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Role of Nasal Surgery in Adult Obstructive Sleep Apnea: A Systematic Review

Eduardo J. Correa[1] Diego M. Conti[2] Ramón Moreno-Luna[3] Serafín Sánchez-Gómez[3] Carlos O'Connor Reina[4]

[1] Continuing Education Master's Program in Advanced Rhinology and Anterior Skull Base, Universidad Internacional de Andalucía, Sevilla, Spain
[2] Scientific Expert Team, European Forum for Research and Education in Allergy and Airway Diseases (EUFOREA), Brussels, Belgium

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Address for correspondence Eduardo J. Correa, MD (e-mail: ecorreaorl@gmail.com; coconnor@us.es).

[3] Rhinology and Anterior Skull Base Department, Hospital Universitario Virgen Macarena, Sevilla, Spain
[4] Department of Otorhinolaryngology, Hospital Quirónsalud Marbella, Marbella, Málaga, Spain

Abstract

Objective To perform a systematic review to determine if isolated nasal surgery has any impact on subjective or objective parameters in adult obstructive sleep apnea (OSA) patients.
Materials and Methods From December 2022 to March 2023, we conducted a search on the PubMed, Cochrane, Scopus, and Web of Science databases. Two independent investigators performed a study selection according to the established criteria, as well as data collection, including the study design, the subjective and objective parameters addressed, the type of intervention, and the outcomes, considering the methodological quality and risk of bias.
Results In total, 25 studies met the selection criteria, and they showed that there is a significant improvement in sleep quality, sleepiness, nasal resistance, and snoring after isolated nasal surgery. Still, there is no relevant modification of other polysomnographic parameters. It also reduces the required titration pressures of continuous positive airway pressure (CPAP) and increases the duration of its use.
Conclusion Isolated nasal surgery is not a primary treatment for OSA. Still, it improves the subjective parameters and can lead to CPAP therapy success by enhancing its effectiveness and long-term compliance.

Keywords
- sleep apnea
- obstructive
- nasal obstruction
- sleep apnea syndromes
- nasal surgical procedures
- systematic review

Introduction

Obstructive sleep apnea (OSA) is a prevalent disease that affects between 4% and 30% of the population,[1] and whose importance is related to the consequences on the quality of life and cardiovascular,[2,3] metabolic,[4,5] and neurologic comorbidities.[6]

There are many therapeutic approaches[7,8] to treat OSA; the most relevant is continuous positive airway pressure (CPAP), and the other options include mandibular advancement devices (MADs),[9,10] positional therapy,[11] myofunctional therapy[12–14] and upper airway (UA) surgery.[15–18]

Even though CPAP therapy is the gold-standard treatment, objectively improving OSA parameters and quality of sleep,[19–21] its adherence shows a significant reduction in long-term follow-up, being estimated at around 50% until the end of the first year, according to several studies.[22–25]

The first factor involved in this low adherence rate is related to the mask,[20,21] which is firmly attached to impaired

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nasal function. Of the problems with the mask, nasal symptoms, such as obstruction or trauma to the nostrils or dorsum skin, are reported by ~ 30% to 50% of the patients.[26]

As well as the nose represents around 50% of UA resistance,[27] nasal obstruction has a prevalence close to the 30% in Europe, with its leading causes being Allergic Rhinitis and Chronic Rhinosinusitis,[28,29] which is why different authors have informed about the strong correlation between nasal pathology and a poor quality of sleep.

Given the consequences of nasal insufficiency on sleep and the correlation with low adherence to the CPAP therapy, nasal function acquires a strong relevance for the OSA patient. One may ask if nasal surgery has consequences on OSA, as much on the disease indeed, or secondarily as an adjuvant treatment to improve and strengthen the results and efficacy of other therapies.

The present systematic review aims to identify whether isolated nasal surgery has any impact on subjective or objective parameters in adult OSA patients.

Materials and Methods

We designed a systematic review protocol following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[34] and registered it in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42022385205). The search was conducted from December 2022 to February 2023 on the PubMed (MEDLINE), Scopus, Web of Science, and Cochrane databases. With the objective of including most studies available, the search was designed using the Medical Subject Headings (MeSH) described in ►**Table 1**, and studies written in both English and Spanish were considered.

The search strategy and results are provided as complementary material. After the first search, the results were deduplicated using the SR-Accelerator[35] (Institute for Evidence-Based Healthcare, Bond University, Robina, QLD, Australia), and the selection of studies was performed using the Rayyan (Rayyan Systems Inc., Cambridge, MA, United States) web and mobile app.[36]

The inclusion criteria were: patients over 18 years old, with a diagnosis of anatomical nasal pathology (such as septal deviation, turbinate hypertrophy, nasal polyps, and nasal valve collapse), an objective diagnosis of OSA, who were submitted to an isolated nasal surgical procedure.

We excluded publications with: patients under 18 years of age, subjective OSA diagnosis, nasal surgical procedure not specified, lack of postoperative sleep study, craniofacial malformations, neurological impairment, non-surgical nasal pathologies, and other concomitant UA surgical procedures.

Table 1 Medical subject headings (MeSH) used in the present study.

MeSH
obstructive sleep apnea, *snoring*, *nose surgery*, *rhinoplasty*, *nasal obstruction*, *functional endoscopic sinus surgery*, *septoplasty*, *turbinoplasty*, *nasal valve*, and *turbinectomy*.

The risk of bias quality assessment was made following the Risk of Bias in Non-randomized Studies – of Interventions (ROBINS-I) tool from Cochrane.[37]

Results

After deduplication, 3,405 studies were obtained. Titles and abstract were screened, and studies not related to the research topic were discarded. Of the 63 studies selected for full reading, 38 were discarded for not fulfilling the established criteria (19 on pediatric population, 7 with concomitant pharyngeal surgical procedures, and 12 only with subjective measures), resulting in 25 studies for inclusion in the present review, **with diverse methodological approaches, including 13 prospective studies, 2 retrospective studies, 1 randomized controlled trial, 6 systematic reviews, and 3 bibliographic reviews (►Fig. 1).**

The following data was extracted from the articles: type of study, parameters assessed, intervention, and conclusion, as presented in ►**Table 2**; **the specific outcomes of each study are presented in ►Table 3.**

Discussion

The current scientific literature obtained through our systematic review shows that nasal surgery positively impacts OSA, mainly improving the subjective parameters, but with a non-significant consequence on the apnea-hypopnea index (AHI). The diversity of the parameters informed in the studies does not enables to perform a meta-analysis in the present systematic review.

Nasal Obstruction and Pathophysiology of OSA

During the evaluation of an OSA patient with nasal obstruction, it is important to understand how the affected nose impacts on the lower airway. According to the Starling model theory,[38] during inspiration, an increased resistance at the level of the nose, due to the Bernoulli effect,[39] will favor the collapsibility of the pharyngeal soft tissues. In the normal airway, there will be no collapse, but in OSA patients, after overcoming the critical closing pressure (Pcrit), a partial or total airway collapse will happen.[40,41] This concept enables us to understand the relevance of nasal permeability, which makes us search systematically for pathologies at this level in OSA patients. At the same time, oral breathing due to nasal insufficiency modifies UA dynamics, displacing the mandible, tongue, and soft palate posteriorly, reducing the caliber of the UA.[21,42] As was shown by Fitzpatrick et al.[43] in a randomized study conducted in a healthy population, oral breathing entails an increase in the AHI measured by polysomnography (PSG), compared with nasal breathing during sleep. When these changes present at an early age, maxillomandibular development is affected in the long term, which has been correlated to the onset of OSA in adulthood by other authors[109].

Consequences of Nasal Obstruction on Sleep

Nasal pathology carries an evident implication on the quality of sleep and cognitive functions;[44] it negatively influences the

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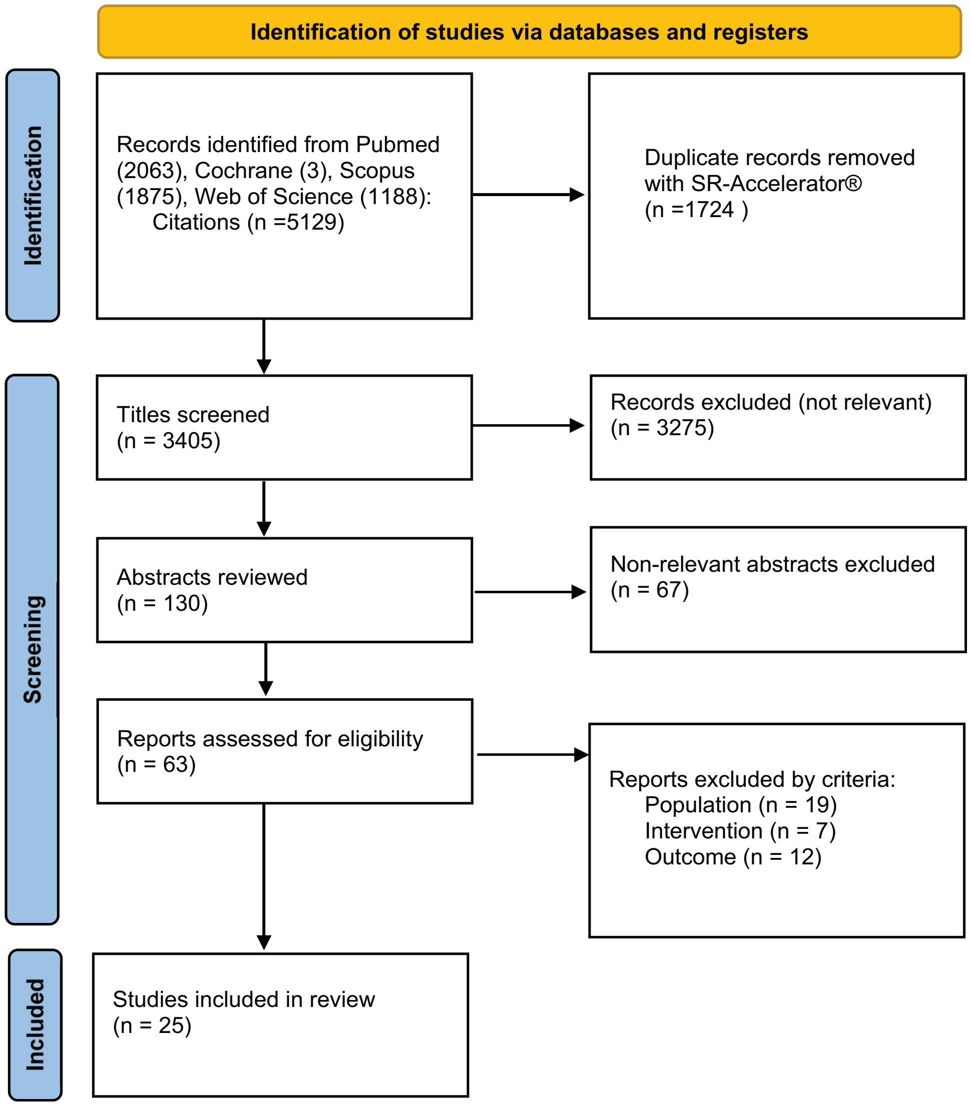

Fig. 1 Process of selection of studies. **PRISMA 2020[34] flow diagram for new systematic reviews, which included searches on databases and registers only.** *Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). **If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools. For more information, visit: http://www.prisma-statement.org/.

objective parameters in sleep studies[45–47] and constitutes a relevant factor for CPAP intolerance.[48] Already in 1986, Suratt et al.[49] found that exposing a healthy population to nasal obstruction by packing the nose with a gauze soaked in petrolatum led to an increased AHI. Following the same line of thought, in 1997, Young et al.[50] proposed chronic nasal congestion as a risk factor for OSA, after identifying through questionnaires a correlation between the frequency of nocturnal nasal congestion and snoring in 4,927 patients. Therefore, a correlation between nasal resistance and adherence to CPAP therapy has been shown,[51] as in the publication by Sugiura et al.,[52] in which 77 OSA patients were prescribed CPAP therapy with a nasal mask. The authors[52] found that high nasal resistance, assessed objectively through rhinomanometry, was statistically correlated as a predictor of low adherence to CPAP.

Nasal Surgery and OSA

The most performed nasal surgical procedures, as described in the included studies, are septoplasty, with or without concomitant turbinoplasty or turbinectomy, rhinoseptoplasty, and endoscopic sinus surgery (ESS). The role of nasal surgery on OSA has been questioned for many years, such as in early publications by Fairbanks[53] (1985), who found an improvement in snoring of 77% among OSA patients who underwent septoplasty with turbinoplasty.

Several authors[54,55] have addressed the consequences of nasal surgery for obstructive anatomical diseases (septal deviation, turbinate hypertrophy, nasal polyps), measuring subjective and objective parameters, such as sleepiness through the Epworth Sleepiness Scale,[56] sleep quality through the Visual Analog Scale on Quality of Sleep (VAS-QS), nasal resistance by rhinomanometry, and the

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Table 2 Studies included in the systematic review.

Author		Year	Type of study	Parameters	Intervention	Conclusion
Friedman et al.[78]		2000	Prospective ($n=50$)	PSG, use of CPAP	SP with or without TP	98% improved nasal breathing; 34% improved snoring; no changes in AHI; reduces CPAP titration pressures
Verse et al.[54]		2002	Prospective ($n=26$)	Epworth, rhinomanometry, PSG	SP with/without TP, RSP, nasal valve surgery	Improved Epworth and nasal resistance; no significant changes in AHI
Kim et al.[58]		2004	Retrospective ($n=21$)	PSG	SP with or without TX	19% improved PSG parameters
Virkkula et al.[65]		2006	Prospective ($n=40$)	Rhinomanometry, PSG	SP with or without TX, RSP	Improved nasal resistance; no significant changes in snoring
Nakata et al.[59]		2008	Prospective ($n=49$)	Epworth, rhinomanometry, PSG	SP with or without TX, ESS	Improved Epworth and nasal resistance; no significant changes in AHI
Li et al.[55]		2008	Prospective ($n=51$)	Epworth, SF-36, SOS	SP + Nasal valve surgery	Improved quality of sleep, quality of life and snoring
Koutsourelakis et al.[57]		2008	Randomized controlled trial ($n=49$)	Epworth, rhinomanometry, PSG	SP with or without TP	Improved Epworth and nasal resistance; No changes in AHI
Tosun et al.[60]		2009	Prospective ($n=27$)	VAS-QS, Epworth, rhinomanometry, PSG	ESS	Improved quality of sleep, Epworth and nasal resistance; No significant changes in AHI
Li et al.[62]		2009	Prospective ($n=66$)	Epworth, PSG	SP + TX	Improved Epworth and snoring; No significant changes in AHI
Bican et al.[63]		2010	Prospective ($n=20$)	Epworth, PSG	RSP, nasal valve surgery	Improved Epworth (higher in CPAP users) and sleep architecture; no significant changes in AHI
Choi et al.[64]		2011	Prospective ($n=22$)	Epworth, PSG	SP with or without TP, ESS	Improved Epworth and sleep architecture; no significant changes in AHI
Sufioğlu et al.[79]		2012	Prospective ($n=28$)	Epworth, VAS-QS, PSG, CPAP titration	SP with or without TP, RSP, TP, ESS	Improved Epworth, quality of sleep and CPAP titration pressures; no changes in AHI
Poirier et al.[82]		2014	Prospective ($n=18$)	NOSE, use of CPAP	SP + TP	Improved nasal obstruction and CPAP adherence
Park et al.[61]		2014	Prospective ($n=25$)	VAS-NO, Epworth, Acoustic Rhinometry, WatchPAT device	SP with or without TP	Improved Epworth, nasal obstruction, and resistance; improved AHI in 56%
Ishii et al.[72]		2015	Sytematic review and meta-analysis (10 studies)	Epworth, PSG	Isolated nasal surgery	Improved Epworth (3.3 points) and Respiratory Disturbance Index (11.06); no significant changes in AHI
Mickelson[76]		2016	Bibliographic review	Epworth, PSG, and use of CPAP	Nasal surgery (not specified)	Improved CPAP adherence

(*Continued*)

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Table 2 (*Continued*)

Author		Year	Type of study	Parameters	Intervention	Conclusion
Wu et al.[70]		2017	Sytematic review and meta-analysis (18 studies)	Epworth, PSG	Isolated nasal surgery	Improved Epworth; no significant changes in AHI
Sukato et al.[69]		2018	Systematic review (7 studies)	Epworth, PSQI, SNOT-22, PSG	ESS	Improved Epworth, PSQI, and SNOT-22; no changes in AHI
Sharma et al.[73]		2019	Systematic review (16 studies)	Epworth, PSG	Isolated nasal surgery or combined multilevel	Improved Epworth (3.9 points), AHI (10.6 points) and Respiratoy Disturbance Index[4,6]
Wang et al.[71]		2019	Sytematic review and meta-analysis (19 studies)	Epworth, PSG	Isolated nasal surgery	OSA subgroup improved Epworth; non-OSA subgroup without changes; no changes in AHI in either group
Iwata et al.[80]		2020	Retrospective ($n = 86$) with control group	Epworth, rhinomanometry, PSG	SP + TX	Improved sleepiness and nasal resistance; no changes in AHI; improved CPAP adherence
Cai et al.[77]		2020	Bibliographic review	QoL, CPAP tolerance	SP, TP, RSP, ESS	Improved sleepiness, snoring, quality of sleep and CPAP adherence
Kim et al.[103]		2021	Prospective ($n = 25$)	VAS-NO, Epworth, PSG	SP + TP	Improved Epworth and nasal obstruction (more in allergic rhinitis group); no significant changes in AHI
Schoustra et al.[67]		2022	Systematic review (21 studies)	Epworth, PSG	Isolated nasal surgery	Improved Epworth; no significant changes in AHI
Newsome[68]		2023	Review	AHI	SP with or without TP, RSP	RSP may improve AHI in mild OSA; SP inconsistent

Abbreviations: AHI, apnea-hypopnea index; CPAP, continuous positive airway pressure; ESS, Endoscopic sinus surgery; NOSE, Nasal Obstruction Symptom Evaluation; PSG, polysomnography; PSQI, Pittsburg Sleep Quality Index; QoL, quality of life; RSP, rhinoseptoplasty; SF-36, 36-item Short-Form Health Survey; SNOT-22, 22-item Sinonasal Outcome Test; SOS, Snore Outcome Survey; SP, septoplasty; TP, turbinoplasty; TX, turbinectomy; VAS-NO, Visual Analog Scale on Nasal Obstruction; VAS-QS, Visual Analog Scale on Quality of Sleep.

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Table 3 Outcomes assessed by each study included.

Outcomes											
Author		Subjective				Objective					
		Nasal obstruction	Sleepiness (Epworth Sleepiness Scale)	Quality of sleep	Quality of life	Nasal resistance	Snoring	AHI	Sleep architecture	CPAP use	CPAP titration pressure
Friedman et al.[78]		Yes	No	No	No	No	Yes	Yes	No	No	Yes
Verse et al.[54]		No	Yes	No	No	Yes	No	Yes	No	No	No
Kim et al.[58]		No	No	No	No	No	No	Yes	No	No	No
Virkkula et al.[65]		No	No	No	No	Yes	Yes	No	No	No	No
Nakata et al.[59]		No	Yes	No	No	Yes	No	Yes	No	No	No
Li et al.[55]		No	No	Yes	Yes	No	Yes	No	No	No	No
Koutsourelakis et al.[57]		No	Yes	No	No	Yes	No	Yes	No	No	No
Tosun et al.[60]		No	Yes	Yes	No	Yes	No	Yes	No	No	No
Li et al.[62]		No	Yes	No	No	No	Yes	Yes	No	No	No
Bican et al.[63]		No	Yes	No	No	No	No	Yes	Yes	No	No
Choi et al.[64]		No	Yes	No	No	No	No	Yes	Yes	No	No
Sufioğlu et al.[79]		No	Yes	Yes	No	No	No	Yes	No	No	Yes
Poirier et al.[82]		Yes	No	No	No	No	No	No	No	Yes	No
Park et al.[61]		Yes	Yes	No	No	Yes	No	Yes	No	No	No
Ishii et al.[72]		No	Yes	No	No	No	No	Yes	No	No	No
Mickelson[76]		No	No	No	No	No	No	Yes	No	Yes	No
Wu et al.[70]		No	Yes	No	No	No	No	Yes	No	No	No
Sukato et al.[69]		No	Yes	Yes	Yes	No	No	Yes	No	No	No
Sharma et al.[73]		No	Yes	No	No	No	No	Yes	No	No	No
Wang et al.[71]		No	Yes	No	No	No	No	Yes	No	No	No
Iwata et al.[80]		No	Yes	No	No	Yes	No	Yes	No	Yes	No
Cai et al.[77]		No	Yes	Yes	No	No	Yes	No	No	Yes	No
Kim et al.[103]		Yes	Yes	No	No	No	No	Yes	No	No	No
Schoustra et al.[67]		No	Yes	No	No	No	No	Yes	No	No	No
Newsome[68]		No	No	No	No	No	No	Yes	No	No	No

Abbreviations: AHI, apnea-hypopnea index; CPAP, continuous positive airway pressure.

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AHI through PSG, each of them collected before the surgical procedure and after two to six months of follow-up, depending on the study. All of the authors homogeneously reported a significant improvement in the subjective measures after nasal surgery, but no statistically significant differences in the AHI.

A relevant randomized controlled trial was published by Koutsourelakis et al.[57] in 2008. In this study, 49 OSA patients with nasal obstruction due to septal deviation were randomly assigned to the surgical group or the control group, which was blinded for the patients and nursing staff, including the postoperative care. The authors[57] reported improved sleepiness and nasal resistance in the surgery group, with no changes among the controls. On the other hand, the AHI showed no differences in either group, and the authors concluded that nasal surgery by itself is ineffective to treat OSA; however, it can benefit the patients and must be considered in the therapeutic plan. In 2004, Kim et al.[58] reached the same conclusion, that this therapeutic approach benefits some patients, but a pharyngoplasty must be considered for a second surgical stage. This concept is supported by the findings of other studies.[59–62] Other authors[63,64] have informed not only an improvement in sleepiness but also in sleep quality and its architecture, measured by PSG. Nevertheless,the AHI remained with the same values as in the preoperative measure.

On the other hand, Virkulla et al.[65] and Kalam[66] informed no changes in the snoring parameters after nasal surgery. Despite this, there are few publications showing no impact of nasal surgery on the assessed parameters.

Several reviews showed an improvement of the subjective parameters after nasal surgery, with no relevant changes regarding the AHI, such as the ones published by Schoustra et al.[67] and Newsome.[68] Sukato et al.[69] reported a substantial improvement in nasal symptoms and sleep quality after surgery for chronic rhinosinusitis, although there was a slight decrease in the AHI. Similar results were reported by Wu et al.[70] and Wang et al.,[71] who highlighted that isolated nasal surgery improved sleepiness and the AHI, but the latter with scarce significance.

Ishii et al.[72] focused on the role of isolated nasal surgery in their meta-analysis published in 2015, which included ten studies. They identified an improvement in the Epworth Sleepiness Scale and Respiratory Disturbance Index (RDI) after surgery, but without significant changes in the AHI.

In a systematic review, Sharma et al.[73] compared isolated or combined nasal surgery and no surgical therapies or non-rhinological surgical procedures as a treatment for OSA. They concluded that isolated nasal surgery could benefit OSA patients despite not being a primary treatment for this disease, but an adjuvant to improve CPAP adherence and lower the associated symptoms.

The literature found shows a substantial improvement in subjective parameters in OSA patients after nasal surgery, with no significant changes in the objective PSG parameters.

Nasal Surgery and CPAP Therapy

Even with the technological advances in OSA diagnosis and treatment,[21] such as the development of smaller and more portable equipment, a reduction in the high rate of CPAP dropout has not been achieved yet,[74] and problems with the mask, such as the nasal symptoms reported by 30% to 50% of the patients,[26] are the first cause of lack of adherence.

Considering that CPAP therapy is the gold-standard treatment for OSA, in 2015, Camacho et al.[75] published a systematic review in which they evaluated the effects of nasal surgery, as an isolated treatment, on CPAP use and adherence, as well as the consequences on the required titration pressures. Their analysis[75] showed that 89.1% of patients who did not tolerate CPAP or refused to use it, adapted and became adherent after the surgery. In addition, they informed an increase in the daily use of CPAP (from 3.0 to 5.5 hours/day on average) in the 6-month follow-up. This can be explained by another relevant finding in this revision: CPAP titration pressure was statistically reduced by an average of 2.66 cm H_2O.

At the same time, Mickelson[76] reported that the initial CPAP adherence rate among their OSA patients was of around 40%, but nasal surgery reduced the required titration pressures and improved adherence. Similar findings were described in the bibliographic review by Cai et al.[77] in 2020, who concluded that nasal surgery improves sleepiness, snoring, and sleep quality in OSA patients, as well as CPAP adherence.

In 2000, Friedman et al.[78] found that 50 OSA patients required lower pressure in the postoperative CPAP titration after nasal surgery, without distinction regarding the severity of OSA. This improvement was also more significant in the subgroup with severe OSA, even while not showing a statistically significant reduction in the AHI. In 2012, Sufioğlu et al.[79] also reported that CPAP titration pressure was significantly lowered after nasal surgery, which supports the concept of considering nasal surgery an option to improve CPAP adherence.

Iwata et al.[80] compared a group of 43 OSA patients who were intolerant to CPAP, treated with septoplasty and turbinoplasty, and a control group with similar anthropometric characteristics who underwent no intervention. Nasal resistance and sleepiness were reduced in the surgical group, with no relevant changes in the AHI. The most remarkable finding of this study[80] is that 40 of the 43 surgical patients could adapt to the CPAP therapy after the procedure, and that the remaining 3 patients fulfilled OSA cure criteria. This study[80] concluded that despite the fact that nasal surgery could not alter objective PSG parameters, its consideration is relevant for OSA patients to adapt to CPAP therapy.

In 2022, Brimioulle and Chaidas[81] concluded that low nasal resistance correlates with higher CPAP adherence rates, and they identified a beneficial effect of nasal surgery on the use of CPAP. At the same time, they found that CPAP can produce a local inflammatory reaction, thus increasing nasal symptoms, but this does not significantly affect nasal resistance. Similar findings were reported by Poirier et al.,[82] who found a subjective improvement on the Nasal Obstruction

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Symptom Evaluation (NOSE) scale,[83,84] as well as an increase in the hours of use of CPAP.

Isolated nasal surgery may not be considered a primary treatment for OSA, but should be offered to those CPAP intolerant patients, aiming to improve adherence.

Phenotyping OSA Patients

Different phenotypes are recognized in OSA, revealing the heterogeneity of its pathophysiology, such as low arousal threshold, high loop gain, low muscle effectiveness,[85] and anatomical anomalies.[86–88] This encourages the identification of the factors presented by each patient, with the main objective of providing a personalized approach.

The assessment of an OSA patient during surgical planning requires drug-induced sleep endoscopy (DISE),[89] through which the collapse pattern is identified and recognized, to offer an adequate and tailored surgical procedure.[90–93] Even though surgery in the nose decreases its resistance and improves its function, the effects on the collapse pattern at other levels (pharynx or larynx) show contradictory results. Victores and Takashima[94] compared the DISE findings before and after nasal surgery on 24 patients, reporting that the procedure did not modify the collapse pattern in OSA. On the other hand, Bosco et al.[95] reported significant changes after nasal surgery in the pharyngeal collapse pattern during DISE, concluding that a new assessment is required before a second pharyngeal surgical stage.

Allergic rhinitis is an influential factor both in terms of nasal symptoms and CPAP therapy failure, and it can be found in $\sim$ 30% of the general population,[96,97] with the rates in some series rising to 60%.[98] The scientific literature exposes in different studies the impact of allergic disease on the quality of sleep[99,100] and, in objective sleep studies parameters, with impaired self-reported sleep questionnaires and increased AHI.

Considering that topical nasal steroid therapy is the first line of treatment for AR, Charakorn et al.[101] reported that, although this treatment was correlated with a slight benefit in the use of CPAP, there was no statistically significant difference in the time of use of CPAP or the nasal symptoms between the therapy and control groups. Meen and Chandra[102] compared the medical and surgical treatments for OSA, concluding that pharmacological therapy can improve sleep quality and snoring, but has no impact on the AHI.

In 2021, Kim et al.[103] reported that OSA patients subjected to isolated nasal surgery presented postoperative improvement on the 6-month follow-up. The authors[103] identified a success rate of 14.3% in the surgical group, but in the subgroup of patients with diagnosed AR (measured by history, prick test, and serum immunoglobulin E, IgE), that rate was increased to 50%, and they concluded that concomitant AR affects the surgical results.

We must take into consideration that AR diagnosis is mandatory in every patient candidate to nasal surgery, as it is correlated with a poor quality of sleep, and it also impacts the surgical outcomes.

Unsatisfactory Surgical Outcomes

Finally, some patients refer no improvement in their nasal breathing after surgery, despite their postoperative endoscopy evidencing a satisfactory outcome with objective permeability. Breathing dysfunction is estimated to affect 9,5% of the general population.[104] It has been correlated with OSA pathophysiology, specifically with reduced ventilatory control stability, and an elevated loop gain,[105] a non-anatomical contributor trait to OSA.[106]

Although the literature regarding functional breathing evaluation in OSA patients is still scarce, Messineo et al.[107] have published a simplified breath-holding maneuver to be performed in the office, demonstrating a strong correlation between ventilatory response during wakefulness and the estimation of a high loop gain.[108]

We must consider breathing dysfunction an underlying factor in patients with no improvement after nasal surgery. They may be candidates for breathing therapies, which have shown promising outcomes and may benefit our unsatisfied patients in terms of restoring nasal breathing.[104]

To approach an OSA patient with a nasal obstruction focusing only on surgical pathology is a failure, as we must take into consideration functional factors, such as low muscle effectiveness, high loop, AR, and breathing disfunction.

Final Considerations

All of the studies included in the present review used the AHI as the objective OSA diagnostic and follow-up parameter. Nevertheless, recent advances in the knowledge regarding the pathophysiology of OSA have enabled the establishment of new indicators of severity, such as the body mass index, cardiovascular comorbidities, and the time spent with oxygen saturation below 90% (CT90), which have been included in the latest international consensus.[7] Thereby, we consider that further investigation must be performed, including all of these parameters by standard, for a more comprehensive approach to the OSA patient.

The nose plays a vital role in respiratory physiology and the pathogenesis of UA obstruction. The scientific literature has widely shown the negative impact of nasal obstruction on the quality of sleep and OSA severity. During the evaluation of an OSA patient, both anatomical and functional assessments are of radical relevance, as is the knowledge of all the therapeutic strategies. To date, it is inadmissible to prescribe CPAP therapy without prior UA evaluation.

Although non-surgical therapy has been shown to improve the symptoms of OSA patients, it does not have a place in the primary treatment of OSA. At the same time, surgical treatment has been demonstrated to widely improve the quality of sleep and associated symptoms, although the benefits on the PSG parameters are not statistically significant. To date, it has not been shown that nasal surgical treatment can objectively benefit OSA patients. Nevertheless, the available literature strongly indicates that nasal surgery significantly improves CPAP adherence, even in patients who are reluctant to begin the therapy.

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Conclusion

Isolated nasal surgery is not a primary treatment for OSA, but it improves the subjective parameters of quality of sleep and sleepiness, and it also reduces nasal resistance and snoring, with no significant changes in objective PSG parameters. At the same time, it reduces the required CPAP titration pressures and increases its time of use, improving the adherence to and effectiveness of this therapy.

Isolated nasal surgery does not critically modify the evolution of this disease. Still, it can lead to the success or failure of the CPAP therapy by increasing its effectiveness and long-term compliance, thereby finding its role as an adjuvant of isolated nasal surgery. In OSA, the recommendation of nasal surgery will be offered to a patient with a suboptimal use of CPAP, or whose titration pressure is too high. Given the high abandonment rate of CPAP, we must prioritize a correct evaluation and treatment of the nose as a first stage before starting the CPAP therapy.

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