

Long-term skeletal stability after maxillary advancement with distraction osteogenesis in cleft lip and palate patients

A systematic review

Humam Saltaji^a; Michael P. Major^b; Mostafa Altalibi^b; Mohamed Youssef^c; Carlos Flores-Mir^d

ABSTRACT

Objective: To systematically review the long-term skeletal stability after maxillary advancement with distraction osteogenesis (DO) in cleft lip and palate (CLP) patients.

Materials and Methods: Electronic databases, grey literature, and reference list searches were conducted. The inclusion criteria were stability of maxillary advancement with distraction osteogenesis assessed at the posttreatment follow-up ≥ 1 year in CLP patients. Full articles were retrieved from abstracts or titles that appear to meet the inclusion criteria or lacked sufficient detail for immediate exclusion. Once full articles were collected, they were again reviewed considering more detailed inclusion criteria for a final selection decision. A methodologic quality assessment tool was utilized.

Results: Thirty abstracts/titles met the initial search criteria, and 13 articles were finally selected. Overall, methodologic quality scores were high in only one randomized clinical trial. After maxillary advancement with DO in CLP patients, the long-term horizontal relapse in A-point was less than 15% in eight studies and between 20% and 25% in four studies. The study that was judged as a high-quality study reported 8.2% horizontal relapse in A-point. The relapse rate was higher in DO with external distracter device than DO with internal distracter device.

Conclusions: Current evidence suggests maxillary advancement with DO has good stability in CLP patients with moderate and severe maxillary hypoplasia. (*Angle Orthod.* 2012;82:1115–1122.)

KEY WORDS: Stability; Distraction osteogenesis; Cleft lip and palate; Systematic review

INTRODUCTION

Patients with cleft lip and palate (CLP) usually develop a significant maxillary hypoplasia that requires

orthognathic surgery procedures. These surgeries are indicated in approximately 25% to 40% of CLP patients and aim to achieve functional and esthetic results by advancing the maxilla.^{1,2}

The traditional and standard surgical procedure for correcting associated maxillary retrusion is the conventional Le Fort I osteotomy.³ Over the last 15 years, distraction osteogenesis (DO) has become an apparently effective and reliable alternative technique in the management of maxillary hypoplasia in CLP patients.^{4,5}

Management of maxillary hypoplasia in CLP patients has been a challenge for the reconstructive team as the surgical approach may not be stable enough.² One of the features of DO is that it allows for a progressive bone regeneration accompanied by more gradual soft tissue adaptation, which may contribute to less relapse.² This is crucial, especially in the management of CLP patients, because of the increased soft tissue tensions due to scar contracture.⁵

It is important, therefore, to assess not only the immediate post intervention effects but also the long-term effects and relapse. A previous literature review

^a PhD Graduate Student, Orthodontic Graduate Program, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Canada.

^b MSc Graduate Student, Orthodontic Graduate Program, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Canada.

^c Professor and Dean, Department of Orthodontics, Faculty of Dentistry, Damascus University, Damascus, Syria.

^d Associate Professor and Head of the Division of Orthodontics, Faculty of Medicine and Dentistry, University of Alberta, Edmonton, Canada.

Corresponding author: Humam Saltaji, DDS, MSc Ortho, Orthodontic Graduate Program, University of Alberta, 5528 Edmonton Clinic Health Academy, Edmonton, Alberta, Canada, T6G 1C9
(e-mail: saltaji@ualberta.ca)

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of cleft maxillary osteotomy and DO found that both techniques, conventional Le Fort I osteotomy and DO, can achieve a pronounced improvement with no differences in velopharyngeal function, speech, and short-term stability.⁶ This review assessed post intervention effects, but did not consider the long-term stability. Additionally, it was published in 2006 and, thus, new data may have become available that could challenge its conclusions. The objectives of this article are, therefore, to systematically review the long-term skeletal stability after maxillary advancement with DO in CLP patients and to update previous evidence-based recommendations with new findings.

MATERIALS AND METHODS

The research design of this article was a systematic review of the literature. Reporting of this systematic review was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for reporting systematic reviews of studies that evaluate health care interventions.⁷ No ethics approval was required for this research as there was no human or animal intervention.

Data Sources and Searches

Electronic searches up to December 9, 2011 were conducted using the following electronic bibliographic databases: PubMed (1966 to December 2011, week 2), MEDLINE (1980 to 2011, week 52); Embase (1980 to 2011, week 52); ISI Web of Science (1965 to December 9, 2011); EBM (Evidence-Based Medicine) Reviews: Cochrane Central Register of Controlled Trials (CCTR) (1991 to 4th quarter of 2011); all EBM Reviews, comprising the Cochrane Database of Systematic Reviews (CDSR), ACP (American College of Physicians) Journal Club, Database of Abstracts of Reviews of Effects (DARE) (1991 to 4th quarter of 2011); and HealthSTAR (1966 to November 2011). Key words used in the search were: "cleft," "distraction osteogenesis," "relapse," "stability," "recurrence," and "follow-up studies." Table 1 provides details on the specific search terms and combinations used in each individual database.

The electronic searches were developed with the assistance of a librarian specializing in health science databases. The literature search also involved searches through the bibliographies of relevant publications. No restrictions were applied regarding publication year or language. The references resulting from the searches were entered in EndNote X4, and within this program duplicates were electronically removed. When additional information was needed, efforts were made to contact the authors.

Study Selection

Appropriate studies to be included fulfilled the following predefined inclusion criteria:

- *Population:* Cleft lip and/or palate patients.
- *Intervention:* Surgical therapy of maxillary hypoplasia with distraction osteogenesis.
- *Outcome:* Stability of the outcome assessed at least 12 months post treatment.
- *Study design:* Randomized and nonrandomized controlled clinical trials, clinical trials, case series studies, and prospective and retrospective studies were included. Case reports with $\leq$ five subjects, animal studies, systematic reviews, meta-analyses, and editorials articles were excluded.

Two researchers independently reviewed the list of titles and abstracts for inclusion. Once potentially adequate abstracts were selected, full articles were retrieved in a second final selection process. If the abstract was judged to contain insufficient information for a decision of inclusion or exclusion, the full article was obtained and reviewed before a final decision was made. Any discrepancies in inclusion of articles between researchers were addressed through discussion until consensus was reached.

Data Extraction and Methodologic Quality Assessment

To perform an analysis of the included studies, data were collected for each selected study on the following items: study design, age, sample size, type of cleft, surgical procedure, latency period, device, rate of distraction, consolidation period, follow-up period, and mean movement and mean relapse in the horizontal and vertical dimensions (Table 2). In addition, to evaluate the methodologic quality of each study, a methodologic quality assessment was performed by analyzing the study design, the study measurements, and the statistical analysis for each selected study (Table 3). The scoring process was a modified version of a previously developed checklist used in a systematic review published by one of the study authors.⁸ Each study was scored by the same two investigators, and discrepancies were resolved by discussion until consensus was reached. The maximum quality score possible was 19. A meta-analysis was planned if the quality of the information retrieved warranted a meaningful statistical combination.

RESULTS

The search strategy returned 310 potential articles for inclusion. The search results from different electronic databases are listed in Table 1.

Table 1. Search Strategies and Results From Different Electronic Databases

Database	Keywords	Results
PubMed	#1 relaps* OR recurr* OR stability OR follow-up studies #2 distraction* osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	108
MEDLINE	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	105
Embase	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	63
ISI Web of Science	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	55
EMB Reviews: Cochrane Central Register of Controlled Trials	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	5
EBM Reviews: Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, and ACP Journal Club	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	0
HealthSTAR	#1 relaps\$ OR recurr\$ OR stability OR follow-up studies #2 distraction\$ osteogenesis #3 cleft OR cleft palate OR cleft lip palate #4 #1 AND #2 AND #3	84
Total electronic databases searches		420
Duplicates		110
Final		310

Of the 310 abstracts, 30 full articles were retrieved for more detailed evaluation. Of the 30 full articles retrieved, only 13 studies fulfilled the final selection criteria and were included in the study.^{2,9-20} No articles were found during grey literature searches or reference list searches. A flow diagram of the literature search is given in Figure 1.

Of the 30 full articles initially selected, seven were excluded because there was no long-term follow-up,²¹⁻²⁷ seven were excluded because of an incomplete report of data,²⁸⁻³⁴ one because Class III patients were included,³⁵ one because it was a literature review,³⁶ and one because it was a meta-analysis.⁶ We attempted to contact the authors of articles with incomplete report of data but no responses were obtained. Table 5 provides the list of the 17 excluded articles and the reasons for their exclusion.

Ultimately, only 13 articles that fulfilled all of the inclusion criteria remained.^{2,9-20} Table 2 provides a study summary of the study design, age, sample size, type of cleft, surgical procedure, latency period, device, rate of distraction, consolidation period, follow-up period, mean movement, and mean relapse in the horizontal and vertical dimensions. Meta-analysis

was not possible due to heterogeneity of outcome measures. Methodologic quality assessment of the finally selected articles resulted in scores ranging from 26% to 87% of the possible total maximum. Methodologic scores are summarized in Table 4.

DISCUSSION

Maxillary surgical advancement is the most common surgical technique for correcting maxillary hypoplasia in CLP patients. Alternatively, distraction osteogenesis is another commonly used technique that may have less relapse. In this systematic review, all of the clinical trials and case series that examined the long-term skeletal stability of DO maxillary advancement were included. For the purposes of this review, postsurgical posterior and superior changes of the maxilla were considered as relapse since the treatment direction is usually an anterior and inferior movement of the maxilla.¹¹

The study designs of the 13 articles were as follows: one prospective randomized clinical trial,¹¹ one prospective clinical trial,¹⁰ one retrospective clinical trial,¹⁶ four prospective case series studies,^{9,13,15,19} and six retrospective case series studies.^{2,12,14,17,18,20} Mean

Table 2. Description of Studies Included in Final Selection

Article	Study Design, Sample Size, Mean Age (years) ^a	Type of Cleft, Surgical Procedure, Latency Period ^b	Device, Rate of Distraction, Consolidation Period ^c	Follow-Up	Horizontal Dimension ^d		Vertical Dimension ^d	
					Mean Movement	Mean Relapse	Mean Movement	Mean Relapse
Aksu et al. ⁹ 2010	P, CS 7 (3 F, 4 M) 21.56 ± 4.73 y	3 UCLP, 4 BCLP High LFI 5 days	RED I 1 mm/d 12 weeks	37.3 months (range, 21–58)	Ant—9 mm	Ant—22% (2 mm)	N/R	N/R
Daimaruya et al. ¹⁰ 2010	P, CT 6 (2 F, 4 M) 21.3 (range, 17.3–26)	6 UCLP Traditional LFI 3 days	RED II 0.5 mm × 2/d 5 weeks	1 year	Ant—9.8 ± 3.3 mm SNA—7.6 ± 1.8°	Ant—13.4% (1 mm) SNA—7.8% (6°)	Ant—7 ± 5.9 mm	Ant—29% (2.03 mm)
Chua et al. ¹¹ 2010	P, RCT 22 ≥ 16	Traditional LFI (segmental in 4 cases) 3 days	ID (Synthes Dis- tractor) 1 mm/d 12 weeks	Up to 5 years	Ant—7 mm Post—7.1 mm	Ant—8.2% (0.6 mm) Post—9.6% (0.7 mm)	Ant—1.3 mm post—0.9 mm	Ant—127.5% (1.7 mm) Post—192.8% (1.9 mm) N/R
He et al. ¹² 2010	R, CS 17 (12 M, 5 F; G1:13, G2:4) G1: 10.8 y; G2: 14.5 y	10 UCLP, 7 BCLP High LFI 5 days	RED 0.5 mm × 2/d 4–12 weeks	G1—2.2 years (range, 1–4.8) G2—2 months	12.84 mm	G1—12% (1.53 mm) G2—61.4% (range, 8–16 mm)	N/R	N/R
Gürsoy et al. ¹³ 2010	P, CS 13 (8 M, 5 F) F—12.8 ± 1.2 y M—13.6 ± 1.3 y	6 UCLP, 3 BCLP, 4 CP High LFI 3–4 days	RED 0.5 mm × 2/d 6–8 weeks	5 years (range, 3.5–6.5)	Ant—12.1 mm Post—10.5 mm SNA—12.4°	Ant—24% (2.9 mm) Post—40% (4.3 mm) SNA—33% (4.1°)	Ant—2.1 mm Post—2.6 mm	After follow up: Ant—2.3 mm Post—4.3 mm
Huang et al. ¹⁴ 2007	R, CS 6 (3 M, 3 F) 10.5 (range, 9.4–12.3)	2 UCLP, 4 BCLP High LFI 5 days	RED I 1 mm/d 6–8 weeks	3.4 years (range, 1.3–5.6)	Ant—9.4 mm Post—6.2 mm	Ant—34% (3.2 mm) Post—43.5% (2.7 mm)	Ant—3.5 mm Post—6.7 mm	After follow up: Ant—8.3 mm Post—10.9 mm
Rachmiel et al. ¹⁵ 2006	P, CS 18 (Range, 11–22)	10 UCLP, 8 BCLP High LFI 4 days	RED 0.5 mm × 2/d 8 weeks	Up to 2 years	Ant—12.9 mm SNA—9.16°	Ant—2% (0.25 mm) SNA—14% (1.33°)	N/R	N/R
Kumar et al. ¹⁶ 2006	R, CT	13 UCLP, 7 BCLP Traditional LFI 1 day	ID (Zurich Distractor) 0.5 mm × 2/d 12 weeks	>1 year	Ant—16.5 mm SNA—10.8°	Ant—2.4% (0.4 mm) SNA—3.6% (0.4°)	Ant—1.1 mm	Ant—9.1% (0.1 mm)
Harada et al. ¹⁷ 2006	N/R R, CS	6 UCLP, 1 BCLP, 1 UCLA High LFI 4–5 days	RED 0.5 mm × 2/d 3–6 weeks	Up to 3 years	Ant—10.1 mm (range, 6–14.6)	Ant—12% (1.2 mm)	N/R	N/R
Cho & Kyung ¹⁸ 2006	R, CS 9 (5 M, 4 F) (Range, 13–19)	7 UCLP, 2 BCLP LFI 5 days	RED I 1 mm/d 5 weeks	(Range, 1–6 years)	13.6 mm SNA—12.2°	23% (3.2 mm) SNA—31.4% (3.8°)	N/R	N/R
Rachmiel et al. ¹⁹ 2005	P, CS 12 (Range, 12–18)	7 UCLP, 5 BCLP Traditional LFI 4 days	ID (Zurich Distractor) 0.5 mm × 2/d 8 weeks	Up to 2 years	Ant—11.83 mm SNA—7.75°	Ant—3.5% (0.4 mm) SNA—1% (0.08°)	N/R	N/R

Table 2. Continued

Article	Study Design, Sample Size, Mean Age (years) ^a	Type of Cleft, Surgical Procedure, Latency Period ^b	Device, Rate of Distraction, Consolidation Period ^c	Follow-up	Horizontal Dimension ^d		Vertical Dimension ^d	
					Mean Movement	Mean Relapse	Mean Movement	Mean Relapse
Figuerola et al. ² 2004	R, CS 17 (13 M, 4 F) 12.6 ± 5.2	10 UCLP, 6 BCLP, 1 ICP High LFI 3–7 days	RED 1 mm/d 3–4 weeks	3.1 years (range, 2–5.3)	Ant—9.6 mm SNA—10.2°	Ant—3.1% (0.3 mm) SNA—23.5% (2.4°)	Ant—5.2 mm	Ant—50% (2.6 mm)
Suzuki et al. ²⁰ 2004	R, CS 12 (4 M, 12 F) 16.1	12 UCLP High LFI 3–7 days	RED 1 mm/d 2–3 weeks	1 year	Ant—11.7 mm	Ant—22.% (2.6 mm)	Ant—1.6 mm	After follow up: Ant—1.7mm

^a R indicates retrospective study; P, prospective study; CS, case series; CT, clinical trial; RCT, randomized clinical trial; F, female; and M, male.

^b BCLP, bilateral cleft lip and palate; UCLP: unilateral cleft lip and palate; CP: cleft palate; and LFI, Le Fort I osteotomy.

^c RED indicates rigid external distraction; ID, internal distraction.

^d SNA, sella-nasion-A point; Ant, anterior; Post, posterior; and N/R, not reported.

follow-up time was 3 years or more in five studies. Regarding the type of cleft in the treated patients, there were more than two times as many unilateral CLP patients treated as bilateral CLP patients (85 vs 41). High Le Fort I osteotomy was the most commonly used technique. The latency times ranged from 3 to 5 days and the consolidation periods ranged from 3 to 12 weeks.

Thirteen studies were finally selected and several of them showed consistent results. Only one randomized controlled clinical trial (RCT) was found. This RCT examined the long-term stability of maxillary advancement with DO in 22 patients greater than 16 years of age, and showed that DO is a stable technique in patients with CLP and that the maxilla moved forward and downward during the initial postoperative period. After a follow-up of 5 years, the A-point relapsed 8.24% horizontally. The relapse rate was lower in the DO group than in the conventional orthognathic surgery group after a follow-up of 5 years (8.24% vs 37%).¹¹

All of the finally included studies demonstrated DO as an effective technique for correction of maxillary hypoplasia in CLP patients. The maxilla was significantly advanced as indicated by the change in A-point. The mean horizontal movement was between 7 and 10 mm in five studies,^{2,9–11,14} between 10 and 15 mm in seven studies,^{12,13,15,17–20} and more than 15 mm in one study.¹⁶

In the horizontal dimension, all included studies reported DO as a stable surgical technique for correction of maxillary hypoplasia in CLP patients. The horizontal relapse in A-point was less than 15% in eight studies^{2,10–12,15–17,19} and between 20% and 25% in four studies.^{9,13,18,20} Similarly, the horizontal relapse in SNA angle was less than 15% in four studies^{10,15,16,19} and between 20% and 35% in three studies.^{2,13,18} The two articles that were judged as high-quality articles reported less than 10% of horizontal relapse in A-point.^{2,11}

As for the vertical dimension, the movement was less than 3 mm in four studies^{11,3,16,20} and between 3 and 7 mm in three studies.^{2,10,14} However, the vertical relapse in A-point was variable between the studies. Two particular articles that were judged as high-quality articles reported more than 50% of vertical relapse in A-point.^{2,11}

In the randomized controlled trial published by Chua et al.,¹¹ the authors reported conventional Le Fort I advancement of CLP patients was 6.8 mm and a relapse rate was 37% (2.5 mm) after 5 years of follow-up. The findings of this systematic review suggest that DO can be expected to relapse about 15% (1.5 mm) after 10 mm of DO advancement in CLP patients. The lower relapse rate in the DO technique compared with

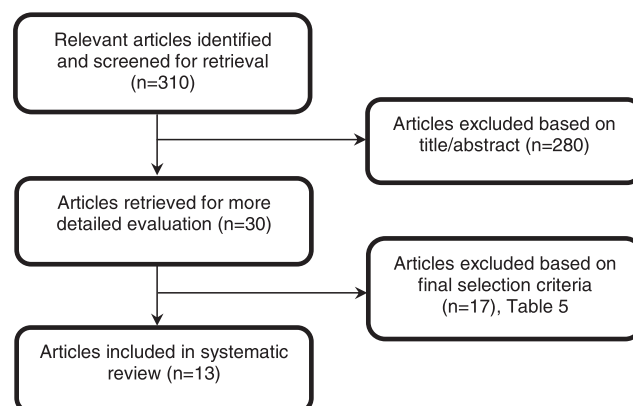
Table 3. Methodologic Score for the Included Studies^a

Study Design (11 ✓)	
A. Objective—clearly defined (✓)	
B. Population—adequately described (✓)	
C. Sample size—considered adequate (✓)	
D. Selection criteria—clearly described (✓), adequate (✓)	
E. Randomization or consecutive selection—stated (✓)	
F. Follow up length—clearly described (✓)	
G. Timing—prospective design (✓)	
H. Type of study—RCT (✓✓✓), CT (✓✓), CS (✓)	
Study Measurements (4 ✓)	
I. Measurement method—mentioned (✓), appropriate (✓)	
J. Blinding—stated (✓)	
K. Reliability—described (✓)	
Statistical Analysis (4 ✓)	
L. Dropouts—accounted (✓)	
M. Statistical analysis—appropriate (✓)	
N. Presentation of data—exact <i>P</i> value stated (✓), variability measures (SD or CI) stated (✓)	

^a Maximum number of ✓s = 19.^b RCT indicates randomized clinical trial; CT, clinical trial; and CS, case series.

Le Fort conventional osteotomy may be explained by the gradual movement of the maxilla as well as the resistance of the external or internal distracter. These two factors reduce the unwanted backward and upward pull caused by the scarred tissues and muscles.^{2,11}

The literature identified by the current systematic review suggested that the method of distraction was an important predictor of long-term stability. The long-term skeletal stability after DO was higher in the studies that used internal distracters than the studies that used external distracters. The rate of relapse was less than 10% in the three studies that used internal distracters, which may be related to the differences in

**Figure 1.** Flow diagram of the literature search.

the method of delivering forces from the distracter.^{11,16,19}

In addition to the disharmony of occlusion, the presence of scarred palatal and lip tissues as well as posterior pharyngeal flaps from a prior surgery are expected to be the main reasons for relapse in CLP patients. Soft tissue scarring is known to be one of the greatest challenges facing surgical management of CLP patients, and has been suggested as an etiologic cause for the higher incidence of mid-face deficiency in CLP populations. Fibrotic scar tissue may restrict the movement of the maxilla and is thought to be significant for relapse to the preadvanced position.^{2,11,37} Finally, a well-conducted and clearly reported randomized controlled clinical trial comparing the results of conventional orthognathic surgery and DO in patients with CLP would be very useful in assessing the differences in the skeletal and dental stability between the two techniques in short-term and long-term follow-up.

Table 4. Methodologic Score of Selected Articles^a

Article	Study Design								Study Measurements			Statistical Analysis			Total	% of Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	N		
Aksu et al. ⁹ 2010	✓	✓	x	✓≠	x	✓	✓	✓	✓≠	x	✓	x	≠	≠x	10	52.6%
Daimaruya et al. ¹⁰ 2010	✓	✓	x	x≠	x	≠	✓	✓✓	✓✓	x	✓	x	≠	x✓	10.5	55.3%
Chua et al. ¹¹ 2010	✓	≠	✓	✓✓	✓	✓	✓	✓✓✓	✓✓	x	✓	x	✓	✓✓	16.5	86.9%
He et al. ¹² 2010	✓	✓	x	≠≠	x	✓	x	✓	✓≠	≠	x	✓	≠	≠✓	10	52.6%
Gürsoy et al. ¹³ 2010	✓	✓	≠	≠≠	✓	✓	✓	✓	✓✓	x	✓	x	✓	✓x	12.5	65.8%
Huang et al. ¹⁴ 2007	✓	≠	x	xx	x	≠	x	✓	≠≠	x	≠	x	≠	xx	5	26.3%
Rachmiel et al. ¹⁵ 2006	≠	≠	✓	≠≠	x	x	✓	✓	✓≠	x	x	x	≠	x≠	7.5	39.5%
Kumar et al. ¹⁶ 2006	✓	≠	✓	✓✓	x	x	x	✓✓	✓≠	x	x	≠	≠	xx	9	47.4%
Harada et al. ¹⁷ 2006	✓	≠	x	≠≠	x	≠	x	✓	✓≠	x	≠	x	≠	xx	6.5	34.2%
Cho and Kyung ¹⁸ 2006	✓	✓	x	≠≠	x	x	x	✓	✓≠	x	x	x	≠	x✓	7	36.8%
Rachmiel et al. ¹⁹ 2005	≠	≠	x	≠≠	x	x	✓	✓	✓≠	x	x	x	≠	x✓	6.5	34.2%
Figuroa et al. ² 2004	✓	✓	✓	✓✓	✓	✓	x	✓	✓✓	≠	≠	✓	✓	x✓	14	73.7%
Suzuki et al. ²⁰ 2004	✓	≠	x	≠≠	x	≠	≠	✓	✓≠	x	✓	x	≠	x✓	8.5	44.7%

^a (A to N: methodologic criteria in Table 3); X indicates did not fulfill the methodologic criteria (0 check point); ✓, fulfilled satisfactorily the methodologic criteria (1 check point); ≠, fulfilled partially the methodologic criteria (0.5 check point).

Table 5. Articles Not Selected From the Initial Abstract Selection List and Reasons for Exclusion

Article	Reason for Exclusion ^a
Hussain ²⁸ 2009	2
Lee and Park ²⁹ 2009	2
Bevilacqua et al. ³⁰ 2008	2
Kahn et al. ³¹ 2008	2
Kok-Leng Yeow and Por ³² 2008	2
Vodolatskii and Vodolatskii ³³ 2008	2
Wong et al. ²¹ 2008	3
Scolozzi ⁵ 2008	4
Figuerola and Polley ³⁴ 2007	2
Baek et al. ²⁷ 2007	3
Cheung and Chua ⁶ 2006	4
Cheung et al. ²² 2006	3
Jayade et al. ²⁶ 2006	3
Nadjmi et al. ³⁵ 2006	1
Wang et al. ²³ 2005	3
Fan et al. ²⁴ 2002	3
Mehra et al. ²⁵ 2001	3

^a 1 indicates Class III patients are included in the sample; 2, no or incomplete report of data; 3, no long-term follow up reported; and 4, review.

CONCLUSIONS

- Maxillary advancement in CLP patients using DO appears to be a fairly stable procedure.
- The DO technique can effectively transpose the maxilla forward and downward in moderate and severe maxillary retrusion.
- The relapse rate is higher in DO with an external distracter than DO with an internal distracter.

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