Effect of the type of surgery, use of intraoperative topical mitomycin C or stenting on the outcome of choanal atresia repair: a systematic review and meta-analysis

Marwa M. El-Begermy, Mohamed Magdy Samir, Samia A. Fawaz, Wael G. Elkelany

Department of Otolaryngology, Ain Shams University, Cairo, Egypt

Correspondence to Marwa Mohamed El-Begermy, MD, 5th settlement, 1st district, 3rd area, villa 76, Cairo, Egypt Tel: +20 111 176 6566; e-mail: marwabegermy@gmail.com

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Background
Restenosis and recurrence of symptoms after posterior choanal atresia (CA) repair is a major concern for surgeons, which leads to the use of a variety of surgical approaches and adjuvant treatment modalities to avoid restenosis.
Aim
The study was designed to compare the outcome of transnasal endoscopic and transpalatal repair of CA as regards restenosis, and also to compare the effect of using topical mitomycin C (MMC) or nasal stenting with not using these modalities on the outcome of repair as regards restenosis.
Methods
A systematic search was conducted on the PubMed/MEDLINE to locate and select relevant studies without applying any limits. Studies included in meta-analysis were tested for heterogeneity of the estimates.
Results
As regards comparing the transnasal endoscopic and transpalatal approaches, eight studies, involving 410 cases, met our criteria; 197cases were repaired endoscopically with 37.5% restenosed and 188 through transpalatal approach with 28.2% restenosed. Using the estimated odds ratio, no statistically significant difference was found as regards restenosis. For the use of MMC, five articles fulfilled our criteria; they involved 155 cases; MMC was used in 70 cases where 24.2% restenosed, and was not used in 85 cases where 35.2% restenosed. By estimated odds ratio, there was no statistically significant difference between the two groups as regards restenosis. For the use of stenting, four articles fulfilled our criteria; they involved 165 cases, out of which 93 cases used nasal stent after repair of CA (21.5% restenosed), whereas in 72 cases stent was not used (18% restenosed). By estimated odds ratio there was no statistically significant difference between the two groups.
Conclusion
The available evidence suggests that there is no statistically significant difference between transnasal endoscopic and transpalatal approach in the repair of CA as regards restenosis; furthermore, there is no statistically significant difference between using intraoperative topical MMC and nasal stent and not using such modalities on the outcome of CA repair.

Keywords:
choanal atresia repair, mitomycin C, restenosis of choanal atresia repair, stenting, transnasal endoscopic, transpalatal

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Introduction

Choanal atresia (CA) is a relatively rare congenital anomaly occurring in about one in 5000–8000 live births; its female to male ratio is 2: 1. Generally, 65–75% of patients with CA are unilateral, and about 30% are pure bony, whereas 70% are mixed bony-membranous [1].

Management of these patients varies and depends on the type of atresia, age, and general condition of patients. The most common surgical techniques used are the transnasal and transpalatal approaches. While transnasal endoscopic approach is the method of choice and has been used successfully in newborns and infants and is suitable for membranous or very thin bony atresia, the transpalatal approach is normally reserved for the older children, thick bone, or cases with restenosis [2].

The concern was always to adequately repair CA and prevent recurrence of symptoms by preventing restenosis.

Therefore, in this study we aimed to systematically review the data about the repair of CA and outcome of repair, through comparing, via statistical analysis, the transnasal endoscopic and transpalatal approaches as regards restenosis, and to find out the role of using mitomycin C (MMC) as adjuvant treatment and the role of stenting in improving the outcome of CA repair.

Methods

Identification and location of articles

Medline database at *http://www.pubmed.gov* was searched, using the keyword 'choanal atresia' without applying any limits. Then the search was conducted by entering the following keywords

choanal atresia+repair, choanal atresia+endoscopic, choanal atresia+transnasal, choanal atresia+stent, and choanal atresia+topical mitomycin C. The last search was conducted on 10 January 2015.

Screening and evaluation

After blinding the articles regarding authors and journal of publication, the articles yielded by the search were screened regarding four inclusion and three exclusion criteria.

(1) *Inclusion criteria*: Articles in which the number of cases reported was three or more in each group for case–control studies were included; in addition, only primary cases and those studies in which outcomes were reported in detail and complications mentioned were included in the present study.
(2) *Exclusion criteria*: Review articles were excluded because there were no cases or results. Articles reporting on less than three cases or revision cases were also excluded. Only articles fulfilling the criteria of screening were included for further steps of data collection, analysis, and reporting.

Data collection

Data collected from the articles included the type of study, number of cases reported in each article, surgical approach used (whether transnasal endoscopic or transpalatal), and the topical application of MMC or stenting, functional outcomes (improvement of symptoms after treatment), and the presence and type of complications.

Data analysis

Statistical analysis was carried out using comprehensive meta-analysis, version 2 (Biostat, Englewood, New Jersey, USA). Every article fulfilling the criteria of screening and data collection was fed into the above-mentioned computer software.

Testing for heterogeneity

Studies included in meta-analysis were tested for heterogeneity of the estimates using the following tests:

(1) Cochran Q chi square test: A statistically significant test (P-value <0.1) denoted heterogeneity among the studies.
(2) I^2 index, which is interpreted as, $I^2 = 0$–40%: unimportant heterogeneity; 30–60%: moderate heterogeneity; 50–90%: substantial heterogeneity; and 75–100%: considerable heterogeneity.
(3) τ^2 index ($\tau^2 > 1 =$ substantial heterogeneity).

Pooling of estimates

Risk for unwanted outcomes was expressed in terms of odds ratio with 95% confidence interval (CI); estimates from included studies were pooled using both the Mantel-Haenszel fixed-effects method and the DerSimonia laerd random-effects method.

Examination of publication bias

Publication bias was examined using the Funnel plot and Duval and Tweedie's trim and fill tests.

Results

Searching Medline database, http://www.pubmed.gov with the last search on 10 January 2015 using 'choanal atresia' without applying any limits yielded 12 400 articles; the number of articles yielded by using each keyword is mentioned in Table 1.

Results of comparing the outcome of transpalatal versus transnasal endoscopic repair of CA

First, we compared between the studies of transnasal and transpalatal approach in CA repair. We screened for keywords choanal atresia, transnasal endoscope, and

Table 1 Keywords used in search and the number of articles yielded for each keyword

Search keywords	Number of articles
Choanal atresia	12 400
Choanal atresia+repair	8010
Choanal atresia+transnasal	1320
Choanal atresia+endoscopic	3140
Choanal atresia+stent	1500
Choanal atresia+mitomycin c	396

Table 2 Articles involved in comparing the endoscopic transnasal versus transpalatal repair of CA. as regard the outcome of repair of CA

References	Methods	Participates	Interventions	Outcome
Al Muhaimeed [3]	Case–control (retrospective study)	30 cases; 16 unilateral, 14 bilateral; 18 male, 12 female; Age from 3 days to 28 years; Bony atresia in 11 cases, mixed atresia in 10 cases, membranous atresia in nine cases; Three patients had other congenital anomalies, Including: Submucosal cleft palate; Down syndrome; Apert's syndrome	Endoscopic, 24 cases; Transpalatal, six cases; Stent was used in all cases for 6–8 weeks	10 cases had restenosis by endoscopic approach; Six cases had restenosis by transpalatal approach; Other complications were minor and included; Slight pressure necrosis of nasal tip in two patients; Mild soft palate injury in one patient; Severe nasal discomfort; Plus headache in another patient; These complications were encountered in those patients who had transnasal puncture using large size hard portex nasal stent
Madry *et al*. [4]	Case–control (retrospective study)	136 cases; 77 unilateral, 59 bilateral; 40 male, 96 female; Age not mentioned; Type of atresia not mentioned	Endoscopic, 45 cases; Transpalatal 91 cases; Stent was used in all cases	19 cases had restenosis by endoscopic approach; 28 cases had restenosis by transpalatal approach
Kim *et al.* [5]	Case–control (retrospective study)	40 sides in 27 cases; 14 unilateral (seven cases were on the right side, and the remaining seven were found on the left side), 13 bilateral; 11 males, 16 females; Age from 6 days to 28 years; The incidence of atretic type, bony or mixed bony membranous obstruction was similar in both unilateral and bilateral CA; The most common associated malformation in bilateral CA was CHARGE association whereas that of unilateral CA was cleft lip and cleft palate; Follow-up periods varied from 7 to 180 months	Transnasal endoscopic, 22 sides; Transnasal nonendoscopic, six sides; Transpalatal, 12 sides; Stent was used in 21 nasal cavities in 14 cases for 6–8 weeks cases	Rate of restenosis in endoscopic approach 40.9%; Rate of restenosis in transpalatal approach 58.3%; Rate of restenosis intransnasal nonendoscopic approach 40%
Gosepath *et al.*[6]	Case–control (retrospective study)	41 cases; 13 bilateral, 28 unilateral; Gender not mentioned; Age not mentioned; Type of atresia not mentioned	Endoscopic, 38 cases; Transpalatal three cases; Stent not used	15 cases had restenosis by endoscopic approach
Hengerer *et al*. [7]	Case–control (retrospective study)	73 cases; 28 bilateral, 45 unilateral; 33 male, 41 female; Age not mentioned; 69 cases bony atresia, four cases mixed atresia	Endoscopic 23 cases; Transpalatal 32 cases; Transnasal nonendoscopic 18 case; Stent not used	Restenosis by endoscopic in four cases; Restenosis by transpalatal in four cases; Restenosis by transnasal nine in cases
Jung [8]	Case–control (retrospective study)	40 cases; Five bilateral, 35 unilateral; Gender not mentioned; Age not mentioned; Type of atresia not mentioned	Endoscopic nine cases; Transpalatal 30 cases; Transmaxillary one case; Stent not used	Seven cases had restenosis by endoscopic approach; Six cases had restenosis by transpalatal approach
Richardson and Osguthorpe [9]	Case–control (retrospective study)	37 case; All cases bilateral; Gender not mentioned; Age from 1 week up to 5 years, mean = 10 months	Endoscopic, 25 cases; Transpalatal approach, 12 cases; Stent was used for 6–12 weeks	36% of cases by endoscopic approach had restenosis; 17% of cases by transpalatal approach had restenosis
Wiatrak [10]	Case series (retrospective study)	13 cases; Six bilateral, 11 unilateral; Gender not mentioned; Age from 2 months up to 13 years; Type of atresia not mentioned	Endoscopic, 11 cases; Transpalatal, two cases; Stent was used in 12 cases	One case restenosis by transnasal endoscopic

CA, choanal atresia.

transpalatal. We found eight articles fulfilling our criteria, and they involved 410 cases. Cases that were repaired endoscopically were 197 in number, whereas transpalatal approach was used in 188 cases. Restenosis occurred in 37.5% of those who had undergone endoscopic approach and in 28.2% of those who had undergone transpalatal approach (Table 2).

The incidence of restenosis after transnasal endoscopic or transpalatal repair, using the estimated odds ratio

(statistical measure), showed a statistically non significant difference between the two techniques. The measures of heterogeneity revealed unimportant heterogeneity of the estimates reported by the included studies (Cochran *Q* *P*-value, 0.050; I^2, 50.318; τ^2, 0.893). Pooling of the estimates using a fixed-effects model confirmed the result (pooled odds ratio, 1.58; 95% CI, 0.94–2.66), as shown in Table 3 and Figs. 1 and 2.

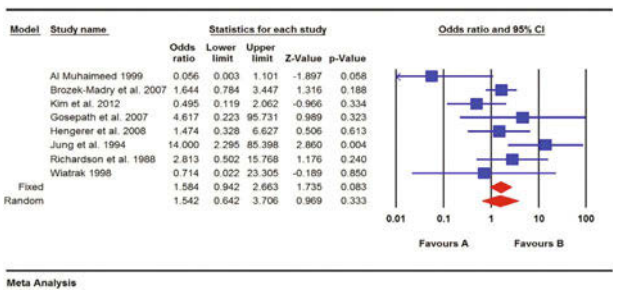
Moreover, the incidence of restenosis after transnasal endoscopic or transpalatal repair by using the estimated risk ratio (statistical measure) showed a statistically nonsignificant difference between the two techniques. Measures of heterogeneity revealed important heterogeneity of the estimates reported by the included studies (Cochran *Q* *P*-value, 0.001; I^2, 72.740; τ^2, 0.683). Pooling of the estimates using a random-effects model confirmed the result (pooled risk ratio, 1.25; 95% CI, 0.67–2.32), as shown in Table 4 and Fig. 3.

The funnel plot for the log risk ratio versus the SE of risk ratio showed some evidence of publication bias (Fig. 4). The Duval and Tweedie's Trim and Fill method suggested that three studies were missing; under the random-effects model the point estimate and 95% CI for the combined studies was 1.25 (0.67–2.32); using Trim and Fill the imputed point estimate was 0.84 (0.44–1.57).

Results of comparing the outcome of transpalatal and transnasal endoscopic repair of CA with and without the usage of mitomycin C

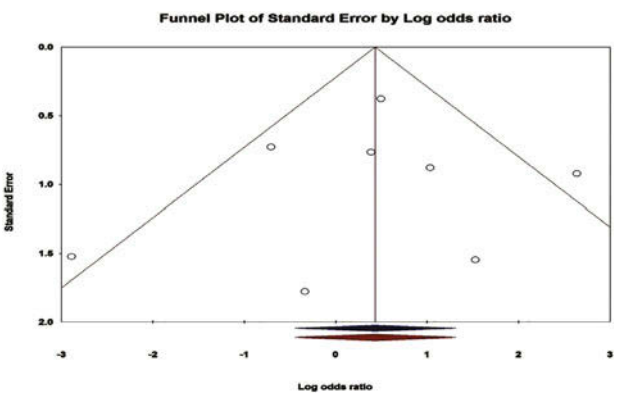
When we screened the articles for the application of topical MMC for improving the outcome of CA repair by using key words choanal atresia and mitomycin C, seven articles met our criteria but two of them were excluded as these were one-armed studies giving insufficient data, and thus only five articles were included for comparison; these articles involved 155 cases, managed by transnasal endoscopic and transpalatal approach. MMC was used in 70 cases, and was not used in 85 cases. We found that the rate of restenosis in cases of MMC application was 24.28%,

Figure 1



Forest plot for the incidence of restenosis after transnasal or transpalatal repair using the estimated odds ratio (OR) as the effect measure, A endoscopic technique; B transpalatal technique. CI, confidence interval.

Figure 2



Funnel plot of the log odds ratio and the SE of odds ratio for determination of publication bias.

Table 3 Meta-analysis for the incidence of restenosis after transnasal or transpalatal repair using the estimated odds ratio as the effect measure

Numbers	References	Transnasal Events	Transpalatal Total	Events	Total	Odds ratio	Lower limit	Upper limit	*Z*-value	*P*-value	RW (F)	RW (R)
1	Al Muhaimeed [3]	10	24	6	6	0.06	0.00	1.10	–1.90	0.06	3.03	6.62
2	Madry *et al.*[4]	19	45	28	91	1.64	0.78	3.45	1.32	0.19	49.27	23.64
3	Kim *et al.*[5]	9	22	7	12	0.49	0.12	2.06	–0.97	0.33	13.24	16.21
4	Gosepath *et al.*[6]	15	38	0	3	4.62	0.22	95.73	0.99	0.32	2.94	6.46
5	Hengerer *et al.*[7]	4	23	4	32	1.47	0.33	6.63	0.51	0.61	11.95	15.49
6	Jung *et al.*[8]	7	9	6	30	14.00	2.30	85.40	2.86	0.00	8.26	12.87
7	Richardson and Osguthorpe [9]	9	25	2	12	2.81	0.50	15.77	1.18	0.24	9.09	13.54
8	Wiatrak [10]	1	11	0	2	0.71	0.02	23.31	–0.19	0.85	2.22	5.18
Model	Fixed					1.58	0.94	2.66	1.73	0.08		
	Random					1.54	0.64	3.71	0.97	0.33		

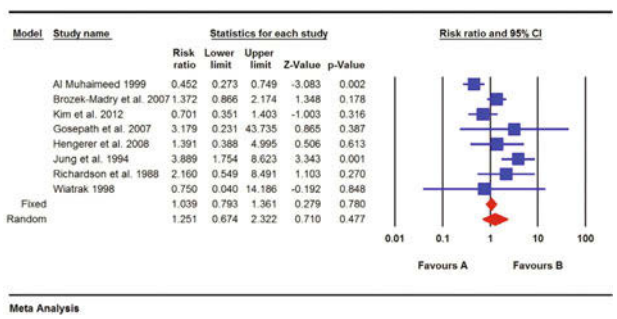
Tests of heterogeneity: Cochran *Q* *P*-value = 0.050, I^2 = 50.318, τ^2 = 0.893. Publication bias: Duval and Tweedie's Trim and Fill number = 0. RW (F), relative weight under fixed model; RW (R), relative weight under random model.

Table 4 Meta-analysis for the incidence of restenosis after transnasal or transpalatal repair using the estimated risk ratio as the effect measure

Numbers	References	Transnasal Events	Transpalatal Total	Events	Total	Odds ratio	Lower limit	Upper limit	*z*-value	*P*-value	RW (F)	RW (R)
1	Al Muhaimeed [3]	10	24	6	6	0.45	0.27	0.75	–3.08	0.00	28.66	18.68
2	Bro□ek-M□dry *et al.*[4]	19	45	28	91	1.37	0.87	2.17	1.35	0.18	34.42	19.08
3	Kim *et al.*[5]	9	22	7	12	0.70	0.35	1.40	–1.00	0.32	15.16	16.82
4	Gosepath *et al.* [6]	15	38	0	3	3.18	0.23	43.74	0.86	0.39	1.06	4.41
5	Hengerer *et al.*[7]	4	23	4	32	1.39	0.39	4.99	0.51	0.61	4.46	11.16
6	Jung *et al.*[8]	7	9	6	30	3.89	1.75	8.62	3.34	0.00	11.50	15.76
7	Richardson *et al.* [9]	9	25	2	12	2.16	0.55	8.49	1.10	0.27	3.89	10.43
8	Wiatrak [10]	1	11	0	2	0.75	0.04	14.19	–0.19	0.85	0.84	3.66
Model	Fixed					1.04	0.79	1.36	0.28	0.78		
	Random					1.25	0.67	2.32	0.71	0.48		

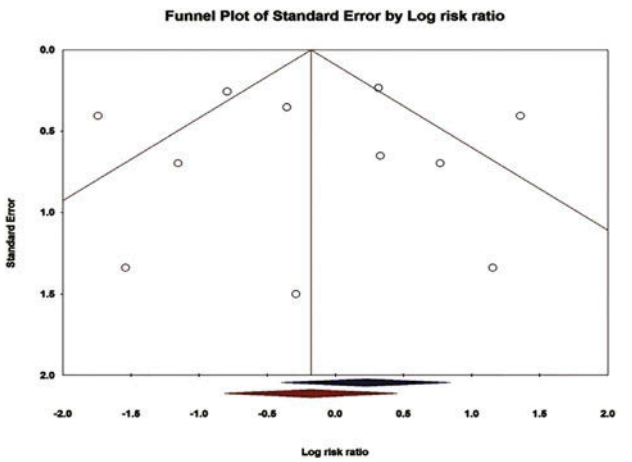
Tests of heterogeneity: Cochran *Q* *P*-value = 0.001, I^2 = 72.740, τ^2 = 0.683. Publication bias: Duval and Tweedie's Trim and Fill number = 3. RW (F), relative weight under fixed model; RW (R), relative weight under random model.

Figure 3



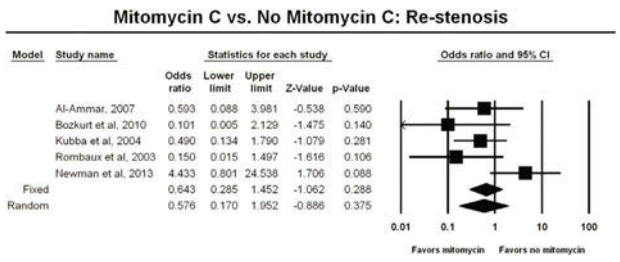
Forest plot for the incidence of restenosis after transnasal or transpalatal repair using the estimated risk ratio (RR) as the effect measure. CI, confidence interval.

Figure 4



Funnel plot of the log risk ratio and the SE of risk ratio for determination of publication bias.

Figure 5



Showed the forest plot for meta-analysis of studies comparing mitomycin C versus no mitomycin C as regards the incidence of restenosis. CI, confidence interval.

whereas in cases without MMC it was 35.29% (Table 5).

The meta-analysis of studies comparing MMC application versus no MMC as regards the incidence of restenosis using the estimated odds ratio (statistical measure) showed a statistically nonsignificant difference between the two groups. Measures of heterogeneity revealed unimportant heterogeneity of the estimates reported by the included studies (Cochran *Q* *P*-value, 0.091; I^2, 50.1; τ^2, 0.939).

Pooling of the estimates using a fixed-effects model showed an odds ratio of 0.643 (95% CI, 0.285–1.452; *P*-value, 0.288) (Fig. 5).

Results of comparing the outcome of transpalatal and transnasal endoscopic repair of CA with and without using stenting

For comparing the result of using nasal stent as an adjuvant tool to improve the outcome of transnasal or transpalatal approach, we screened for keywords choanal atresia and nasal stent. Seven articles met our criteria but three of them were excluded as these were one-armed studies giving insufficient data, and thus only four articles

Table 5 Articles involved in studying the role of topical mitomycin c as adjuvant treatment to improve the outcome of repair of CA

References	Methods	Participates	Interventions	Outcome
Al-Ammar [11]	Case–control (retrospective study(	20 cases; 15 unilateral, five bilateral; 8 male, 12 female; Age from 11 days to 17 years; Type of atresia, all cases are mixed bony membranous except one case bony atresia	All cases repaired by transnasal endoscope; The cases were distributed randomly to two group; A; 13 cases received intraoperative mitomycin c; B; seven cases in which mitomycin was not used	Four cases with MMC had restenosis; Three cases with non-MMC had restenosis
Bozkurt *et al*. [12]	Case–control (retrospective study(	20 cases; Eight unilateral, 12 bilateral; Five male, 15 female; Age range from 18 to 144 months in unilateral cases and from 3 to 7 days in bilateral cases; Type of atresia not mentioned	Transnasal endoscopic approach; Mitomycin c applied in six cases; 14 cases with no MMC; Stent for 3 weeks	No stenosis in cases with MMC; Six cases had stenosis in cases with non-MMC
Kubba *et al*. [13]	Case–control (retrospective study(	46 cases; 23 unilateral (seven male, 16 female); 23 bilateral (nine male, 14 female); Type of atresia not mentioned	Transnasal endoscopic approach; MMC applied in 13 cases of bilateral atresia and in nine cases in unilateral atresia; 11 cases lost in follow-up	Five cases with MMC had restenosis; Nine cases with non-MMC had restenosis
Rombaux *et al.*[14]	Case–control (retrospective study(	1. Study group with MMC, seven cases, all are unilateral; Two male, five female; Age from 6 to 46 months; Bony atresia in four cases, mixed atresia in three cases; 2. Control group with no MMC 19 cases; Four male, 15 female; Age not mentioned; Type of atresia not mentioned	Transnasal endoscopic approach in study group; Transnasal and transpalatal in control group	One cases with MMC had restenosis; 10 cases with non-MMC had restenosis
Newman *et al.*[15]	Case–control (retrospective study)	42 cases; Three of them were excluded because of inadequate follow-up data; Excluding six patients whose initial repair was performed by other physicians; 19 unilateral, 12 bilateral; Age range from 3 days to 15 years; Bony atresia in six cases, membranous in three, mixed in 30 cases	Transnasal endoscopic approach in 31 cases; Transpalatal in two cases; Mitomycin C therapy was used as an adjunct to surgery in approximately half of atretic choanae treated endoscopically; 22 of 43 operative sides (51%) in 31 patients	Seven cases with MMC had restenosis; Two cases with non-MMC had restenosis

CA, choanal atresia; MMC, mitomycin C.

were included; they involved 165 cases, managed by transnasal endoscopic and transpalatal approach. In total, 93 cases used nasal stent after the repair of CA, whereas in 72 cases stent was not used. Rate of restenosis in cases for which nasal stent was used was 21.5%, whereas in cases without nasal stent the rate of restenosis was 18% (Table 6).

Meta-analysis of studies comparing stent insertion versus no stent insertion after CA repair, as regards the incidence of restenosis using the estimated odds ratio (statistical measure), showed a statistically nonsignificant difference between the two modalities. The measures of heterogeneity revealed unimportant heterogeneity of the estimates reported by the included studies (Cochran Q P-value, 0.874; I^2, 0.000; τ^2, 0.000).

Pooling of the estimates using a fixed-effects model showed an odds ratio of 1.427 (95% CI, 0.593–3.433; P-value, 0.428) (Fig. 6).

Discussion

Many surgical approaches have been described for CA repair; among them are the transnasal, transpalatal, trans-septal, and transantral routes. Although their success rate are almost equal, the most widely used techniques are the transnasal and transpalatal routes [18].

A study by Pirsig [19] reviewed over hundreds of papers on surgical approaches to CA. Many authors found that the results of both transnasal and transpalatal approaches are comparable (80 and 84% success rates, respectively).

This is in agreement with our study, as we found that the incidence of restenosis after transnasal endoscopic or transpalatal repair, using the estimated odds ratio and risk ratio (statistical measures), showed a statistically nonsignificant difference between the two techniques.

Whereas Shivakumar *et al.*[20], Panda *et al.*[21], Sadek [18], Reddy *et al.*[22], Wiatrak [10], Anderhuber and Stammberger [23], Forer *et al.*[24], Ibrahim *et al.*[25], Önerci *et al.*[26], Yaniv *et al.*[27], Friedman *et al.*[17], Romeh and Albirmawy [28], Van Den Abbeele *et al.* [29], Saetti *et al.*[30], Schoem [31] and Pasquini *et al.* [32], in their respective studies, preferred transnasal

Table 6 Articles involved in studying the role of Stenting in improving the outcome of repair of CA

References	Methods	Participates	Interventions	Outcome
Elsherif *et al.*[16]	Prospective study	1. Study group with stent seven cases, five unilateral, two bilateral; Three male, four female; Age from 4 days to 17 years; Bony atresia in four cases, membranous in one case, mixed atresia in two cases; 2. Control group with no stent five cases, four unilateral, one bilateral; Two male, three female; Age from 2 days to 2 years; Bony atresia in three cases, membranous in one case, mixed atresia in one	Transnasal endoscopic repair	Three cases with nasal stent had restenosis; One case with no nasal stent had restenosis
Newman *et al.*[15]	Case–control (retrospective study(	42 cases, three of them were excluded because of inadequate follow-up data, excluding six patients whose initial repair was performed by other physicians; 19 unilateral, 12 bilateral; Age range from 3 days to 15 years; Bony atresia in six cases, memberanous in three, mixed in 30 cases	Transnasal endoscopic approach in 31 cases; Transpalatal in two cases; Intranasal stents were used in 36 of 43 choanae (84%) operated on endoscopically. When we used stents, they were usually (in 28 of 36 patients) left in place for 15 days or longer	Five cases with nasal stent had restenosis; One case with no nasal stent had restenosis
Kubba *et al.*[13]	Case–control (retrospective study)	46 cases; 23 unilateral (seven male, 16 female), 23 bilateral (nine male, 14 female); Type of atresia not mentioned	Transnasal endoscopic approach; Stent applied in 23 cases of bilateral atresia and in 10 cases in unilateral atresia; 11 cases lost in follow-up	Seven cases with nasal stent had restenosis; Two case with no nasal stent had restenosis
Friedman *et al.*[17]	Case–control (retrospective study)	65 cases; 30 unilateral, 35 bilateral; 19 male, 46 female; Type of atresia not mentioned	Transnasal endoscopic approach; Cases stented> 12 weeks, 5; Cases stented<12 weeks, 14	Five cases with nasal stent had restenosis; Nine case with no nasal stent had restenosis

CA, choanal atresia.

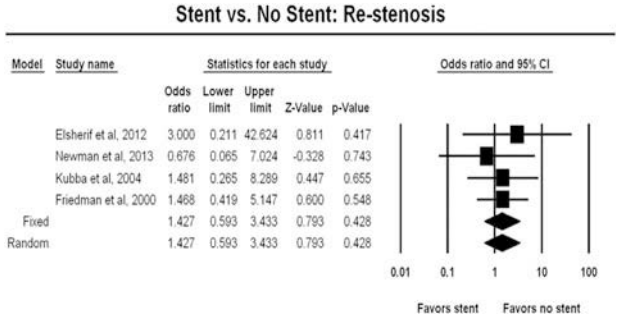
endoscopic approach, as it is quick, safe, and avoids hard palate and alveolar arch growth retardation, with less morbidity, and short hospital stay. In addition, it has the ability to exactly locate the site of puncture and drill the atretic plate under constant vision using the nasal endoscope.

On the other hand, a study by Bergonse *et al.* [33] reported that despite current development and improvement of endoscopic technique transpalatal technique, when performed properly by a skilled surgeon, the result is satisfactory. A study by Gujrathi *et al.* [34] suggested that endoscopic repair is difficult and should not be preferred in neonates because of narrow nasal cavities. Moreover, Schraff *et al.* [35] preferred transpalatal approach as the intervention of choice in CA repair.

During studying the results of meta-analysis of studies comparing MMC versus no MMC as regards the incidence of restenosis using the estimated odds ratio (statistical measure), we found that there was no statistically significant difference between the two groups.

Al-Ammar [11], Kubba *et al.* [13], and Newman *et al.* [15], in their respective studies, agreed with our outcome that there is no statistically significant

Figure 6



Forest plot for meta-analysis of studies comparing stent insertion versus no stent insertion as regards the incidence of restenosis. CI, confidence interval.

difference between using MMC or no MMC as regards the incidence of restenosis. In addition, a study by Teissier *et al.* [36] found that using topical MMC as an adjuvant treatment to CA repair does not improve the outcome. On the other hand, Prasad *et al.* [37], Holland and McGuirt [38], Bozkurt *et al.* [12], Rombaux *et al.* [14], Gosepath *et al.* [6], and Mcleod *et al.* [39] found that using topical MMC as an adjuvant treatment to CA repair has great effect in improving the outcome.

Finally, we aimed to find out the role of stenting in improving the outcome of CA repair.

The meta-analysis of studies comparing stent insertion versus no stent insertion as regards the incidence of restenosis using the estimated odds ratio (statistical measure) showed statistically nonsignificant difference between the two modalities.

Studies by Newman *et al.*[15], Kubba *et al.* [13], Friedman *et al.* [17], Cedin *et al.* [40], Gosepath *et al.* [6], Elloy [41], Durmaz *et al.* [42], and Uzomefuna *et al.* [43] agreed with our outcome that there is no statistically significant difference between using or not using stent as regards the incidence of restenosis.

Wiatrak [10] and Romeh and Albirmawy [28] found that using nasal stent as adjuvant tool to CA repair improves the outcome.

On the other hand, studies by Josephson *et al.*[44], Schoem [31], Van Den Abbeele *et al.* [29], Wang *et al.* [45], and Elsherif *et al.* [16] showed that the stents may act as a nidus for infection and cause pain, in addition to the formation of granulation tissue, and nasal synechia. Thus, using stent as an adjuvant tool to CA repair does not improve the outcome.

Conclusion

Although there is much debate about which approach is better and preferable in the repair of CA, the available evidence from this statistical analysis indicates that there is no statistically significant difference between transnasal endoscopic and transpalatal approach in the repair of CA as regards restenosis. In addition, we found that there is no statistically significant difference between using intraoperative topical MMC and nasal stent or not using such modalities in the outcome of CA repair.

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Conflicts of interest

There are no conflicts of interest.

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