# Open versus endoscopic septoplasty techniques: A systematic review and meta-analysis

Chris J. Hong, M.D.,[1,2] Eric Monteiro, M.D., M.Sc.,[2] Jetan Badhiwala, M.D.,[3] John Lee, M.D., M.Sc.,[2] John R. de Almeida, M.D., M.Sc.,[2] Allan Vescan, M.D.,[2] and Ian J. Witterick, M.D., M.Sc.[2]

## ABSTRACT

**Background:** *Septal deviation is a condition of high prevalence, which ranges from 22% in newborns to 90% in adults. Surgical intervention is frequently considered in the management of patients with symptoms. Although many surgeons prefer either the endoscopic or the open approach to septoplasty, there is an ongoing debate regarding comparative outcomes between the two approaches.*

**Objective:** *The purpose of this study was to systematically review the literature and provide pooled summary estimates to evaluate the efficacy and safety of open versus endoscopic septoplasty techniques.*

**Methods:** *This study was registered with PROSPERO (CRD42014010730). MEDLINE, EMBASE, Google Scholar, CINAHL, Web of Science, and The Cochrane Central Registry for Randomized Trials were searched for relevant studies by using the following keywords in varying combinations: "nasal septum," "nasal obstruction," "nasal cartilages," "nose," "nose diseases," "surgery," "nasal/septal deviation," and "septoplasty." All the studies that compared open versus endoscopic septoplasty techniques for the management of symptomatic septal deviation were considered. Two reviewers independently extracted data by using a preestablished extraction form and performed quality assessment by using the Jadad and Newcastle Ottawa Scales. Weighted pooled estimates were calculated and reported, along with relative risks and 95% confidence intervals.*

**Results:** *Fourteen studies met our inclusion criteria. When comparing open versus endoscopic septoplasty techniques, there was significant improvement in postoperative symptoms (i.e., nasal obstruction, headaches) ($p < 0.05$) in the endoscopic septoplasty group. There also were significantly fewer complications associated with the endoscopic septoplasty technique ($p < 0.05$). Based on the quality assessment, included studies were deemed at a moderate-to-high risk of bias.*

**Conclusion:** *Our analysis indicated that endoscopic septoplasty may have some advantages over open septoplasty. However, our findings should be taken with caution given the poor quality of included studies.*

(Am J Rhinol Allergy 30, 436–442, 2016; doi: 10.2500/ajra.2016.30.4366)

The nasal septum is integral to nasal stability and provides support to the nasal tip, nasal dorsum, and middle nasal third.[1] When significantly deformed or deviated, it may result in nasal obstruction, a predisposition to chronic or recurrent sinusitis, and, less commonly, contact point headaches.[2] The prevalence of septal deviation may vary, depending on age, with as many as 22% of newborns and 90% of adults affected.[3,4] Although traumatic injury is a frequent cause of septal deviation, there are often no identifiable causes. Some investigators have postulated that trauma during birth or early microfractures may predispose the septal cartilage to asymmetrical growth.[5]

Surgical intervention is often considered when septal deviation produces symptoms. The two main surgical approaches used for addressing a deviated nasal septum include the traditional "open" approach, and the endoscopic septoplasty technique.[6] The open approach involves addressing the septum through direct visualization by using headlight illumination. Alternatively, the endoscopic technique uses a rigid endoscope to directly visualize the septum, which allows for correction of any deformities.[6,7] Both techniques are frequently used to approach nasal septal deviations; however, there is ongoing debate over which approach is associated with improved outcomes (*e.g.*, improvement in nasal obstruction) and fewer complications (*e.g.*, postoperative hemorrhage, mucosal adhesions, septal tear). The purpose of this study was twofold: (1) to systematically review and meta-analyze the relevant literature to evaluate the efficacy and safety of open versus endoscopic septoplasty techniques, and (2) to identify evidence gaps that will guide future research on comparative outcomes between the two techniques for the management of symptomatic septal deviation.

*From the [1]Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada, [2]Department of Otolaryngology—Head & Neck Surgery, University of Toronto, Toronto, Ontario, Canada, and [3]Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, Ontario, Canada*

*Presented at the 69th Canadian Society of Otolaryngology-Head and Neck Surgery annual meeting, Winnipeg, Manitoba, Canada, June 6–9, 2015*

*No external funding sources reported*

*The authors have no conflicts of interest to declare pertaining to this article*

*Supplemental data available at www.IngentaConnect.com*

*Address correspondence to Eric Monteiro, M.D., Department of Otolaryngology—Head & Neck Surgery, Mount Sinai Hospital, 600 University Ave., Room 401, Toronto, Ontario, Canada M5G 1X5*

*E-mail address: EMonteiro@mtsinai.on.ca*



## METHODS

We performed a systematic review and meta-analysis based on an *a priori* protocol that was registered with PROSPERO (CRD42014010730).[8] This study was reported in accordance with the Meta-analysis of Observational Studies in Epidemiology guidelines[9] and Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[10]

### Search Strategy

Two independent reviewers (C.H., E.M.) performed a detailed electronic search of MEDLINE, EMBASE, Google Scholar, CINAHL, Web of Science, and The Cochrane Central Registry for Randomized Trials for comparative studies that reported clinical outcomes of the two aforementioned septoplasty techniques. A manual search of relevant journals and reference lists of included articles was also performed to identify any applicable studies that were not previously identified. In consultation with a medical librarian, the following key words and Medical Subject Headings terms were used in varying combinations: "nasal septum," "nasal obstruction," "nasal cartilages," "nose," "nose diseases," "surgery," "nasal/septal deviation," and "septoplasty." The MEDLINE search strategy was adapted to the other data bases (see Supplemental Appendix 1).

### Selection Criteria

The same two reviewers (C.H., E.M.) independently scanned the titles and abstracts of the retrieved articles to determine their poten-

tial relevance. The full-text versions of all potentially relevant articles were then assessed by using a predefined eligibility form based on our inclusion criteria. Studies were included if they evaluated (1) the population: adult and/or adolescent patients with symptomatic nasal septal deviation that required surgical intervention (studies were included even if this criterion was poorly defined); (2) intervention and/or comparison: open versus endoscopic septoplasty techniques; (3) outcomes: at least one of several primary outcomes (*i.e.,* change in acoustic rhinometry or rhinomanometry test scores, change in Nasal Obstruction Septoplasty Effective instrument scores, change in rhinosinusitis quality of life survey scores) or secondary outcomes (*i.e.,* operative time, recovery time, change in postoperative symptoms, peri- and postoperative pain, complications); (4) study design: randomized controlled trials (RCT) or observational cohort studies; (5) timing: January 1970 to May 2014 (1970 was the earliest available year in standard bibliographic data bases); and (6) language: English only. Articles that dealt with the pediatric population, a sample size of <3, duplicate references, preliminary studies, letters to the editor, conference abstracts, meeting proceedings, studies with no controls, and literature reviews were excluded. Any disagreement between the two reviewers (C.H., E.M.) was resolved through discussion and consensus, and if necessary, through consultation with a senior author (A.V., I.W.).

## Data Extraction and Quality Assessment

The senior authors of all included studies were contacted for additional items that may have been omitted in their published studies by following the guidelines established by Mullan *et al.*[11] All data were extracted independently by two reviewers (C.H., E.M.) by using a preestablished data extraction form. Data were extracted on the following items: title; first author; year of publication; study design; general study and patient characteristics; surgical methods; preoperative data; and outcomes of interest, including postoperative symptoms, peri- and postoperative pain, and complications. In our study, cure was defined as any postoperative improvement in patient symptoms (*e.g.,* nasal obstruction) from baseline, as measured by using patient-reported improvement or improvement in rhinometry. Peri- and postoperative pain referred to any subjective pain experienced by patients during and after surgery (*i.e.,* patient-reported pain as either present or absent). Disagreements during data extraction were settled through discussion and consensus between the two reviewers. The same reviewers (C.H., E.M.) were also involved in assessing the quality of the included studies. We used the Jadad scale to grade the evidence and determine the risks of bias for RCTs.[12] The Newcastle Ottawa Scale was used to assess the methodologic quality of nonrandomized studies.[13]

## Data Analyses

Cohorts were grouped based on surgical approach, and a direct comparison of outcomes was made. Because there were a limited number of studies within each study design, separate analyses of RCTs and observational studies were not feasible. Statistical heterogeneity among studies was investigated by using the Cochrane Q test and was quantified by the $I^2$ statistic, which represents the percentage of total variation across studies due to heterogeneity. We used the DerSimonian-Laird random effects model[14] to calculate weighted pooled proportions of outcomes for each surgical approach because a large between-study heterogeneity was observed. Weights were calculated by using the inverse variance method. Publication bias was evaluated visually by funnel plots and quantified by the Egger regression[15] and Begg-Mazumdar tests.[16] We calculated relative risks (RR) and 95% confidence intervals (95% CI), and generated forest plots for all outcomes. An $\alpha$ error of <0.05 was considered a criterion for statistical significance. We used Review Manager (version 5.2.6., The Nordic Cochrane Centre, Copenhagen) to perform the statistical analyses.

# RESULTS

A Preferred Reporting Items for Systematic reviews and Meta-Analyses study flow diagram for the literature search is presented in Fig. 1. Our search identified 2499 records, of which 286 remained after removing duplicate entries and excluding noneligible articles from title and abstract screening. Fourteen studies remained after application of our inclusion criteria by reviewing potential articles in full text; one additional article was identified through a manual search of relevant journals and references of included studies. Fifteen studies were included in qualitative synthesis, and 14 studies that reported on 1119 patients of interest were included in quantitative synthesis. There were a total of 10 RCTs (2 multicentered, 8 single-centered), and the remaining 4 studies were observational cohort studies.

## Study Characteristics and Risk of Bias Assessment

Study characteristics are presented in Supplemental Appendix 2, which also summarizes the outcomes of the 14 included studies. All the studies were written in English and published between January 1970 and May 2014, and directly compared and reported at least one of our predefined outcomes. The mean age of the study cohorts were poorly reported in most studies, and it was assumed that the majority of included subjects were adults (≥18). At least two of the included studies contained adolescents as part of their study populations. Most studies reported preoperative symptoms or "indications" that led to surgical correction of septal deviation. Nasal obstruction was the most common indication for septoplasty ($n$ = 677 [92%]), followed by contact point headaches ($n$ = 250 [34.1%]). Although standard open and endoscopic septoplasty techniques were applied in the included studies, there were minor practice variations among institutions and, in some cases, other cosurgical procedures (*e.g.,* endoscopic sinus surgery, turbinoplasty) were performed concomitantly with the septoplasty. The risk of bias assessments by domain for the included RCTs and observational cohort studies are outlined in Tables 1 and 2, respectively. Overall, the studies were deemed at a moderate-to-high risk of bias (average of 2.2 of 5 on the Jadad scale) for outcomes.

## Cure

Eight studies that comprised six RCTs and two observational studies reported on cure (Appendix 2). The two most commonly reported outcome measures, nasal obstruction and contact point headaches, were used in the analyses. The pooled results of these studies showed a statistically significant improvement in nasal obstruction (8 studies: RR 3.70 [95% CI, 2.13–6.43], $I^2$ = 0%, $p < 0.001$) and contact point headaches (5 studies: RR 2.65 [95% CI, 1.11–6.30], $I^2$ = 0%, $p = 0.03$) in patients managed with endoscopic septoplasty (Fig. 2).

## Peri- and Postoperative Pain

Two studies ($n$ = 143) reported on peri- and postoperative pain (Appendix 2). The open septoplasty technique was associated with an increase in peri- and postoperative pain; however, a meta-analysis was not performed because it was deemed to have limited value, with only two studies that assessed peri- and postoperative pain.

## Complications

All included studies ($n$ = 1119) reported on complications (Appendix 2). There were more complications associated with the open septoplasty technique, namely intra- or postoperative hemorrhage (7 studies: RR 2.62 [95% CI, 1.45–4.71], $I^2$ = 0%, $p = 0.001$), mucosal adhesions and/or synechiae (13 studies: RR 3.30 [95% CI, 1.49–7.31], $I^2$ = 46%, $p = 0.003$), persistent deviation (9 studies: RR 2.09 [95% CI, 1.44–3.04], $I^2$ = 0%, $p < 0.001$), and septal tear (5 studies: RR 1.84 [95% CI, 1.27–2.68], $I^2$ = 0%, $p = 0.001$) (Fig. 3). No statistically significant difference was seen in other complication measures, including nasal crusting, persistent spur, infection and/or septal abscess, septal perforation, septal hematoma, external deformity, and recurrence.

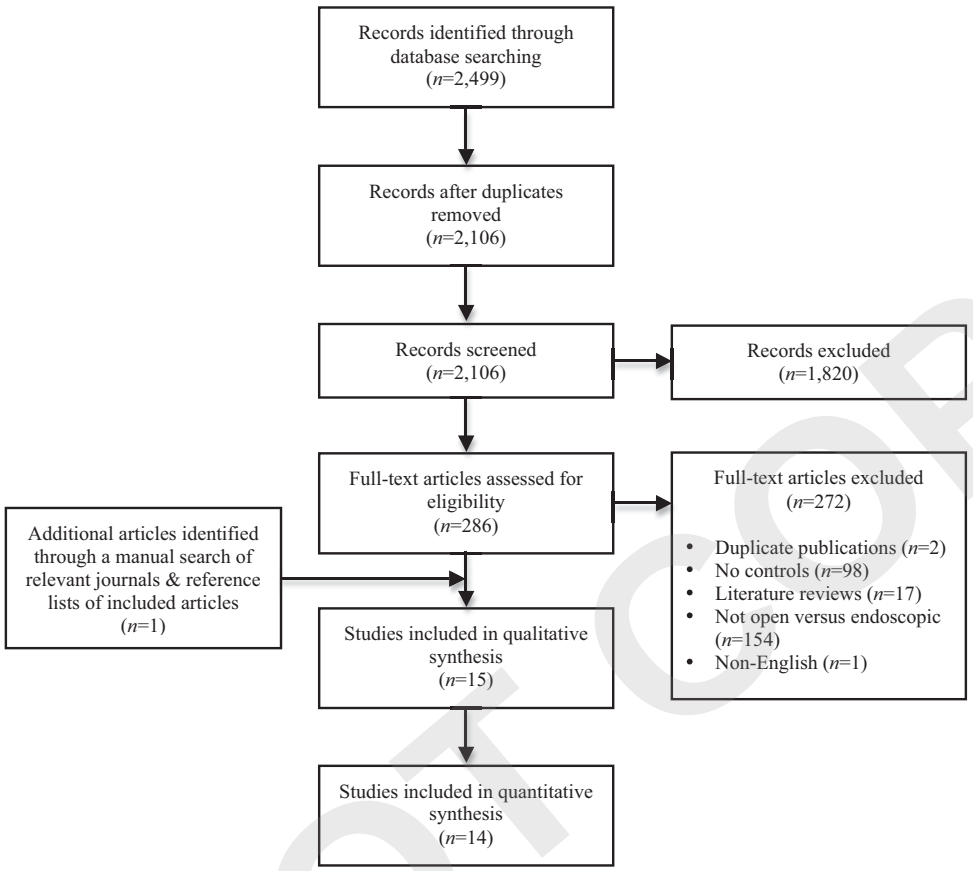



***Figure 1.*** *Preferred Reporting Items for Systematic Reviews and Meta-Analyses study flow diagram.*

Table 1 **Risk of bias assessments by domain for included randomized controlled trials**

| Study, y | Randomization Is Mentioned | Method of Randomization Is Appropriate | Method of Randomization Is Inappropriate | Blinding Is Mentioned | Method of Blinding Is Appropriate | Method of Blinding Is Inappropriate | Account of All Patients | Total Score (of a total of 5) |
|---|---|---|---|---|---|---|---|---|
| Bothra and Mathur,[29] 2009 | + | O | − | O | O | O | + | 1 |
| Paradis and Rotenberg,[30] 2011 | + | + | O | + | + | O | + | 5 |
| Gulati *et al.*,[32] 2009 | + | O | O | O | O | O | + | 2 |
| Gupta,[34] 2005 | + | O | O | O | O | O | + | 2 |
| Talluri *et al.*,[35] 2014 | + | O | O | O | O | O | + | 2 |
| Sathyaki *et al.*,[36] 2014 | + | O | − | O | O | O | + | 1 |
| Shahzad and Bhawana,[38] 2013 | + | O | O | O | O | O | + | 2 |
| Rao,[40] 2013 | + | O | O | + | O | O | + | 3 |
| Suligavi *et al.*,[41] 2010 | + | O | O | O | O | O | + | 2 |
| Kaushik *et al.*,[42] 2013 | + | O | O | O | O | O | + | 2 |

*+ = 1 point; O = 0 points; − = −1 point.*

## DISCUSSION

Nasal septal deviation is one of the most common medical conditions, prevalent in up to 80% of the general population.[17] Although many do not require treatment, surgical correction is often warranted when septal deviation leads to symptoms that can impact a patient's quality of life.[18] It has been estimated that as many as one-third of the population has some nasal obstruction and that as many as one-fourth of these patients seek surgical treatment.[2] Apart from nasal obstruction, septal deviation has been associated with recurrent epistaxis, contact point headaches, and recurrent or chronic rhinosinusitis.[2,17,19] Furthermore, a deviated septum can impact nasal cosmesis and hinder access for endoscopic sinus surgery.[20]

The open and the endoscopic septoplasty techniques are two of the most common surgical approaches used to correct a deviated septum. The open technique was first introduced by Freer[21] and Killian[22] at the turn of the 20th century and has since undergone several modifications.[23–26] This technique has an important economical advantage over the endoscopic technique (*i.e.,* requires less equipment) and is particularly useful when addressing a caudal septal deviation.[27] However, the endoscopic technique theoretically permits a more di-

Table 2 **Risk of bias assessments by domain for included observational cohort studies.**

| Study, y | Representativeness of the Exposed Cohort | Selection of the Nonexposed Cohort | Ascertainment of Exposure | Demonstration that Outcome of Interest Was Not Present at the Start | Study Controls for Sex | Study Controls for Any Additional Factor | Assessment of the Outcome | Was Follow-up Long Enough for Outcomes to Occur? | Adequacy of Follow-up of Cohorts* |
|---|---|---|---|---|---|---|---|---|---|
| Jain *et al.*,[31] 2011 | √ | √ | √ | † | † | † | † | † | √ |
| Dolan,[33] 2004 | † | † | √ | † | † | † | † | † | † |
| Ashour,[37] 2010 | √ | √ | √ | † | † | † | √ | † | √ |
| Salama[39] 2014 | √ | √ | √ | † | † | † | † | √ | √ |
| Iqbal *et al.*,[43] 2013 | √ | √ | √ | √ | † | † | † | † | √ |

√ = *Yes*; † = *no*.
*20%.

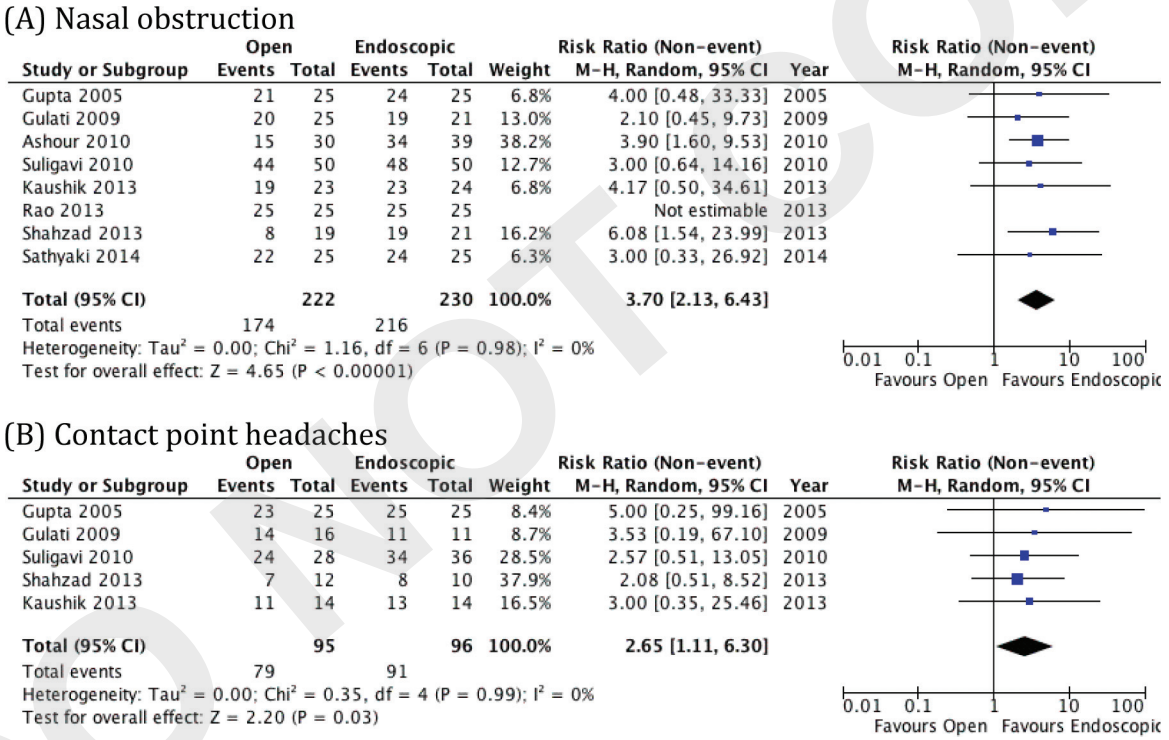



***Figure 2.*** *Forest plots of meta-analyses of cure with open versus endoscopic septoplasty techniques. Outcomes evaluated are nasal obstruction (A) and contact point headaches (B).*

rect anatomic assessment, provides enhanced illumination, and improves visualization, and an equally precise correction of septal pathologies. Moreover, some investigators would argue that this approach is particularly beneficial when treating isolated posterior deflections, septal spurs, and septal deviations adjacent to septal perforations.[28] Notwithstanding the theoretical benefits of the endoscopic septoplasty technique, there is currently a lack of consensus on which surgical technique, if any, has better efficacy and safety profiles. The wealth of studies that described individual experiences with each technique, as well as the numerous studies in our review that compared clinical outcomes between the two techniques, attest to the lack of management consensus today.[29–43]

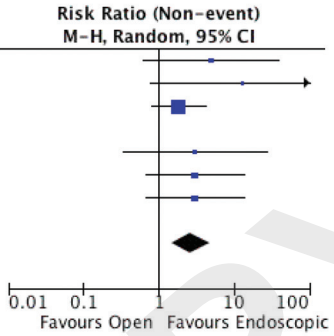
In this systematic review and meta-analysis, we set out to critically evaluate the clinical outcomes of open versus endoscopic septoplasty techniques based on the most up-to-date methodologic principles. We aimed to provide both qualitative and quantitative syntheses of the available evidence of one of the most frequently performed procedures in otolaryngology—head & neck surgery today. This review, which, to our knowledge, is the first of its kind, was based on a comprehensive search of >40 years of the global literature, and our meta-analysis provides a critical assessment of pooled summary estimates by comparing a number of important clinical outcomes of the two surgical techniques.

The results from this study yielded several important findings. Our main finding was that the endoscopic septoplasty technique seemed to offer certain advantages, with fewer overall complications compared with the traditional open technique. The pooled results in our study demonstrated a significant improvement in nasal obstruction and contact point headaches. Several complications, including intra- and/or postoperative hemorrhage, mucosal adhesions and/or synechiae, persistent deviation, and septal tear were also found to be more common among those who underwent open septoplasty. In addition, in two of the included studies, peri- and postoperative pain that favored the endoscopic septoplasty technique was reported.[29,30]

## (A) Intra/postoperative hemorrhage

| Study or Subgroup | Open Events | Total | Endoscopic Events | Total | Weight | Risk Ratio (Non-event) M-H, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Gupta 2005 | 20 | 25 | 24 | 25 | 8.0% | 5.00 [0.63, 39.79] | 2005 |
| Bothra 2009 | 34 | 40 | 40 | 40 | 4.3% | 13.00 [0.76, 223.33] | 2009 |
| Suligavi 2010 | 37 | 50 | 43 | 50 | 50.0% | 1.86 [0.81, 4.26] | 2010 |
| Paradis 2011 | 31 | 31 | 32 | 32 | | Not estimable | 2011 |
| Kaushik 2013 | 27 | 30 | 29 | 30 | 7.1% | 3.00 [0.33, 27.23] | 2013 |
| Shahzad 2013 | 19 | 25 | 23 | 25 | 15.3% | 3.00 [0.67, 13.46] | 2013 |
| Sathyaki 2014 | 19 | 25 | 23 | 25 | 15.3% | 3.00 [0.67, 13.46] | 2014 |
| **Total (95% CI)** | | **226** | | **227** | **100.0%** | **2.62 [1.45, 4.71]** | |
| Total events | 187 | | 214 | | | | |

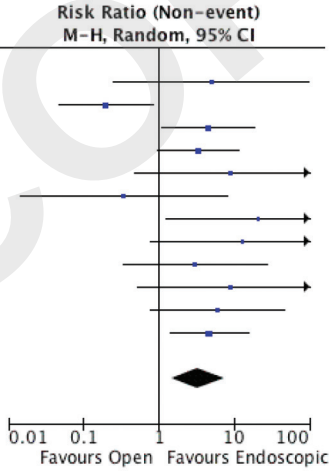
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.46$, df = 5 (P = 0.78); $I^2 = 0\%$
Test for overall effect: Z = 3.21 (P = 0.001)




## (B) Mucosal adhesions/synechiae

| Study or Subgroup | Open Events | Total | Endoscopic Events | Total | Weight | Risk Ratio (Non-event) M-H, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Dolan 2004 | 55 | 55 | 112 | 112 | | Not estimable | 2004 |
| Gupta 2005 | 23 | 25 | 25 | 25 | 5.2% | 5.00 [0.25, 99.16] | 2005 |
| Bothra 2009 | 38 | 40 | 30 | 40 | 12.0% | 0.20 [0.05, 0.86] | 2009 |
| Gulati 2009 | 16 | 25 | 23 | 25 | 12.1% | 4.50 [1.08, 18.77] | 2009 |
| Suligavi 2010 | 40 | 50 | 47 | 50 | 13.5% | 3.33 [0.98, 11.40] | 2010 |
| Ashour 2010 | 27 | 30 | 39 | 39 | 5.4% | 9.03 [0.48, 168.45] | 2010 |
| Paradis 2011 | 31 | 31 | 31 | 32 | 4.8% | 0.34 [0.01, 8.13] | 2011 |
| Jain 2011 | 40 | 50 | 50 | 50 | 5.7% | 21.00 [1.26, 348.93] | 2011 |
| Shahzad 2013 | 19 | 25 | 25 | 25 | 5.7% | 13.00 [0.77, 219.11] | 2013 |
| Kaushik 2013 | 27 | 30 | 29 | 30 | 7.9% | 3.00 [0.33, 27.23] | 2013 |
| Sathyaki 2014 | 21 | 25 | 25 | 25 | 5.5% | 9.00 [0.51, 158.85] | 2014 |
| Salama 2014 | 34 | 40 | 39 | 40 | 8.5% | 6.00 [0.76, 47.60] | 2014 |
| Talluri 2014 | 61 | 75 | 72 | 75 | 13.7% | 4.67 [1.40, 15.57] | 2014 |
| **Total (95% CI)** | | **501** | | **568** | **100.0%** | **3.30 [1.49, 7.31]** | |
| Total events | 432 | | 547 | | | | |

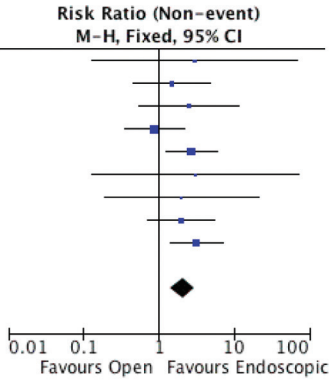
Heterogeneity: $Tau^2 = 0.82$; $Chi^2 = 20.52$, df = 11 (P = 0.04); $I^2 = 46\%$
Test for overall effect: Z = 2.94 (P = 0.003)




## (C) Persistent deviation

| Study or Subgroup | Open Events | Total | Endoscopic Events | Total | Weight | Risk Ratio (Non-event) M-H, Fixed, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Gupta 2005 | 24 | 25 | 25 | 25 | 1.5% | 3.00 [0.13, 70.30] | 2005 |
| Bothra 2009 | 34 | 40 | 36 | 40 | 11.8% | 1.50 [0.46, 4.91] | 2009 |
| Gulati 2009 | 20 | 25 | 23 | 25 | 5.9% | 2.50 [0.53, 11.70] | 2009 |
| Suligavi 2010 | 43 | 50 | 42 | 50 | 23.5% | 0.88 [0.34, 2.23] | 2010 |
| Jain 2011 | 31 | 50 | 43 | 50 | 20.6% | 2.71 [1.25, 5.88] | 2011 |
| Paradis 2011 | 30 | 31 | 32 | 32 | 1.4% | 3.09 [0.13, 73.17] | 2011 |
| Kaushik 2013 | 28 | 30 | 29 | 30 | 2.9% | 2.00 [0.19, 20.90] | 2013 |
| Talluri 2014 | 65 | 75 | 70 | 75 | 14.7% | 2.00 [0.72, 5.57] | 2014 |
| Salama 2014 | 21 | 40 | 34 | 40 | 17.7% | 3.17 [1.41, 7.09] | 2014 |
| **Total (95% CI)** | | **366** | | **367** | **100.0%** | **2.09 [1.44, 3.04]** | |
| Total events | 296 | | 334 | | | | |

Heterogeneity: $Chi^2 = 5.26$, df = 8 (P = 0.73); $I^2 = 0\%$
Test for overall effect: Z = 3.86 (P = 0.0001)




## (D) Septal tear

| Study or Subgroup | Open Events | Total | Endoscopic Events | Total | Weight | Risk Ratio (Non-event) M-H, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Suligavi 2010 | 32 | 50 | 40 | 50 | 31.6% | 1.80 [0.92, 3.50] | 2010 |
| Paradis 2011 | 20 | 31 | 29 | 32 | 10.1% | 3.78 [1.17, 12.28] | 2011 |
| Kaushik 2013 | 27 | 30 | 28 | 30 | 4.8% | 1.50 [0.27, 8.34] | 2013 |
| Talluri 2014 | 51 | 75 | 60 | 75 | 44.8% | 1.60 [0.91, 2.80] | 2014 |
| Sathyaki 2014 | 19 | 25 | 22 | 25 | 8.7% | 2.00 [0.56, 7.12] | 2014 |
| **Total (95% CI)** | | **211** | | **212** | **100.0%** | **1.84 [1.27, 2.68]** | |
| Total events | 149 | | 179 | | | | |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.77$, df = 4 (P = 0.78); $I^2 = 0\%$
Test for overall effect: Z = 3.19 (P = 0.001)

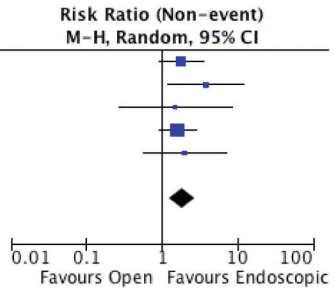



***Figure 3.*** *Forest plots of meta-analyses of complications with open versus endoscopic septoplasty techniques. Outcomes evaluated are intra- and/or postoperative hemorrhage (A), mucosal adhesions and/or synechiae (B), persistent deviation (C), septal tear (D), nasal crusting, persistent spur, infection and/or septal abscess, septal perforation, septal hematoma, external deformity, and recurrence.*

A 2014 study that assessed medical negligence claims in rhinology over a 15-year period within the National Health Service found that septoplasty and functional endoscopic sinus surgery were the most common procedures in successful claims. Therefore, any potential for fewer surgical complications associated with the endoscopic septoplasty technique may be worthwhile in considering and exploring further in future studies.[44] Furthermore, with competency-based education becoming more prominent within medical education, evaluating trainee competency in various approaches to septoplasty will be necessary.[45]

In the study by Paradis and Rotenberg,[30] the endoscopic septoplasty technique was also associated with a significantly shorter operative time (mean difference, 28 minutes). When assuming that these results are generalizable, a shorter operative time with a faster recovery may help offset the higher equipment costs associated with the endoscopic technique.

To date, there exists only a handful of studies that directly compared clinical outcomes of open versus endoscopic septoplasty techniques. As demonstrated in our review, there were only a total of 14 studies (10 RCTs and 4 observational studies) that could be used to quantitatively compare the efficacy and safety of the two techniques. Despite our findings that favored the endoscopic technique for certain measured parameters, the overall quality of included studies was low, which indicated that any conclusions must be made with appropriate discretion. In addition, the open technique may be more appropriate in certain clinical situations, such as caudal septal deviations or severe septal deformities. However, surgeon experience and preference will continue to play an important role in the selection of the septoplasty technique. In moving forward, the distinction of open versus endoscopic septoplasty will likely become blurred. The option of an endoscopically assisted open ("combined") approach may allow surgeons who prefer the open approach to take advantage of some of the possible benefits of endoscopic septoplasty found in this meta-analysis. Furthermore, a combined approach may also allow surgeons to expand the types of septal deformities that are currently addressed endoscopically and allow surgeons to take advantage of the unique benefits that each approach offers.

The greatest limitation of our meta-analysis, as is the case with most meta-analyses, was the significant clinical heterogeneity among studies, including age and variations in practice patterns. Other important limitations included coprocedures (*e.g.*, submucous resection, rhinoplasty) and postoperative procedures (*e.g.*, nasal packing) done at the time of septoplasty, which may have been due to different indications for endoscopic septoplasty than that of open septoplasty, particularly in the presence of posterior deviation or a spur, or when further endoscopic sinus surgery is required. We could not account for these confounders in the meta-analysis because many studies did not quantify coprocedures and postoperative procedures done at the time of septoplasty. This variability, particularly in nonrandomized studies, may have created a selection bias and overestimated the benefits of the endoscopic septoplasty technique.

Furthermore, the variable quality, definitions, and length of follow-up were other critical limitations of the included studies. Importantly, most studies omitted many of our predefined outcomes of interest, thus we had to rely on contacting the authors to obtain significant portions of our data set. Each of the included studies also had a moderate-to-high risk of bias, which could have led to an overestimation of the various treatment effects. Another important limitation of our study was that we did not actively seek to identify studies outside of standard bibliographic data bases and Google Scholar, which potentially missed a number of nonindexed studies. As well, our review included at least two studies that contained adolescents as a subset of the adult population, which could have skewed results because adolescents, for instance, may be more prone to early recovery from surgery.[46]

Future research that evaluates the efficacy and safety of open versus endoscopic septoplasty techniques should take into consideration several study design factors, including randomization, stratification of prognostic variables (*e.g.*, age, sex, severity of septal deviation, comorbidities), and follow-up periods as well as cost-effectiveness. In addition, we recommend that future trials make use of validated disease-specific instruments, such as the Nasal Obstruction Septoplasty Effective scale, the Fairley nasal symptom score, and/or rhinomanometric measurements, to evaluate the objective outcomes of septal surgery.[47–49] It is also important that future studies investigate the role of using a combined septoplasty approach to clarify its role, indications for, as well as possible advantages and disadvantages. This will serve as an opportunity to abridge current evidence gaps by clarifying the true benefits and drawbacks associated with open and endoscopic septoplasty techniques.

## CONCLUSION

Our findings indicated that endoscopic septoplasty may have some advantages over open septoplasty in properly selected patients. However, these findings should be taken with caution, given that the quality of the included studies was low. Well-designed RCTs with adequate power will help to further refine the true efficacy and safety of these surgical techniques.

## REFERENCES


1. Sykes JM, Kim JE, Shaye D, and Boccieri A. The importance of the nasal septum in the deviated nose. Facial Plast Surg 27:413–421, 2011.
2. Fettman N, Sanford T, and Sindwani R. Surgical management of the deviated septum: Techniques in septoplasty. Otolaryngol Clin North Am 42:241–252, viii, 2009.
3. Kawalski H, and Spiewak P. How septum deformations in newborns occur. Int J Pediatr Otorhinolaryngol 44:23–30, 1998.
4. Mladina R, Cujic E, Subaric M, and Vukovic K. Nasal septal deformities in ear, nose, and throat patients: An international study. Am J Otolaryngol 29:75–82, 2008.
5. Holt GR. Biomechanics of nasal septal trauma. Otolaryngol Clin North Am 32:615–619, 1999.
6. Ketcham AS, and Han JK. Complications and management of septoplasty. Otolaryngol Clin North Am 43:897–904, 2010.
7. Gupta N. Endoscopic septoplasty. Indian J Otolaryngol Head Neck Surg 57:240–243, 2005.
8. National Institute for Health Research. PROSPERO—International Prospective Register of Systematic Reviews (2013). Available online at http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42014010730; accessed April 20, 2015.
9. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: A proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA 283: 2008–2012, 2000.
10. Moher D, Liberati A, Tetzlaff J, and Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. J Clin Epidemiol 62:1006–1012, 2009.
11. Mullan RJ, Flynn DN, Carlberg B, et al. Systematic reviewers commonly contact study authors but do so with limited rigor. J Clin Epidemiol 62:138–142, 2009.
12. Jadad AR, Moore RA, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: Is blinding necessary? Control Clin Trials 17:1–12, 1996.
13. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. Ottawa, Ontario: Ottawa Hospital Research Institute, 2003.
14. DerSimonian R, and Laird N. Meta-analysis in clinical trials. Control Clin Trials 7:177–188, 1986.
15. Egger M, Davey Smith G, Schneider M, and Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 315:629–634, 1997.
16. Begg CB, and Mazumdar M. Operating characteristics of a rank correlation test for publication bias. Biometrics 50:1088–1101, 1994.
17. American Academy of Otolaryngology (2015). Deviated Septum. Available online at http://www.entnet.org/content/deviated-septum; accessed April 21, 2015.
18. Siegel NS, Gliklich RE, Taghizadeh F, and Chang Y. Outcomes of septoplasty. Otolaryngol Head Neck Surg 122:228–232, 2000.

19. Orlandi RR. A systematic analysis of septal deviation associated with rhinosinusitis. Laryngoscope 120:1687–1695, 2010.
20. Cantrell H. Limited septoplasty for endoscopic sinus surgery. Otolaryngol Head Neck Surg 116:274–277, 1997.
21. Freer OT. The correction of deflections of the nasal septum with a minimum of traumation. JAMA 38:636–642, 1902.
22. Killian G. Die submucosae Fensterresektion der Nasenscheidewand. Archiv fur Laryngologie und Rhinologie 16:362, 1904.
23. Metzenbaum M. Replacement of the lower end of the dislocated cartilage versus submucous resection of the dislocated end of the septal cartilage. Arch Otolaryngol 9:282–296, 1929.
24. Fomon S, Syracuse VR, Bolotow N, and Pullen M. Plastic repair of the deflected nasal septum. Arch Otolaryngol 44:141–156, 1946.
25. Cottle MH, Loring RM, Fischer GG, and Gaynon IE. The maxilla-premaxilla approach to extensive nasal septum surgery. AMA Arch Otolaryngol 68:301–313, 1958.
26. Maran AG. Septoplasty. J Laryngol Otol 88:393–405, 1974.
27. Nayak DR, Balakrishnan R, and Murthy KD. An endoscopic approach to the deviated nasal septum—A preliminary study. J Laryngol Otol 112:934–939, 1998.
28. Hwang PH, McLaughlin RB, Lanza DC, and Kennedy DW. Endoscopic septoplasty: Indications, technique, and results. Otolaryngol Head Neck Surg 120:678–682, 1999.
29. Bothra R, and Mathur NN. Comparative evaluation of conventional versus endoscopic septoplasty for limited septal deviation and spur. J Laryngol Otol 123:737–741, 2009.
30. Paradis J, and Rotenberg BW. Open versus endoscopic septoplasty: A single-blinded, randomized, controlled trial. J Otolaryngol Head Neck Surg 40(suppl. 1):S28–S33, 2011.
31. Jain L, Jain M, Chouhan AN, and Harshwardhan R. Conventional septoplasty verses endoscopic septoplasty: A comparative study. PJSR 4:24–28, 2011.
32. Gulati SP, Wadhera R, Ahuja N, et al. Comparative evaluation of endoscopic with conventional septoplasty. Indian J Otolaryngol Head Neck Surg 61:27–29, 2009.
33. Dolan RW. Endoscopic septoplasty. Facial Plast Surg 20:217–221, 2004.
34. Gupta M, and Motwani G. Comparative study of endoscopic aided septoplasty and traditional septoplasty in posterior nasal septal deviations. Indian J Otolaryngol Head Neck Surg 57:309–311, 2005.
35. Talluri KK, Motru B, Avvaru K, et al. Correction of deviated nasal septum: Conventional vs endoscopic septoplasty. IOSR-JDMS 13:14–15, 2014.
36. Sathyaki DC, Geetha C, Munishwara GB, et al. A comparative study of endoscopic septoplasty versus conventional septoplasty. Indian J Otolaryngol Head Neck Surg 66:155–161, 2014.
37. Ashour T. Endoscopic septoplasty versus traditional septoplasty. JBMS 22:72–75, 2010.
38. Shahzad A, and Bhawana P. Comparative evaluation of endoscopic septoplasty with conventional septoplasty in deviated nasal septum: A clinical study. JARBS 6:43–47, 2013.
39. Salama MA. Endoscopic aided septoplasty versus conventional septoplasty. WJMS 11:33–38, 2014.
40. Rao M. Is endoscopic septoplasty really superior than conventional septoplasty? National J Otolaryngol Head Neck Surg 1:16–18, 2013.
41. Suligavi SS, Darade MK, and Guttigoli BD. Endoscopic septoplasty: Advantages and disadvantages. AIJCR 3:27–30, 2010.
42. Kaushik S, Vashistha S, and Jain NK. Endoscopic vs conventional septoplasty: A comparative study. AIJCR 6:84–87, 2013.
43. Iqbal SM, Hussain SI, and Bhojani MJ. A comparative study of endoscopic verses conventional septoplasty: An analysis of 110 cases. Pak J Surg 29:220–223, 2013.
44. Geyton T, Odutoye T, and Mathew R. A report on 15 years of clinical negligence claims in rhinology. Am J Rhinol Allergy 28:219–223, 2014.
45. Obeid AA, Al-Qahtani KH, Ashraf M, et al. Development and testing for an operative competency assessment tool for nasal septoplasty surgery. Am J Rhinol Allergy 28:e163–e167, 2014.
46. Shyh-Chang N, and Daley GQ. Lin28: Primal regulator of growth and metabolism in stem cells. Cell Stem Cell 12:395–406, 2013.
47. Stewart MG, Smith TL, Weaver EM, et al. Outcomes after nasal septoplasty: Results from the Nasal Obstruction Septoplasty Effectiveness (NOSE) study. Otolaryngol Head Neck Surg 130:283–290, 2004.
48. Arunachalam PS, Kitcher E, Gray J, and Wilson JA. Nasal septal surgery: Evaluation of symptomatic and general health outcomes. Clin Otolaryngol Allied Sci 26:367–370, 2001.
49. Holmstrom M, and Kumlien J. A clinical follow-up of septal surgery with special attention to the value of preoperative rhinomanometric examination in the decision concerning operation. Clin Otolaryngol Allied Sci 13:115–120, 1988. □