Systematic Review of Surgical Outcomes and Complications of Extracorporeal Septoplasty and Its Modifications

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Abstract

Importance: While extracorporeal septoplasty (ECS) and its modifications has been previously studied, to our knowledge, no systematic review of surgical outcomes and complications of this technique has been performed.

Objective: To evaluate the evidence of surgical outcomes and complications of ECS (including modified techniques) to treat severe L-strut septal deviation defined as deviation within 1.0 cm of the caudal or dorsal septum.

Data Sources: Medline, Embase, Cinahl, Central, Scopus, and Web of Science databases and reference lists were searched for clinical and observational studies.

Study Selection: Selection criteria were defined according to the population, intervention, comparison, and outcome (PICO) framework. Relevant studies were selected by 2 independent reviewers based on abstracts and full texts.

Data Extraction and Synthesis: Data were extracted using standardized lists chosen by the authors according to Cochrane Collaboration guidelines. Data were collected and synthesized with ranges reported, as well as assessment of bias and heterogeneity when applicable.

Main Outcomes and Measures: Outcomes assessed included functional nasal airway improvement by objective measurements and subjective measurements (NOSE scores and VAS scores); complications including bleeding, infection, dorsal irregularities, and other functional or cosmetic deficits, as well as revision surgery rates.

Results: Of 291 records initially obtained, 31 were considered relevant after review according to PRISMA guidelines. All studies except 1 randomized control trial were observational in nature, with 21 retrospective studies and 9 prospective studies. Conventional ECS was performed in 16 studies, and modified ECS performed in 15 studies. Sample size varied from 10 to 567, and

average age varied from 22.5 to 46 years. Less than half (14 of 31) of these studies were of good methodology. Meta-analysis was performed on 5 studies reporting change in NOSE scores, with pooled effect of -60.0 (95% CI -67.8 to -52.2) points, but heterogeneity was high with I^2=96%. When comparing complications between modified and conventional ECS, the relative risk for infections was 1.25 (95% CI 0.47 to 3.35), for bleeding was 0, for nasal dorsal irregularities 0.33 (95% CI 0.17 to 0.60), for other cosmetic complications 4.8 (95% CI 0.97 to 23.8), for other functional complications 0.61 (95% CI 0.27 to 1.37), and for revision operations 0.71 (95% CI 0.41 to 1.21).

Conclusions and Relevance: Of the 31 studies included in this systematic review, less than half were of good methodology, and a significant level of heterogeneity was found regarding type of outcome measure used and reporting of complications. To improve the level of evidence, better study methodology, standardization of surgical outcomes measures and reporting of complications is needed.

Key Points

Question: Is ECS (including modified techniques) effective in the treatment of severe L-strut septal deviation**?**

Findings: In this systematic review of 31 studies, a meta-analysis of 5 studies reporting change in Nasal Obstruction Symptom Evaluation scores, with pooled effect of -60.0 (95% CI -67.8 to -52.2) points, but heterogeneity was high with I^2=96%.

Meaning: These findings highlight that although ECS and its modifications are likely effective methods to reduce nasal airway obstruction for deviations of the septal L-strut, standardized reporting of outcomes and sound methodology of study design is needed.

INTRODUCTION

It is estimated that septal deformities are present in 77-90% of the general population, and the best treatment depends on the location and severity of the septal deviation[1-5]. Standard endonasal septoplasty approaches are beneficial for most patients with mild to moderate middle or posterior septal deviations, however this is not as effective for more severe deformities[5,6]. Severe deviations, especially if located in the anterocaudal septum makes repair more challenging[7-11]. Caudal septal deviation causing obstruction of the internal nasal valves often results in aesthetic deformity as well, and repair of the septum in this location places nasal tip support mechanisms at risk. Thus, repair needs to address the obstruction but not impair tip support.[12]

Numerous repair techniques have been described for deformities of the caudal septum such as swinging door, septal translocation, cartilage scoring, grafting techniques, septal extension grafts, and replacement grafts[13-15]. Metzenbaum described the swinging door technique as early as 1929, wherein a vertical piece of septal cartilage is removed from deviated side and the caudal septum is repositioned to midline[13]. Scoring incisions, spreader grafts, morselization, tongue in groove stabilization, batten grafts, polydioxanone (PDS) foil matrix for reconstruction with native septal cartilage, cartilage grafts, and grafts have also been described[15].

Extracorporeal septoplasty (ECS) for severe deviations of dorsal and caudal septum was first described in 1952 by King and Ashley[16]. This technique entails complete removal and replacement of the cartilaginous septum, held in place with transeptal sutures[16]. This technique has been most extensively described by Gubisch[17]. In their large case series, the revision rate

was 9%, but decreased by use of camouflage grafts to mask settling at rhinion, as it is difficult to reform the bony-cartilaginous attachment at the keystone[17]. Modifications of the ECS technique include use of PDS plates introduced in the 1980s to further stabilize implanted cartilage[18-23]. Other modifications include grafting techniques, limited dorsal septal removal, and methods to better secure the cartilage to reduce dorsal irregularities[17-27].

The objective of this study was to investigate evidence of the safety and effects of extracorporeal septoplasty (including modified techniques) to treat severe L-strut septal deviation, defined as deviation occurring within 1.0 cm of the caudal or dorsal septum.

METHODS

This review protocol was based the Cochrane Handbook for Systematic Reviews of Interventions[28]. Inclusion and exclusion criteria based on the population, intervention, comparison, and outcome (PICO) framework, described below.

Population: Adults (>=18 years) with nasal obstruction due to severe L-strut caudal septal deviation, excluding other causes of nasal obstruction such as non-L strut septal deviation, lateral nasal wall insufficiency, turbinate hypertrophy, nasal polyps, intranasal masses, rhinitis, and sinusitis.

Type of studies: Clinical and observational studies published in peer-reviewed academic journals with abstracts available without restrictions on language or time of publication. Excluding pilot

reports, case reports, case series (<5 patients), descriptive publications on surgical techniques, theses, conference proceedings, letters (except research letters and brief reports), and editorials.

Intervention: Extracorporeal septoplasty or its modifications including anterior septal reconstruction with or without turbinoplasty. Excluding standard septoplasty with or without turbinoplasty, and sinus surgery. Standard septoplasty is defined as a surgical procedure to remove a variable portion of the mid-posterior bony and cartilaginous nasal structure leaving in place a minimum of 1.0 cm dorsal and caudal L-strut. An extracorporeal septoplasty and its modification may involve total or partial removal and reconstruction of the cartilaginous septum which includes the L-strut.

Comparison: Rates of complications in reference populations. Pre- and post-surgery results within the sample. If control group available, comparison with no surgery, other surgery, or intranasal medications (e.g., steroids).

Outcome: Rate of complications. Change in nasal obstruction severity level before and after the surgery or difference between groups in that change.

Data sources and searches

The MEDLINE (via PubMed), Embase, Cinahl, Web of Science, and Scopus databases were searched in April 2018. When searching on Medline, the following clause was used: extracorporeal AND (septoplasty* OR septum) NOT (case [TI] OR protocol[TI] OR pilot[TI] OR reliability[TI] OR validity[TI] OR sinus[TI] OR sinuit*[TI] OR cardio*[TI] OR vascul*[TI]

OR arter*[TI] OR ventricul*[TI] OR myocard*[TI] OR heart[TI] OR atrial[TI] OR child*[TI] OR neonat*[TI]) AND (hasabstract[text] AND "humans"[MeSH Terms])

The clause was adjusted when searching on other databases. In order to avoid missing any potentially relevant studies, the search clauses were left as generic as possible and a refining search was conducted manually. The references of identified articles and reviews were also checked for relevancy.

Study selection

Two independent reviewers (EAS and CKK) screened titles and abstracts of articles and assessed the full texts of potentially relevant studies according to PRISMA guidelines (Figure 1). Disagreements between the reviewers were resolved by consensus or by a third reviewer (MS).

Assessment of risk of systematic bias

The methodological quality of the included trials was rated according to the Guidance for Assessing the Quality of Before-After (Pre-Post) Studies with No Control Group[29]. The following 12 domains were evaluated: 1 – Study question, 2 – Eligibility criteria and study population; 3 – Study participants representative of clinical populations of interest; 4 – All eligible participants enrolled; 5 – Sample size; 6 – Intervention clearly described; 7 – Outcome measures clearly described, valid, and reliable; 8 – Blinding of outcome assessors; 9 – Follow-up rate; 10 – Statistical analysis; 11 – Multiple outcome measures; and 12 – Group-level interventions and individual-level outcome efforts. Individual criteria were valued as ‘yes’, ‘no’, or ‘NA’ (Not applicable or not reported). The total quality was valued as ‘poor’, ‘fair’, or ‘good’.

Data extraction

The potentially relevant data were extracted of the records by one reviewer using a predefined structured form (CKK). The extracted data were then checked by a second reviewer (EAS).

Statistical analysis

The interrater reliability for review of screened records by independent authors were assessed using the kappa (K) statistic. To quantify the pooled effect size of included studies, a random effects meta-analysis was used as a more natural choice than fixed effects in the context of medical data obtained from very different sources. The test for heterogeneity was conducted using the I^2 statistic describing the percentage of variation across studies originating rather from heterogeneity than from chance. The results were reported along with their 95% confidence intervals (95% CI) or two-tailed *p*-values when appropriate (level of *p*-value significance set at =<0.005). A non-standardized ('raw') mean of difference in change in NOSE total scores were calculated. A standardized mean of difference was calculated when several outcome measures were involved into the same analysis.

The pre-/post-correlation coefficient was set to 0.6. To ensure that the overall result of the analysis is robust to the use of imputed correlation coefficients, a sensitivity analysis was conducted setting the correlation coefficient at 0.8. In the initial synthesis calculations 7[26,27,30-33] studies that reported NOSE scores, 4[21,27,34,35] that reported visual analogue scores, and 2[31,36] that reported acoustic rhinomanometry were included. Results were reported as means, 95% CI, and p-values.

Of the estimates reported by Surowitz et al.[27], the total NOSE scores for the longest follow-up of 225 days was included and other estimates excluded from the meta-synthesis. The study by Asher et al.[30] was excluded from meta-synthesis as total NOSE scores were not reported. Additionally, studies by Jang et al. (2009)[34] and Code et al.[35] were excluded as variances were not reported along with average estimates. For the estimates reported by Mobley et al.[37], means and SDs were obtained from median and ranges as follows: Mean = (low end of range + 2 x median + high end of range)/4 and Variance = 1/12 x [(low end of range - 2 x median + high end of range)^2/4 + (high end of range - low end of range)^2]. This way, for that study, preoperative and postoperative mean NOSE total scores were 14.5 (1.41) and 3.0 (1.17), respectively.

The potential publication bias was evaluated by Egger's test for asymmetry of the funnel plot (test for the Y intercept = 0 from the linear regression of normalized effect estimate against precision), where the trim-and-fill method was used to impute studies into funnel plot to correct asymmetry.

All calculations for the meta-analysis were performed using Comprehensive Meta-Analysis CMA, 3rd Edition, available from www.meta-analysis.com, and Microsoft Excel® 2010.

RESULTS

All studies except 1 randomized control trial were observational in nature, with 21 retrospective studies and 9 prospective studies. Conventional ECS was performed in 16 studies[20,22,24,25,35-46], while the other 15 were modifications of this technique[21,26,27,30-34,47-53], although heterogeneity of

each technique used for every study was present. Sample size varied from 10 to 567, and average age varied from 22.5 to 46 years (Table 1).

Risk of systematic bias

Of the included 31 studies[20-22,24-27,30-53], methodologically, 14 were considered to be good[21,26,27,31,33,35-37,40,45,48,50-52], 11 were considered poor[22,24,25,38,39,41,42,46,47,49,53], and 6 were considered fair[20,30,32,34,43,44] (eTable 1).

Patient-reported outcome measures

The initial meta-analysis was conducted including seven studies[21,27,31-33,37] that reported complete data for NOSE or VAS scores (Table 2, Figure 2A). The pooled standardized difference in means was -5.8 (95% CI -7.6 to -4.0) indicating a large effect size. The heterogeneity was I^2=97%. While there was potential publication bias (Egger's regression intercept' *p*-value 0.026), no trim-and-fill imputations were needed. There was a slight change in results after excluding Mobley et al.[37], the only paper on conventional ECS (Figure 2B): -5.1 (95% CI -6.8 to 3.4). For clearer interpretation, the final meta-analysis was conducted on a raw difference of means instead of a standardized one. Excluding one study[21] reporting only VAS scores, based on the results of five studies[26,27,31-33] on modified ECS only, the change in total NOSE score was -60.0 (95% CI -67.8 to -52.2) points (Figure 2C). The heterogeneity was high I^2=96%.

Objective outcome measures

Two studies[31,36] reported both pre- and post-operative objective outcomes, as well as standard deviations (Table 3). Three other studies[40,50,51] reported objective outcomes, but did not report full data to allow pre- and post-operative comparison. In Garcia et al[31], the mean postoperative changes in minimum cross-sectional area using acoustic rhinometry increased by 0.33 (95% CI 0.21 to 0.44) cm^2 before constriction and 0.30 (95% CI 0.18 to 0.42) cm^2 after constriction. Serna et al.[36], reported the changes in nasal flow and nasal resistance using active anterior rhinomanometry: the smallest estimates of changes were 321 (95% CI 253 to 389) cm^3/s and -0.09 (95% CI -0.11 to -0.08) Pas/cm^3, respectively.

Risks of complications or revision surgery

Rates of complications and/or revision surgery were reported in 24 studies (eTable 2): infection rates ranged from 0-8.9%; bleeding from 0-6.25%; dorsal irregularities from 0-12.5%; and revision surgery from 0-14%. Of the 11 studies[21,27,30,32-34,49-53] on modified ECS (pooled n=695, only including groups of interest), there were 7 infections (1.0%), no bleeding events, 12 nasal dorsal irregularities (1.7%), 6 other cosmetic complications (0.86%), 8 other functional complications (1.2%), and 19 revision operations (2.7%). Of the 13 studies[20,22,24,25,35,38-44,46] on conventional ECS (pooled n=1119, only including groups of interest), there were 9 infections (0.80%), 6 bleeding events (0.54%), 59 nasal dorsal irregularities (5.3%), 2 other cosmetic complications (0.18%), 21 other functional complications (1.9%), and 43 revision operations (3.8%). When comparing modified versus conventional ECS, the relative risk for infections was 1.25 (95% CI 0.47 to 3.35), for bleeding was 0, for nasal dorsal irregularities 0.33 (95% CI 0.17 to 0.60), for other cosmetic complications 4.8 (95% CI 0.97 to 23.8), for other functional

complications 0.61 (95% CI 0.27 to 1.37), and for revision operations 0.71 (95% CI 0.41 to 1.21).

DISCUSSION

In this systematic review, 31 studies were included to assess surgical outcomes and complications of ECS and its modifications. When evaluating surgical outcomes, final meta-analysis could only be performed using five studies[26,27,31-33] all of modified ECS techniques reporting NOSE outcomes, as most studies used variable methods to report results. While the meta-analysis of the five studies showed a change in total NOSE score of -60.0 (95% CI -67.8 to -52.2) points, indicating both a clinically and statistically significant improvement of nasal obstruction, as this was higher than the NOSE MCID[54] , the heterogeneity was high (I^2=96%). Additionally, less than half of the studies (14 of 31) were considered to be of "good" methodology according to the Guidance for Assessing the Quality of Before-After (Pre-Post) Studies with No Control Group[29](e Table 1). These findings highlight that although ECS and its modifications are likely effective methods to reduce nasal airway obstruction for deviations of the septal L-strut, standardized reporting of outcomes and sound methodology of study design is needed.

Objective outcomes measures were reported in 5 studies[31,36,40,50,51], however only 2 studies[31,36] provided data required for pre- and post-operative assessment of outcomes (Table 3). These results increased minimum cross-sectional area by 0.33 (95% CI 0.21 to 0.44) cm^2 before constriction and 0.30 (95% CI 0.18 to 0.42) cm^2 after constriction[31], increased nasal flow of 321 (95% CI 253 to 389) cm^3/s and decreased nasal of -0.09 (95% CI -0.11 to -0.08) Pas/cm^3 [36]. While these results show improvement in these objective parameters, it is difficult to draw

conclusions on the efficacy of ECS using these measures based on only single studies with small sample sizes (10 and 26 patients, respectively).

Complication and/or revision surgery rates were reported in 24 studies, 11 using the modified ECS [21,27,30,32-34,49-53] and 13 using conventional ECS[20,22,24,25,35,38-44,46] . Pooled data analysis comparing modified versus conventional ECS resulted in statistically significant difference in the relative risk of nasal dorsal irregularities 0.33 (95% CI 0.17 to 0.60). Dorsal irregularities were also the most common complication reported among the conventional ECS group (5.3%). Thus, as many of the modified ECS techniques aim to reduce this most common complication of conventional ECS, these results show their effectiveness in achieving this goal. Other complications, such as infection, bleeding, other cosmetic or functional complication and revision surgery rates were not found to be significantly different between the two groups.

As stated previously, limitations of this study include the heterogeneity of outcomes reporting in the included studies of conventional and modified ECS, as well as the low number of studies employing good methodology. While the 5 studies included for meta-analysis showed significant improvement in nasal obstruction using ECS, there was also a high level of heterogeneity among them. These findings point to the need for improved standardization of outcomes reporting for nasal airway procedures. Additionally, as the most common complication of these procedures would be considered cosmetic (dorsal irregularities), it also highlights the need for assessing both functional and cosmetic outcomes even when only performing functional nasal surgery. Thus outcomes measures such as the newly developed Standardized Cosmesis and Health Nasal

Outcomes Survey (SCHNOS), would be ideal for future reporting of standard or modified ECS outcomes.[55,56]

CONCLUSION

Of the 31 studies included in this systematic review, a majority were of fair or poor methodology, and a significant level of heterogeneity was found regarding type of functional and/or cosmetic outcome measure used and reporting of complications. To improve the level of evidence, better study methodology, standardization of surgical outcomes measures and reporting of complications is needed.

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Figure 1. PRISMA flow-diagram

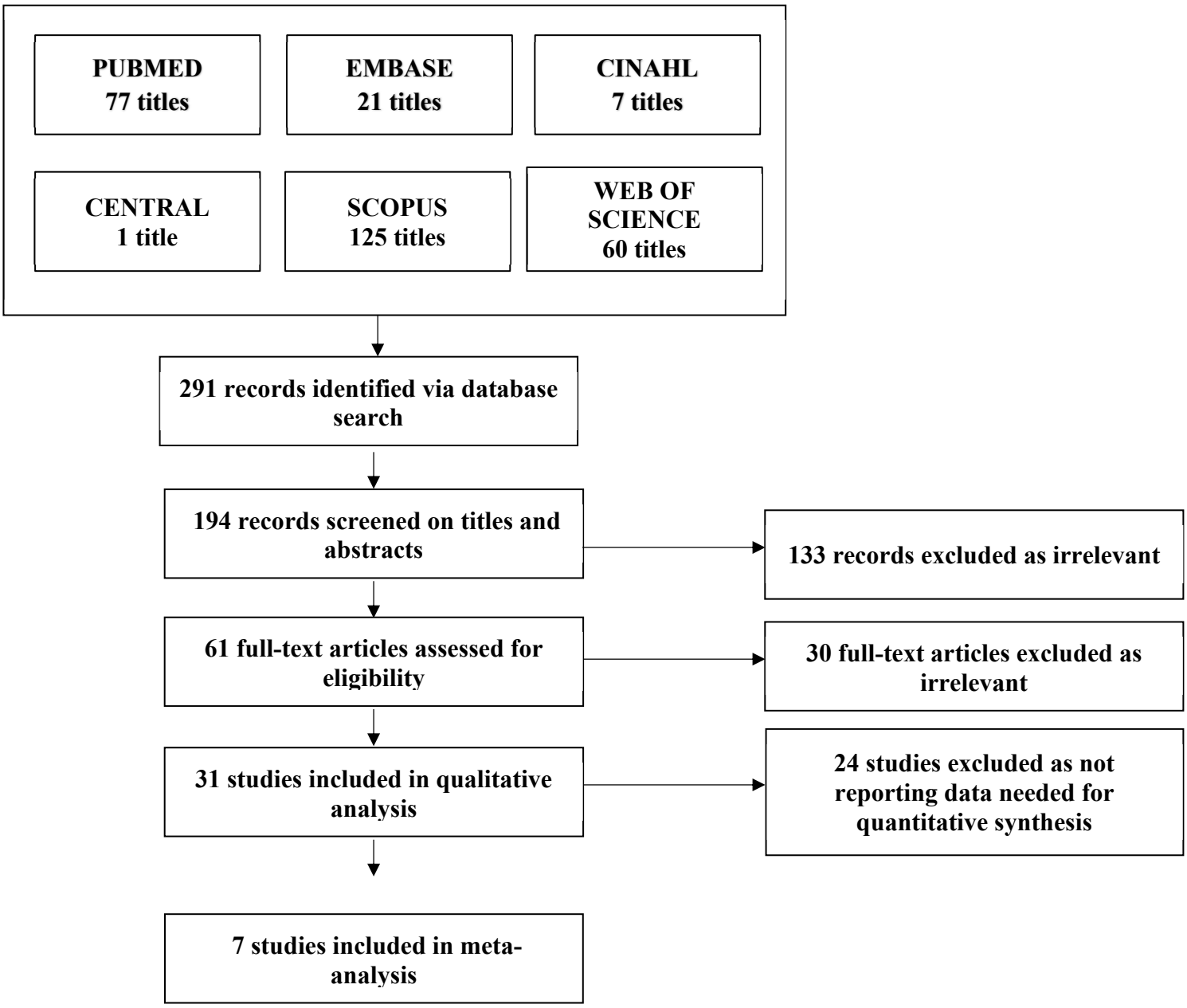

Figure 2. Forest plots

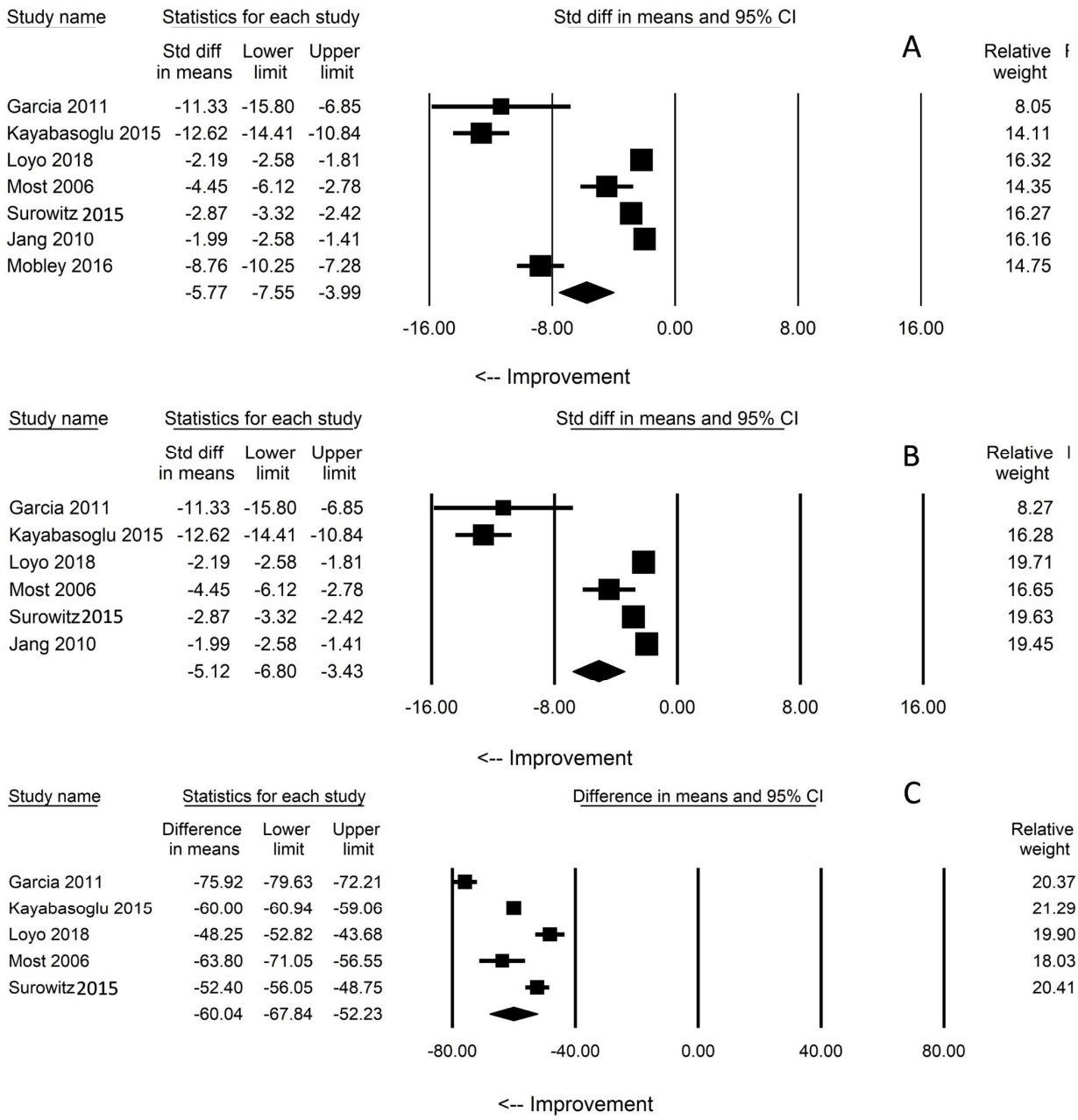

Figure 2 C: Jang et al 2010 excluded as not reporting NOSE score

Table 1. Basic characteristics of the included studies

Study	n	Mean age or range (SD [3] or range), years	Gender, % women
Modified extracorporeal septoplasty			
Andre 2006 (Netherlands) [1]	45	32.6	29%
Asher 2018 (USA)	144	37.3 (13.7)	72%
Boulanger 2013 (France)	35	31.0	45%
Chang, 2010 (China)	41	23 to 59	NR
Garcia 2011(Brazil)	10	NR	40%
Jang 2010 [2] (Korea)	27	31.4 (11.5)	11%
Jang 2009 [2] (Korea)	45	32.0 (17 to 63)	4%
Kayabasoglu 2015′(Turkey) [1]	78	34.76 (11.91)	NR
Lee 2014 (South Korea) [1]	84	30.0	12%
Loyo 2018 (USA)	71	46.0 (16 to 72)	68%
Most, 2006 (USA)	12	34.5 (18 to 51)	33%
Persichetti 2016 (Italy)	120	30.8 (19 to 58)	48%
Srinoglu 2016 (Turkey)	16	26.5 (18 to 35)	63%
Surowitz 2015 (USA)	77	38.4 (17 to 66)	32%
Won 2012 (Korea)	25	40.0 (18 to 67)	8%
Extracorporeal septoplasty			
Gerlinger 2007 (Austria)	16	42.0 (22 to 66)	69%
Gevorgyan 2013 (Canada)	17	18 to 46	41%
Gode 2018 (Turkey)	20	27.5 (18 to 37)	20%
Gubisch, 2005 (Germany)	2119	NR	NR
Kantas 2008 (Greece)	64	34.0	64%
Karamese 2016 (Turkey)	19	30.47 (7.32)	32%
Mendis 2013 (UK)	46	NR	39%

Mobley 2016	55	36.02 (15.20)	36%
Numanoglu 1996 (Turkey)	45	NR	NR
Rezaeian 2016 (Switzerland)	110 (58 + 52)	Median 37 (14 to 64)	39%
Rimmer 2012 (Australia)	102	36.5 (20 to 63)	32%
Senyuva 1997 (Turkey)	17	22.5 (19 to 33)	24%
Serna 2014 (Spain)	26	21 to 56	15%
Tweedie 2010 (UK)	17 [5]	Median 33 (15 to 56)	20%
Wilson 2011 (USA)	46	34.0 (16 to 72)	22%
Unsal 2016 (Turkey)	32	34.8 (10.5)	19%

[1] Only groups with septal replacement were included; [2] Jang 2009 ja Jang 2010 samples are partially overlapping; [3] Standard deviation; [4] Not reported; [5] The entire sample n=50

Table 2: Changes in Nasal Obstruction Symptom Evaluation (NOSE) or nasal obstruction visual anlogue scale scores reported by the included studies

Study	Outcome	Follow-up, days	Preoperative		Postoperative	
			Mean	SD [2]	Mean	SD
Modified extracorporeal septoplasty						
Asher 2018 [1]	NOSE Item1	260	2.3	1.3	1.0	0.9
	NOSE Item2		2.3	1.3	0.7	0.9
	NOSE Item3		2.5	1.3	0.7	1.0
	NOSE Item4		1.9	1.4	0.5	1.0
	NOSE Item5		2.2	1.3	0.4	0.8
Garcia 2011	NOSE total	60	83.48	7.23	7.56	5.91
Kayabasoglu 2015	NOSE total	180	85.0	5.17	25.0	2.12
Loyo 2018	NOSE total	420	72.25	14.55	24	24.58
Most 2006	NOSE total	162	76.7	14.8	12.9	13.8
Surowitz 2015	NOSE total	42	68.2	17.4	21.1	19.8
Surowitz 2015	NOSE total	225	68.2	17.4	15.8	19.0
Surowitz 2015	VAS [5]	42	7.2	1.8	2.1	2.6
Surowitz 2015	VAS	225	7.2	1.8	1.4	1.8
Jang 2009	VAS	60 to 180	8.04		3.68	
Jang 2009	VAS	60 to 180	8.36		3.14	
Jang 2010	VAS	195	6.0	1.9	2.6	1.0
Extracorporeal septoplasty						
Mobley 2016	NOSE total	60	14.5 [3]	11.0 to 16.0 [4]	3.0 [3]	1.0 to 5.0 [4]
Gode 2018	VAS	365	3.0		7.9	

[1] No total score reported, individual scores in raw points; [2] Standard deviation; [3] Median; [4] Interquartile range; [5] Nasal obstruction visual anlogue scale;

Table 3: Results of acoustic rhinomanometry

Study	Preoperative		Postoperative		Mean change		
	Mean	SD	Mean	SD	Mean	Lower 95% CL	Upper 95% CL
Garcia 2011 [1]; MCA [2], cm^2							
Before constriction	0.35	0.22	0.67	0.18	0.33	0.21	0.44
After constriction	0.43	0.24	0.73	0.17	0.30	0.18	0.42
Serna 2014 [3]							
Nasal flow (cm^3/s)							
Group 1	665.8	109.4	1111.6	141.3	445.8	393.8	497.8
Group 2	620.3	76.9	1094.2	168.8	473.9	339.4	608.4
Group 3	862.7	73.4	1183.7	55.6	321.0	253.3	388.7
Nasal Resistances (Pas/cm^3)							
Group 1	0.23	0.04	0.14	0.02	-0.09	-0.11	-0.08
Group 2	0.25	0.03	0.14	0.02	-0.11	-0.13	-0.09
Group 3	0.22	0.02	0.12	0.01	-0.10	-0.12	-0.08

[1] Modified extracorporeal septoplasty; [2] Minimum Cross-sectional Area; [3] Extracorporeal septoplasty

SUPPLEMENTARY

eTable 1. Methodological quality of the included studies.
Criteria:
1 – Study question,
2 – Eligibility criteria and study population;
3 – Study participants representative of clinical populations of interest;
4 – All eligible participants enrolled;
5 – Sample size;
6 – Intervention clearly described;
7 – Outcome measures clearly described, valid, and reliable;
8 – Blinding of outcome assessors;
9 – Follow-up rate;
10 – Statistical analysis;
11 – Multiple outcome measures;
12 – Group-level interventions and individual-level outcome efforts

Criteria [1] → Study ↓	1	2	3	4	5	6	7	8	9	10	11	12	Total [2]
Andre 2006	Yes	Yes	Yes	Yes	NA	Yes	No	No	Yes	Yes	No	NA	Poor
Asher 2018	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	No	Yes	No	NA	Fair
Boulanger 2013	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Chang 2010	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	No	Yes	NA	Poor
Garcia 2011	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	NA	Yes	No	NA	Good
Jang 2009	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Fair
Jang 2010	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	Yes	Yes	No	NA	Good
Kayabasoglu 2015	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	No	NA	Fair
Lee 2014	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Loyo 2018	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Most 2006	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	NA	NA	Good
Persichetti 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	Yes	Yes	Yes	NA	Good
Srinoglu 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	No	NA	Good
Surowitz 2015	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	Yes	NA	Good
Won 2012	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	No	No	NA	Poor
Gerlinger 2017	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	No	NA	Fair
Gevorgyan 2013	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	No	No	NA	Poor
Gode 2018	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Gubisch 2005	Yes	Yes	Yes	Yes	NA	Yes	No	No	NA	No	No	NA	Poor
Kantas 2008	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	No	No	NA	Poor

Karamese 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	Yes	Yes	No	NA	Good
Mendis 2013	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	No	No	NA	Poor
Mobley 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Numanoglu 1997	Yes	No	Yes	Yes	NA	Yes	No	No	Yes	No	No	NA	Poor
Razaeian 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	No	NA	Fair
Rimmer 2012	Yes	Yes	Yes	Yes	NA	Yes	No	No	Yes	No	Yes	NA	Fair
Senyuva 1997	Yes	Yes	Yes	Yes	NA	Yes	No	No	Yes	No	No	NA	Poor
Serna 2014	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No	NA	Good
Tweedie 2010	Yes	Yes	Yes	Yes	NA	Yes	No	No	NA	No	Yes	NA	Poor
Unsal 2016	Yes	Yes	Yes	Yes	NA	Yes	Yes	NA	Yes	Yes	No	NA	Good
Wilson 2011	Yes	Yes	Yes	Yes	NA	Yes	Yes	No	Yes	No	No	NA	Poor

[1] Individual criteria are valued as 'yes', 'no', or 'NA' (Not applicable or not reported) ; [2] Total quality is valued as 'poor', 'fair', or 'good'

eTABLE 2: COMPLICATIONS & REVISIONS (Modified ECS)

	Study		Total No. Pt	Complications					Unknown (Complications Not Reported)	Revision Surgery	Unknown (Revision rate not reported)
				Infection	Bleeding	Dorsal Irregularity	Other Cosmetic	Other Functional			
1.	Andre et al, 2006	M-ECS	(114)						NR		NR
2.	Asher et al, 2018	M-ECS	(144)	1/144 (0.7%)						14/144 (9.7%)	
3.	Boulanger et al, 2013	M-ECS	(35)						NR		NR
4.	Chang, 2010	M-ECS	(41)				4/41 (9.8%)			4/41 (9.8%)	
5.	Garcia et al, 2011	M-ECS	(10)						NR		NR
6.	Jang et al, 2010	M-ECS	(27)				1/27				NR
7.	Jang et al, 2009	M-ECS	(45)	4/45		1/45		1/45		1/45	
8.	Kayabasoglu et al, 2015	M-ECS	(78) (33/**45**)			G1:1/33 **G2: 2/45**					NR
9.	Lee et al, 2014	M-ECS	**G1: 84** G2: 85 Total: 169	1/84		5/84		1/84			NR
10.	Loyo et al, 2018	M-ECS	(71)			4/71					
11.	Most, 2006	M-ECS	(12)						NR		NR
12.	Persichetti et al, 2016	M-ECS	(120)					3/120			NR
13.	Srinoglu et al, 2016	M-ECS	(16)				1/16				NR
14.	Surowitz et al, 2017	M-ECS	(77)					1/77			NR
15.	Won et al, 2012	M-ECS	(25)					1/25			NR

eTABLE 2 (contd): COMPLICATIONS & REVISIONS (ECS)

	Study		Total No. Pt	Complications					Unknown (Complications Not Reported)	Revision Surgery	Unknown (Revision rate not reported)
				Infection	Bleeding	Dorsal Irregularity	Other Cosmetic	Other Functional			
1.	Gerlinger et al, 2007	ECS	(16)		1/16	2/16		3/16			NR
2.	Gevorgyan et al, 2013	ECS	(17)	1/17				2/17			
3.	Gode et al, 2018	ECS	(40); **G1: 20**			1/20 (5%)		1/20 (5%)		1/20 (5%)	
4.	Gubisch, 2005	ECS	(567)(459/108)	1 (1/0)		50(38/12)		8 (6/2)		28 pt (20-4%/ 8-7%)	
5.	Kantas et al, 2008	ECS	(64)			2/64	2/64	1/64			NR
6.	Karamese et al, 2016	ECS	(19)						NR	1/19	
7.	Mendis et al, 2013	ECS	(46)	1/46	1/46					2/46	
8.	Mobley et al, 2016	ECS	(55)						NR		NR
9.	Numanoglu 1996	ECS	(45)					5/45		1/45	
10.	Rezaeian et al, 2016	ECS	(110)				0/110	0/110		5/110	
11.	Rimmer et al, 2012	ECS	(102)	2/102							NR
12.	Senyuva et al, 1997	ECS	(17)		4/17					0/17	
13.	Serna et al, 2014	ECS	(26)				0/26	0/26			NR
14.	Tweedie et al, 2010	ECS	(50)	1/50		4/50				7/50	
15.	Wilson et al, 2011	ECS	(46)	3/46				1/46			NR
16.	Unsal et al, 2016	ECS	(32)						NR		NR