Review Article

A Systematic Review Concerning Early Orthodontic Treatment of Unilateral Posterior Crossbite

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Abstract: The aim of this study was to assess the orthodontic treatment effects on unilateral posterior crossbite in the primary and early mixed dentition by systematically reviewing the literature. A literature search was performed by applying the Medline database (Entrez PubMed) and covering the period from January 1966 to October 2002. The inclusion criteria were primary and early mixed dentition with unilateral posterior crossbite, randomized controlled trials (RCT), prospective and retrospective studies with concurrent untreated as well as normal controls, and clinical trials comparing at least two treatment strategies without any untreated or normal group involved. Two reviewers extracted the data independently and also assessed the quality of the studies. The search strategy resulted in 1001 articles, and 12 met the inclusion criteria. Two RCTs of early treatment of crossbite have been performed, and these two studies support grinding as treatment in the primary dentition. There is no scientific evidence available to show which of the treatment modalities, grinding, Quad-helix, expansion plates, or rapid maxillary expansion, is the most effective. Most of the studies have serious problems of lack of power because of small sample size, bias and confounding variables, lack of method error analysis, blinding in measurements, and deficient or lack of statistical methods. To obtain reliable scientific evidence, better-controlled RCTs with sufficient sample sizes are needed to determine which treatment is the most effective for early correction of unilateral posterior crossbite. Future studies should also include assessments of long-term stability as well as analysis of costs and side effects of the interventions. (*Angle Orthod* 2003;73:588–596.)

Key Words: Early treatment; Crossbite; Systematic review; Quality analysis

INTRODUCTION

Posterior crossbite is one of the most prevalent malocclusions in the primary and early mixed dentition and is reported to occur between 8% and 22%.[1–4] In most cases, the crossbite is accompanied by a mandibular shift, a so-called forced crossbite, which causes midline deviation.[2,5] Factors involved in the etiology of the crossbite, besides heredity, are sucking habits[6] and impaired nasal breathing caused by, for example, enlarged tonsils and adenoids.[7–9]

The status of the primary occlusion affects the development of the permanent occlusion. Thus, a posterior crossbite is believed to be transferred from primary to permanent dentition, and the posterior crossbite can have long-term effects on the growth and development of the teeth and jaws.[10,11] The abnormal movement of the lower jaw (mandibular shift) may place a special strain on the orofacial structures, causing adverse effects on the temporomandibular joints and masticatory system. EMG; electromyographic studies have shown that the activity of the temporal and masseter muscles is disturbed in children with unilateral crossbite.[12,13] Studies of adolescents and adults have revealed that patients with posterior crossbite have an increased risk to develop craniomandibular disorders, showing more signs and symptoms of these problems.[4,14–16] Therefore, early treatment is often advised to normalize the occlusion and create conditions for normal occlusal development.[1,10,17] Furthermore, postponement of treatment has been claimed to result in prolonged treatment of greater complexity.[1,18]

Several studies have been carried out during the last decade concerning early treatment of posterior crossbite, ie, treatment in the primary dentition or in the early mixed dentition usually before the age of nine years. However, a considerable variety in treatment approaches, study design, sample sizes, and research approach has produced disparate outcomes among these studies. Therefore, the results and

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TABLE 1. Initial Inclusion and Exclusion Criteria for the Retrieved Studies

Inclusion Criteria	Exclusion Criteria
Human studies	Case reports and case series
Primary and early mixed dentition with posterior crossbite	Review articles and abstracts
Randomized controlled trials, prospective and retrospective observational studies with concurrent untreated/normal controls	Treatment in late mixed and permanent dentition, adults
Clinical trials comparing at least two treatment strategies	Treatment combined with extractions or full-fixed appliances
Articles written in English, German, French, and Scandinavian languages	Surgically assisted treatments Anterior crossbite, Angle Class III Cleft lip and/or palate or other craniofacial syndrome diagnosis

evidence can sometimes be difficult to interpret and compare and because it is time consuming for the practitioner to read and analyze every article, they may rely on literature reviews. Even if many reviews are well designed,[19–21] they most often are biased because of lack of formal methodology and inclusion criteria.[22] In view of this and because evidence-based medicine has grown in importance,[23] a systematic review seems warranted.

Systematic reviews locate, appraise, and synthesize the evidence from scientific studies to provide informative answers to scientific questions by including a comprehensive summary of the available evidence.[24] One systematic review considering only randomized and controlled trials which reported quantitative data on the outcomes of crossbite correction has so far been presented.[25] In contrast to this report, which dealt with correction of crossbite in all ages including adults, the present systematic review will focus on early treatment of crossbite. Moreover, besides covering randomized and controlled clinical trials, the scope of the Cochrane report,[25] the present review also covers prospective and retrospective observational studies with concurrent controls as well as observational studies comparing different treatment modalities. The main reason for this strategy was that it has recently been claimed that randomized trials should rule but observational prospective or retrospective studies should not be ignored when assessing the scientific literature.[26]

This systematic review was undertaken to answer the following important questions:

- Is early treatment of unilateral posterior crossbite effective?
- Which treatment modality is the most effective?
- Is the treatment result stable and long lasting?

Furthermore, a quality analysis of the methodological soundness of the studies in the review was performed.

MATERIALS AND METHODS

Search strategy

The strategy for undertaking this systematic review was mainly influenced by the National Health Service, NHS, Center for Reviews and Dissemination.[27] To identify all the studies that examined the relationship between early orthodontic treatment and unilateral crossbite, a literature survey was done by applying the Medline database (Entrez PubMed, www.ncbi.nim.nih.gov). The survey covered the period from January 1966 to October 2002 and used the MeSH, Medical Subject Headings, terms: ''palatal expansion'' or ''palatal expansion technique,'' which were crossed with various combinations of the following MeSH terms: ''dentition, primary'' and ''dentition, mixed.'' Additionally, a search in the Cochrane Controlled Clinical Trials Register was performed.

TABLE 2. The Articles Included in the Review[a]

Articles	Study Design[a]
Admund et al[30]	P, CCT, UC
Bell and LeCompte[31]	P, CT
Bjerklin[32]	R, L, CCT, NC
Boysen et al[33]	P, CT
Erdinc et al[34]	R, CCT, UC
Hermansson et al[35]	R, CT
Kurol and Berglund[5]	P, L, CCT, NC
Lindner[18]	RCT, L, UC
Ranta[36]	R, CT
Sandikcioglu and Hazar[37]	P, CT
Thilander et al[38]	RCT, L, UC, NC
Tsarapatsani et al[39]	R, L, CT

[a] P indicates prospective study; R, retrospective study; L, longitudinal study; RCT, randomized clinical trial; CCT, controlled clinical trial; CT, clinical trial, i.e. comparison of at least two treatment modalities without any untreated or normal group involved; UC, untreated control group; and NC, normal control group.

Selection criteria

The inclusion and exclusion criteria are given in detail in Table 1. Early treatment of posterior unilateral crossbite was defined as treatment in primary dentition or in early mixed dentition, ie, before the age of 10 years. The following studies that reported data on the treatment effects were included: randomized clinical trials (RCT), prospective and retrospective studies with concurrent untreated as well as normal controls, clinical trials comparing at least two treat-

TABLE 3. Summarized Data of the 12 Studies Included in the Review[a]

Article Material and Age	Methods/ Measurements	Treatment Time/ Retention Time	Success Rate	Expansion Obtained Molars/ Cuspids (mm)	Expansion Remained Molars/ Cuspids (mm)	Side Effects	Authors' Conclusion
Admund et al[30]							
20 GR 20UC ~6 y	Clinical examination Study casts Sliding calipers	2–5 appointments	GR 14/20 UC10/20	GR 0.4 UC 0.1	GR 1.6 UC 1.5	Not declared	Grinding should be carried out before the age of 5 yr
Bell and LeCompte[31]							
5 QH in primary dentition ~5 y	Study casts Sliding calipers Occlusal radiographs	~30 d Retention time not declared	QH 5/5	5.7/3.9	3.9/2.3	Loose bands Gingivitis	No significant difference between the groups
5 QH in mixed dentition ~8 y			QH 5/5	4.8/4.4	3.6/2.2 3 months follow-up		
Bjerklin[32]							
19 QH ~9.3 y 19 EP ~ 9.2 y 19 NC ~ 8.8 y	Study casts Sliding calipers	QH 7.7 mo EP 12.5 mo Retention time 3 to 5 mo	QH 16/19 EP 18/19	QH 3.3/1.3 EP 2.6/0.7 NC 1.0/−0.8	QH 3.3/3.3 EP 3.3/3.5 NC 1.2/0.9	Not declared	Expansion was similar for both groups. Never as good as normals. EP longest treatment time
Boysen et al[33]							
17 QH ~8.3 y 17 EP ~8.6 y	Study casts Sliding calipers Frontal/lateral radiographs	QH 3.4 mo EP 3.8 mo 3 mo retention	QH 17/17 EP 17/17	QH 5.6/5.2 EP 4.7/3.5	QH 4.1/3.1 EP 3.1/2.5	Not declared	QH significantly greater expansion than EP. QH is recommended
Erdinc et al[34]							
14 QH ~9.7 y 13 EP ~9.3 y 10 UC ~9.4 y	Study casts Sliding calipers Frontal/lateral radiographs	QH 0.6 y EP 1.2 y Retention not declared	QH 14/14 EP 13/13 UC not declared	QH 5.6/3.1 EP 3.9/2.9 UC 0.7/1.6	Not analyzed	Not declared	Sufficient results in both groups. QH faster and significantly more expansion but also more dental tipping
Hermansson et al[35]							
27 QH ~8.6 y 25 EP ~7.6 y	Study casts Sliding calipers	QH 1–1.5 mo EP 11 mo	Not declared	Not declared	QH 3.6 3 mo follow up EP 3.7 11 mo follow up	QH: loose bands EP: poor fit, broken appliance	QH is recommended due to lower costs
Kurol and Berglund[5]							
33 Gr 20 UC 171 NC 3 to 5 y	Clinical examination	Not declared	Gr 21/33 UC 9/20	Not declared	Not declared	Not declared	Since spontaneous correction is common grinding can be unnecessarily
Lindner[18]							
38 GR ~4.3 y 38 UC ~4.3 y ~9 y at follow-up	Study casts	Unknown, but until stable occlusion was achieved	GR 19/38 UC 6/38	GR −0.4/3.3 UC −0.5/2.6	GR 0.7/4.1 UC 0.5/4.1	Not declared	Supports early treatment with grinding
Ranta[36]							
25 QH ~8.6 y 25 EP ~7.6 y	Study casts Sliding calipers	QH 1–2.5 mo EP 11 mo	Not declared	Not declared	QH 3.6 3 mo follow-up EP 3.7 11 mo follow up	QH: felt pain EP: poor fit, broken appliance	QH is recommended due to lower costs

TABLE 3. Continued

Article Material and Age	Methods/ Measurements	Treatment Time/ Retention Time	Success Rate	Expansion Obtained Molars/ Cuspids (mm)	Expansion Remained Molars/ Cuspids (mm)	Side Effects	Authors' Conclusion
Sandikcioglu and Hazar[37]							
10 QH ~8.6 y 10 EP ~6.6 y 10 RME ~8.9 y	Study casts Cephalometric radiographs	QH 2 mo EP 5.5 mo RME 0.5 mo	QH 10/10 EP 10/10 RME 10/10	QH 5.6/4.9 EP 4.1/4.1 RME 5.5/3.2	QH 5.1/3.3 EP 3.6/3.7 RME 5.4/3/3 3 to 7 mo follow up	Not declared	All appliances effective More skeletal effects with RME and QH
Thilander et al[38]							
33 GR ~5 y 28 UC ~4 y 25 NC ~4 y 13 y at follow up	Clinical examination	Not declared	GR 9/33 EP 17/33 UC 6/28	Not declared	Not declared	None	Griding in the primary dentition QH in the early mixed dentition if no effects is obtained by grinding
Tsarapatsani et al[39]							
15 QH ~4 y 14 GR ~4 y 20 y at follow up	Clinical examination Study casts Photos	Not declared	QH 15/15 GR 8/14 Long-term QH 9/15 GR 8.14	Not declared	Not declared	Not declared	No long-term difference between QH and GR

[a] QH indicates quad-helix; EP, expansion plate; GR, grinding; RME, rapid maxillary expansion; UC, untreated control group; and NC, normal control group.

ment strategies without any untreated or normal control group involved. No restrictions were set for sample size, but abstracts, case reports, case series, review, and opinion articles were not considered. Articles written in English, German, French, and Scandinavian languages were included. The reference lists of the articles retrieved finally were also hand-searched for additional studies.

Data collection and analysis

Data were extracted on the following items: year of publication, study design, materials, dropouts, measurements, treatment time, success rate, expansion obtained, expansion remained, side effects, costs, and author's conclusion. Additionally, to document the methodological soundness of each article, a quality evaluation modified by the methods described by Antczak et al[28] and Jadad et al[29] was performed with respect to preestablished characteristics. The following characteristics were used: study design, sample size and prior estimate of sample size, selection description, withdrawals (dropouts), valid methods, confounding factors considered, for example, sucking habits, method error analysis, blinding in measurements, and adequate statistics. The quality was categorized as low, medium, and high.

Two independent reviewers assessed the articles separately (Dr Petrén and Dr Bondemark). The data were extracted from each article without blinding to the authors, and interexaminer conflicts were resolved by discussion on each article to reach a consensus. One author (Dr Söderfeldt) performed the quality evaluation of the statistical methods used in the articles.

RESULTS

The search strategy resulted in 1001 articles. After selection according to the inclusion/exclusion criteria stated in Table 1, 12 articles[5,18,30–39] qualified for the final review analysis/result report. The main reasons for exclusion were technical and clinical presentation of appliances, trials not comparing at least two treatment strategies (case series), case reports, studies concerning treatment in permanent dentition/adult patients, surgically assisted treatment, treatment combined with extractions, or full-fixed appliances and discussion or debate articles. Seven of the studies[5,18,30,32,35,38,39] were performed in Sweden, two in Turkey,[34,37] one in Denmark,[33] one in United States,[31] and one in Finland.[36]

Study design and treatment modalities

The study design of the 12 articles is shown in Table 2, and the results of the review are summarized in Tables 3 and 4. Only two RCTs had been performed.

The treatment modalities Quad-helix (QH) and expansion plates were compared in five studies,[32–36] and one study[37] compared treatment with QH, expansion plate, and rapid maxillary expansion (RME). Four studies[5,18,30,38] evaluated the effects of grinding vs no treatment, whereas one study[39]

compared QH and grinding. One study[31] analyzed and compared QH treatment in the primary dentition with QH treatment in the early mixed dentition.

Success rate

The success rate was reported to be 100% or close to 100% for treatment with QH and RME. For expansion plates, the success rate reported was between 51% and 100% and for grinding, between 27% and 90%. Spontaneous correction was found to occur between 16% and 50% in the untreated control groups (Table 3).

Treatment time and expansion effects

The treatment time for QH varied between one and 7.7 months and that for expansion plate between four and 14 months. For RME, the treatment time was 19 days (Table 3).

The mean expansion obtained immediately after treatment for QH varied 3.3–6.4 mm in the molar region and 1.3–5.2 mm in the canine region. For expansion plate treatment, the corresponding figures were 2.6–4.7 mm and 0.7–4.1 mm and those for RME were 5.5 and 3.2 mm. When grinding was performed, minor expansion effects were found in the molar region and up to three mm in the canine region (Table 3).

In most of the articles, the expansion effect was followed longitudinally, however, there was a wide range in follow-up time (three months to seven years). Thus, the remaining expansion, ie, expansion after retention or follow-up, varied for QH between 3.6 and 5.1 mm in the molar region and between 2.2 and 3.3 mm in the canine region. For expansion plates, the corresponding values were 3.1–3.7 mm and 2.5–3.7 mm. The remained expansion in the molar and canine region for RME was 5.4 and 3.3 mm, respectively (Table 3).

Comparison of expansion effects between the treatment strategies

Three studies[32,35,36] found QH equivalent to expansion plates. One study[37] judged the expansion effect of RME, QH, and expansion plate of equal value but with a more skeletal effect with QH and RME. Two studies[33,34] reported significantly more expansion of QH compared with expansion plates. However, in these two studies divergent results were found regarding tipping of posterior teeth. Boysen et al[33] found more tipping in the expansion plate group compared with the QH group, whereas in the study by Erdinc et al,[34] the QH group showed the most tipping.

The effect between QH and grinding was compared in one study,[39] and an equal success rate in the long term was found.

Four studies[5,18,30,38] analyzed the treatment effect between grinding and spontaneous correction, and two of these[5,30] found that the effect of spontaneous correction was almost equal to the grinding effect, whereas two studies[18,38] supported grinding as treatment in the primary dentition.

Side effects and costs

Four studies[31,35,36,38] reported on whether there were any side effects during the treatment (Table 3). Loose bands for QH and poor fit and broken appliances for expansion plates were the most frequent side effects reported. Only two studies[35,36] had performed a cost analysis. In these studies, the costs of QH and expansion plates were compared, and both studies found that there were lower costs with QH treatment.

Quality analysis

The analysis revealed that the research quality or methodological soundness was low in eight studies and of medium quality in four studies (Table 4). The most obvious shortcomings were small sample sizes implying low power, problems of bias and confounding variables, lack of method error analysis, blinding in measurements, and deficient or lack of statistical methods. Furthermore, no study declared any power analysis or discussed the possibility of type-II error occurring.

One study[18] was judged to have an adequate sample size, whereas the other studies had partly sufficient or insufficient sample sizes implying low power with high risk to achieve insignificant outcomes (Table 4). The selection description was adequate or fair in all studies. Withdrawals (dropouts) were declared in 11 of the 12 studies, and in these studies, the number of dropouts was generally low (Table 4). No study declared the presence of ethical approval.

Considering the confounding variable sucking habit, three studies[5,30,38] declared that some patients still had a sucking habit during the study period, and in three other studies,[18,32,39] patients with sucking habits were excluded. Six studies[31,33–37] did not comment or consider this matter at all.

In all studies, the methods used to detect and analyze the treatment effects were valid and well known. However, only four studies[32–34,37] included a method error analysis, and none of the studies used blinding in measurements (Table 4).

Three studies used proper statistical methods (Table 4). For the others, there was mainly a shortcoming in disregard of the risks for mass significance, with very many variables used for significance testing. There were also a couple of instances where there was no statistics used despite clear quantitative research aims. In one case,[34] the choice of test method was inadequate, nonparametric tests on interval level data.

TABLE 4. Quality Evaluation of the Retrieved Studies

Article Sample Size	Previous Estimate of Sample Size	Selection Description	Withdrawals	Valid Methods	Confounding Factors Considered	Method Error Analysis	Blinding in Measure-ments	Adequate Statistics Provided	Judged Quality Standard
Admund et al[30] Insufficient (20 + 20)	No/unknown	Adequate	Unknown	Yes	Sucking habit present in some cases	No	No	No statistics provided	Low
Bell and LeCompte[31] Insufficient (5 + 5)	No/unknown	Adequate	None	Yes	Not declared	No	No	Partly, risk of mass significance	Low
Bjerklin[32] Insufficient (19 + 19 + 19)	No/unknown	Adequate	Yes, 2 QH and 1 EP discarded	Yes	No subjects with sucking habits	Yes	No	Yes	Medium
Boysen et al[33] Insufficient (17 + 17)	No/unknown	Adequate	None	Yes	Not declared	Yes	No	Partly, risk of mass significance	Medium
Erdinc et al[34] Insufficient (13 + 14 + 10)	No/unknown	Adequate	None	Yes	Not declared	Yes	No	Inadequate	Low
Hermansson et al[35] Insufficient (27 + 17)	No/unknown	Adequate	None	Yes	Not declared	No	No	No statistics provided	Low
Kurol and Berglund[5] Partly insufficient (33 + 20 + 171)	No/unknown	Adequate	Yes, 3 discarded	Partly	Yes	No	No	No statistics provided	Low
Lindner[18] Sufficient (38 + 38)	No/unknown	Adequate	None	Yes	Yes	No	No	Yes	Medium
Ranta[36] Insufficient (25 + 25)	No/unknown	Adequate	None	Yes	Not declared	No	No	No statistics provided	Low
Sandikcioglu and Hazar[37] Insufficient (10 + 10 + 10)	No/unknown	Partly adequate	None	Yes	Not declared	Yes	No	Partly, risk of mass significance	Low
Thilander et al[38] Partly sufficient (33 + 28 + 25)	No/unknown	Adequate	Yes, 7 discarded	Partly	Yes	No	No	No statistics provided	Low
Tsarapatsani et al[39] Insufficient (14 + 15)	No/unknown	Adequate	None	Yes	Yes	No	No	Yes	Medium

DISCUSSION

Effectiveness and long-term effects of early treatment

In this systematic review, an exhaustive literature search attempted to find all randomized and controlled clinical trials and all prospective and retrospective observational studies with concurrent controls as well as observational studies comparing different treatment modalities for early treatment of unilateral posterior crossbite. Although it was not possible to combine the data statistically because of heterogeneity, some consistent results among the 12 studies were found. Two RCTs[18,38] evaluated the effects of grinding vs no treatment, and both studies came to the conclusion that

it was beneficial to perform grinding in the primary dentition.

Regarding intervention in the early mixed dentition, a high success rate was found and a substantial expansion effect was shown of treatment with QH, expansion plates, and RME. However, the remaining expansion, ie, expansion after retention and follow-up, was difficult to analyze and interpret because the follow-up time varied substantially among the studies (range three months to seven years). Furthermore, regarding the comparison of treatment modalities, the evidence was too weak to draw any conclusions, ie, no randomization, small sample sizes, and the fact that most authors did not mention how or whether the confounding variables were regarded.

Nine[5,18,30,32,33,35,36,38,39] of the 12 studies were performed in the Nordic countries. This may be explained by the structure of the dental health systems in these countries, where preschool and school children are examined annually at their local dental clinic. This conceivably facilitates the accessibility to large number of patients with different occlusal deviations and, therefore, makes it easier to perform short- and long-term studies. Furthermore, in these countries there has been a long tradition of early intervention and correction of posterior crossbites either by occlusal adjustment or by maxillary expansion.

Quality of the studies

Several methods and scales to incorporate quality into systematic reviews have been proposed[28,29,40] and have since been extensively applied to miscellaneous RCTs in medicine. However, application of these scales to the present trials was not without problems. Many items suggested were clearly not applicable, for example, placebo appearance/taste, patient blinded or observer blind to treatment. Moreover, one item of the original scale (retrospective analysis) could not be used because its definition did not clearly state what was meant with the retrospective analysis. Therefore, it was decided not to use the suggested scoring system in this review. Instead, the quality of the articles was judged as low, medium, or high according to the characteristics in Table 4.

In most of the studies, there were serious shortcomings, such as small sample sizes, no previous estimate of sample size, or no discussion on the possibility of type-II error occurring. The sample size required to make the observed differences statistically significant would have been very informative to the readers. Problems of bias and confounding variables, lack of method error analysis, blinding in measurements, and deficient or lack of statistical methods were other examples of shortcomings in most of the studies. However, it was encouraging that withdrawals (dropouts) were well declared in 11 of the 12 studies and that the number of dropouts was generally low.

The presence of a sucking habit may cause a crossbite and also counteract the effects of an expansion treatment. Consequently, in studies regarding treatment of crossbites, sucking habits must be considered as a confounding variable. Thus, presence or absence of a sucking habit is useful information when evaluating the results, and therefore, it was remarkable that six of the 12 studies did not make any comments or declare this matter (Table 4).

In all studies, the methods used to detect and analyze the treatment effects were valid and well stated. However, only four studies included a method error analysis (Table 4). From a methodological point of view, no study declared use of blinding in measurement or analysis. For example, it has been shown that nonrandomized trials or RCTs without double-blind design are more likely to show the advantage an innovation has over a standard treatment method.[41] Also, RCTs in which treatment allocation was inadequately concealed showed significantly larger treatment effects than did trials using adequate concealment.[42] This implies that the measurements can be affected by the researcher.

Many studies were defective according to statistical quality or did not use statistics at all. This might influence the outcome reliability of the studies. Particularly, the implications of statistical significance do not always seem to be realized. Multivariate methods should also have been used to a greater extent. Moreover, the possibility of type-II error occurring was not discussed.

The results of this quality analysis were somewhat disappointing and similar shortcomings of study results have also been presented in another systematic review by Harrison and Ashby.[25] Moreover, in a meta-analysis on the stability of maxillary expansion by Schiffman and Tuncay,[43] it was concluded that maxillary expansion stability was minimal and that there was no adequate literature available to study the effect of maxillary expansion because the reason for expansion, ie, skeletal or dental correction or anterior-posterior correction was not stated.

Why were so few RCTs found on early treatment of posterior unilateral crossbite? Overall, RCTs have been used rarely in orthodontics[44] and one reason might be the practical difficulty to gather many patients with a certain occlusal deviation. Another reason can be ethical or logistic because the patients in an RCT do not have the right to choose treatment and some can be designated to an untreated control group in which the treatment is postponed during the study period and, therefore, refuse to participate in the trial. Thus, to perform RCTs demands an enthusiastic research team, well-motivated patients and parents, and, in many cases, also sufficient financial resources. Still, it is no doubt a practical task and challenge in the field of early intervention of unilateral posterior crossbite.

A randomized clinical trial is our most powerful tool to evaluate therapy, and the quality of the trial significantly affects the validity of the inferences.[29] In our opinion, there is an urgent need for and a great possibility of conducting well-controlled RCTs regarding the effectiveness of differ-

ent treatment strategies and for assessing which treatment is the most effective in early treatment of unilateral posterior crossbite. Future studies should also include assessments of long-term stability as well as analysis of costs and side effects of the interventions. To facilitate this, the researchers have to focus on and make efforts to avoid bias by using well-defined matched groups and sufficient large sample sizes, using randomization of therapies with untreated controls, taking the opportunity to perform blinding in measurements, and using proper method error analysis and correct statistical methods.

CONCLUSIONS

The aim of this systematic review was to find out whether early treatment of crossbite is effective, which treatment modality is the most effective, and whether the treatment results are stable in the long run. After assessing the quality of the retrieved articles, it may be concluded that these questions cannot be fully answered.

- Only two RCTs of early treatment of crossbite have been performed, and these two studies support grinding as treatment in the primary dentition.
- The treatment strategies QH, expansion plates, and RME are effective in the early mixed dentition at a high success rate. However, there is no scientific evidence available that shows which of the treatment modalities, grinding, QH, expansion plates, or RME, is the most effective. Consequently, no conclusions could be drawn regarding stability in the long term, especially because the follow-up time varied substantially among the studies.
- Most of the studies have serious problems of lack of power because of small sample size, bias, and confounding variables, lack of method error analysis, blinding in measurements, and deficient or lack of statistical methods. Thus, the studies did not reach a quality level sufficient enough to draw any evidence-based conclusions.
- To obtain reliable scientific evidence, better-controlled RCTs with sufficient sample sizes are needed to determine which treatment is the most effective for early correction of unilateral posterior crossbite. Future studies should also include assessments of long-term stability as well as analysis of costs and side effects of the interventions.

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