Aesth Plast Surg (2023) 47:313–329
https://doi.org/10.1007/s00266-022-03060-w

REVIEW RHINOPLASTY

Effectiveness of Nasolabial Flap Versus Paramedian Forehead Flap for Nasal Reconstruction: A Systematic Review and Meta-analysis

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Received: 29 May 2022 / Accepted: 4 August 2022 / Published online: 14 September 2022

Abstract

Background Different studies performed on nasal subunit reconstruction by either the nasolabial flap or the paramedian forehead flap have reported contradictory outcomes and complications, claiming one flap or the other as superior. This inconsistency has led to a gap in existing literature regarding the preferable flap for nasal reconstruction. Our aim was to statistically evaluate and compare these two flaps for nasal reconstruction, in terms of subunit preference, complications, and outcomes, using data from previous studies.

Methods This systematic review is reported using PRISMA protocol and was registered with the International prospective register of systematic reviews. The literature search was done using "paramedian forehead flap", "nasolabial flap", "melolabial flap", "nasal reconstruction". Data regarding demography of study and population, subunit reconstructed, complications, and aesthetic outcomes were extracted. Meta-analysis was performed using MetaXL and summary of findings using GRADEpro GDT.

Results Thirty-eight studies were included, and data from 2036 followed-up patients were extracted for the review. Meta-analysis was done on data from nine studies. Difference in alar reconstruction by forehead versus nasolabial flap is statistically significant [pooled odds ratio (OR) 0.3; 95% CI 0.01, 0.92; $p = 0.72$; $I^2 = 0\%$, $n = 6$ studies], while for dorsum and columella reconstruction the difference is not statistically significant. Risk of alar notching is marginally more in forehead flap, however difference in incidence of partial/complete flap necrosis, alar notching and hematoma/bleeding among the flaps is not statistically significant.

Conclusion Alar reconstruction is preferred by nasolabial flap. Complications are similar in both groups. Comparison of aesthetic outcome needs further exploration.

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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 Nasolabial flap · Melolabial flap · Paramedian forehead flap · Systematic review · Complication · Nasal reconstruction

Introduction

Nasal defects occur following excision of tumors, namely Basal cell carcinoma, Squamous cell carcinoma, melanomas, sarcoma, lymphomas, sweat gland carcinoma and other benign/inflammatory growth, trichoepithelioma, arteriovenous malformations, rhinophyoma; trauma; insect, animal or human bite; post burns (thermal, electrical, chemical); skin necrosis following radiotherapy, sepsis; cosmetic removal of various skin lesions, nevi; congenital craniofacial deformities.

A wide variety of flaps have been devised for nasal defect reconstruction depending upon the nasal subunit(s) involved, extent and size and the layers involved. However, the paramedian forehead flap and the nasolabial flap have been explored far more than other reconstruction modalities, hence they may be considered the workhorse for nasal defect reconstruction. The proponents of either flap had enumerated various pearls and pitfalls of their flaps. Some authors have also compared the two flaps in their studies [1–9]. But more often their outcomes and conclusions were not coherent to one another.

Our primary objective was to estimate the frequency of each type of nasal subunit being reconstructed with either the paramedian forehead flap or the nasolabial flap, and also the incidences of various post-operative complications in each group. Our secondary objective was to determine the relative risk of various complications among both the groups of flap reconstruction. The complications included partial or total flap necrosis, alar notching, hematoma or bleeding, following reconstruction with either these flaps.

Materials and Method

Search Strategy

This systematic review was registered with the international prospective register of systematic reviews (PROSPERO), adhering to the standards of the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines. An electronic database search on PubMed, Google Scholar and the Cochrane Library was conducted on December, 2020 using a combination of both Medical Subject Heading (MeSH) terms and plain text related to nasal reconstruction. Studies limited to humans and published in English language were searched since inception. The syntax used for search strategy was as follows:

PubMed: (“paramedian forehead flap”) OR (“nasolabial flap”) OR (“melolabial flap”) OR (“nasal reconstruction”).

The Cochrane Library: “paramedian forehead flap” in Title Abstract Keyword OR “nasolabial flap” in Title Abstract Keyword OR “melolabial flap” in Title Abstract Keyword OR “nasal reconstruction” in Title Abstract Keyword.

Google Scholar: “paramedian forehead flap” OR “nasolabial flap” OR “melolabial flap” OR “nasal reconstruction” (excluding patents and citations).

The manuscripts were reviewed manually by two independent authors (SSC, NS) to identify appropriate studies. Duplicate studies were removed. References of appropriate articles were also screened to identify additional related studies. Predetermined inclusion and exclusion criteria (Table 1) were applied for eligibility for inclusion. In case of any discrepancy, a consensus was formed by mutual discussion with other reviewers.

Data Extraction

Two independent reviewers (SA, AKM) extracted the data independently from the included studies in a standardised Data Extraction sheet for various parametersusing Microsoft® Excel®. In case of any discrepancy, a consensus was formed by mutual discussion with other reviewers. The data extracted includes demographic details (Title, authors, country of origin, year of publication, type of study, level of evidence), population details (Total number of patients, number of males/females, number of flaps done and followed-up, patients’ age, comorbidities and addiction), perioperative details (Flaps performed, with any modifications, defect size, subunit reconstructed, follow-up duration), outcomes (Functional outcomes measured by methods like questionnaire, NAFEQ scores, quality of speech, total nasal function; Aesthetic outcomes assessed by questionnaire, visual analog scale, pigmentation, contour deformity, Derriford Appearance Scale 24, height, colour etc.),and complications (necrosis, dehiscence, pin cushioning, hematoma, infection, scar contracture, congestion, notching, revision surgery, donor morbidities).

Statistical Analysis

Two review authors (ADG, SSC) analysed data. The weighted mean of each outcome was calculated based on sample sizes of each included study using the following method: (1) multiply the mean outcome of each study by the study sample size, (2) sum the products to get the total value, (3) sum the sample sizes to get the total weight, and (4) divide the total value by the total weight to provide a weighted mean for each outcome. The meta-analysis was performed using the Microsoft® Excel® 2016, with MetaXL version 5.2, add-in software (developed by Epi-Gear International Pty Ltd). The summary effect was ascertained using Odds Ratio (OR) which was calculated using the Inverse Variance Heterogenity model. Heterogeneity was ascertained using the I squared statistic. Small study effects like publication bias were evaluated using the Doi plot and Luis Furuya-Kanamori (LFK) index. High heterogeneity in the summary effect was further explored using sensitivity analysis. A p value of less than 0.05 was considered as significant.

Evidence Certainty

The certainty of evidence for the systematic review was assessed by two independent reviewers (ADG, NS) using the GRADEpro GDT: GRADEpro Guideline Development Tool [Software]. McMaster University and Evidence Prime, 2021. Available from gradepro.org. In case of any discrepancy, a consensus was formed by mutual discussion with other reviewers.

Results

Summary of Study and Patient Demography

The electronic database search produced 16,698 results. After title and abstract review 124 citations were identified (Fig. 1), that were considered for full text review. Thirty-eight articles [1–38] met our inclusion/exclusion criteria. The other 86 studies were either case reports; or less than 10 patients were followed-up; or complications/outcomes were not recorded independently for the reconstructed flaps; or variations of the forehead/nasolabial flaps have

Table 1 Inclusion and exclusion criteria

Inclusion criteria
1. Original article/comparative study
2. Nasal reconstruction with one-, two-, three-staged paramedian forehead flaps and nasolabial/melolabial flaps
3. Nasal reconstruction with interpolation/transposition/island/advancement/rotation type of paramedian forehead and nasolabial flaps
4. Nasal reconstruction with cross paramedian forehead flap
5. Study including at least ten cases of nasal defect reconstruction using paramedian forehead and nasolabial flap in which outcomes and complications was assessed
6. Outcomes and complications of the various nasal defect reconstruction modalities, each being used for different case, have been evaluated independently; and forehead/nasolabial flap were part of the study
7. Study evaluating at least one or many following parameters-
(a) Functional outcomes (Nasal appearance and function evaluation questionnaire/speech quality/total nasal function/airway collapse, etc.)
(b) Aesthetics (visual analogue scale/Likert score/Derriford appearance scale 24, etc.)
(c) Complications (necrosis, dehiscence, pin cushioning, hematoma, infection, scar contracture, congestion, notching, requirement of revision surgery, etc.)
Exclusion criteria
1. Case reports/case series with less than ten cases undergoing reconstruction with paramedian forehead and nasolabial flap
2. Nasal reconstruction with expanded, prelaminated or prefabricated flaps
3. Nasal reconstruction with median forehead flap
4. Nasal reconstruction with perforator or propeller type of flaps
5. Nasal reconstruction where prothesis/implants were used
6. Study using blanket statements like ‘no complications were noted’ or ‘all flaps were aesthetically normal’
7. The results and complications of nasal defect reconstruction using various modalities have been reported in a combined way
8. Both nasolabial and paramedian forehead flap have been used for the same nasal defect
9. The nasolabial/forehead flap have been combined with another major/defined flap for the same nasal defect, and the outcomes have not been assessed independently

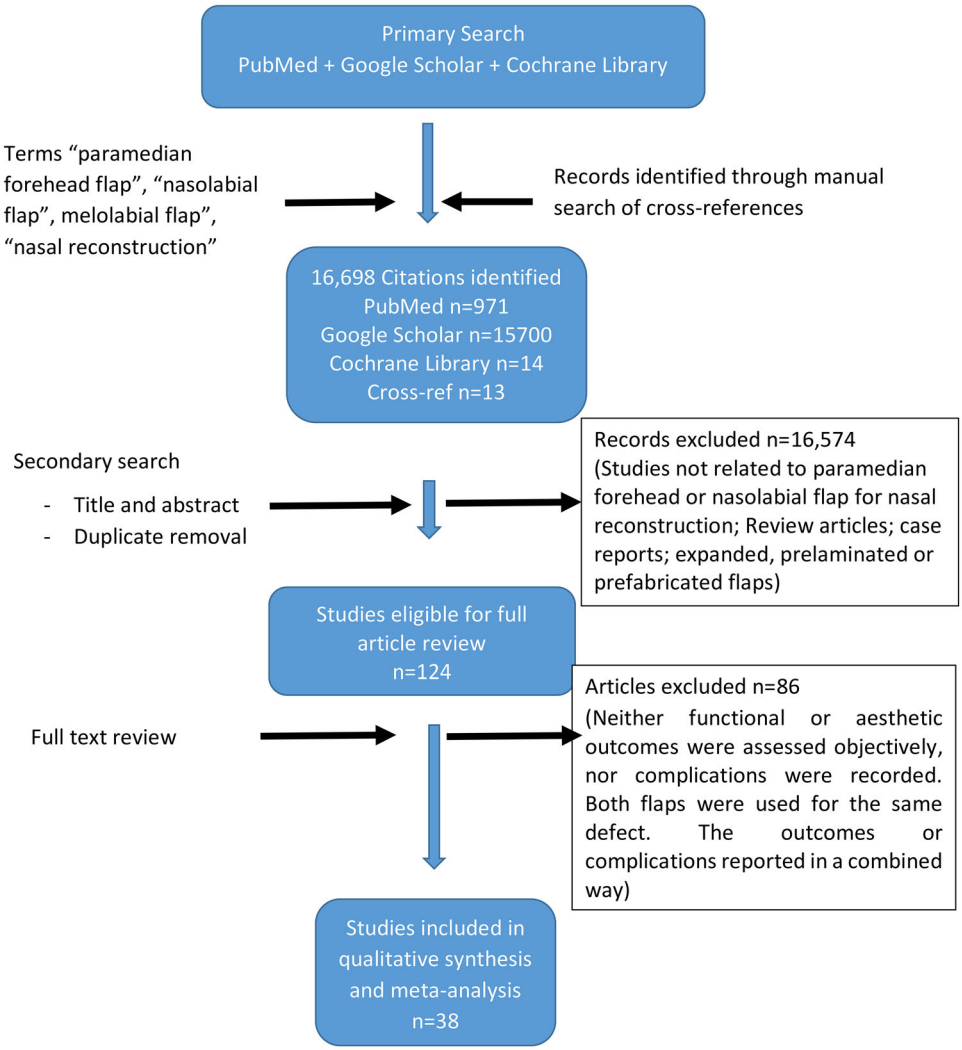

Fig. 1 Flowchart of literature search

been used. Twenty-seven studies were retrospective, while one study was prospective (Table 2). Out of total 2652 patients in these studies, 2036 patients were followed-up, in which 1443 underwent reconstruction with paramedian forehead flap. In the forehead flap group reported male and female patients were 425 and 399 respectively, while in nasolabial flap group this was 150 and 208 respectively. The weighted mean age of patients in the forehead and nasolabial group is 66.63 and 64.91 yearsrespectively. The weighted mean follow-up in the groups is 10.7 and 21.9 months respectively.

Summary of Flap Demography

Twenty-six studies have reported the relative number of nasal subunits that were reconstructed with either forehead or nasolabial flaps (Supplementary Table 1). Forehead flap was most commonly used for reconstruction of alar defects, immediately followed by sidewall, tip and dorsum (Table 3). Nasolabial flap was predominantly used for alar reconstruction. Our Meta-analysis shows a statistically significant difference in the incidence of alar reconstruction by forehead versus nasolabial flap [pooled odds ratio (OR): 0.3; 95% CI 0.01, 0.92; $p = 0.72$; $I^2 = 0\%$, $n = 6$ studies] (Fig. 2). To analyse the impact of individual studies on the pooled estimate a sensitivity analysis was done. On excluding the study of Vasalikis et al. [6], it is found that the pooled OR is not significant statistically, anymore (95% CI 0.14, 2.43) (Table 4). The meta-analysis done on incidence of dorsum and columella reconstruction by these flaps shows that the pooled odds ratios are not significant statistically [pooled OR for dorsum reconstruction: 5.97; 95% CI 0.99, 35.95; $p = 0.61$; $I^2 = 0\%$; $n = 3$ studies and pooled OR for columellar reconstruction: 1.84; 95% CI 0.35, 9.67; $p = 0.4$; $I^2 = 0\%$; $n = 4$ studies] (Fig. 2). Although, the study of Vasalikis et al. [6] and of Yoon et al. [7] appears outlier for dorsum and columella respectively, the sensitivity analysis performed shows that

Table 2 Demographic details of the studies included

Year of publication (duration of study)	Author	Place of study	Type of study/ level of evidence	Type of flap	No of patients (followed-up/ Total)	No of patients (male/female)	Mean age of patients (range) in years	Duration of follow-up (range) in months
Demographic analysis								
1974	Dhawan	New Delhi, India		Forehead	–/16			
1981	Conley	New York		Forehead	22/31			
1990	Zitelli	Pittsburg		Superiorly based 1-staged nasolabial	32/32			3.5 years (6–96)
1992	Younger	Canada		Melolabial	70/70	22/48	59.7	3.5 years
				Interpolation: 30				
				Transposition: 35				
				Rotation: 5				
1994	Klingensmith	Pennsylvania and Washington	Retrospective	Glabellar	7			6
2 years				Nasolabial	10			
1995	Quatela	Rochester, New York	Retrospective	Paramedian forehead	32/32			
7 years								
1997	Uchinuma	Kanagawa, Japan	–	Forehead	9/9	12/10		6
				Nasolabial	13/13			
1997	Konz	Munich, Germany		Forehead	30/30			
18 years								
1999	Arden	Michigan	Retrospective	Ipsilateral paramedian forehead	20/20	9/11	69 (42–86)	6.7 (3–12)
2 years								
				Melolabial island	18/18	9/9	68 (53–86)	7.5 (3–14)
2001	Drisco	Michigan		Interpolated forehead	15/15	20/30	61 (33–86)	> 3
6 years								
				Interpolated melolabial	35/35			> 3
2001	Lindsey	Virginia	Retrospective	Melolabial	105/105			6
4.5 years								
2002	Park	Charlottesville	Retrospective	Single-staged forehead	10/51	5/5	57 (46–65)	28 (6–60)
5 years								
2002	Sherris	Minnesota	Retrospective	Forehead	8/10		55.1 (4–79)	17.2 (1–30)
18 years				Nasolabial	1/2			
2005	Ullmann	Israel		Paramedian forehead	17/17	6/11	– (46–84)	
1 year								
2006	Yoon	Barcelona, Spain		Paramedian forehead	19	12/7	60.4 (33–81)	18 (12–24)
2 years				Nasolabial	5	3/2	69.8 (52–81)	

Table 2 continued

Year of publication (duration of study)	Author	Place of study	Type of study/ level of evidence	Type of flap	No of patients (followed-up/ Total)	No of patients (male/female)	Mean age of patients (range) in years	Duration of follow-up (range) in months
2008 5 years	Thornton	Dallas, Texas	Retrospective	Nasolabial	38/80	19/19		
2009 13 years	Little	Virginia, USA	Retrospective	Forehead	205/205	96/109	64.6 (17–19)	4
2009 11 years	Angobaldo	California	Retrospective	Cross-paramedian forehead	94/94	54/40	71 (35–95)	
2010	Dong	China		Paramedian forehead	15/15	5/10	35 (8–56)	– (4–20)
2011 9 years	Jones	UK	Retrospective	Paramedian forehead	50/50		67	
2011 6 years	Somoano	California	Retrospective	Accelerated takedown forehead	26/26	15/11	70 (41–94)	
				Conventional forehead	9/9	6/3	66 (49–88)	
2012	Paddack	Little rock	Retrospective	Paramedian forehead	82/82	43/39	65.5 (23–82)	
9 years				Nasolabial	25/25	5/20	65.4 (47–85)	
2012 12 years	Ribuffo	Italy		2-staged/3-staged forehead	31		68 (37–87)	– (6–12)
2012 7 years	Arden	Michigan	Retrospective Level IV	Interpolated melolabial	48/48	15/33	68 (36–90)	
2012	Monarca	Italy	Prospective	Nasolabial	30/30	15/15	63.35 (54–75)	– (7 days to 12 months)
2 years				Islanded nasolabial	30/30	15/15		
2012	Han	Korea	Retrospective	Paramedian forehead	3		59 (34–78)	64
12 years				Nasolabial	12			
2013 5 years	Kendler	Leipiz, Germany	Retrospective	Forehead	28/28	12/16	81 (75–95)	10 (1–60)
2014 2 years	Pochat	Brazil	Retrospective	2-staged and 3-staged paramedian forehead	11/11	5/7	49 (25–72)	1.4 years
2015	Uzun	Turkey	Retrospective	Forehead	4		– (21–98)	– (6–36)
3 years				Nasolabial	44			
2015	Stahl	Germany	Retrospective	2-staged forehead	25/25	14/11		6
12 years			Level III	3-staged forehead	35/35	23/22		
2017 10 years	Sanniec	Dallas, Texas	Retrospective	Forehead 2-staged: 317 3-staged: 103	420/420		67.8 (28–98)	1 year

Table 2 continued

Year of publication (duration of study)	Author	Place of study	Type of study/ level of evidence	Type of flap	No of patients (followed-up/ Total)	No of patients (male/female)	Mean age of patients (range) in years	Duration of follow-up (range) in months
2017 5 years	Mughal	Arrowe Park Hospital	Retrospective	Paramedian forehead	41/41			
2018 11 years	Orangi	Texas	Retrospective	Melolabial rotation	68/86	(46/40)	67.3 ± 11.9 (32.6–92.5)	2.7 years (6 days–10.1 years)
2018 5 year	Noel	Paris, France	Retrospective	3-staged folded forehead Standard forehead	15/15 16/16	16/15	57.7	18 (12–38)
2019 8 years	Rudolph	Winstar-Salem, USA	Retrospective	Cross-paramedian forehead	53/53	37/16	68 (40–91)	13.3
2019 14 years	Vasilakis	New York	Retrospective	Forehead Nasolabial	14 17		70.3 ± 12.4	8
2019 18 years	Lo Torto	Rome, Italy	Retrospective	2-staged and 3-staged paramedian forehead	46/52	29/17	68 (37–87)	6.1 years
2019 5 years	Genova	Tennessee and Michigan, USA	Retrospective	Paramedian forehead Superiorly based nasolabial	15/25 8/11	6/9 1/7	68.87 ± 14.63 71.75 ± 13.93	2.3 ± 1.09 years 2.0 ± 1.37 years

Table 3 Comparative analysis of subunit reconstructed and complication in the two groups

	Forehead flap			Nasolabial flap		
	Findings in	Out of	Percentage	Findings in	Out of	Percentage
Subunit reconstruction						
Dorsum	314	923	34.02	5	435	1.15
Ala	486	923	52.65	266	435	61.15
Columella	79	923	8.56	3	435	0.7
Tip	365	923	39.54	44	435	10.11
Sidewall	390	923	42.23	38	435	8.74
Soft triangle	148	923	16.03	2	435	0.46
Radix	3	923	0.33	0	435	0
Complications						
Infection	33	787	4.2	12	515	2.33
Dehiscence	13	349	3.72	3	181	1.67
Partial flap necrosis	68	1403	4.85	26	475	5.47
Complete flap necrosis	3	728	0.41	1	350	0.29
Oedema	6	48	12.5	6	30	20
Pin cushioning	25	135	18.52	24	238	10.1
Trap door deformity	2	110	1.82	1	62	1.6
Thick scar/Bulky	25	186	13.44	4	146	2.74
Nasal obstruction	44	588	7.48	22	113	19.5
Hematoma	8	693	1.15	6	379	1.58
Pigmentation	3	11	27.3	5	94	5.32
Epidermolysis	26	293	8.87	–	–	–
Revision surgery	109	350	31.14	6	28	21.43
Kenacort injection	33	94	35.1	3	32	9.97
Psychiatric problem	5	15	33.3	1	70	1.43
Alar notching	64	385	16.6	16	135	11.85
Ischemia	0	14	0	0	17	0
Hair growth	1	28	3.57	2	48	4.17
Alar groove blunting	0	3	0	1	12	8.33
Transient discoloration	1	3	33.3	0	12	0
Flap contracture	0	3	0	1	12	8.33

even on omitting the studies the pooled OR obtained is not significantly different from the overall pooled estimates [pooledOR: 3.02; 95% CI 0.32, 28.4; $p = 0.96$; $I^2 = 0\%$; $n = 3$ studies; and pooled OR: 4.77; 95% CI 0.65, 35.15; $p = 0.37$; $I^2 = 0\%$; $n = 4$ studies respectively] (Table 4).

Summary of Complications and Outcomes

The incidence of complications following nasal reconstruction with nasolabial or forehead flap was reported by 36 studies (Supplementary table 2). The frequency of pin cushioning effect, thick/bulky scar,pigmentation, and subsequent steroid injection seemed more common in forehead flap reconstruction than nasolabial flap, while in the latter nasal obstruction seemed more frequently present (Table 3). All other complications were comparable in both groups. Meta-analysis was performed over data from 9 observational studies [1–9] which have reported the relative incidences of complications of both flaps, or the relative number of the nasal subunits reconstructed. Our meta-analysis shows that there is no significant difference in the risk of partial flap necrosis in the forehead flap vs nasolabial flap [pooled OR 1.28; 95% CI 0.46–3.53; $p = 0.7$; $I^2 = 0\%$, $n = 6$ studies] (Fig. 3). On visual inspection, the study by Uzun et al. [9] appears to be an outlier with OR 9.89 (95% CI 0.17, 560.85). However, on excluding this study the pooled OR is 1.117 (95% CI 0.392, 3.183) which is not significantly different from the overall pooled estimate ($p = 0.739$) (Table 5). The difference in the risk of complete flap necrosis in-between these flaps is also not significant statistically [pooled OR 1.28; 95% CI 0.19–8.39; $p = 0.67$; $I^2 = 0\%$, $n = 4$ studies] (Fig. 3). Again, the study by Uzun et al. [9] seems an outlier with OR 9.89 (95% CI 0.17, 560.85). However, on excluding

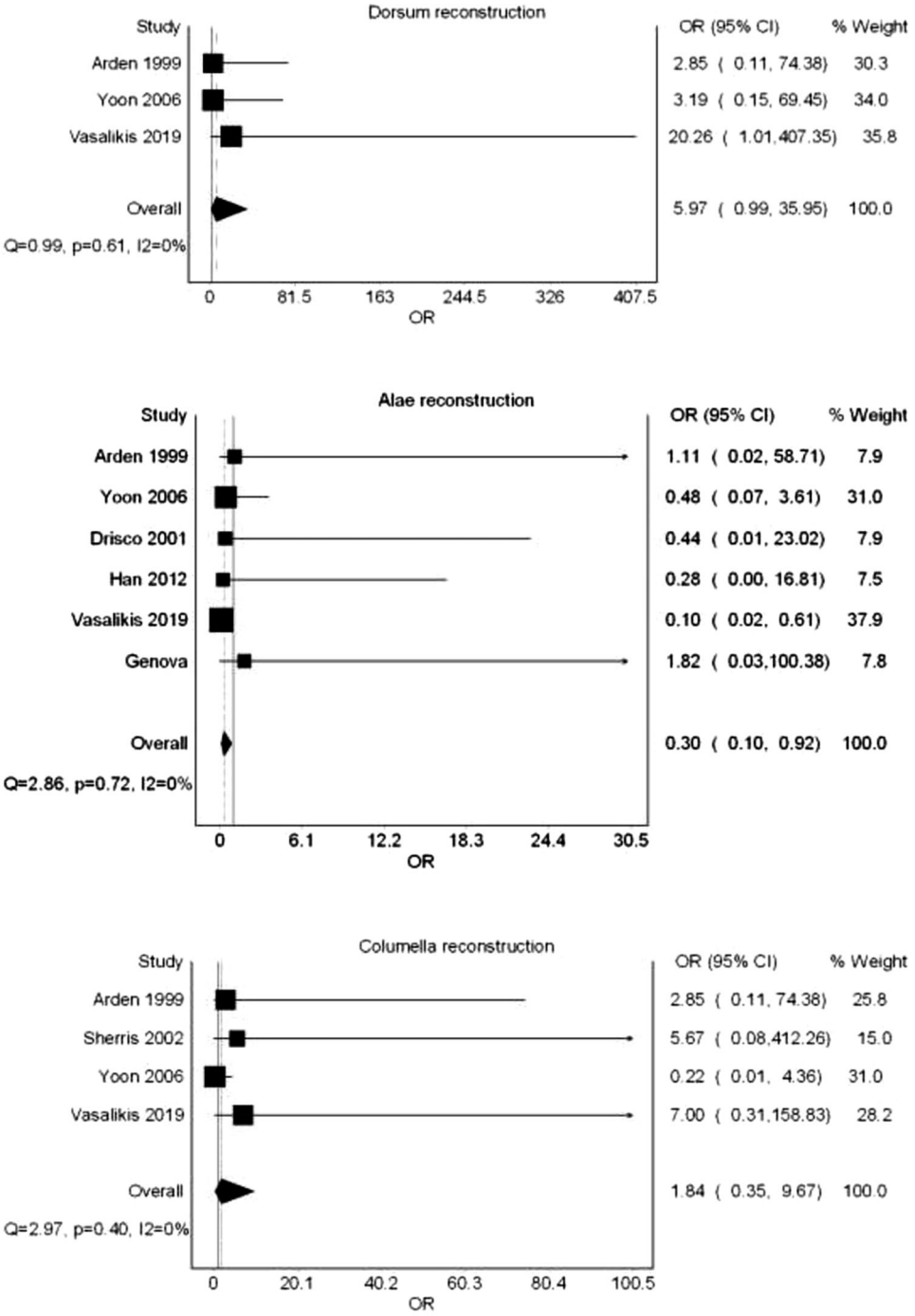

Fig. 2. Forest plots of nasal subunit reconstruction in different studies

this study the pooled OR is 0.721 (95% CI 0.086, 6.070) which is not significantly different from the overall pooled estimate ($p = 0.862$) (Table 5). There is no significant difference in the risk of alar notching also [pooled OR 1.81; 95% CI 0.55–5.91; $p = 0.27$; $I^2 = 0\%$, $n = 4$ studies] (Fig. 3). Here the study by Han et al. [8] appears an outlier with OR = 10.00 (95% CI 0.58, 171.2). On excluding this study, the pooled OR is not significantly different from the overall pooled estimate [OR: 1.453; 95% CI 0.460, 4.59; $p = 0.309$; $I^2 = 14.85$; $n = 4$ studies] (Table 5). There is no significant difference in the risk of hematoma/bleeding in the forehead flap vs nasolabial flap [OR 2.04; 95% CI 0.34–12.81; $p = 0.79$; $I^2 = 0\%$, $n = 4$ studies] (Fig. 3). Although the study by Uzun et al. [9] seems an outlier with OR 9.89 (95% CI 0.17, 560.85), on excluding this study the pooled OR is not significantly different [OR: 1.38; 95% CI 0.19, 10.18; $p = 0.85$; $I^2 = 0.0$; $n = 4$ studies] (Table 5). Five studies have compared the paramedian forehead and

Table 4 Sensitivity analysis for heterogeneity of subunit reconstruction in different studies

Excluded study	Pooled OR	LCI 95%	HCI 95%	Cochran Q	*p*	I^2	I^2 LCI 95%	I^2 HCI 95%
Sensitivity analysis of studies of dorsum reconstruction								
Arden et al. [1]	8.239	0.960	70.669	0.709	0.400	0.000	0.000	0.000
Yoon et al. [7]	8.244	0.905	75.062	0.753	0.386	0.000	0.000	0.000
Vasilakis et al. [6]	3.025	0.322	28.404	0.003	0.960	0.000	0.000	0.000
Sensitivity analysis of studies of alar reconstruction								
Arden et al. [1]	0.268	0.084	0.860	2.405	0.662	0.000	0.000	65.412
Yoon et al. [7]	0.242	0.063	0.930	2.539	0.638	0.000	0.000	67.242
Drisco and Baker [4]	0.291	0.091	0.932	2.819	0.589	0.000	0.000	70.492
Han et al. [8]	0.302	0.095	0.965	2.855	0.582	0.000	0.000	70.863
Vasilakis et al. [6]	0.588	0.142	2.427	0.587	0.964	0.000	0.000	0.000
Genova	0.258	0.081	0.826	2.013	0.733	0.000	0.000	58.671
Sensitivity analysis of studies of columellar reconstruction								
Arden et al. [1]	1.584	0.150	16.695	2.883	0.237	30.628	0.000	92.784
Sherris et al. [5]	1.513	0.189	12.075	2.665	0.264	24.946	0.000	92.193
Yoon et al. [7]	4.774	0.649	35.149	0.160	0.923	0.000	0.000	0.000
Vasilakis et al. [6]	1.091	0.154	7.720	1.997	0.368	0.000	0.000	89.583

nasolabial flaps used for nasal reconstruction in terms of functional and aesthetic outcomes of donor and recipient sites [1, 3–5, 8]. We refrained from performing meta-analysis of other complications and the outcomes due to paucity of uniform level of information.

Publication Bias

The Doi plot with LFK index of the subunit reconstructions (dorsum, alae, columella) (Fig. 4) and the complications (partial or complete flap necrosis, alar notching, hematoma or bleeding) (Fig. 5) shows no or minor asymmetry. This suggests that there is no publication bias and small study effects, which may be affecting the results of meta-analysis done.

Evidence Certainty

The certainty of evidence assessed for the various outcomes as per GRADE (Grading of Recommendations, Assessment, Development and Evaluations) criteria are of lowcertainty category. The summary of findings table shows a mild increased risk difference of complications with paramedian forehead flap than the nasolabial flap (Table 6).

Discussion

In our review, based on 38 studies, we found that ala is the most commonly reconstructed subunit. Seven studies were dedicated for alar reconstruction [1, 3, 4, 8, 18, 28, 36], four of which [1, 3, 4, 8] have compared the nasolabial flap and paramedian forehead flap for alar reconstruction in their studies. Most of the nasolabial flaps (melolabial is an anatomically more precise description) [13] have been used for alar reconstruction in comparison to other subunits, which is not the case with forehead flap (Table 3). Our meta-analysis shows that there is increased propensity of alar reconstruction by nasolabial versus forehead flap, which is statistically significant. Vasalikis et al. [6] suggested larger alar reconstruction to be done using nasolabial flap, while tip and dorsal defects > 1.5 cm using forehead flap. However, our meta-analysis shows that there is no significant difference in the incidence of dorsal or columellar reconstructions by either flap. The I^2 values in Forest plot shows that there is no heterogeneity in these studies (Fig. 2).

We were not able to find any relation of the nasal defect size with either flap type used for reconstruction, due to heterogeneity in the information of the studies. In the algorithm suggested by Uzun et al. [9], nasolabial flaps are preferred for lateral defects in middle or lower third, while forehead flap reconstruction for distal 2/3rd or combined defects. Based on their study of 17 nasal defects'

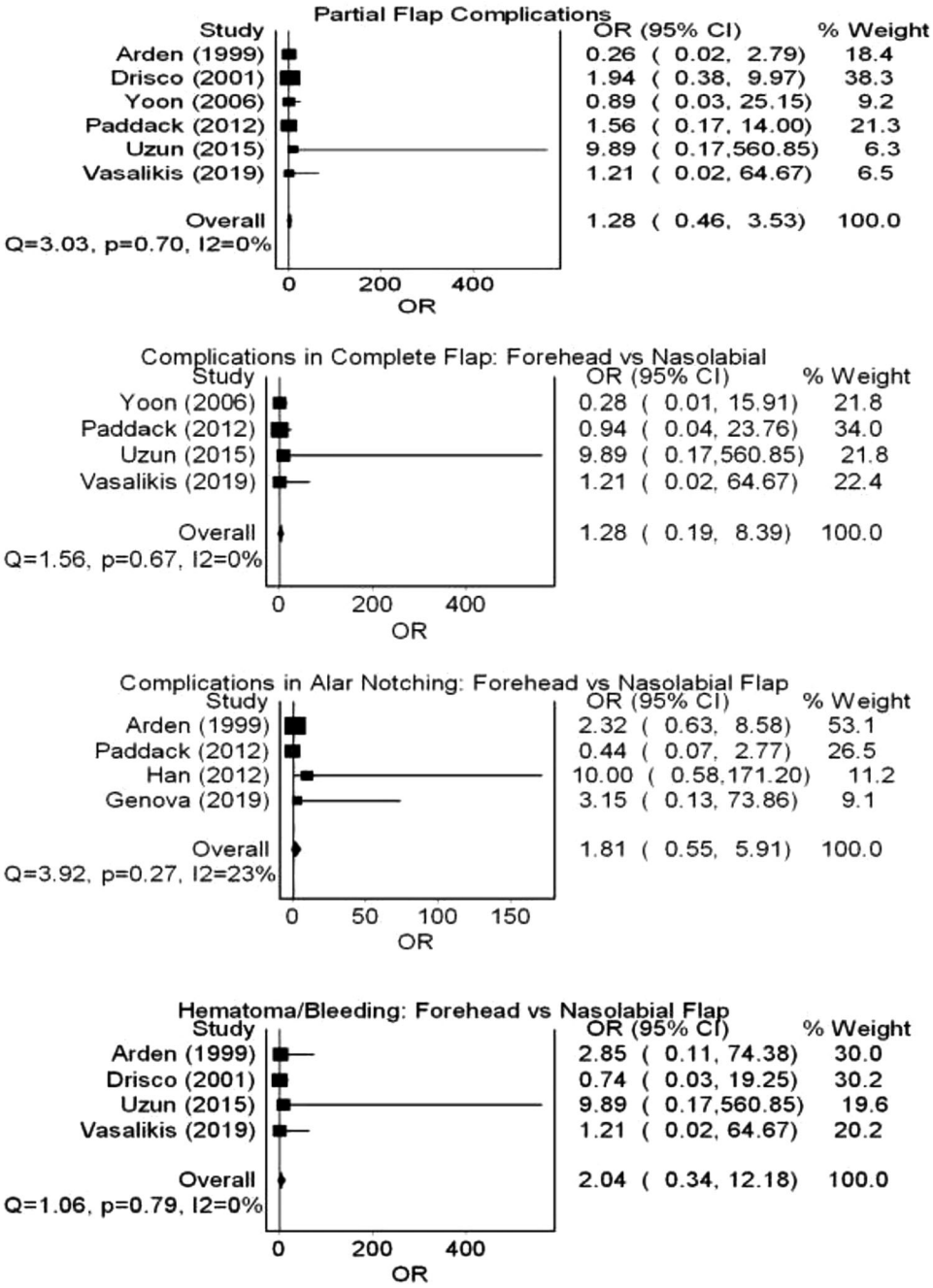

Fig. 3. Forest plot of complications (outcome) in different studies

reconstruction, Han et al. [8] suggested that for a full thickness defect, that is > 2 cm, forehead flap is preferred. While for defects < 2 cm nasolabial flap reconstruction is preferred. In 2001, Drisco and Baker [4] suggested forehead flap reconstruction for nasal alar defects > 1.5 cm, young patient with inconspicuous melolabial fold and cheek involvement, while in other alar defects interpolated cheek flap is preferred. In their follow-up of 83 nasal reconstructions, Vasilakis et al. [6] reported statistically significant difference in the size of the defects ($p < 0.001$), in their greater diameter, in-between the groups. However, all these studies were retrospective so they would be prone to selection bias.

Our meta-analysis shows that there is no statistically significant difference in the risk of complications (partial or total flap necrosis, alar notching, hematoma/bleeding) in-between the groups. Overall, there is no heterogeneity in most of these studies (Fig. 3). However, in our summary of findings table it seems that there is mild increased risk of alar notching in case of paramedian forehead flap (Table 6). Paddack et al. [2], with a follow-up of 25 nasolabial and 82 paramedian forehead flaps, found that

Table 5. Sensitivity analysis of complications (outcome) in different studies.

Excluded study	Pooled OR	LCI 95%	HCI 95%	Cochran Q	*P*	I^2	I^2 LCI 95%	I^2 HCI 95%
Sensitivity analysis of studies with partial flap necrosis as outcome								
Arden et al. [1]	1.832	0.596	5.626	0.916	0.922	0.000	0.000	9.160
Drisco and Baker [4]	0.992	0.273	3.603	2.634	0.621	0.000	0.000	68.415
Yoon et al. [7]	1.329	0.459	3.852	2.980	0.561	0.000	0.000	72.086
Paddack et al. [2]	1.215	0.388	3.810	2.991	0.559	0.000	0.000	72.189
Uzun et al. [9]	1.117	0.392	3.183	1.980	0.739	0.000	0.000	57.987
Vasilakis et al. [6]	1.287	0.451	3.670	3.029	0.553	0.000	0.000	72.537
Sensitivity analysis of studies with complete flap necrosis as outcome								
Yoon et al. [7]	1.944	0.231	16.373	0.873	0.646	0.000	0.000	76.182
Paddack et al. [2]	1.493	0.147	15.184	1.509	0.470	0.000	0.000	86.214
Uzun et al. [9]	0.721	0.086	6.070	0.298	0.862	0.000	0.000	30.192
Vasilakis et al. [6]	1.296	0.153	11.000	1.561	0.458	0.000	0.000	86.668
Sensitivity analysis of studies with alar notching necrosis as outcome								
Arden et al. [1]	1.358	0.177	10.436	3.618	0.164	44.722	0.000	83.563
Paddack et al. [2]	3.015	0.992	9.160	0.839	0.657	0.000	0.000	75.201
Han et al. [8]	1.453	0.460	4.591	2.349	0.309	14.855	0.000	91.143
Genova et al. [3]	1.707	0.361	8.070	3.790	0.150	47.230	0.000	84.528
Sensitivity analysis of studies with hematoma/bleeding as outcome								
Arden et al. [1]	1.765	0.208	14.972	1.007	0.604	0.000	0.000	79.335
Drisco and Baker [4]	3.152	0.371	26.791	0.535	0.765	0.000	0.000	61.121
Uzun et al. [9]	1.385	0.188	10.184	0.333	0.847	0.000	0.000	37.507
Vasilakis et al. [6]	2.325	0.314	17.214	0.981	0.612	0.000	0.000	78.797

diabetes, hypertension, coronary arterial disease, COPD and smoking were not statistically significant factors in flap failure, although in the latter flap failure shows an increasing trend.

In 1999, Arden et al. [1] in a follow-up of 20 forehead flaps and 18 melolabial flaps for alar reconstruction reported that objective scar measurements (rim thickness difference, donor scar length and width), subjective rating of textural quality, and post-operative alar notching favoured melolabial reconstructions. Patient's questionnaire results demonstrated a statistically significant ($p = 0.026$) difference in donor site rating, favouring melolabial group responses. While in 2019, Genova et al. [3] reported that for alar reconstruction forehead flaps gave statistically better aesthetic and functional results ($p = 0.03$ for both variable) than nasolabial flaps, according to patient satisfaction survey, after a mean follow-up period of 2.3 years. Forehead flaps also had superior alar contour, telangiectasia/erythema, post-operative scar, alar and nostril symmetry from basilar view, compared to nasolabial flaps, according to Surgeons' questionnaire (comprising of all 5 above variables, each scored as 1–3). Sherris et al. [5] recorded better aesthetic results after forehead flap reconstruction than nasolabial flap, 5.5 versus 4.4 respectively (change on a 1–10 Visual Analog Scale from defect to after reconstruction) for columellar defects. However, due to small group size, authors refrained from any statistical analysis. Drisco and Baker [4] found on a scale of 1–3 that forehead flap reconstruction seemed better in terms of breathing self-assessment, patient result, and observer result of scar and overall. We were not able to perform any meta-analysis on the overall aesthetic outcome from the data of these studies, as different scales for measurement were used.

Despite our sincere efforts there were certain limitations in this study. Statistical significance of the difference in cosmetic and functional outcomes of the paramedian forehead and nasolabial flaps could not be calculated because the included studies have used different parameters and scales to assess them. Meta-analysis of many outcome complications (infection, dehiscence, congestion, pin cushioning, nasal obstruction etc.) and few subunit reconstructions (nasal tip and sidewall) could not be done due to inadequate data. The included studies have different follow-up periods. The variations in nasolabial flap, namely interpolated, islanded flaps, or in forehead flaps, namely 2- or 3-staged flaps, included in our review might be a limitation in our results. Most of the studies in the

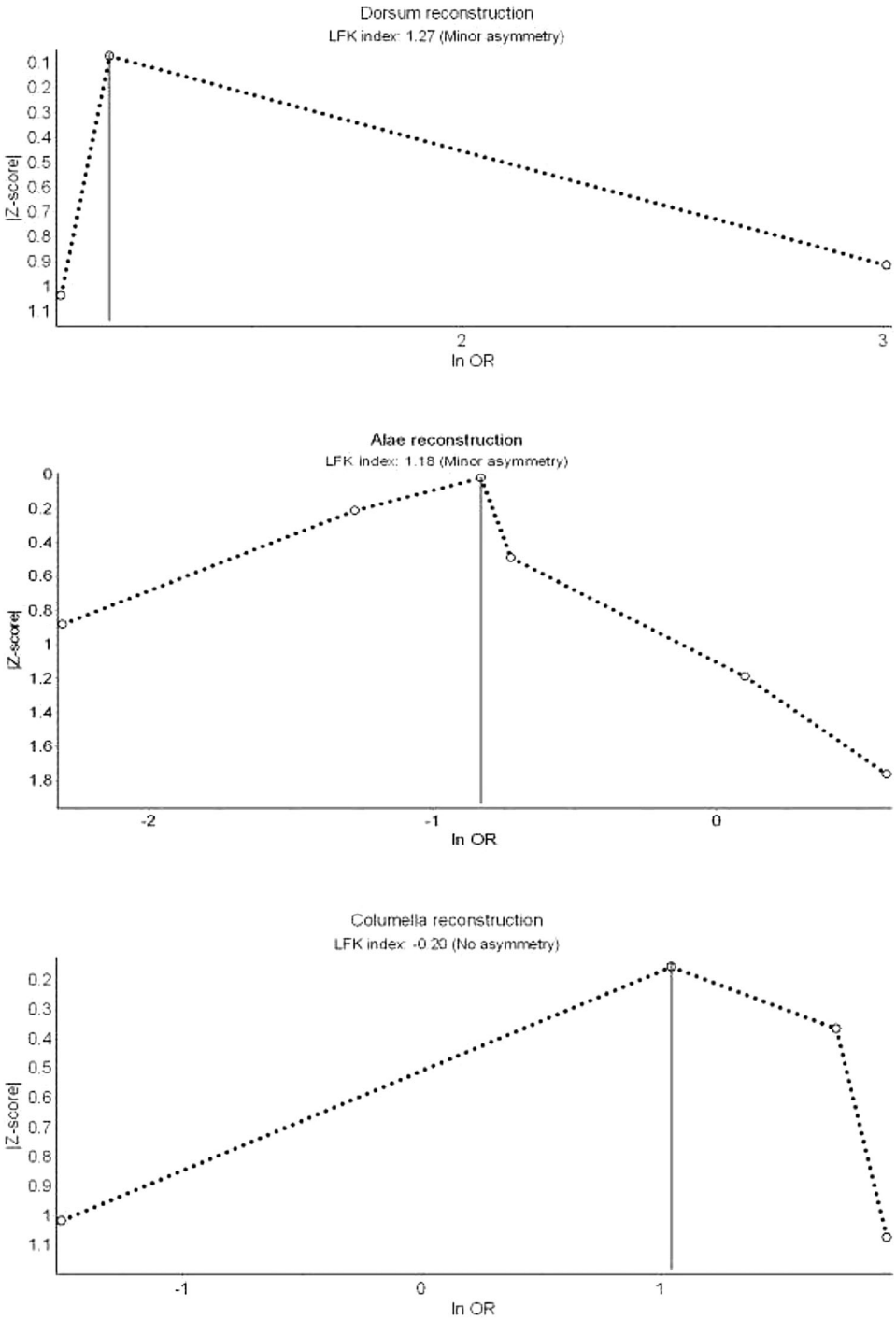

Fig. 4. Doi plot of nasal subunit reconstruction in different studies

review are retrospective and some are prospective which could have affected the results. Lastly, confounding factors such as age, gender, co-morbidities of patients, dimension and extent of the flap or the defect etc could not be taken into account due to absence of individual data.

Conclusion

We conclude that for the alar subunit, reconstruction using the nasolabial (melolabial) flap is significantly preferable than the paramedian forehead flap. This does not hold true

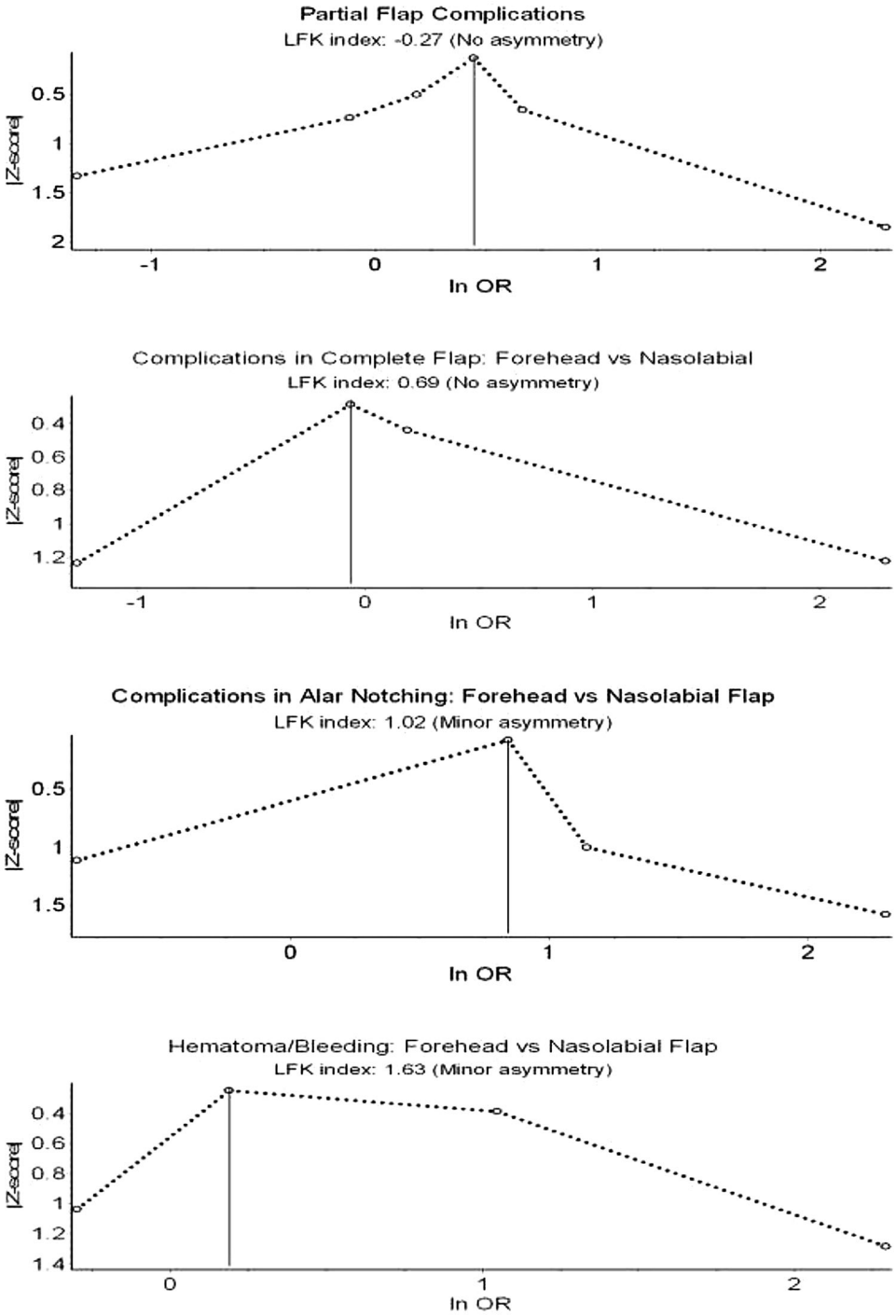

Fig. 5. Doi plot of complications (outcome) in different studies

for other subunits. There is an inclination to reconstruct larger defects by forehead flap. The difference in the risk of complications in the post operative period in either group is statistically insignificant, though there is a mild increased risk in the forehead flap group. The aesthetic outcomes among the groups compared by the studies are contradictory to each other and needs further exploration.

Table 6. Certainty of evidence using GRADEpro GDT

Certainty assessment and summary of findings table using GRADEpro GDT											
Paramedian forehead flap compared to nasolabial flap for nasal reconstruction?											
Certainty assessment							Summary of findings				
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	Study event rates (%)		Relative effect (95% CI)	Anticipated absolute effects	
							With nasolabial flap	With paramedian forehead flap		Risk with nasolabial flap	Risk difference with paramedian forehead flap
Complication (*assessed with: partial flap necrosis*)											
298 (6 observational studies)	Not serious	Not serious	not serious	Not serious	None	⊕⊕◯◯ Low	8/144 (5.6%)	10/154 (6.5%)	**OR 1.28** (0.46 to 3.53)	6 per 100	**1 more per 100** (from 3 fewer to 12 more)
Complication (*assessed with: complete flap necrosis*)											
210 (4 observational studies)	Not serious	Not serious	not serious	Not serious	None	⊕⊕◯◯ Low	0/91 (0.0%)	1/119 (0.8%)	**OR 1.28** (0.19 to 8.39)	0 per 100	**0 fewer per 100** (from 0 fewer to 0 fewer)
Complication (*assessed with: alar notching*)											
183 (4 observational studies)	Not serious	Not serious	not serious	Not serious	None	⊕⊕◯◯ Low	12/63 (19.0%)	20/120 (16.7%)	**OR 1.81** (0.55 to 5.91)	19 per 100	**11 more per 100** (from 8 fewer to 39 more)
Complication (*assessed with: hematoma/bleeding*)											
167 (4 observational studies)	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ Low	1/114 (0.9%)	1/53 (1.9%)	**OR 2.04** (0.34 to 12.18)	1 per 100	**1 more per 100** (from 1 fewer to 9 more)

CI confidence interval; *OR* odds ratio

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00266-022-03060-w.

Acknowledgements None declared.

Declarations

Conflict of Interest The authors declare that they have no conflicts of interest to disclose.

Human and Animal Rights, or Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study informed consent is not required.

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