Long-term Stability of Anterior Open bite Correction: a Systematic Review

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Abstract

Background: Anterior open bite is one of the malocclusions the most commonand the most difficult to treat successfully. The real challenge remains the stability of this correction over time. Evidence based dentistry related the long-term stability of the correction of open bite are limited. The evidence based on the long-term stability of open bite correction is to be searched in systematic reviews. The purpose of thissystematic reviewwas to evaluate the long-term stability of anterior open correction.

Methods: Electronic databases were searched and nonelectronic journals were hand searched on the long-term stability of anterior open bitecorrection. The appropriate papers for an inclusion in this review were found and analyzed. Their scientific quality was estimated and the data which they contain extracted and summarized.

Results: The electronic and hand searches retrieved *598* unique citations but 29 articles were eligible for evaluating their quality and data extraction. More than half of the studies had a high risk of bias*(58.62%);* when *13.79*% were low risk and 27.59 % a moderate risk of bias.The combination of orthognathic surgery associated with orthodontic treatment was the most commonly used involving 600 patients. The rate of open bite relapse was 31.28 %.

Conclusion: Taking into account the limitations of the study design and the quality of the papers included in this review, anterior open bite correction are not stable one year after treatment in about one third of the patients. ***Key words:*** Systematic review;open bite;Stability;Relapse.

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Introduction

The long term stability of open bite correction is still a real challenge regardless the implemented therapeutic modality[1-5]. It would depend on many factors such as age or stage of maturation, the type of treatment used and the etiological factors implicated[6]. The stability of the results obtained at the end of treatment remains controversial. Information's available on this topic were certainly plentiful, but also fragmented, contradictory, sometimes redundant and not always independent. Attempts to summarize them in narrative literature reviews were undertaken. But the risk of very important bias to this type of protocol,put them in the last row of the levels of scientific evidence. The best way to examine in comprehensive and explicit medical literature and to make an objective synthesis remains the systematic review. The objective of this study is to compile in a systematic literature review the best available evidence on the stability of the results of open bite correction.

Materials and Methods

A systematic review of the literature was realized. In this perspective, a research question was formulated, on the basis of PICO format (Patient-Intervention-Comparison-Outcome) (Table I).

Table I: PICO format and research question

PICO format	
Patient	Patients of any ages, genders and ethnic groups with no history of craniofacial syndromes
Intervention	Open bite correction
Comparison	Where applicable between different types of treatments, age ranges and facial characteristics
Outcome	Long-term stability of open bite correction
Research question	
Do patients who received treatment resulted in open bitekeepstable treatment outcomes over time?	

SYSTEMATICREVIEWARTICLE

Ad-hoc search strategy intended to find all the relevant papers on the question was implemented. The quality of the studies meeting the inclusion criteria was evaluated and data collected and analyzed.

Study eligibility criteria for an inclusion in this review

Given the substantial difficulties in the implementation of randomized controlled trials (RCTs) on the stability of open bite correction, rarity or perhaps their lack was suspected. Thus, it was decided to include all clinical cross-sectional, prospective and retrospective studies available provided that:

- The subjects had received open bite correction
- It is performed exclusively in humans;
- The stability of open bite correction is the main purpose;
- The follow up has taken at least one year after removal of the appliances;
- The subjects are free of craniofacial syndromes which can lead to open bite or affect its treatment and stability.
- The number of cases is equal to at least five subjects.

Database search strategy

To find the appropriate articles, a search was first conducted in the following databases: PubMed,Embase, Cochrane Library, Lilacs and OpenGrey (1966 to the second week of May 2011). The main terms used in the search were open bite, stability, long term, follow up. The reference lists of the retrieved articles were also hand searched for additional relevant publications that might have been missed in the database searches. Websites of major orthodontic journals (American Journal of Orthodontics and Dentofacial Orthopedics, Angle Orthodontist, European Journal of Orthodontics, Journal of Orthodontics, Journal of Clinical Orthodontics, Orthodontics and Craniofacial Research) were also checked.
Keywords used on different databases are shown in Table II.

Study selection

Studies provided by the electronic search in different databases and hand searched were reviewed initially by browsing their title and abstract. Three reviewers independently examined and selected studies for inclusion in this review. Studies that clearly were not relevant for inclusion were excluded at this stage. The full copies of study which reading titles and abstracts, was not sufficiently informative for final inclusion in the review were required. Following this selection work carried out independently by the same reviewers, a comparison of their results was carried out, and any disagreements were resolved by discussion until consensus.

Table II: Research strategy applied to different databases

Database	Keys words
Medline	(OPEN BITE) AND (Stability OR Relapse OR Postretention OR Follow-up OR Long term OR Longitudinal)
Embase	(Open bite OR Open-bite OR Openbite) AND (Stability OR Relapse OR Postretention OR Follow-up OR Long term OR Longitudinal)
Cochrane library	(Open bite OR Open -bite OR Openbite) and (Stability OR Relapse OR Postretention OR Follow -up OR Long term OR Longitudinal)
Lilacs	(Open Bite AND Stability)
Open Grey	Open bite

Assessment of study quality

Two orthodontists evaluated independently

the quality of the studies on the basis of a table established from the recommendations proposed by *Chan and Bandhari*[7] *and Yang et al.*[8]. This table of evaluation of the studies contains 10 questions. The possible answers are "Yes", "No" or "Uncertain". A score of 2 is given if the answer is "Yes", 1 if the answer is "Uncertain" and 0 if the answer is "No". The maximal score that an article can get is 20 and the minimal score is 0. Any study bringing together a score =12 points was considered to have a high risk of bias, a score > 12 and = 15 a moderated risk of bias and a score > 15 a low risk of bias.

Data extraction

Data were extracted independently by one trained orthodontist on an Excel spreadsheet. Parameters collected from each study were: author name, study population (age, gender), age at the start of treatment, type of intervention, outcome, duration of follow-up, results after treatment and after retaining, relapse rate.

Results

The electronic and hand searches retrieved 598 unique citations, which were entered into a QUORUM flow chart to illustrate the path for selecting the final articles (Figure 1):

Study selection

After evaluating titles and abstracts by the 3 reviewers, 520 articles were eliminated. Seventy eightarticles were selected for more detailed based on a full report or offprint of the articles. Evaluating the full texts resulted in the exclusion of 21 of them according to the inclusion criteria described above. Fifty articlesthatfulfilledtheinitial selectioncriteria were identified. After assessing, 21 articles were rejected because the data were not extractable (qualitative assessment or problems of translation of the articles in German). The remaining 29 articles were eligible for evaluating their quality and data extraction.

Assessment of study quality

The results of the evaluation of the quality of the articles are listed in Table III.More than half of the studies had a high risk of bias(58,62%); when 13.79% were low risk (with a score> 15) and 27.59 % a moderate risk of bias (score> 12 and = 15) (Table IV).

Data extraction

The information contained in the remaining 29 articles were extracted and a summary of the sample size, age at the start of treatment (years), method of treatment, results, duration of the follow up after treatment, stability parameters and the rate of relapse

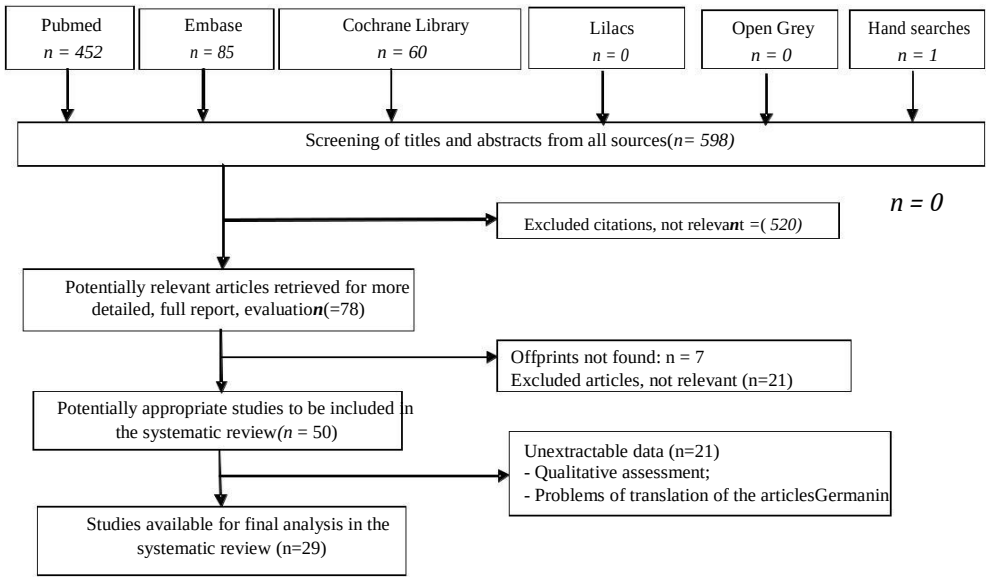

Figure 1: QUOROM flow diagram of the citations retrieved by titles and abstracts and trials evaluated in full text.

Table III: Assessment of study quality

Authors/ Years	Aims	Patients	JudgingCriteria			Carrying out the study			Résultats		final score
		Inclusion/ Exclusion criteria	*Description*	*Validity*	*Unchangedduringfollow up*	*Prospective data registration*	*consecutive inclusion*	*12 monthsfollow up*	*Clarityresults*	*Stratification*	
Akkaya et Haydar 1996 (9)	2	0	0	1	2	0	0	2	2	0	9
Arpornmaeklong et Heggie 2000 (10)	2	0	2	2	2	0	0	2	2	2	14
Baek et *al.* 2010 (11)	2	2	0	0	2	0	0	2	2	0	10
Bailey et al 1994 (12)	0	2	0	1	2	0	1	1	2	0	9
Bianchi et *al.* 2009 (13)	2	0	2	2	2	0	0	2	0	2	12
Bisase et *al.* 2010 (14)	2	1	0	0	2	0	0	1	0	0	6
De Freitas et *al.* 2004 (15)	2	0	2	2	2	0	0	2	2	2	14
Ding et *al.* 2007 (16)	2	1	2	2	2	0	0	2	0	0	11
Espeland 2008 (17)	0	0	0	1	2	0	2	1	2	1	9
Fischer et *al.* 2000 (18)	2	0	0	0	2	0	2	1	2	2	11
Haymond et *al.* 1991 (19)	2	0	2	2	2	0	0	1	0	0	9
Iannetti et *al.* 2007 (20)	2	2	2	2	2	0	0	1	2	2	15
Janson et *al.* 2003 (21)	2	0	2	2	2	0	0	2	2	0	12
Janson et *al.* 2006 (22)	2	0	2	2	2	0	1	2	2	2	15
Katsaros et Berg 1993 (23)	2	2	2	2	2	0	0	2	2	0	14
Kucukkeles 1999 (24)	2	0	0	1	2	0	0	2	2	0	9
Lo et Shapiro 1998 (25)	2	1	2	2	2	0	2	2	2	2	17
Maia et *al.* 2010 (26)	2	2	2	2	2	0	0	2	2	2	16
Mccance et *al.* 1992 (27)	1	1	0	0	2	0	0	1	1	1	7
Moldez et *al.* 2000 (28)	2	2	2	2	2	0	1	2	2	2	17
Proffit et *al.* 2000 (29)	0	2	1	2	2	0	1	1	2	2	13
Remmers et *al.* 2008 (30)	2	2	2	1	2	0	1	2	2	0	14
Ricard et Ferri 2009 (31)	2	2	0	1	0	2	1	1	0	0	9
Smithpeter et Covell 2010 (32)	2	0	1	2	2	0	1	0	1	2	11
Stansbury et *al.* 2010 (33)	2	2	2	0	2	0	0	1	2	0	11
Sugawara et *al.* 2002 (34)	2	1	2	0	2	0	1	2	2	0	12
Swinnen et *al.* 2001 (35)	2	2	2	2	2	0	2	1	2	2	17
Teittinen et *al.* 2011 (36)	2	0	0	0	2	0	0	2	2	2	10
Zuroff et *al.* 2010 (37)	2	1	2	2	2	0	0	2	2	1	14

from each of these studies is shown in Table V. All these articles are in English and have been published between 1991 and 2011. They have an average age of 7.65 years. The overall study population of these 29 articles was 954 subjects with a mean age of 22.61 years. Some studies did not provide the age of their patients. This problem affects 61 patients. The kind of treatment these patients received to correct the open bite is distributed as follows:

- The fixed orthodontic appliances only was used in8 articlesincluding 254 patients
- The fixed orthodontic appliances associated with a myofunctional treatment has been used in 4 articlesand included 100 patients.

A combination of orthognathic surgery associated with orthodontic treatment has been used in 16 studies involved 600 patients. LefortImaxillary surgery was performed in 403 patients. It was linked with anObwegeser / Dalpont mandibular osteotomy in 197 patients. The treatment was successful in all patients with a positive overbite.

The mean duration of follow-up in these patients was at least one year and a maximum of 15 years. The rate of open bite correction relapse was produced by 21 studies. It is equal to 31.28% and concerned 744 subjects included in these 21 studies. The remaining 8 articlesdo not provide data on the relapse rate.

However they determined an average relapse in millimeters difficult to analyze.

Discussion

The best orthodontic literature on the stability of open bite correction was compiled and summarized in this review. On an initial of 598 articles retrieved for inclusion in the study, only 29 were selected. The final inclusion date of studies in this review is November, 11th 2012.In comparison, the systematic review of Greenlee et al.[38]which is the only prior study to be carried out on this subject, had included 21 items on an initial total of 428. It should be noted that the last inclusion of studies in this review datedfrom the second week of May 2011, while those of Greenlee dated from April 2009. Nearly two years separate the date of the latest inclusions in these studies.

Table IV: Risk of bias in included studies

Risk of bias	Number of studies	
	Number	Percentage (%)
High	17	58,62
Moderate	8	27,59
Low	4	13,79
Total	29	100

This review is the second on this topic. Nevertheless it has some limitations mainly linked to the choice of the kind of study and the assessment of study quality. Indeed, systematic reviews of clinical issues usually include randomized controlled trials. This systematic review includes case reports. This approach is based on the fact that in the specific issue of the anterior open bite, there is no better than cases reports and as Jadad[39] said,

« The best scientific evidence-based is the appropriate and available one»

The quality of studies was assessed objectively and quantified using a score table developed specifically for this study. Studies with a high risk of bias represent more than half of the studies included in this review (58.62%). The main defect of these studies lies in their conduct. In fact, of all the studies included in this review, only one has proceeded to a prospective data registration. Others items have a score of "0" for this criterion. The same observation applies to consecutive inclusion of patients which is one of the qualities required for a report of case reports. Seventeen studies on a total of 14 (ie 78.57%) have failed this criterion. Recent studies have better quality with scores > 12. Comparatively, Greenlee et al., Who used another system of assessment found a scoreequal to 10.3. These authors have classified these studies generally poor.

With a mean age of 22.61 years, the majority of patients included in this study, is adult. This is less interesting to the extent that the analysis of the stability of open bite correction in youngest subjects would have data on the benefit of treatment made ??during growth. Orthognathic surgerywas the most therapeutic method used and concern16 articles, slightly more than half of the included studies. Orthodontic appliances only (n=8) or associated with a myofunctional treatment (n=5) has been used in 45% of the articles. Similar results were reported by Greenlee et al.[38] who found that surgery was performed in 11items including 7 bimaxillaryosteotomies and 4 Lefort 1 maxillary impaction only. All studies included in this review reported open bite correctionat the end of treatment with positive overbite from 0 to several millimeters.In terms of stability, 31.28% had relapsed.This indicates that therapeutic results are not stable one year after treatment in about one third of the patients. We can conclude that 30% of patients treated for open bite may lose the benefit of this treatment after one year. Greenlee et al.[38] reported stability rate averaging 82% for those who underwent surgical treatment and 75% for those who had orthodontic treatment. The differences between this study and ours may be related to differences in the articles included in the 2 systematic reviews. Bondemark et al. carried out a systematic review on the stability of orthodontic treatment in general without taking into account particular malocclusion[40]. Their analysis of the data was not sufficiently complete to give a percentage

Table V:Characteristics of included studies

Auhors , date	Participants (n)	Ageat the start of reatment (years)	Interventions	Outcomes	Duration of follow-upafter reatment	Treatmentstabilityparameters	Relapse (rate / mean)
Akkaya et Haydar 1996 (9)	10 patients	9.87	spring-loaded posterior bite blocks	overbitebetween 1 and 1.5 mm	> 2 years	overbitebetween 1 and 1.5 mm	1. 90% = relapse over than 0.5mm 70% of open bite
Arpornmaeklong et Heggie 2000 (10)	37 patients 28 females 8 males	21.7	orthognathic surgery + fixed orthodontic treatment. G1 : 17 Lefort 1 G2 : 20 Lefort 1 + bilater sagittal section mandibularramusosteotom	Mean overbite G1 : 2.6±1.8 mm G2 : 1.6±3.0 mm	22.9 months	Meanoverbite G1 : 0.9± 1.8 G2 : 0.7± 1.5	Mean relapse G1 : 0.0 = 2.3 G2 : 0.4 = 1.6
Back et *al.* 2010 (11)	9 patients 1 male 8 females	23.7	Orthodontic treatment maxillary posterior teeth. intrusion with miniscreew	Mean overbite 1.65 mm Mean open bite correction : 5.56 ±1.94 mm	3 yearsat least	Meanoverbite 0.66 ± 0.79 mm	Mean relapse 0.99± 1.5 mm
			orthognathic surgery Superior repositioning of the maxilla by Le Fort 1 osteotomy	Meanoverbite 1.30= 1.46 mm	5 yearsat least	Meanoverbite 1.30= 1.46 mm	0.80 ± 1.28 mm

of relapse which would permit a comparison with the results of our study.

Conclusion

About one half of the studies included had a high risk of bias. Patients included were generally adults and were mostly treated with combined orthodontic orthognathic surgery. The treatments used were all successful but 31.28% of patients had a post-treatment relapse of a few millimeters. Under the limitations of the design and the quality of the items included in this systematic review, one third of patients treated for an open bite may lose the benefit of this treatment after one year.

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