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The Safety and Efficacy of Spreader Grafts and Autospreaders in Rhinoplasty: A Systematic Review and Meta-analysis

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Abstract

Background The aim of this study was to systematically evaluate the evidence of surgical outcomes and complications of spreader grafts and autospreader flaps in the context of middle vault reconstruction after dorsal hump removal.

Material and Methods A systematic review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions. Inclusion and exclusion criteria were based on the population, intervention, comparison, and outcome (PICO) framework. Medline (via PubMed), EMBASE, Cinahl, Scopus, and Web of Science were searched for Clinical and observational studies published in peer-reviewed academic journals with abstracts available that reported rhinoplasty employing either spreader graft or autospreader flap techniques and were published prior to March, 2021.

Results Fifty-two of 1129 relevant studies were included in the qualitative analysis. Thirty-four studies (65.4%) were related to spreader graft (SG), 10 (21.1%) studies of autospreader flap (AF) alone and 8 (13.5%) studies involving both grafts. Meta-analysis was performed on 17 studies reporting change in NOSE scores, with pooled effect of − 23.9 (95% CI, − 26.7 to − 21.1) points. High heterogeneity with I^2 = 99%. Summary data showed no differences between groups, AF group versus no graft (p = 0.7578), AF versus SF group (p = 0.9948), and SG group versus no graft (p = 0.6608).

Conclusion Based on available data, change in NOSE scores after rhinoplasty was similar in procedures that used spreader graft only or autospreader flap only.

Level of Evidence III This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266

Keywords Systematic review · Spreader grafts · Autospreader flaps · Nasal obstruction · Nasal cosmesis · Surgery outcome

Introduction

Rhinoplasty is one of the most frequently performed procedures in facial plastic surgery. The most common patient complaint is a "dorsal hump," followed by "too large" of a nose, "bulbous tip," and "nasal airway obstruction" [1]. Reduction in a dorsal hump alters the structure of the nose with resulting aesthetic and functional implications. The conservation of natural anatomical relationships to prevent functional sequelae of aesthetic nasal surgery has become an integral concept in rhinoplasty [2]. Since resection of the dorsal hump consists of the removal of an important portion of the osseocartilaginous dorsum, preservation, or reconstruction of the middle third of the nose is imperative to prevent midvault insufficiency, nasal valve dysfunction

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and/or an inverted-V deformity. Over the years, different techniques and grafts have been created so that this objective is achieved in dorsal hump reduction.

Since its description by Sheen, the spreader graft has become the gold standard for midvault reconstruction after hump resection [3]. A spreader graft is a rectangular strip of cartilage placed submucosally, along the superior border of the septum between the upper lateral cartilage and septum. It has been shown to preserve support of the nasal dorsum and function of the internal nasal valve [3]. It results in a wider dorsal roof, improved dorsal aesthetic lines and expands the internal valve angle, as it moves the lateral wall away from the septum [3]. In addition to being used for reduction rhinoplasty, spreader grafts have become an important technique to help straighten the deviated septum and nasal dorsum [4].

Release, preservation, and resuspension of the upper lateral cartilages to the dorsal septum were described by Fomon, though not in the context of dorsal hump reduction [5]. The more modern iteration, used in midvault reconstruction after dorsal hump reduction, was described by O'Neal and Berkowitz [6]. Spreader flaps, also known as autospreader flaps, are our primary method of midvault reconstruction after hump reduction.

Both the spreader graft and autospreader have been extensively studied and used throughout the years [2–4, 6, 9, 10, 14]. However, there is heterogeneity in the reported efficacy and outcome measures of these techniques and limited comparative data. Therefore, the aim of this study was to systematically compare the outcomes of spreader grafts and autospreader flaps in the context of midvault reconstruction after dorsal hump removal.

Materials and Methods

A systematic review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions [7]. Inclusion and exclusion criteria were based on the population, intervention, comparison, and outcome (PICO) framework.

Population

Adults (≥18 years) with nasal dorsal irregularities requiring nasal dorsal reconstruction with spreader graft or upper lateral cartilage turn-in flaps.

Type of Studies

Clinical and observational studies published in peer-reviewed academic journals with abstracts available without restrictions on language or time of publication were included. Studies were excluded from the systematic review and meta-analysis when they met the following criteria: 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

Rhinoplasty employing either spreader graft or autospreader flap techniques. Dorsal hump reduction usually involves reducing the cartilaginous dorsal septum and trimming the vertical height of the upper lateral cartilages. The spreader graft is the standard method for stabilizing the middle vault. The upper lateral cartilage turn-in flap (autospreader or spreader flap) has later been introduced as a viable alternative to the spreader graft for middle nasal vault reconstruction.

Comparison

Spreader graft versus autospreader flap technique

Outcome

Difference between groups in the rates of complications and changes in nasal cosmesis and nasal obstruction severity levels before and after the surgery.

Data Sources and Searches

Medline (via Pubmed), Embase, Cinahl, Central, Scopus, and Web of Science databases were searched in March 2021. To prevent losing any relevant studies, common search clauses were utilized. The search strategy for each database is as follows:

- *Pubmed* ((spreader [TIAB] OR autospreader[TIAB]) AND (graft[TIAB] OR flap[TIAB])) OR ("turn in" [TIAB] AND cartilage) AND hasabstract[TW]
  EMBASE: (spreader:ab,ti OR autospreader:ab,ti) AND graft:ti,ab,kw AND 'human'/de AND 'article'/it AND 'human'/de
- *Cinahl* ((TI spreader OR AB spreader OR TI autospreader OR AB autospreader) AND (TI graft OR AB graft OR TI flap OR AB flap)) OR ((TI "turn in" OR AB "in turn") AND (TI cartilage OR AB cartilage))
  Limiters: Abstract Available Source Types: Academic Journals
- *Central* ((spreader OR autospreader) AND (graft OR flap)) OR ("turn in" AND cartilage) in Title Abstract Keyword in Trials

- *Scopus* ((TITLE-ABS-KEY (spreader) OR TITLE-ABS-KEY (autospreader)) AND (TITLE-ABS-KEY (graft) OR TITLE-ABS-KEY (flap))) OR (TITLE-ABS-KEY ("turnin") AND TITLE-ABS-KEY (cartilage)) AND (LIMITTO (EXACTKEYWORD , "Rhinoplasty")) AND (LIMIT-TO (EXACTKEYWORD , "Human")) AND (LIMIT TO (DOCTYPE , "ar"))
- *Web of science* (TS= (((spreader OR autospreader) AND (graft OR flap)) OR ("turn in" AND cartilage)) OR TI= (((spreader OR autospreader) AND (graft OR flap)) OR (("turn in"ANDcartilage)))) *AND* DOCUMENT TYPES: (Article) *Indexes=SCI-EXPANDED Timespan=All years*

Study Selection

Search results were first screened based on titles and abstracts by two independent reviewers (C.M.B. and P.N.P.). The identified manuscripts were then screened on full texts according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline (Figure 1). Disagreements between the reviewers were resolved by consensus or by a third reviewer (C.K.K.).

Assessment of Risk of Systematic Bias

The methodological quality of our systematic review was classified according to the Guidance for Assessing the Quality of Before–After (Pre–Post) Studies with No Control Group [60]. Twelve attributes were assessed: (1) study question or objective clearly stated; (2) study population and eligibility criteria; (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. Quality of the included trials was estimated as poor, fair, or good.

Data Extraction

Relevant data were extracted from the records by 1 reviewer (C.M.B) using a predefined structured form and verified by a second reviewer (C.K.K).

Statistical Methods

Seventeen studies reported NOSE scores with complete data. The NOSE score estimates reported by the original studies were pooled together depending on the use of

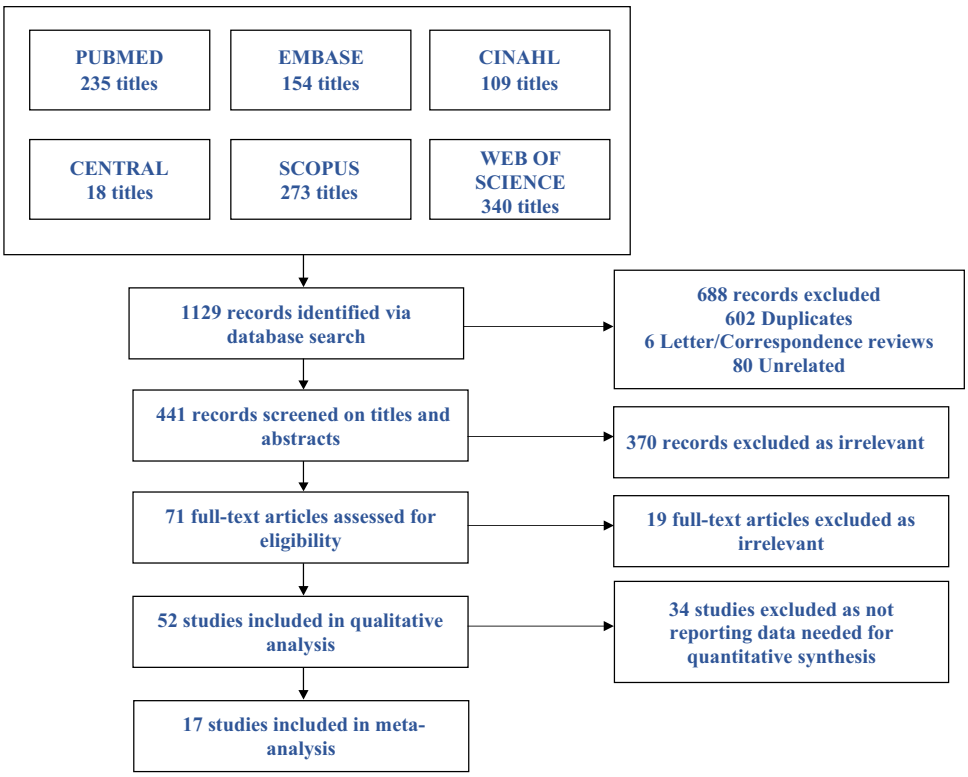


Fig. 1 PRISMA Flow-diagram

spreader grafts, autospreader or none, employing a random effects synthesis. The results were reported as weighted raw mean differences in the NOSE scores before and after the surgery. The results were accompanied by 95% confidence intervals (95% CIs). The heterogeneity was assumed being present if Q-statistics exceeded the degree of freedom (DF). The amount of heterogeneity related to true effect was assessed by using I^2 statistics. The differences between treatment groups were assessed on the pooled summary data using ANOVA with Tukey HSD Post hoc Test setting a desired confidence level for post hoc confidence intervals at 95%. The results of ANOVA were reported as two-tailed p values considering $p < = 0.05$ statistically significant. All the analyses were carried out using the CMA software, version 3.3 available from www.meta-analysis.com and Stata/IC Statistical Software: Release 16. College Station (StataCorp LP, TX, USA).

Results

The search yielded 1129 studies (Figure 1). After excluding duplicate records, reviews, case studies, conference proceedings, letters, and editorials, 441 records were screened by 2 independent reviewers based on titles and abstracts. The remaining 71 records were further assessed based on their full texts. Fifty-two studies [2, 4, 8–57] were included in the qualitative analysis. Of the 52 included studies, 16 were conducted in Turkey, 14 in the USA, 5 in Iran, 3 in Egypt, 3 in Italy, 3 in Canada, 2 in Germany, 1 in Brazil, 1 in South Korea, 1 in Portugal, 1 in Argentina, 1 in the Netherlands and 1 in Oman. Among them, 45 were observational in nature, with 13 retrospective studies (25.0%), 30 prospective studies (57.7%), 1 descriptive analytical study (1.9%), and 1 case series (1.9%). There were 6 randomized clinical trial (11.5%) and 1 non-randomized clinical trial (1.9%). There were 34 studies (65.4%) related to spreader graft (SG) alone [8–13, 16–23, 25, 27, 28, 30–34, 37, 40, 41, 43, 46–48, 50–52, 54, 55], 10 studies of autospreader flap (AF) alone (21.1%) [2, 24, 26, 29, 36, 39, 42, 49, 53, 56], and 8 studies involving (13.5%) both grafts [4, 14, 15, 35, 38, 44, 45, 57]. Sample size varied from 15 to 694, and the mean age varied from 13 to 73 years (Table 1). Among the identified 52 studies, 8 studies [8, 9, 18, 19, 25, 32, 47, 54] were found to have included patients aged less than 18 years of age in their cohort. Although this contradicts the adopted PICO framework for this review, it was decided to include these studies in the review as the patient cohorts in these studies included adult patients and due to the relevance of the study content to this review. Of the 52 studies, NOSE data were included in 19, but only 17 contained complete preoperative and postoperative data. Twenty-two studies included patients who underwent revision surgery [8, 10–12, 18, 19, 22, 23, 27, 30–32, 34, 38, 41, 43, 46, 47, 52–55].

Risk of Systematic Bias

Of the included 52 studies [2, 4, 8–57], methodologically, 25 (48.1%) were considered to be good [2, 4, 9, 13–15, 18, 20, 22–24, 30, 31, 33, 35, 37, 41, 42, 45–48, 50, 52, 57], 6 (11.5%) were considered poor [26, 32, 34, 38, 51, 53], and 21 (40.4%) were considered fair [8, 10–12, 16, 17, 19, 21, 25, 27–29, 36, 39, 40, 43, 44, 49, 54–56] (eTable 1).

Patient-Reported Outcome Measures

Of the 52 studies, 19 reported NOSE [59] scores (Nasal Obstruction Symptom Evaluation Survey) [2, 9, 12, 15, 21–23, 29, 30, 33, 35, 41, 45, 47–50, 52, 56] (Table 2). However, only 17 [2, 9, 12, 15, 21–23, 29, 30, 33, 35, 45, 47, 49, 50, 52, 56] presented complete NOSE data preoperatively and postoperatively. Studies by Paul et al [41] and Talmadge et al [48] were excluded in the qualitative synthesis due to the lack of clarity of the data reported. The included 17 studies were divided into three groups (SG, AF and/or none) and the pooled estimates analyzed. Four of the 17 studies included the AF technique [2, 29, 49, 56], ten described the SG as the chosen technique [9, 12, 21–23, 30, 33, 47, 50, 52], and three reported both [15, 35, 45]. The overall preoperative and postoperative change in the NOSE score was − 23.9 (95% CI, − 26.7 to − 21.1) points. The changes in the NOSE scores before and after the surgery were similar for all three groups, for AF they were − 27.1 (95% CI, − 36.2 to − 18.0) points; for SG, they were − 26.5 (95% CI, − 30.4 to 22.6) points and for those where none of them were used, the scores were − 19.9 (95% CI, − 24.3 to − 15.5) points (Table 3). The heterogeneity was substantial: overall $Q = 7182$, df 36, $I_2 = 99\%$. The ANOVA for summary data (Tukey HSD Post hoc Test) showed no differences between groups, AF group versus no graft ($p = 0.7578$), AF versus SF group ($p = 0.9948$), and SG group versus no graft ($p = 0.6608$).

Six studies reported results using a VAS (Visual analog scale) [2, 4, 35, 37, 42, 56]. Three studies [2, 42, 56] reported scores for AF [2, 42, 56], one for SG [37] and two for both [4, 35] (Table 2). One study analyzed only functional aspects [37], three studies the aesthetic aspects [2, 35, 56] and two studies both aesthetic and functional aspects [4, 42]. The study by Hassanpour et al. [4] did not report preoperative and postoperative mean scores and standard deviation, only the percentage of satisfaction with appearance and function.

Table 1 Basic characteristics of included studies

#	Study	*n*	Type of study (autospreaders, spreaders or both)	Mean age years	SD, years	Age range, years	Gender, % women	Available outcomes (functional, cosmetic, both)	Name of outcomes used
1	Eren, Tugrul et al. [2]	15	Autospreader	32.2	6.3	*	Female 7 (47%), Male 8 (53%)	Functional	NOSE—Acoustic Rhinometry
2	Gorgulu et al. [24]	64	Autospreader	24	*	19–33	Female 45 (70%), Male 19 (30%)	Functional	Rhinomanometry
3	Gruber, Park et al. [26]	25	Autospreader	*	*	Female 18–43, Male 23–55	Female 18 (72%), Male 7 (28%)	None	None
4	Hussein et al. [29]	22	Autospreader	24.68	*	18–35	Female 12 (54,54%), Male 10 (45,45%)	Functional	NOSE
5	Kucuke et al. [36]	147	Autospreader	29.2	*	17–65	*	None	None
6	Ozmen et al. [39]	180	Autospreader	28.34	*	17–63	Female 114 (63%), Male 66 (37%)	None	None
7	Saedi et al. [42]	66	Autospreader	24.6	5.5	17–41	Female 46 (69,7%), Male 20 (30,3%)	Functional and Aesthetic	VAS—Acoustic Rhinometry
9	Taş and Erden [49]	54	Autospreader	Autospreader group: 25.96 SD 7.583, Let down group: 26.52 SD 7.198	Autospreader group: 7.583, Let down group: 7.198	*	Female 31 (57,4%), Male 23 (42,6)	Functional	NOSE—SNOT-22
10	Wurm and Kovacevic [53]	164	Autospreader	*	*	17.5–63	Female 133 (81,1%), Male 31 (18,9%)	None	None
11	Yoo and Most [56]	38	Autospreader	*	*	*	*	Functional and Aesthetic	NOSE—VAS
8	Sowder et al. [45]	26	Autospreader and Spreader graft	General: 38.4, Spreader flap: 38, Spreader graft: 37.4	*	General: 18–64, Spreader flap: 18–57, Spreader graft: 18–64	Female 14 (54%), Male 12 (46%)	Functional	NOSE
12	Barone et al. [14]	264	Autospreader and Spreader graft	32.1	*	18–65	Female 154 (58,3%), Male 110 (41,7%)	Aesthetic	Face Q
13	Bilgin et al. [15]	60	Autospreader and Spreader graft	28.6	1.46	18–50	Female 33 (55%), Male 27 (45%)	Functional	NOSE—Olfactory score
14	Hassanpour et al. [4]	50	Autospreader and Spreader graft	Autospreader 24.64–Spreader graft 29.64	Autospreader: 5.08–Spreader graft: 9.02	*	Female 37 (74%), Male 13 (26%)	Functional and Aesthetic	Rhinomanometry—VAS
15	Manavbaşi and Başaran [38]	169	Autospreader and Spreader graft	*	*	*	Female 112 (68%), Male 52 (32%)	None	None
16	Kocak and Duzenli [35]	36	Autospreader and Spreader graft	26.06	5.4	18–40	Female 30 (83%), Male 6 (17%)	Functional and Aesthetic	NOSE—VAS
17	Shafaeei and Zare [44]	130	Autospreader and Spreader graft	*	*	*	*	None	None
18	Zeid et al. [57]	40	Autospreader and Spreader graft	24	4	18–35	Female 14 (35%), Male 26 (65%)	Functional	Rhinomanometry

Table 1 continued

#	Study	*n*	Type of study (autospreaders, spreaders or both)	Mean age years	SD, years	Age range, years	Gender, % women	Available outcomes (functional, cosmetic, both)	Name of outcomes used
19	Al Abduwani and Singh [8]	179	Spreader graft	27.3	*	16–55	Female 43 (24,02%), Male 136 (75,97%)	None	None
20	Albergo et al. [9]	35	Spreader graft	31	*	13–66	Female 6 (17%), Male 29 (83%)	Functional	NOSE—Rhinomanometry
21	André et al. [10]	89	Spreader graft	38.6	*	21–65	Female 29 (32,58%), Male 60 (67,4%)	None	None
22	Arslan et al. [11]	25	Spreader graft	26.5	*	18–39	Female 18 (72%), Male 7 (28%)	None	None
23	Atespare and Boyaci [12]	115	Spreader graft	27.2	4.55	19–62	Female 50 (43,47%), Male 65 (56,52%)	Functional	NOSE
24	Atighechi et al. [12]	210	Spreader graft	25.54	5.68	18–45	Female 112 (53,3%), Male 98 (46,7%)	Functional	AlSarraf standardized questionnaire
25	Boccieri [16]	40	Spreader graft	32	*	19–48	Female 24 (%) , Male 16 (%)	Functional	Rhinomanometry
26	Boccieri et al. [17]	60	Spreader graft	32	*	*	Female 25 (41,66%)–Male 35 (58,33%)	Functional	Rhinomanometry
27	Constantian and Clardy [18]	160	Spreader graft	Female: 34, Male: 34	*	Female 14–65, Male 17–72	Female 107 (67%), Male 53 (33%)	Functional	Rhinomanometry
28	Constantinides et al. [19]	27	Spreader graft	31	*	16–58	Female 17 (63%), Male 10 (37%)	Functional	Plethysmography
29	De Pochat et al. [20]	20	Spreader graft	31	6	20–40	Female 14 (70%), Male 6 (30%)	Functional	Acoustic Rhinometry
30	Erickson et al. [21]	17	Spreader graft	34.5	12.2	*	Female 16 (94%), Male 1 (6%)	Functional	NOSE—SNOT-22–Acoustic Rhinometry
31	Fuller et al. [22]	281	Spreader graft	36.3	15.5	*	Female 159 (56,6%), Male 122 (43,4%)	Functional	NOSE—PNIF
32	Fuller et al. [23]	154	Spreader graft	36.8	15.4	*	Female 82 (53,2%), Male 72 (46,8%)	Functional and Aesthetical	NOSE—FACE-Q
33	Grigoryants and Baroni [25]	32	Spreader graft	*	*	16–38	Female 24 (75%) , Male 8 (25%)	None	None
34	Gürlek et al. [28]	20	Spreader graft	31	*	21–48	Female 8 (40%), Male 12 (60%)	None	None
35	Gurlek et al. [27]	15	Spreader graft	32	*	20–45	*	None	None
36	Ismail et al. [30]	79	Spreader graft	Female: 28, Male: 31	Female: 4, Male: 3	Female 18–42, Male 18–54	Female 23 (29%), Male 56 (71%)	Functional	NOSE

Table 1 continued

#	Study	*n*	Type of study (autospreaders, spreaders or both)	Mean age years	SD, years	Age range, years	Gender, % women	Available outcomes (functional, cosmetic, both)	Name of outcomes used
37	Jalali [31]	220	Spreader graft	Total: 28.3, Spreader graft group: 29.9	Total: 6.9 Spreader graft group: 5.8	*	Female 153 (70%), Male 67 (30%)	Functional	Rhinomanometry
38	Jang and Sinha [32]	33	Spreader graft	33	*	16–49	Female 6 (18%), Male 27 (82%)	None	None
39	Kahraman et al. [33]	50	Spreader graft	21	2.1	19–23	Female 0, Male 50 (100%)	Functional	NOSE—Acoustic Rhinometry
40	Khosh et al. [34]	53	Spreader graft	38	*	17–73	Female 29 (55%), Male 24 (45%)	None	None
41	Mamanov et al. [37]	30	Spreader graft	Group 1: 30.2, Group 2: 29.8	*	Group 1: 19–44, Group 2: 19–52	Female 13 (43%), Male 17 (57%)	Functional and Aesthetical	VAS—Acoustic Rhinometry
42	Ozturan [40]	76	Spreader graft	24	*	17–38	Female 26 (34%), Male 50 (66%)	None	None
43	Paul et al. [41]	38	Spreader graft	Closed surgery: 37.1, Open surgery: 36.9	Closed surgery: 12.5, Open surgery: 18.4	*	Female 20 (53%), Male 18 (47%)	Functional	NOSE—Acoustic Rhinometry
44	Samaha and Rassouli [43]	100	Spreader graft	31.2	*	*	Female 83 (83%), Male 17 (13%)	None	None
45	Stacey et al. [46]	34	Spreader graft	Group 1 (Butterfly): 47, Group 2 (Spreader): 29	*	*	Female 23 (67,6%) Male 11 (32,4%)	Functional and Aesthetical	Nasal airway obstruction questionnaire
46	Standlee and Hohman [47]	109	Spreader graft	33	*	16–68	Female 21 (19%), Male 88 (81%)	Functional	NOSE
47	Talmadge et al. [48]	50	Spreader graft	Open approach: 40, Endonasal: 42	*	*	Open: Female 17 (34%), Male 33 (66%). Endonasal: Female (35%), Male (65%).	Functional	NOSE
48	Ulusoy et al. [50]	68	Spreader graft	With spreader: 26.8, Without spreader: 29.7	With spreader: 6.7, Without spreader: 7.3	With spreader: 19–42), Without spreader: 17–48	Female 39 (57,3%), Male 29 (42,7%)	Functional	NOSE
49	Wagner and Schraven [51]	100	Spreader graft	*	*	*	*	None	None
50	Weitzman et al. [52]	694	Spreader graft	SSG: 34.8, ESG: 42.7	SSG: 14.8, ESG: 16.4	*	Female 333 (47,9%), Male 361 (52,1%)	Functional and Aesthetical	NOSE—FACE-Q
51	Xavier et al. [54]	72	Spreader graft	31.74	10.74	16–58	Female 34 (47,22%), Male 38 (52,78%)	Functional	PNIF
52	Yoo and Jen [55]	41	Spreader graft	32	*	19–56	Female 22 (53,7%), Male 19 (46,3%)	None	None

*No data available

Table 2 Nasal obstruction symptom evaluation score and visual analog scale score

#	Study	Type (auto spreaders=1, spreaders=2, both =3)	Outcome	Follow-up interval	Groups	Mean preop score	SD	Range	Mean postop score	SD	Range
1	Eren et al. [2]	1	NOSE	12.6 months		65	13	50–80	7.7	10	0–35
2	Hussein et al. [29]	1	NOSE	6–12 months	Group 1(aesthetic only)	5.9		0–10	1.36		0–5
					Group 2(Functional+aesthetic only)	67.27		50–85	18.63		05–25
3	Tas and Erden [49]	1	NOSE	6 months	Group 1(autospreader only)	12.96	5.019		3.93	3.812	
					Group 2(Letdown)	13.04	5.2266		4.89	4.509	
4	Yoo and Most [56]	1	NOSE	150 days (range: 30–619)	13	16		10.5	12		
5	Albergo et al. [9]	2	NOSE	14 months (12–16)	74.5		55–90	23.5		0–60	
6	Atespare and Boyaci [12]	2	NOSE	12 months		3.14	0.35		0.81	0.75	
7	Erickson et al. [21]	2	NOSE	Early—8.1 +/−1.6 weeks	14	3.3	10–20	Early: 5.9	2.9	02–10	
				Intermediate—17.2 +/−4.2 Weeks				Intermediate: 7.7	4.5	0–15	
8	Fuller et al. [23]	2	NOSE	5.8 (4.1) months, range: 2–12 months)	Functional :	62.8	20.9		21.8	20.3	
					Functional + Cosmetic:	62.5	20.2		26.3	23.2	
9	Fuller et al. [22]	2	NOSE	7.3 (5.4) months Range: 2–24 months	61.8	22		20.9	2.4		
10	Ismail et al. [30]	2	NOSE	0–1 month, 1–3 months, 6–3 years	69.8	8.7	58–89	20.65	4.8	17–24	
11	Kahraman et al. [33]	2	NOSE	1 month	Group 1(septoplasty):	16.8	1.3		2.4	0.5	
					Group2 (Septoplasty with spreader graft) :	15.4	2.4		2.4	1.8	
					Group 3 (septorhinoplasty):	15.2	1.3		3.6	1.1	
					Group 4 (Septorhinoplasty with spreader graft):	16.4	2.3		4.8	2.8	
12	Standlee and Hohman [47]	2	NOSE	Follow-up interval 1 (Mean): 52 days; Follow-up interval 2 (Mean): 115 days; Follow-up interval 3 (Mean): 191 days	69	18		23	20		
13	Paul et al. [41]	2	NOSE	12 months		reported as median (Total scores not x5)	2.1–2.85			0.75–1.1	

Table 2 continued

#	Study	Type (auto spreaders=1, spreaders=2, both =3)	Outcome	Follow-up interval	Groups	Mean preop score	SD	Range	Mean postop score	SD	Range
14	Talmadge et al. [48]	2	NOSE	0–12 months	Open	70			17		
					Endonasal	66			16		
15	Ulusoy et al. [50]	2	NOSE	6 months	Group1(Open Septorhinoplasty with b/l spreader grafts)	61.2	9	44–75	24	7.6	15–59
					Group2(Open Septorhinoplasty without spreader grafts)	63.1	8.6	46–78	27	11.7	15–67
16	Weitzman et al. [52]	2	NOSE	0–6, 6–12 months	Spreader graft	63.9	22.5		20.4	19.5	
					Extended Spreader graft	63.9	24.6		27.6	26.3	
17	Bilgin et al. [15]	3	NOSE	Not specified	Group 1: b/l spreader grafts:	11.6		06–17	1.6		0–7
					Group 2: b/l spreader flaps :	9.5		01–17	2.5		0–10
					Group3: No flaps or grafts :	11.5		05–18	1.4		0–6
					Overall:	10.87		01–18	1.83		0–6
18	Kocak and Duzenli [35]	3	NOSE	3 months	Rectangular graft	22.2	20.2		8.2	5.7	
					Triangular graft	35.6	26.7		9.5	7.2	
					Spreader flap	26.8	18.4		10.5	7.4	
19	Sowder et al. [45]	3	NOSE	1, 3 , 6 months	Spreader Flap	81.9	15.8	72.4–91.4	18.5	21.6	5.4–31.5
					Spreader Graft	75.4	19.3	63.7–87.1	16.9	16.4	7.0–26.8
									Change In NOSE		
					Spreader Flap				63.5	23.5	49.3–77.7
					Spreader Graft				58.5	27.8	41.7–75.3
1	Eren, Tugrul et al. [2]	1	VAS	12.6 months		32.5	20	01–20	88	9	70–100
2	Yoo and Most [56]	1	VAS	150 days (range: 30–619)	1.2	1.6		0.95	1.2		
3	Mamanov et al. [37]	2	VAS	6 months	Group 1: Open Septorhinoplasty (SRP)						
			L VAS		Before decongestion:	5.53	2.83		5.53	2.83	
					After Decongestion:	4.73	2.52		5.27	2.55	
			R VAS								
					Before decongestion:	4.27	2.49		4.27	2.49	
					After Decongestion:	3.87	2.29		4.27	2.49	
					Group 2: Open SRP+ Spreader grafts						
			L VAS		Before decongestion:	4.4	2.59		2.67	0.9	
					After Decongestion:	3.87	2.13		2.2	0.68	
			R VAS								
					Before decongestion:	5.27	3.28		2.4	1.18	
					After Decongestion:	4.8	2.91		2	1.07	

Table 2 continued

#	Study	Type (auto spreaders=1, spreaders=2, both =3)	Outcome	Follow-up interval	Groups	Mean preop score	SD	Range	Mean postop score	SD	Range
4	Hassanpour et al. [4]	3	VAS	1 month		Not reported			Not reported		
5	Kocak and Duzenli [35]	3	VAS	3months	Rectangular graft	4.07	1.8		8.8	1	
					Triangular graft	3.3	1.5		8.7	0.9	
					Spreader flap	4	1.9		8.8	0.7	
6	Saedi et al. [42]	12 months	VAS (Satisfaction)	12 months	Spreader Flap	4.43	2.49		8.38	1.6	
					Control	3.83	1.72		8.68	0.95	
			VAS (Obstruction)	Spreader Flap	5.57	2.51		2.56	0.52		
					Control	6.17	3.28		3.2		1.47

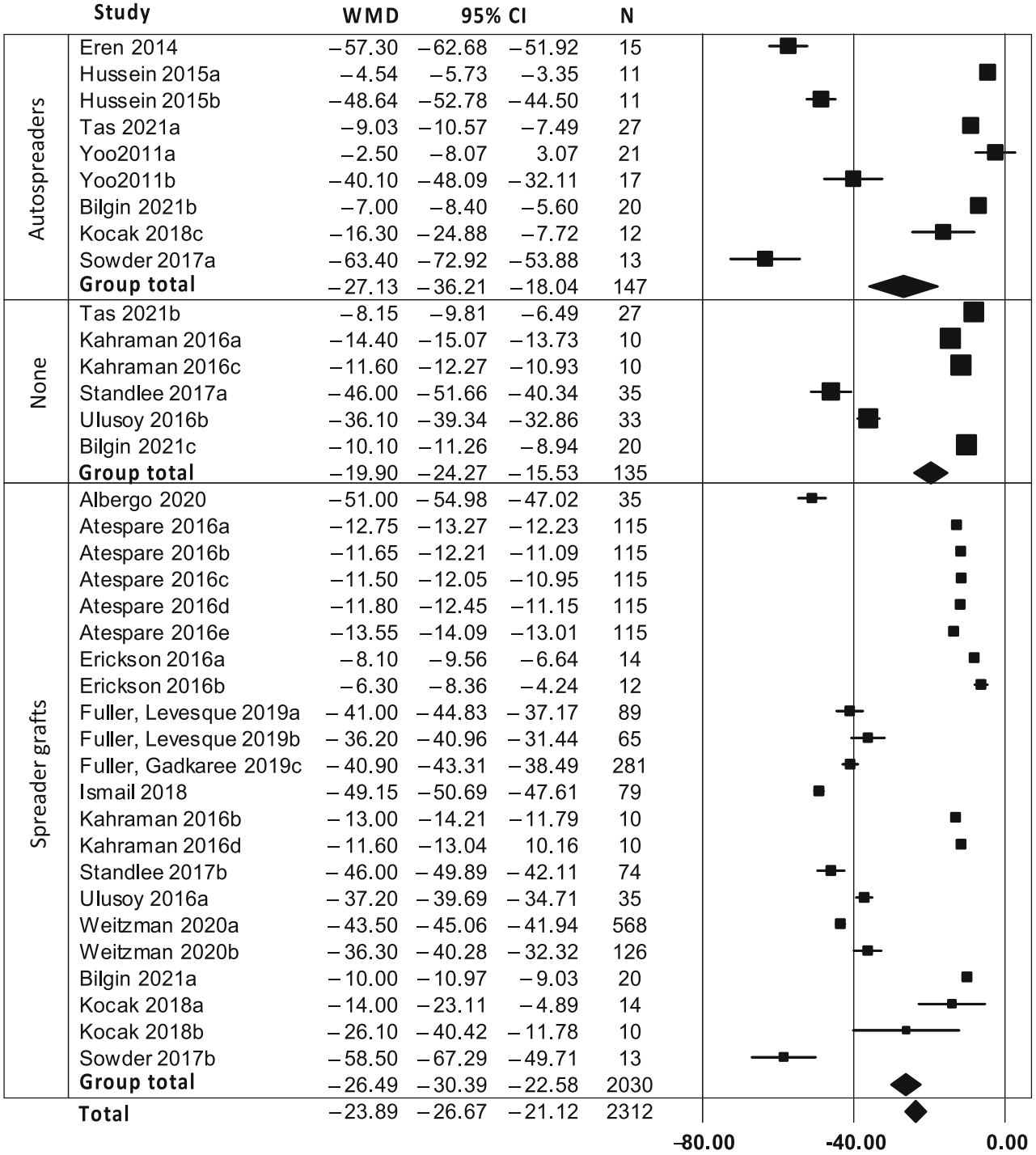
Objective Outcome Measures

Among fifteen studies (28.9%) reporting acoustic rhinomanometry, two were AF related studies [24, 42], eleven were SG studies [2, 9, 16–18, 20, 21, 31, 33, 37, 41] and two studies related with both AF and SG [4, 57] (Table 4). Eight studies (15.4%) reported both preoperative and postoperative outcomes, as well as standard deviations [16, 18, 21, 33, 37, 41, 42, 57]. Six of eight studies reporting complete data were about SG [16, 18, 21, 33, 37, 41], one was about AF [42], and one studied both SG and AF [57]. Seven other studies (13.5%) [2, 4, 9, 17, 20, 24, 31] reported objective outcomes; however, they did not register complete data to compare the changes between preoperative and postoperative results. Due to this reason, a qualitative synthesis was not carried out.

Risks of Complications or Revision Surgery

Of the 52 studies included, 18 studies (34.6%) reported proportion of revision surgery and details of complications [8–11, 16–18, 20, 26, 30, 31, 34, 36, 38, 39, 41, 43, 53]. Complications were reported in 13 of 34 SG studies (38.2%); in 4 of 11 AF studies (36.4%) and in 1 of 7 combined SG and AF studies (14.3%) (eTable 2). Revision rates were reported in 5 of 34 SG studies (14.7%), in 2 of 11 AF studies (18.2%) and 1 of 7 for combined studies (14.2%) (eTable 2). Bleeding ranged from 0 to 4.47%, infection from 0 to 5.62%, aesthetic complications excluding dorsal irregularities from 0 to 11.73%, other functional complications from 0 to 15.0%, and revision surgery from 0 to 6.12%. Of the 34 SG studies (pooled: n = 3326), there were 8 infections (0.24%), 9 bleeding events (0.27%), no dorsal irregularities, 29 other cosmetic complications (0.87%), and 46 other functional complications (1.38%). Of the 5 studies reporting revision rates (n = 367) [8, 9, 16, 17, 34], there were 14 revisional procedures (3.81%). In the 11 AF studies (pooled: n = 801), there were 16 other cosmetic complications (2.00%), 10 other functional complications (1.25%), no infections, no dorsal irregularities, and no bleeding events. One study (n = 147) [38] reported revision surgery for 9 cases (6.12%). Of the 7 studies involving both SG and AF (pooled n = 749), there was 1 other cosmetic complication. Manavbaşi and Başaran [38] reported that a patient-reported problems resulting from excessive dorsal width, excessive swelling in the supratip area and demanded removal of the grafts in the second postoperative week. There were no infections, no bleeding events, no other functional complications, and no dorsal irregularities. Only one study (pooled n = 169) [38] described a revision procedure in 1 patient (0.60%).

Table 3 Change in nasal obstruction symptom evaluation score across the analyzed studies.



WMD weighted mean difference, *CI* confidence interval, *N* number of patients

Table 4 Results of acoustic rhinomanometry

#	Study	Type (Auto spreaders=1, spreaders=2, Both =3)	Follow-up interval (SD), range	Groups		Mean preop score	SD	Range/ Percentage	Mean postop score	SD	Range/ Percentage
1	Gorgulu et al. [24]	1	18 months (12–24)	Group 1: Inspiratory NARs		0.257		0.224–0.276	0.144		0.132–0.163
				Group 2: Expiratory NARs		0.194		0.162–0.216	0.138		0.126–0.159
2	Saedi et al. [42]	1	12 months	Spreader flap group	Left I-notch area	0.71	0.19		0.7		0.17
					Right I-notch area	0.75	0.2		0.73		0.26
					Left C-notch area	0.76	0.48		0.69		0.17
					Right C-notch	1.13	1.07		2.3		1.99
					Left MCA	0.71	0.2		1.2		0.46
					Right MCA	0.76	0.21		0.73		0.26
					Left volume	6.9	11.7		11.26		16.28
					Right volume	4.6	2.24		8.07		7.33
				Control group	Left I-notch area	0.83	0.53		0.6		0.15
					Right I-notch area	0.84	0.81		0.55		0.19
					Left C-notch area	0.92	0.64		0.6		0.15
					Right C-notch	1.34	1.45		0.79		0.28
					Left MCA	0.68	0.19		1.17		0.48
					Right MCA	0.67	0.19		0.55		0.2
					Left volume	7.28	8.41		5.67		4.66
					Right volume	7	11.9		4		0.96
3	Hassanpour et al. [4]	1		Autospreader flap	Nasal airway resistance	0.14			0.24		
					Flow rate	412.14			276.62		
4	Zeid et al. [57]			Autospreader flap	Right nasal cavity's resistance	0.82	0.23		0.37	0.04	
					Left nasal cavity's resistance	0.74	0.14		0.35	0.03	
1	Albergo et al. [9]	2	14 months (12–16)			5.9		0–46	0.9		0–2
2	Boccieri [16]	2	20 months (14–26)		Quiet inspiration	308	34		523	64	
					Forced inspiration	1.034	107		1.759	157	
3	Boccieri et al. [17]	2	17 months (12–24)	NO VALUES/TABLES							
4	Constantian and Clardy [18]	2	8.4 months (1–43)	Internal + external valves + septum	Quiet inspiration	93	22		459	87	
					Forced inspiration	624	123		1222	162	
				Internal + external valves	Quiet inspiration	234	65		884	139	
					Forced inspiration	1080	359		1858	263	
				Internal valve + septum	Quiet inspiration	250	51		556	83	

Table 4 continued

#	Study	Type (Auto spreaders=1, spreaders=2, Both =3)	Follow-up interval (SD), range	Groups			Mean preop score	SD	Range/ Percentage		Mean postop score	SD	Range/ Percentage
					Forced inspiration		983	178			1864	297	
				Internal valves (all)	Quiet inspiration		266	37			529	69	
					Forced inspiration		934	113			1765	163	
				Dorsal graft reconstruction	Quiet inspiration		236	59			477	107	
					Forced inspiration		1001	193			1528	252	
				Spreader graft reconstruction	Quiet inspiration		284	42			560	91	
					Forced inspiration		891	141			1904	210	
				External valve + septum	Quiet inspiration		165	42			477	94	
					Forced inspiration		504	130			1760	371	
				External valves	Quiet inspiration		238	92			608	291	
					Forced inspiration		1114	246			1437	357	
				Septum	Quiet inspiration		442	101			478	106	
					Forced inspiration		1069	189			1579	188	
5	De Pochat et al. [20]	2	5–18 months	NO VALUES/ TABLES									
6	Eren et al. [2]	2	12.6 months		Mean minimal cross-sectional area		1.56 cm^2				2.16 cm^2		
7	Erickson et al. [21]	2	8.1 weeks (1.6)		INV cross-sectional area		0.519	0.28	0.02–1.10	Early postoperative	0.614	0.28	0.19–1.32
			17.7 weeks (4.2)							Intermediate postoperative	0.552	0.23	0.17–1.01
8	Jalali [31]	2	20.9 weeks (2.9)	Spreader grafts			0.247 Pa/ ml/s	0.110–0.250		0.027 Pa/ml/ s	0.110–0.130		
				Flaring sutures			0.247 Pa/ ml/s	0.120–0.930		0.017 Pa/ml/s	0.690–0.790		
9	Kahraman et al. [33]	2	12 months	Group 1	Deviated side	MCA 1 (cm^2)	0.34	0.28			0.56	0.24	
						MCA 2 (cm^2)	0.31	0.35			0.5	0.43	
						Vol 1 (cm^3)	1.69	0.79			1.83	0.74	
						Vol 2 (cm^3)	3.85	2.5			4.06	2.54	
					Non deviated side	MCA 1 (cm^2)	0.46	0.21			0.5	0.26	
						MCA 2 (cm^2)	0.49	0.27			0.48	0.29	
						Vol 1 (cm^3)	1.88	0.39			2.03	0.56	

Table 4 continued

#	Study	Type (Auto spreaders=1, spreaders=2, Both =3)	Follow-up interval (SD), range	Groups			Mean preop score	SD	Range/ Percentage	Mean postop score	SD	Range/ Percentage
						Vol 2 (cm^3)	3.93	1.78		4.16	2.12	
				Group 2	Deviated side	MCA 1 (cm^2)	0.33	0.16		0.54	0.29	
						MCA 2 (cm^2)	0.29	0.22		0.49	0.29	
						Vol 1 (cm^3)	1.56	0.66		1.74	0.58	
						Vol 2 (cm^3)	3.74	1.19		3.78	2.21	
					Non deviated side	MCA 1 (cm^2)	0.39	0.11		0.41	0.08	
						MCA 2 (cm^2)	0.42	0.2		0.43	0.25	
						Vol 1 (cm^3)	1.65	0.4		1.79	0.31	
						Vol 2 (cm^3)	4.05	0.73		4.17	2.14	
				Group 3	Deviated side	MCA 1 (cm^2)	0.29	0.2		0.49	0.1	
						MCA 2 (cm^2)	0.32	0.3		0.55	0.1	
						Vol 1 (cm^3)	1.73	0.65		1.75	0.4	
						Vol 2 (cm^3)	4.13	1.38		4.29	0.86	
					Non deviated side	MCA 1 (cm^2)	0.41	0.18		0.46	0.26	
						MCA 2 (cm^2)	0.39	0.13		0.42	0.34	
						Vol 1 (cm^3)	1.82	0.39		1.91	0.55	
						Vol 2 (cm^3)	4.31	0.93		4.35	2	
				Group 4	Deviated side	MCA 1 (cm^2)	0.32	0.21		0.51	0.26	
						MCA 2 (cm^2)	0.3	0.06		0.53	0.3	
						Vol 1 (cm^3)	1.47	0.58		1.59	0.61	
						Vol 2 (cm^3)	3.88	1.77		4.09	1.46	
					Non deviated side	MCA 1 (cm^2)	0.35	0.15		0.39	0.12	
						MCA 2 (cm^2)	0.37	0.15		0.4	0.08	
						Vol 1 (cm^3)	1.64	0.45		1.82	0.51	
						Vol 2 (cm^3)	3.96	1.91		4.18	1.24	
				Control	Deviated side	MCA 1 (cm^2)	0.5	0.07				
						MCA 2 (cm^2)	0.59	0.07				
						Vol 1 (cm^3)	1.94	0.2				
						Vol 2 (cm^3)	4.17	0.62				

Table 4 continued

#	Study	Type (Auto spreaders=1, spreaders=2, Both =3)	Follow-up interval (SD), range	Groups			Mean preop score	SD	Range/ Percentage	Mean postop score	SD	Range/ Percentage
					Non deviated side	MCA 1 (cm^2)	0.52	0.11				
						MCA 2 (cm^2)	0.63	0.09				
						Vol 1 (cm^3)	2.01	0.19				
						Vol 2 (cm^3)	4.22	0.62				
10	Mamanov et al. [37]	2	6 months		Before decongestion	L MCA1 (cm^2)	0.47	0.3		0.47	0.28	
						L VOL1 (cm^3)	1.65	0.48		1.67	0.46	
						MCA2 (cm^2)	0.42	0.23		0.43	0.22	
						L VOL2 (cm^3)	3.16	1.46		3.22	1.38	
						R MCA1 (cm^2)	0.5	0.21		0.51	0.21	
						R VOL1 (cm^3)	2.04	1.05		2.05	1.04	
						R MCA2 (cm^2)	0.51	0.23		0.53	0.22	
					After decongestion	L MCA1 (cm^2)	0.48	0.25		0.49	0.24	
						L VOL1 (cm^3)	1.63	0.43		1.66	0.43	
						MCA2 (cm^2)	0.47	0.24		0.47	0.24	
						L VOL2 (cm^3)	4.35	2.46		4.4	2.45	
						R MCA1 (cm^2)	0.54	0.23		0.55	0.23	
						R VOL1 (cm^3)	1.81	0.5		1.84	0.49	
						R MCA2 (cm^2)	0.64	0.26		0.66	0.26	
11	Paul et al. [41]	2	4 weeks		Overall average cross-sectional area		0.63	0.29		1.01	0.78	
12	Hassanpour et al. [4]	3	1 month	Spreader graft	Nasal airway resistance		0.26			0.38		
					Flow rate		483.08			265.04		
13	Zeid et al. [57]	3	6 months	Group 1: Spreader graft	Right nasal cavity's resistance		0.87	0.2		0.37	0.02	
					Left nasal cavity's resistance		0.69	0.24		0.35	0.04	

When comparing SG versus AF, the relative risk for infections was 4.10 (95% CI, 0.24–70.93); for bleeding was 4.58 (95% CI, 0.27–78.61); for nasal dorsal irregularities was 0.24 (95% CI, 0.0048–12.14); for other aesthetic complications was 0.4365 (95% CI, 0.24–0.80); for other functional complications was 1.11 (95% CI, 0.56–2.19); and for revision surgery was 0.37 (95% CI, 0.16–0.86).

Discussion

This study systematically evaluated outcomes and complications of SG and AF in 52 studies. Less than half of the studies included in this review, 25 of 52 (48.1%) demonstrated good methodology according to the Guidance for Assessing the Quality of Before–After (Pre–Post) Studies with no control group [58]. Meta-analysis included only 17 studies that reported both preoperative and postoperative NOSE scores [59]. Based on 95% CI, the change in NOSE for SG: − 26.5 (95% CI, − 30.4 to 22.6) is insignificant statistically, whereas the ones for AF: − 27.1 (95% CI, − 36.2 to − 18.0) points, and for no grafts : − 19.9 (95% CI, − 24.3 to − 15.5) especially in that closest to a zero effect level, AF =18.0 and 'none at all'=15.5 are both less than 19.4 the reported MCID for NOSE. There was high heterogeneity (I^2 = 99%) between the three groups).

Of the 52 studies included, rates of revision surgery and complications were described in 18 studies: 13 related to the SG technique [8–11, 16–18, 20, 30, 31, 34, 41, 43], 4 related to the AF technique [26, 36, 39, 53] and 1 related to using both grafts [38]. Revision surgery rates were reported in 5 of 34 studies for SG, in 1 of 11 studies for AF and 1 of 7 for studies that used both grafts. Other functional complications (1.38%) were the most prevalent among the spreader graft group, followed by other cosmetic complications (0.87%). Among the autospreader flap group, other cosmetic complications (2.00%) were more numerous when compared to other functional ones (1.25%) (eTable 2). Other complications, such as bleeding and infections, were not found to be significantly different between the 2 groups. Overall, these complication rates were very low, all occurring at rates less than 2%. More prevalent was revision surgery, which was slightly higher for the patients that were submitted to procedures that used both SG and AF (14.2%) or SG only (14.7%), when compared to those undergoing the AF technique (9.1%).

Five studies, four evaluating the spreader graft technique [21, 33, 37, 41] and one evaluating the autospreader flap technique [42] reported increase in the minimal cross-sectional area postoperatively. Two studies using spreader grafts showed that nasal airflow during quite inspiration improved postoperatively [16, 18]. One study [57] comparing the nasal air resistance in patients that were submitted to rhinoplasty with spreader grafts or autospreader flaps reported decrease in air resistance in both groups postoperatively. Despite the improvements in these objective outcomes, it is difficult to compare and to affirm what graft is more efficient, since the data were collected by analyzing different groups or parameters.

As various modifications have been suggested for the autospreader flaps, it is unclear if certain aspects like scoring the autospreader flaps have any impact on outcomes.

Limitations

We understand the complexity of this chosen topic of middle vault management. Not all spreader grafts or flaps are the same. Moreover, each surgeon also has their respective modification of these grafts. Due to such differences, there exists an inherent problem obtaining a standardized result in the management of the middle vault. One of the main limitations of the study was the lack of consistent methodology among the included studies in this review, coupled with the heterogeneity of reported outcomes, were the main limitations of this study. Over half of the included studies were assessed to be of low quality. While 52 studies were included for the qualitative analysis, most of them did not include complete outcome data or the lack of standardized reporting of patient outcomes in these studies, a major shortcoming, makes it difficult to effectively compare both methods.

Conclusion

Of the 52 studies reviewed, less than half were considered to have a good methodology and only 17 were included for the quantitative analysis. Discrepancies in the functional and/or aesthetic outcome measures made comparisons difficult. To increase the reliability and level of evidence, surgical outcomes measures should be standardized, and improved study methodology is required. We recommend a highly validated and extensively translated PROM like the standardized cosmesis and health nasal outcomes survey (SCHNOS) questionnaire to be accepted as a global standard in assessing rhinoplasty patients [60–72]. As stated by the available data, change in NOSE scores after rhinoplasty were similar in procedures that used spreader graft only or autospreader flap only. Complications did not differ significantly between groups. Considering that the results of this systematic review and meta-analysis demonstrated that there were no significant differences between the two techniques, based on surgeon preference, it may be

beneficial to use autospreader flaps since it limits the need for cartilage harvest.

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