by the patient, provides for more flexibility in adjustment than other designs and is self limiting in action. Two of the chief advantages are that it is fixed, which obviates much of the need for patient cooperation, and also might be used as a retainer, after the crossbite is corrected.[24]

## MATERIALS AND METHODS

The sample studied in the present project consisted of 15 children, 10 girls and 5 boys in the age range of 5.6 to 18 years (mean age 13.4 years), who presented posterior crossbite at the age range of 3.9 to 11 years with a mean age of 7.2 years. Each of these patients were treated at the University of Oregon Dental School, with a W-arch expansion appliance as described by Buck.[3] The period of treatment without retention was in the range of 1 month to 8 months 3 weeks with a mode of 3 to 4 months. Mode is used because of the small statistical sample and because of four extreme values which skewed the mean. The period of retention, after the crossbite was corrected, was determined in 14 subjects because in one of them the dental chart was not available. This was between 1 and 5 months (mean 4 months). The time in which the patients have been out of retention is in a range of 2 to 123 months (mean 60.5 months). Treatment was started in the primary dentition in 7 subjects and in mixed dentition in eight patients. There were no cases treated in the permanent dentition.

The study models were hand held and articulated in acquired centric. Each set of dental casts were held in this position to analyze the buccolingual positions of the upper posterior teeth with their opposing lower teeth. The buccolingual relationship was considered in good relation if the buccal cusp tips of the maxillary posterior teeth were facial or buccal to the buccal cusp tips of the mandibular posterior teeth, and the teeth were considered to be in crossbite, if the buccal cusp tips of the maxillary posterior teeth were lingual to the buccal cusp tips of the mandibular posterior teeth. Cases in which the buccal cusp tips were flush were recorded and considered as failure in the treatment, this, following Hellman's[16] concept of normal occlusion.

A group control of seven patients (Table 1), five girls and two boys ranging in age from six years seven months to 13 years one month (mean 8 years 9 months) when the second set of study models were taken, was used. This group had an untreated posterior crossbite during the period of time when the patients progressed from primary dentition to permanent dentition. The period of time in which this group of patients was followed, in other words, the time between the first and second set of study models, ranges from three months to three years eight months.

The group control was taken from the records classified under the title "Posterior Crossbite" in the Pedodontic Department of the University of Oregon, Dental School.

The purpose for using an untreated control group was to analyze the normal or abnormal buccolingual relation of the upper posterior permanent teeth with their opposing lower permanent teeth, after they had a crossbite in their primary dentition. These results were compared with the study of the treated patients to get more evidence about the effectiveness of early treatment with the W-arch expansion appliance in patients with crossbite.

TABLE 1. GROUP CONTROL

| PATIENT | SEX | DATE FIRST STUDY MODELS | AGE | TEETH IN CROSSBITE | DATE SECOND STUDY MODELS | AGE | TEETH IN CROSSBITE |
|---|---|---|---|---|---|---|---|
| D.K. | F. | 4-30-71 | 4y. 10m. | ABC / TSR | 3-28-74 | 7y. 9m. | 3ABC / 3OTSR |
| L.S. | F. | 3-30-73 | 10y. | J 14 / K 19 | 10-4-74 | 11y. 7m. | 13 14 / 20 19 |
| M.B. | M. | 1-17-75 | 4y. 4m. | AB / TS | 12-9-77 | 7y. 3m. | 3AB / 3OTS |
| C.A. | F. | 10-27-75 | 5y. 3m. | ABC / TSR | 2-23-77 | 6y. 6m. | 3ABC HIJ16 / 3OTSR MLK19 |
| S.G. | F. | 11-18-76 | 5y. 11m. | IJ / LK | 1-11-79 | 8y. 1m. | IJ14 / LK19 |
| H.J. | F. | 3-7-78 | 6y. 8m. | GHIJ / NMLK | 3-6-79 | 7y. 7m. | HIJ14 / MLK19 |
| M.K. | M. | 10-7-80 | 12y. 8m. | (I)J 14 / (21)K 19 | 3-27-81 | 13y. 1m. | 12 13 14 / 21 20 19 |

## FINDINGS

In this study 15 children (10 girls and 5 boys) who were treated with a W-arch expansion appliance, were analyzed to determine the effectiveness of early posterior crossbite treatment on the permanent dentition.

The duration of treatment, including retention, ranged from 11 to 55 weeks, with an average of 30 weeks. The period of retention ranged from 4 to 20 weeks. The average length of retention was 16 weeks. One patient has been out of retention less than 6 months, three 7 to 11 months, and eleven more than 24 months.

Treatment was initiated in the primary dentition in seven children and in the mixed dentition in eight children. One patient is in the primary dentition, 6 in mixed dentition, and eight in the permanent dentition.

Two patients in the sample had bilateral posterior crossbite, and thirteen had unilateral crossbites. Four patients had two teeth in crossbite, three patients four, and eight had six or more. In total there were 88 teeth in crossbite. After treatment, two patients had 2 teeth in crossbite, two patients with 2 teeth in buccolingual relation of end to end, and one patient four teeth in end to end. In total there were 4 teeth in crossbite and eight in end to end buccolingual relation.

Results of treatment: (Table 2)

I. Ten patients had successful treatment. In five of them, the treatment was initiated in their primary dentition and in the other five in the mixed dentition. Of the group treated in the primary dentition one is still in it, three are in the mixed dentition and one is in the permanent dentition. Of the patients treated during mixed dentition, two are still in it, and three are in the permanent dentition. One

patient who was initially treated in the primary dentition for 11 weeks, presented some degree of relapse three years later. She was re-evaluated and retreated for 19 weeks once again correcting the crossbite.

II. Two patients presently have teeth in crossbite. One (E.C.), never had her crossbite fully corrected because according to the dental chart and dental casts, the first left permanent molars and second primary molars, were end to end shortly after the appliance was removed; and at the present time (48 months after correction), the first permanent molars are in crossbite. The permanent bicuspids erupted in normal occlusion. This patient is 14 years old and the second permanent molars are not yet in occlusion. The total time of treatment in this subject was 37 weeks including 5 months of retention.

The second patient (E.D.) has second right permanent molars which have erupted into crossbite. The period of treatment was 34 weeks with 5 months of retention. Both patients were treated during the mixed dentition. E.C. was treated in the late mixed dentition while (E.D.) was treated in the early mixed dentition.

III. Three patients show a buccolingual relation of end to end. In one (H.G.), the initial crossbite was completely corrected, but the second right permanent molars erupted end to end. The period of treatment including 4 months of retention was 28 weeks.

The third case (L.M.), had a posterior crossbite involving the teeth on the left side. Today, the buccolingual relation is end to end in just two teeth. He also presents a bilateral posterior open bite in the cuspid and bicuspid area.

Treatment was initiated in the mixed dentition in all three patients. Presently two (H.G. and L.M.), are in the permanent dentition and H.G. is still in the mixed dentition.

The position of permanent bicuspids and molars after treatment when primary molars or first permanent molars were in crossbite is as follows:

I. The first permanent molar erupted in normal occlusion in the four patients who were successfully treated during primary dentition. In one who now is in the permanent dentition the bicuspids erupted in good relation.

II. Of the ten patients treated in the mixed dentition, seven are now in the permanent dentition.

   a. In five of these seven, the bicuspids erupted in normal occlusion after their preceding teeth were in crossbite. In two of the cases there were a relapse of the first permanent molars. In one it was partial, (end to end), in the other one it was total, (crossbite).

   b. The remaining two cases only had first permanent molars in crossbite. The first molars were treated successfully but in one case the second permanent molars erupted in crossbite and in the other in end to end buccolingual relation.

These findings show that of the whole group treated, 66.7% of the treatments was successful, 13.3% of the patients are in crossbite and 20% are in end to end buccolingual relation.

100% of the cases (4 patients) who had primary molars in crossbite without the first permanent molars present, showed that the later ones erupted in normal occlusion. In the comparable group control (5 patients) the first permanent molars erupted in crossbite in 100% of the cases. A group of six patients were treated during the primary dentition because of crossbite in the primary molars. The bicuspids are now present in these patients and have erupted in good relation. In the comparable group control (2 patients) it was found that the bicuspids erupted into crossbite in both cases.

| Patient | Age | Sex | Teeth in Crossbite | Dentition Age Initiation Tx. | Total time of Tx. (months) | Period of Retention | Months Post Tx. | Crossbite | No Crossbite | End to End |
|---|---|---|---|---|---|---|---|---|---|---|
| B.B. | 11y. 7 m. | M | AB \| <br> TS \| | 10y. 6m. Mixed | 9.5 | 2 months | 2 | | * | |
| D.C. | 11y. 7m. | F | \| HIJ <br> \| MLK | 5y. 11m. Primary | 4.25 | 4 months | 58 | | * | |
| E.C. | 14y. 3m. | F | \| J 14 <br> \| K 19 | 11y. Mixed | 4.25 | 5 months | 48 | \| 14 <br> \| 19 | | |
| E.D. | 14y. | M | 3 \| <br> 30 \| | 7y. 1m. Mixed | 3.5 | 5 months | 86 | 2 \| <br> 31 \| | | |
| G.S. | 18y. | F | 3A \| 14 <br> 30T \| 19 | 8y. 5m. Mixed | 2.75 | - | 104 | | * | |
| H.G. | 15y. 7m. | M | 3 \| <br> 30 \| | 9y. 10m. Mixed | 3 | 4 months | 54 | | | 2 \| <br> 31 \| |
| H.J. | 9y. 3m. | F | \| HIJ 14 <br> \| MLK 19 | 7y. 7m. Mixed | 3 | 4 months | 11 | | | C \| J <br> R \| K |
| K.J. | 13y. 4m. | F | 3A(C) \| <br> 30T(R) \| | 8y. 8m. Mixed | 1 | 4 months | 50 | | * | |
| L.M. | 15y. 6m. | M | \| GHIJ 14 <br> \| NMLH 19 | 8y. 6m. Mixed | 2.75 | 4 months | 53 | | | \| 14 <br> \| 19 |
| L.M. | 5y. 6m. | F | \| GHIJ <br> \| NMLK | 4y. 2m. | 4.25 | 3 months | 7 | | * | |
| M.S. | 8y. 6m. | F | ABC \| <br> TSR \| | 3y. 9m. Primary | 3.75 | 2 months | 55 | | * | |
| P.N. | 8y. 7m. | M | A \| <br> T \| | 4y. 11 m. Primary | 5.75 | 1 month | 66 | | * | |
| P.K. | 17y. 9m. | F | 3ABCD \| GHIJ 14 <br> 30TSRQ \| NMLK 19 | 7y. 4m. Mixed | 7.75 | 3 months | 123 | | * | |
| S.C. | 12y. 9m. | F | A \| <br> T \| | 5y. 9m. Primary | 8.75 | 5 months | 47 | | * | |
| T.L. | 11y. 1m. | F | \| J 14 <br> \| K 19 | 9y. Mixed | 2.75 | 2 months | 11 | | * | |

## DISCUSSION AND CONCLUSIONS

There is no conclusive evidence that the problem of crossbite is improved with eruption of permanent teeth. Histologic manifestations of the influence of early primary tooth movement on the tooth germs has been published by Breitner[41] who demonstrated that orthodontic movement of deciduous teeth induces migration of the underlying tooth germs. The direction of this migration is the same as the direction of the movement of the roots of the primary teeth. Whether or not this process occurred in patients treated in this study, the results demonstrate at least clinically, that the permanent teeth followed the direction that the primary teeth had been moved during crossbite correction.

Kutin, et al.[25] concludes that treatment of posterior crossbite should be undertaken as early as possible. This conclusion was based on the successful treatment of twelve cases that were expanded during the primary and mixed dentitions. In 44 of 48 cases (90%) which were not treated, the first permanent molar erupted into crossbite.

This study as well as Kutin and Hawes' demonstrated that early correction of posterior crossbite, results in a high percentage of permanent teeth erupting in normal occlusion. Even though the study and control groups in this study were small, it is significant that 80% of the treated cases developed a normal occlusion, while in 100% of the untreated cases a crossbite was present both in the bicuspid and molar regions.

Taking into account that this discussion is based on a group of patients treated with a W-arch expansion appliance, is valid to emphasize that this device acts by tipping teeth or by opening of the midpalatal suture or a combination of both. If the patient who is undergoing treatment has a midpalatal suture opening, the crossbite in this specific individual can

be corrected in the late mixed dentition, because there will be bone movement. If the case involves a tooth tipping movement, do the germs of the permanent teeth follow the movement of the primary teeth if treatment occurs during the late mixed dentition? Baker, in Breitner's[41] study presents the opinion that treatment should be instituted when the roots of the primary teeth are fully developed and no reabsorption of them has occurred, because at this time there is a minimum of development of the permanent teeth. A future study doing treatment at different stages of the mixed dentition might demonstrate a specific point in development at which the germs of the permanent teeth do not follow the movement of their corresponding primary teeth.

Starting treatment early in the child's life before the midpalatal suture closes, (midpalatal suture initiates it's closure simultaneously with cranial suture approximately between 8 and 10 years of age) is more beneficial to the patient. Early treatment allows for greater flexibility of the maxillary bone and decreases the probability of trauma. Melsen in Hicks[18] study found numerous microfractures at sites of bony interdigitations in the older children who were treated with a rapid maxillary expansion device.

In my opinion it is not possible to predict the mechanisms in which the W-arch accomplishes correction (tooth tipping or midpalatal suture opening), but one can predict that if a crossbite is corrected at an early age the success rate increases. I consider early treatment as that which is initiated during primary dentition.

In regard to those patients who were treated during the primary dentition and whose permanent molars erupted in normal occlusion, one might establish a hypothesis that midpalatal suture opening is the most common mechanism in

the correction of posterior crossbite when using a W-arch expansion appliance. It is not my intention to prove this hypothesis in the present study, but according to my results there were two cases where the second permanent molars erupted in abnormal relation. This may support the idea that in those cases who were treated during the mixed dentition, the main mechanism was tooth tipping instead of midpalatal suture opening. A future study concerning the above idea might prove my assumption.

The fixed W-arch appliances ability to correct an existing posterior crossbite, is clearly demonstrated in reports by King,[24] Harberson[15] and in the present study. According to the dental charts, all 15 patients in the study had functional or dental crossbites. The affected teeth were brought into a normal faciolingual relation by the appliance at the end of the treatment. This type of appliance is used to produce slow expansion usually up to 5 mm.

The appliance therapy necessary to treat a functional or dental posterior crossbite in the primary or mixed dentition is more simpler than that needed to treat the malocclusion in the permanent dentition. Several considerations should be taken into account to have success in the treatment, no matter which device is chosen. In the present study the fixed W-arch expansion appliance was the device of choice. A brief comment on considerations that need to be taken into account when using the W-arch will be discussed.

Diagnosis. The existing type of crossbite (dental, functional or skeletal) is the first step that has to be considered by the clinician in order to determine if the case has to be treated by an orthodontist or by a competent practitioner. In the majority of the cases the orthodontist is the one who takes care of the narrow maxillary arch of skeletal origin.

This type of malocclusion often includes gross mediolateral disharmony of the craniofacial skeleton produced by aberrations in the bony growth of the maxilla or mandible which are most difficult to treat.[32] The treatment to correct this type of disharmony, usually require more complex appliances such as the rapid palatal expansion device. Dental and functional crossbites can be treated by a pedodontist or by a competent general practitioner who have knowledge of the mechanisms of growth of the maxillary complex and recognize the limitations of treatment that they can accomplish. Study models and radiographs are required for base information and help in determining the diagnosis.

Timing of Treatment. From the review of literature it appears that treatment should be started as soon as the second primary molars are erupted enough so the bands can be placed.

It is important to initiate the treatment early to avoid complications such as permanent dentition in crossbite, interference of normal growth and development of the dental arches, deterioration of the periodontum from abnormal occlusal forces and food impaction because of faulty tooth position.[2][28][34] Also initiating the treatment early the clinician will take advantage of the best growth potential in the masticatory apparatus, which is during the first ten years of life.[42]

Construction of the Appliance. The W-arch expansion appliance has to meet the construction requirements to get the best adaptation once it is placed in mouth. King[24] talking about the treatment protocol using this device says:

"Bands are fitted on the second deciduous molars or on the first permanent molars, if they are erupted and involved in the crossbite. A transfer impression is taken in alginate or compound, with the bands in place. The bands are then removed and secured in the impression with sticky wax. The working model is poured in plaster or stone. The wire (0.36-inch) is adapted to the configuration of the maxillary arch. The anterior loop of the appliance should approximate the contour of the palate. The distal loops should extend distal to the banded molar. Anterior extensions of the wire should contact the band and lingual surfaces of the teeth passively. When the relationships are correct, the wire is soldered to the bands, and the appliance is removed from the model. The wire is then heat-treated according to the manufacturer's directions and polished."

Activation. The W-arch appliance is activated by expansion of six to twelve millimeters before cementation in the mouth. Good adaptation of the bands and an adequate cementation to the teeth are important factors for the appliance to successfully correct the malocclusion.

Follow-up of Treatment in Progress. The patient should be checked at three to four week intervals during treatment. Some cases will require a second or third activation of the appliance in order to achieve correction of the crossbite.

Treatment and Retention Time. In this study, the treatment was accomplished in a range of 1 month to eight months three weeks (mode 3 to 4 months), plus four months retention as average. The reason why the mode was used instead of the mean was because of the small of the sample and because of the extreme values which skewed the mean.

Final Records. A set of post-treatment study models and an adequate clinical examination of the patient, are required to determine if the treatment was successful. A recall six or nine months post appliance removal is recommended to evaluate the occlusion.

## SUMMARY

The study models of fifteen patients who were treated with a W-arch expansion appliance to correct posterior crossbites, were analyzed to determine the effectiveness of early treatment of posterior crossbites. A group control of seven patients with untreated posterior crossbite was used for comparison. Dental casts from both groups were analyzed and then the occlusion of the permanent teeth was compared to support the idea that posterior crossbites should be treated in the primary or mixed dentition.

Clinical evidence demonstrated that if treatment is performed early permanent teeth will have a good chance of erupting in normal occlusion.

The study also demonstrated that the W-arch expansion appliance can be used effectively in the treatment of posterior crossbite during the primary or mixed dentition stages.

Considerations that should be taken into account when using the W-arch to treat posterior crossbites were discussed.

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# APPENDIX I

## PATIENTS TREATED

Brill, Brian (B.B.)
Unit #13-95-43
Model #700-059
Period of treatment: 5-27-80 to 5-5-81
Age of insertion of the appliance: 10 years 8 months
Dentition: mixed
Total time of treatment: 9.5 months
Period of retention: 2 months

Dean, Christine (D.C.)
Unit #13-08-78
Model #700-012
Period of treatment: 8-8-75 to 10-14-75
Age of insertion of the appliance: 6 years 3 months
Dentition: primary
Total time of treatment: 4.25 months
Period of retention: 4 months

Eggert, Carrie (E.C.)
Unit #13-37-63
Model #700-017
Period of treatment: 12-8-75 to 8-19-76
Age of insertion of the appliance: 9 years 2 months
Dentition: primary
Total time of treatment: 4.25 months
Period of retention: 5 months

Elton, David (E.D.)
Unit #11-77-99
Model #790
Period of treatment: 2-22-73 to 10-15-73
Age of insertion of the appliance: 7 years 1 month
Dentition: mixed
Total time of treatment: 3.5 months
Period of retention: 5 months

Gower, Stacey (G.S.)
Unit #11-13-57
Model #770
Period of treatment: 5-14-71 to 7-28-71
Age of insertion of the appliance: 8 years 5 months
Dentition: mixed
Total time of treatment: 2.75 months
Period of retention: unknown

Herder, Guy (H.G.)
Unit #12-95-69
Model #700-006
Period of treatment: 11-13-75 to 5-26-76
Age of insertion of the appliance: 10 years 9 months
Dentition: mixed
Total time of treatment: 3 months
Period of retention: 4 months

Hoopes, Jodee (H.J.)
Unit #14-79-52
Model #700-042
Period of treatment: 4-12-79 to 11-6-79
Age of insertion of appliance: 7 years 10 months
Dentition: mixed
Total time of treatment: 3 months
Period of retention: 4 months

Kirk, Jennifer (K.J.)
Unit #13-69-70
Model #700-024
Period of treatment: 6-16-76 to 11-9-76
Age of insertion of the appliance: 8 years 10 months
Dentition: mixed
Total time of treatment: 1 month
Period of retention: 4 months

Lesage, Matt (L.M.)
Unit #12-65-74
Model #800-018
Period of treatment: 5-14-74 to 11-19-74
Age of insertion of the appliance: 8 years 7 months
Dentition: mixed
Total time of treatment: 2.75 months
Period of retention: 4 months

Lundeen, Michelle (L.M.)
Unit #15-05-39
Model #700-054
Period of treatment: 11-2-79 to 6-17-80
Age of insertion of the appliance: 4 years 4 months
Dentition: primary
Total time of treatment: 4.25 months
Period of retention: 3 months

Maranette, Sara (M.S.)
Unit #13-40-90
Model #700-025
Period of treatment: 4-29-76 to 10-1-76
Age of insertion of the appliance: 3 years 9 months
Dentition: primary
Total time of treatment: 3.75 months
Period of retention: 2 months

Papador, Nick (P.N.)
Unit #13-57-89
Model #700-028
Period of treatment: 5-14-74 to 11-19-74
Age of insertion of appliance: 8 years 7 months
Dentition: mixed
Total time of treatment: 5.75 months
Period of retention: 1 month

Parke, Kim (P.K.)
Unit #10-98-05
Model #765
Period of treatment: 1-21-71 to 11-17-71
Age of insertion of the appliance: 7 years 5 months
Dentition: mixed
Total time of treatment: 7.75 months
Period of retention: 3 months

Schechtman, Claudia (S.C.)
Unit #12-29-01
Model #796
Period of treatment: 12-79-75 to 1-9-77
Age of insertion of the appliance: 7 years 11 months
Dentition: primary
Total time of treatment: 8.75 months
Period of retention: 5 months

Thompson, Lisa (T.L.)
Unit #11-63-36
Model #700-014
Period of treatment: 4-27-78 to 9-13-78
Age of insertion of the appliance: 9 years
Dentition: mixed
Total time of treatment: 2.75 months
Period of retention: 2 months

# APPENDIX II

## CONTROL GROUP

Dynes, Kellie (D.K.)
Unit #11-13-68
Model #771
Dentition when first study models were taken: primary
Dentition when second study models were taken: mixed

Luarca, Sarah (L.S.)
Unit #12-12-94
Model #794
Dentition when first study models were taken: mixed
Dentition when second study models were taken: permanent

Mancia, Brent (M.B.)
Unit #11-71-71
Model #700-009
Dentition when first study models were taken: primary
Dentition when second study models were taken: mixed

Cox, Angela (C.A.)
Unit #12-69-18
Model #700-021
Dentition when first study models were taken: primary
Dentition when second study models were taken: mixed

Gammon, Shannon (G.S.)
Unit #13-27-48
Model #700-058
Dentition when first study models were taken: primary
Dentition when second study models were taken: mixed