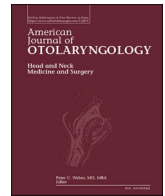




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## Conventional septoplasty complications: A Systematic review and meta-analysis

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### ABSTRACT

**Purpose:** Septoplasty is a commonly performed procedure in otolaryngology. The usual indication is a septal deviation resulting in significant nasal airway obstruction. Although septoplasty is considered a safe technique, some complications can occur. The aim of this investigation was to review and analyze the literature on complications of conventional septoplasty.

**Methods:** A search was run in the PubMed, Scopus, Web of Science databases. To be eligible for this review, a study had to: (i) investigate septoplasty performed on adult patients, (ii) report complications in the short/long period, (iii) be written in English, (iv) be published between January 1, 2017, and May 23, 2022.

**Results:** Ten studies reported quantitative data on post-operative hemorrhage (pooled overall rate [POR] 0.04 [95 % CI, 0.02–0.07]). Twelve investigations were considered for the meta-analysis on septal perforation (POR 0.02 [95 % CI, 0.01–0.04]). Regarding persistent deviation, six studies were eligible (POR 0.13 [95 % CI, 0.07–0.19]). Six papers reported data on post-operative septal hematoma (POR 0.02 [95 % CI, 0.01–0.03]). Finally, six investigations on post-operative synechia were considered (POR 0.04 [95 % CI, 0.00–0.11]). The funnel plots were substantially symmetrical, ruling out any publication bias for all considered complications, except for synechia.

**Conclusions:** Calculation of the occurrence rate of the single complication is useful in clinical practice. Proper pre- and post-operative planning, meticulous attention to anatomy and good visualization during surgery are the keys to a safe and effective septoplasty with a very low complication rate.

### 1. Introduction

Septoplasty is one of the most performed procedures in otolaryngology. The indication for this functional surgery is usually a septal deviation resulting in significant nasal airway obstruction. Septoplasty can also be performed alongside or in addition to rhinoplasty, turbino-plasty, or as part of functional endoscopic sinus surgery to improve surgical exposure and access. Several septoplasty techniques and approaches have been described including intranasal, endoscopic and open procedures [1]. Although septoplasty is considered a safe technique, some complications can occur [2].

Septoplasty's complications can occur immediately after surgery (early complications) or be diagnosed during outpatient check-ups even months after surgery (late complications). In the immediate post-operative period, excessive bleeding and septal hematomas are the most frequent complications, followed by surgical site infections and disorders related to surgical manipulation such as hyposmia, dysgeusia, numbness or hypersensitivity of the upper teeth or lip. Long-term complications can be associated to early ones; sometimes they are related to errors during the surgical procedure. For example, perforations can be due to bilateral and opposing lacerations of the same level of the mucosa. If a perforation occurs at the keystone area, a saddle nose

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deformity may develop [3]. Severe intranasal adhesions (synechiae) can lead to obstruction of the nasal passages. In the long-term, a persistent deviation of the nasal septum, often related to cartilage memory, can be an unfavorable surgical outcome. In such cases a revision procedure should be considered.

The aim of this investigation was to critically review and analyze the last five-year's literature about complications of conventional septoplasty. The incidence of complications, type and causes has been discussed to provide useful information to avoid them.

## 2. Methods

A systematic literature review and meta-analysis were performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement. A literature search for articles published between 2017 and 2022 was run into the following databases: National Library of Medicine (Pub-Med), Scopus, and Web of Science. Three independent investigators (S.F.; S.M.; L.S.) performed a comprehensive search of the source for studies published up to May 23, 2022. The details of the search strategies and results are summarized in Fig. 1.

Early and late complications were studied separately. For short-term septoplasty complications, the following search terms were entered: “septoplasty” OR “nasal septum surgery” AND “complication” AND “bleeding”; OR “septal hematoma”; OR “epistaxis”; OR “infection”; OR “nasal septum abscess”; OR “abscess of nasal septum”. For late complications, the following search terms were chosen: “septoplasty” OR “nasal septum surgery” AND “complication” AND “perforation of the nasal septum”; OR “nasal septum perforation”; OR “nasal septal perforation”; “septoplasty” OR “nasal septum surgery” AND “synechiae”; OR “nasal septum synechiae”; OR “nasal septal synechiae”; OR “synechiae of nasal septum”; “septoplasty” OR “nasal septum surgery” AND “saddle nose”; “septoplasty” OR “nasal septum surgery” AND “persistent deviation”.

### 2.1. Study eligibility criteria

The articles were independently reviewed by three authors (S.M.; S.F.; L.S.). Reviews, meta-analysis, case reports or small case series (<4 cases), books, editorials, notes, conference abstracts, studies conducted on animal models, opinion articles, and articles with unavailable full text were excluded, as well as those with topics not relevant to our research or not in the English language. The following exclusion criteria were therefore applied: age under 18 years old, and oncologic patients. To be eligible for this investigation, a study had to: (i) investigate septoplasty performed on adults, (ii) report complications in the short/long period, (iii) be published between January 1, 2017 and May 23, 2022. Any disagreement between the authors involved in the literature search was resolved through discussion with senior authors (G.B., G.M.) to reach a consensus.

Finally, eligible articles were investigated for septoplasty complications occurrence rate, causes, and prevention.

### 2.2. Statistical analysis

A meta-analysis was performed to evaluate the pooled rate of each specific complication across the considered studies, by using the R *meta* package [R Core Team (2022)].

The complications evaluated with meta-analysis were those described in at least four studies.

The overall effect size (rate of each specific complication) and its 95 % CI were estimated using the inverse variance DerSimonian and Laird's random-effect method applied to the arcsin transformation of the rates. Heterogeneity was assessed by using the tau<sup>2</sup> and I<sup>2</sup> statistics along with the 95 % confidence interval. The I<sup>2</sup> statistic describes the percentage of total variation across studies that is due to heterogeneity rather than chance. A I<sup>2</sup> value of 0 % indicates no heterogeneity, while values around 25 %, 50 % and 75 % may be interpreted as low, moderate and high heterogeneity, respectively [4].

The presence of publication bias was explored by using the funnel plot [5] and the Begg test [6].

### 2.3. Results

Regarding the investigation for septoplasty complications, 222 studies met the inclusion criteria. After applying the appropriate exclusion criteria, 204 studies were excluded. The remaining 18 investigations were included into the following review [Fig. 1].

The features and the main outcomes of the included studies were summarized in Table 1.

### 2.4. Pooled data on complication rates

Ten studies [7–16] reported quantitative data on post-operative hemorrhage. Based on the random effects model, the pooled overall postoperative hemorrhage rate was 0.04 (95 % CI, 0.02–0.07) (Fig. 2A). A large and significant heterogeneity was observed (I<sup>2</sup> = 87 %, 95 % CI: 78 %–92 %,  $P < .01$ ).

Twelve investigations [3,7–14,16–18] were considered for the meta-analysis on septal perforation. Across these studies, the pooled overall septal perforation rate was 0.02 (95 % CI, 0.01–0.04) (Fig. 2B). A large and significant heterogeneity (I<sup>2</sup> = 81 %, 95 % CI: 76 %–89 %,  $P < .01$ ) was found.

Regarding persistent deviation, six studies [8–10,13,16,19] were included in the analysis. The pooled overall persistent deviation rate was 0.13 (95 % CI, 0.07–0.19) (Fig. 2C), and heterogeneity was large and significant (I<sup>2</sup> = 75 %, 95 % CI: 43 %–89 %,  $P < .001$ ).

Six papers [8,9,12,14,15,19] reported data on septal hematoma after conventional septoplasty. Across these studies, the pooled overall rate of this complication was 0.02 (95 % CI, 0.01–0.03) (Fig. 2D). This analysis showed a low and non-significant heterogeneity (I<sup>2</sup> = 25 %, 95 % CI: 0

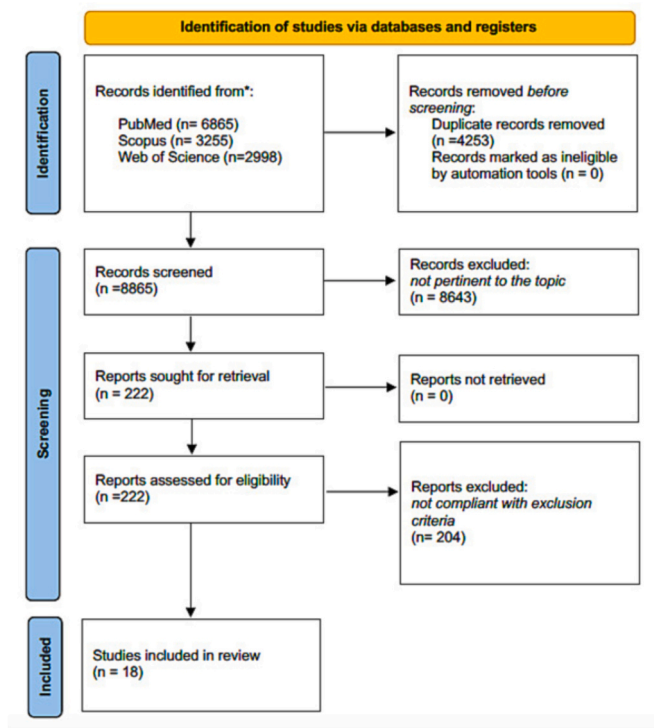


Fig. 1. PRISMA flow diagram summarizing the literature review and inclusion/exclusion process.

**Table 1**  
Summary of features and main results of the included studies.

Authors	Year	No. cases	Concurrent surgery (no. of concurrent procedures)	Maximum follow-up	Clinical assessment	Post-op bleeding no. (%)	Persistent deviation no. (%)	Synechiae no. (%)	Septal perforation no. (%)	Septal hematoma no. (%)	Crusting rhinitis no. (%)	Infection no. (%)	Saddle nose no. (%)
Cetiner [17]	2017	281	No	20 days	ND	ND	ND	ND	9 (3.2)	ND	ND	ND	ND
Dadgarnia [19]	2017	72	No	3 mos	Clinical evaluation	ND	7 (9.7)	1 (1.4)	ND	1 (1.4)	ND	ND	ND
Kurtaran [31]	2017	120	Radiofrequency Concha-plasty (ND)	15 days	Endoscopy	ND	ND	ND	ND	ND	9 (7.5)	ND	ND
Dąbrowska-Bień [7]	2018	5639	Turbinoplasty (2855)	34 mos	Anterior rhinoscopy/endoscopy	188 (3.3)	ND	21 (0.4)	131 (2.3)	ND	ND	178 (3.1)	ND
Kim, Hong et al. [22]	2018	658	No	18 mos	ND	ND	ND	ND	ND	ND	ND	ND	14 (2.1)
Doomra [8]	2019	25	No	3 mos	Anterior rhinoscopy/endoscopy	6 (24.0)	5 (20.0)	5 (20.0)	1 (4.0)	1 (4.0)	4 (16)	ND	ND
Garzaro [9]	2019	147	No	3 mos	Endoscopy	10 (6.8)	18 (12.2)	22 (15.0)	17 (11.6)	4 (2.7)	ND	ND	ND
Kim, Choi et al. [10]	2019	46	Turbinoplasty (46)	13 mos	Endoscopy	0 (0.0)	14 (30.4)	ND	0 (0.0)	ND	ND	ND	0 (0.0)
Zaman [15]	2019	176	No	ND	ND	26 (14.8)	ND	ND	ND	4 (2.3)	ND	ND	ND
Erdivanli [18]	2020	78	No	6 mos	ND	ND	ND	ND	1 (1.3)	ND	ND	ND	ND
Seo [13]	2020	67	Turbinoplasty (67)	6 mos	Endoscopy	0 (0.0)	6 (9.0)	0 (0.0)	0 (0.0)	0 (0.0)	ND	0 (0.0)	ND
Tian [14]	2020	23	No	12–24 mos	ND	2 (8.7)	ND	ND	0 (0.0)	1 (2.2)	ND	ND	ND
Eren [3]	2021	143	Rhinoplasty (100) Turbinoplasty (75)	14 mos	ND	ND	ND	ND	6 (4.2)	ND	ND	ND	ND
Na'ara [11]	2021	30	Turbinoplasty (ND)	3 mos	Endoscopy	1 (3.3)	ND	ND	0 (0.0)	ND	ND	ND	ND
Seghers [12]	2021	534	Rhinoplasty + Turbinoplasty (534)	7 days	ND	15 (2.8)	ND	ND	4 (0.7)	4 (0.7)	ND	ND	ND

ESS: endoscopic sinus surgery; mos: months; ND: no data.

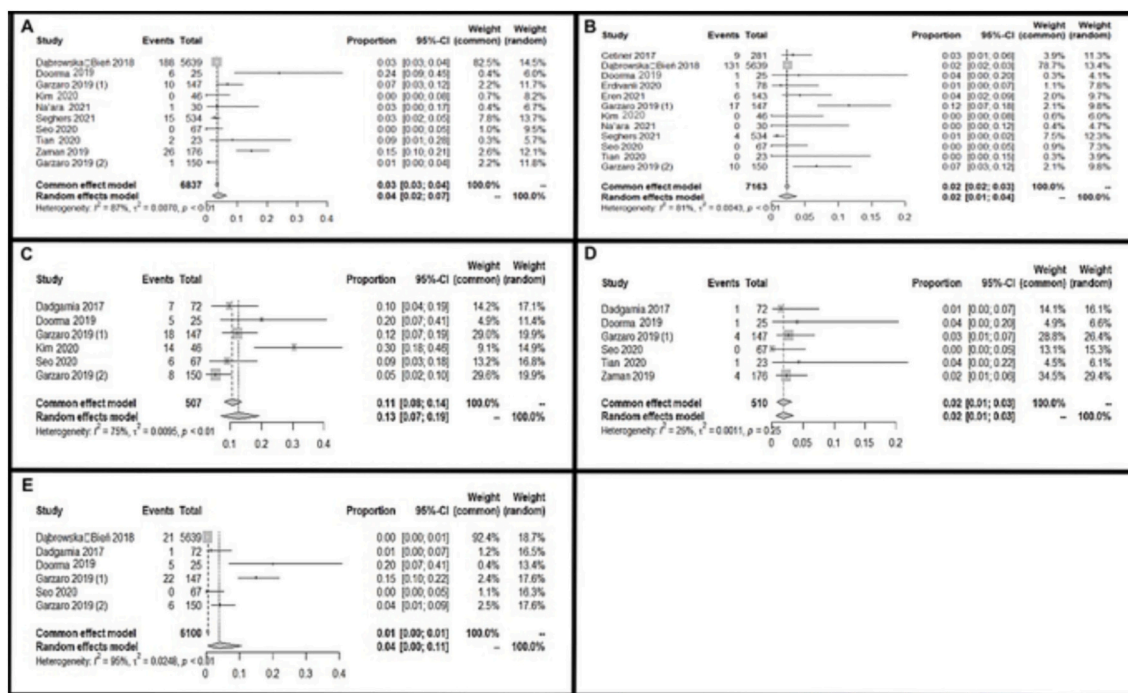


Fig. 2. Forest plots summarizing the pooled overall rate for each of the following complications: A, postoperative hemorrhage; B, septal perforation; C, persistent deviation; D, septal hematoma; E, synechiae.

%–68 %,  $P=.25$ ).

Finally, regarding post-operative synechiae, six investigations [7,19,8,9,13,16] were considered. The pooled overall post-operative synechiae was 0.04 (95 % CI, 0.00–0.11) (Fig. 2E), and heterogeneity was large and significant ( $I^2 = 95 %$ , 95 % CI: 91 %–97 %,  $P<.01$ ).

The funnel plots (Fig. 3A–E) were substantially symmetrical, ruling out any publication bias for all considered complications, except for synechiae, which showed a skewed funnel plot, possibly due to a small-study effect, though not statistically significant.

### 3. Discussion

Nowadays, conventional septoplasty remains the gold standard approach to correct nasal septum deviation and restore nasal patency. However, this surgery is not free from early and late complications that are sometimes disabling for patients' quality of life.

#### 3.1. Early complications

Bleeding or hemorrhage is one of the most common early complications of septoplasty [7] sometimes requiring hospitalization with nasal packing and revision surgery [20]. Hemorrhage between mucosal flaps may cause a septal hematoma that could lead to infection and lyses of the septum [21]. According to this meta-analysis, the pooled overall rate of postoperative bleeding was 4 % (95 % CI, 2–7 %) with a large and significant heterogeneity of the available series. In these series, the surgeons tried to reduce the risk of postoperative bleeding with nasal packing removed on the 1st [7,13,16] or 2nd postoperative day (POD) [12,22], vaseline yarn application [14], or a single intravenous dose of tranexamic acid [15]. Alternatively, transfixated septal sutures were preferred [15,21].

Regarding septal hematoma, the pooled overall rate after septoplasty was 2 % [8,12,14–16,19]. Septal hematoma occurrence usually requires splint removal and revision surgery [7]. In the considered series, the use of a nasal splint was tried to reduce the risk of this complication [7,14,21,22]; the nasal splint was removed at 7 POD [7,22] or at 14 POD [23]. Transfixated sutures with/without silicone splint are alternative

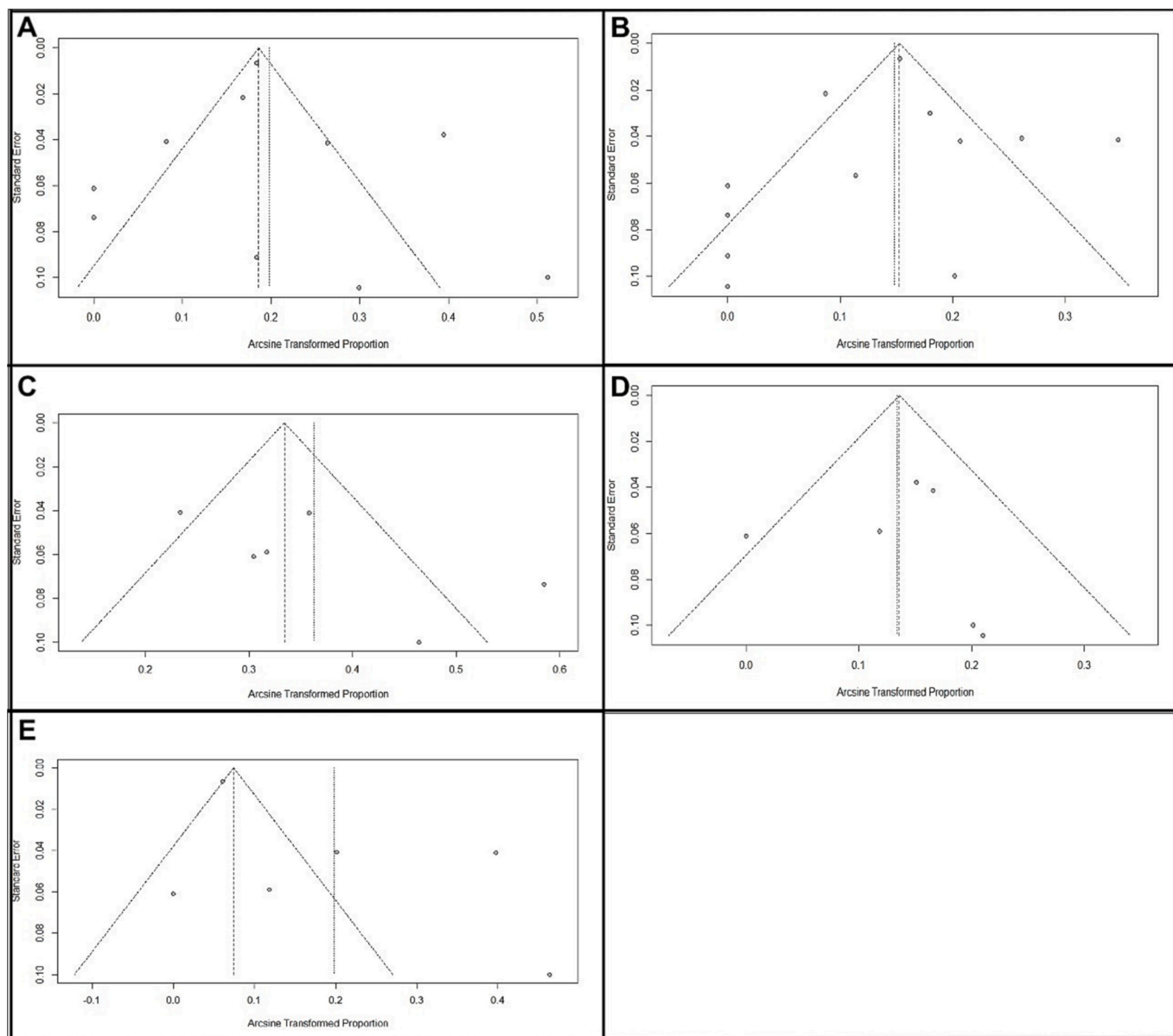
approaches for the prevention of this complication [21].

Although to date only few cases have been described in literature [24], cerebrospinal fluid loss can be regarded as one of the most severe complications of septoplasty. This complication is due to a traumatic manipulation of the perpendicular lamina of the ethmoid and horizontal lamina or *lamina cribrosa ossis ethmoidalis*, leading to a laceration of the *dura mater* with a leakage of fluid through the connection formed between the sub-arachnoid space and nasal cavity [20]. When performing maneuvers on the perpendicular lamina of the ethmoid, it is recommended to preserve a portion of at least 1 cm from the *lamina cribrosa* and to avoid traction maneuvers on the remaining portion to be removed, preferring only rotation maneuvers [21].

Hyposmia is reported as a short-term complication of septoplasty. In a study involving 5639 patients undergoing septoplasty (including 2855 with lower turbinates surgery), Dąbrowska-Bień et al. [7] reported subjective hyposmia lasting >1 week in 3.1 % of cases. Hyposmia was reported more frequently in patients who had undergone turbinoplasty and it resolved spontaneously 2–6 months after surgery. The same authors observed prolonged infection or delayed healing (dryness or excess secretion, congestion, crusting for >1 week) in 3.1 % of their patients. To reduce the risk of this occurrence, appropriate broad-spectrum post-operative antibiotic therapy is advisable, especially in the presence of nasal packing [7], which can potentially lead to bacterial overgrowth [25,26].

#### 3.2. Late complications

Nasal septum perforation is a complete anatomic defect incorporating the mucosa as well as the cartilaginous or osteo-cartilaginous structures. According to this meta-analysis, the pooled overall septal perforation rate after septoplasty was 2 % (95 % CI, 1–4 %), confirming an overall low incidence of such event, which might vary however depending on surgeon's experience and patient's conditions (such as previous surgery, granulomatous disease, etc.). Septal perforations have been classified as small (<0.5 cm), medium (0.5–2 cm), or large (>2 cm) [27,28]. The symptoms can vary in intensity from mild to severe and can affect the quality of life [17,28]. Anterior nasal septum perforations are



**Fig. 3.** Funnel plots ruling out publication biases for each of the following complications ( $p$ -values are based on the Begg test): A, postoperative hemorrhage; B, septal perforation; C, persistent deviation; D, septal hematoma. For synechiae, the funnel plot (E) showed a possible publication bias, due to small-study effect. Dots identify each study's characteristics.

more likely to cause discomfort due to turbulent airflow. Patients may also report dryness, crusting, nasal whistling during breathing, discharge, recurrent bleeding, nasal obstruction, pain, and nose deformity [3,29]. Although posterior perforations are usually asymptomatic, crusting is the most common complaint [28]. Generally speaking, only one third of the nasal septum perforations were symptomatic [3,20], depending on location and size. Mucosal tears on both sides of the septum were the main cause of nasal septum perforations, but also a circulatory defect of the cartilage due to bilateral lifting of the mucoperichondrial flap, due to surgery or septal hematoma formation [3,28]. Intrinsic mucoperichondrium weaknesses caused by septal crest or tightly transfixed sutures and excessive postoperative packaging may also contribute to nasal septum perforations [3,7,17]. Regardless of the cause, when the edges of the nasal septum perforations fail to heal normally, they are covered with an atrophic layer of mucosa, which leads to ongoing crusting and a tendency toward bleeding because of the abnormal airflow forces [3]. The types of surgery, smoking, diabetes mellitus and the presence of allergic rhinitis, the duration of the surgery

and the surgeon's experience did not seem to influence the complication rate [3,12]. Careful and meticulous elevation of the mucosal flaps is the key to prevent this complication as it tries to close any mucosal tears at the end of surgery [7]. Endoscopic and minimal septoplasty aimed to reduce this complication's rate, although they are techniques used only in selected cases, usually simple deviations with modest defects [8,21,30].

The development of intranasal adhesions is a well-known post-operative complication of intranasal surgeries. Typically, synechiae occur between the septum and structures on the lateral wall, especially the inferior turbinate. Considering investigations included in this study, the pooled overall post-operative synechiae rate was 1 % (95 % CI, 0.00–0.01). Intra-operative mucoperichondrial/mucoperiosteal flap tears, concomitant resection of the turbinates, and poor post-operative care leading to excessive crusting are at high risk for synechiae formation. The use of nasal splints has been shown to significantly decrease the risk of synechiae formation with the disadvantage that they can cause discomfort and crusting in the post-surgical period [23]. Nasal



irrigations with saline solutions, which are widely used after endonasal surgery, remove infectious debris and crusts, reducing the likelihood of synechia formation [31]. Recently, Mitomycin-C has been tested to decrease post-operative adhesions after functional endoscopic sinus surgery [32].

### 3.3. Strengths and limitations

The main limitations of this study concern the possible residual between-study and within-study heterogeneity, despite the use of strict inclusion and exclusion criteria, as well as the lack of data on the effectiveness of the clinical practices adopted to avoid complications and the absence of control groups. Investigation's main strength relies in providing a calculation of the occurrence rate of the most common and concerning complication in septoplasty, thus showing a quantitative overview of the safety of such surgical procedure.

### 4. Conclusions

This study provided a quantification of the complication risk related to septoplasty, depicting it as a relatively safe procedure, affected by an overall low risk of short-term complication (about 4 % for hemorrhage, 2 % for post-operative septal hematoma), and long-term sequelae (2 % for septal perforation, 13 % for persistent deviation, 4 % for post-operative synechia).

However, data regarding the efficacy of prophylactic or therapeutic intervention in reducing complication rates are still lacking. To address such issue and improve clinical practice based on evidence, further prospective, controlled studies with larger series are mandatory. In the absence of such data, we should consider that proper pre- and post-operative planning and meticulous attention to detail in identifying the appropriate anatomy and maintaining good visualization during surgery remain the keys to a safe and effective septoplasty with a very low complication rate.

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### CRediT authorship contribution statement

Conceptualization, G.B., G.M.; methodology, G.B., L.F., A.C.F., G.M.; formal analysis, A.C.F.; investigation, G.B., L.F., S.F., S.M., L.S., A.C.F., G.M.; data curation, L.F., S.F., S.M., L.S., A.C.F.; writing—original draft preparation, G.B., L.F., S.F., S.M., L.S., A.C.F., G.M.; writing—review and editing, G.B., L.F., S.F., S.M., L.S., A.C.F., G.M.; visualization, G.B., L.F., S.F., S.M., L.S., A.C.F., G.M.; supervision, G.B., A.C.F., G.M.; funding acquisition, G.M. All authors have read and agreed to the published version of the manuscript.

### Declaration of competing interest

The authors have no conflicts of interest.

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