Keeping your Nose Clean: Implications in OSA Management

Daniel O’Brien MD, MAS, FARS, FRCSC

Disclosures

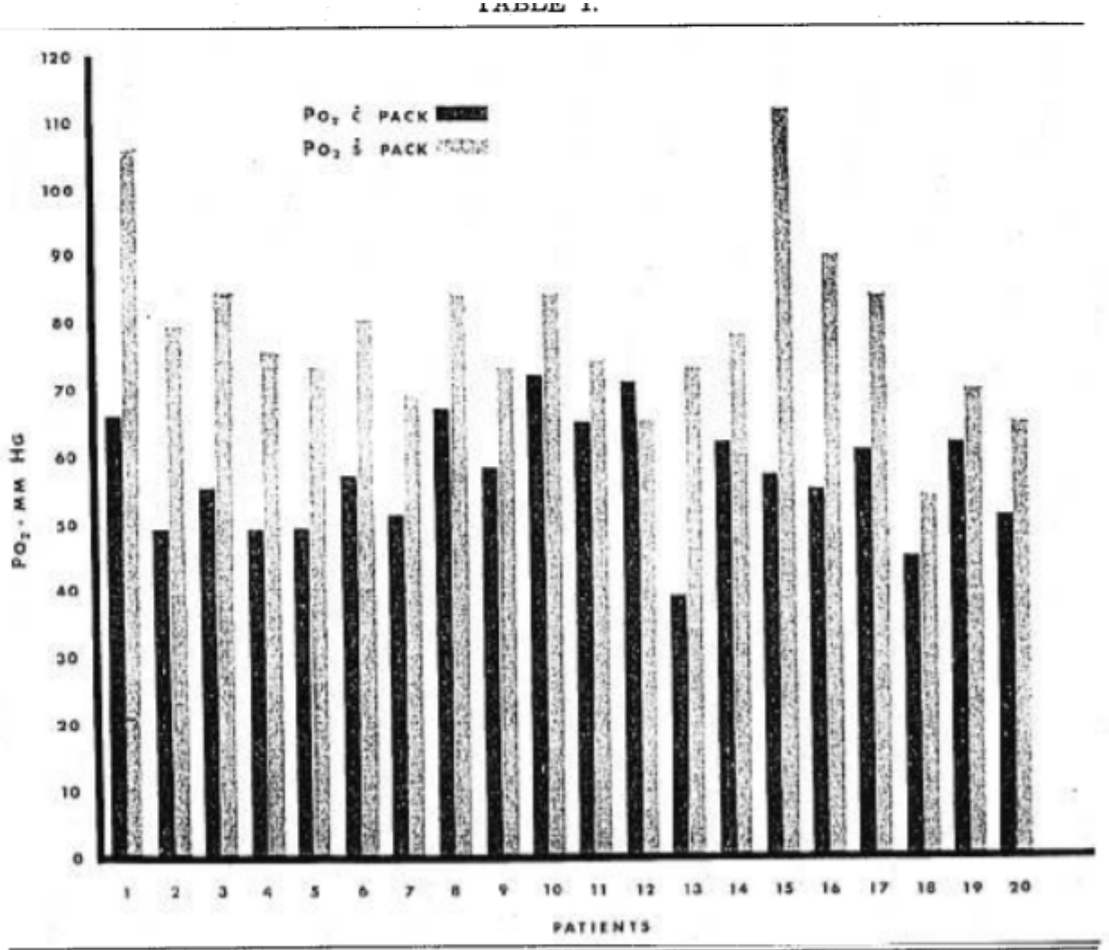
- None currently, or relevant to the topic

Nose and Sleep Apnea

Iatrogenic Nasal Obstruction and Death

Table 1. Polysomnography in epistaxis patients

Patient/age	AHI-1	AHI-2	Lowest SaO2-1	Lowest SaO2-2
JR/57	106	8	83%	88%
RA/53	83	71	74%	86%
JP/64	64	81	17%	67%
HR/88	60	18	90%	91%
DB/60	55	25	85%	88%
DR/65	50	4	73%	82%
QF/65*	35	—	65%	—
CG/55	34	11	85%	91%
CP/60*	39	—	85%	—
RP/46	37	1	91%	90%
HY/38	18	11	86%	90%
HM/46	10	7	90%	90%
Mean age/56	49	24	77%	86%
Paired-*t* test		0.02		0.09 (NS)



The PO_2 values with and without the nasal packing. The PO_2 rose in all patients except No. 12 after the pack was removed.

Does improving nasal obstruction cure sleep apnea?

Does improving nasal obstruction cure sleep apnea?

NO

Can improving nasal obstruction improve sleep apnea management?

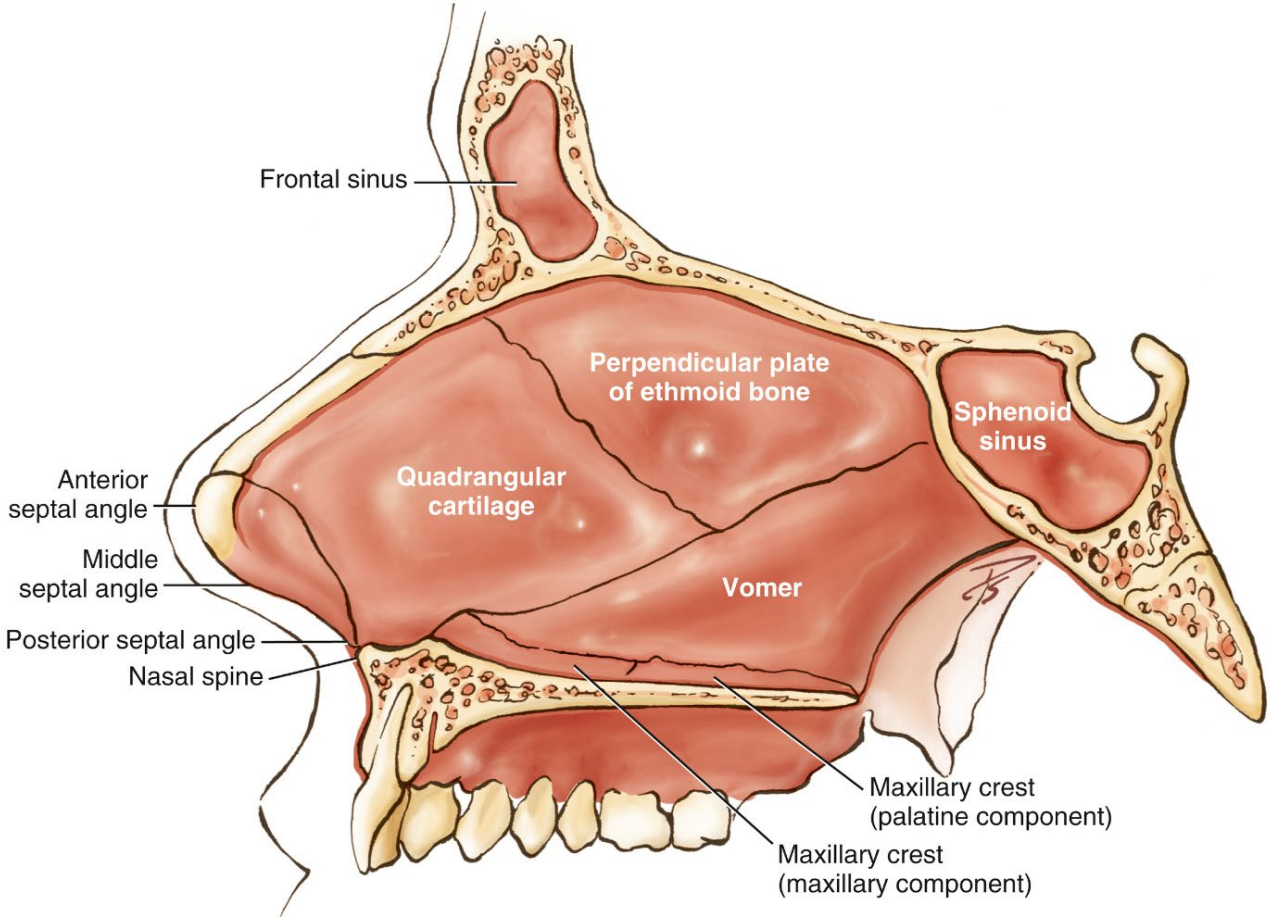
Can improving nasal obstruction improve sleep apnea management?

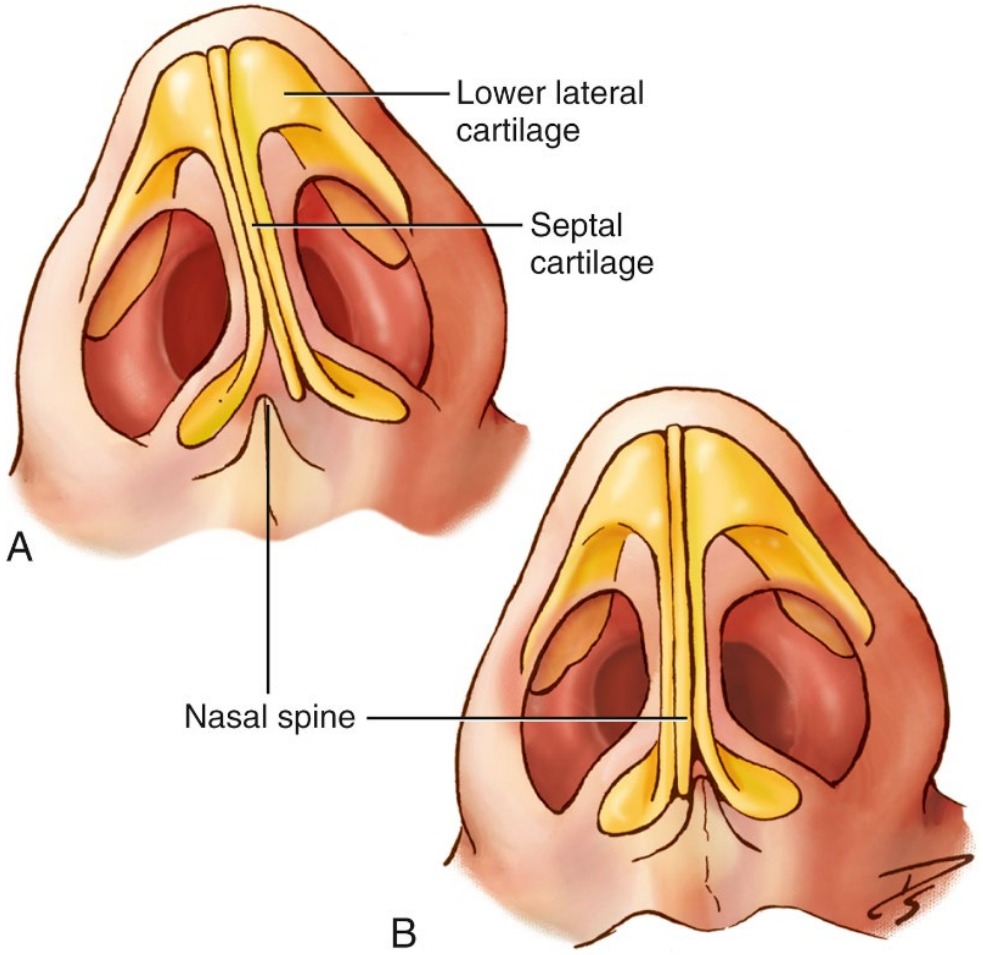
Yes

Can improving nasal obstruction improve sleep apnea management?

Yes?

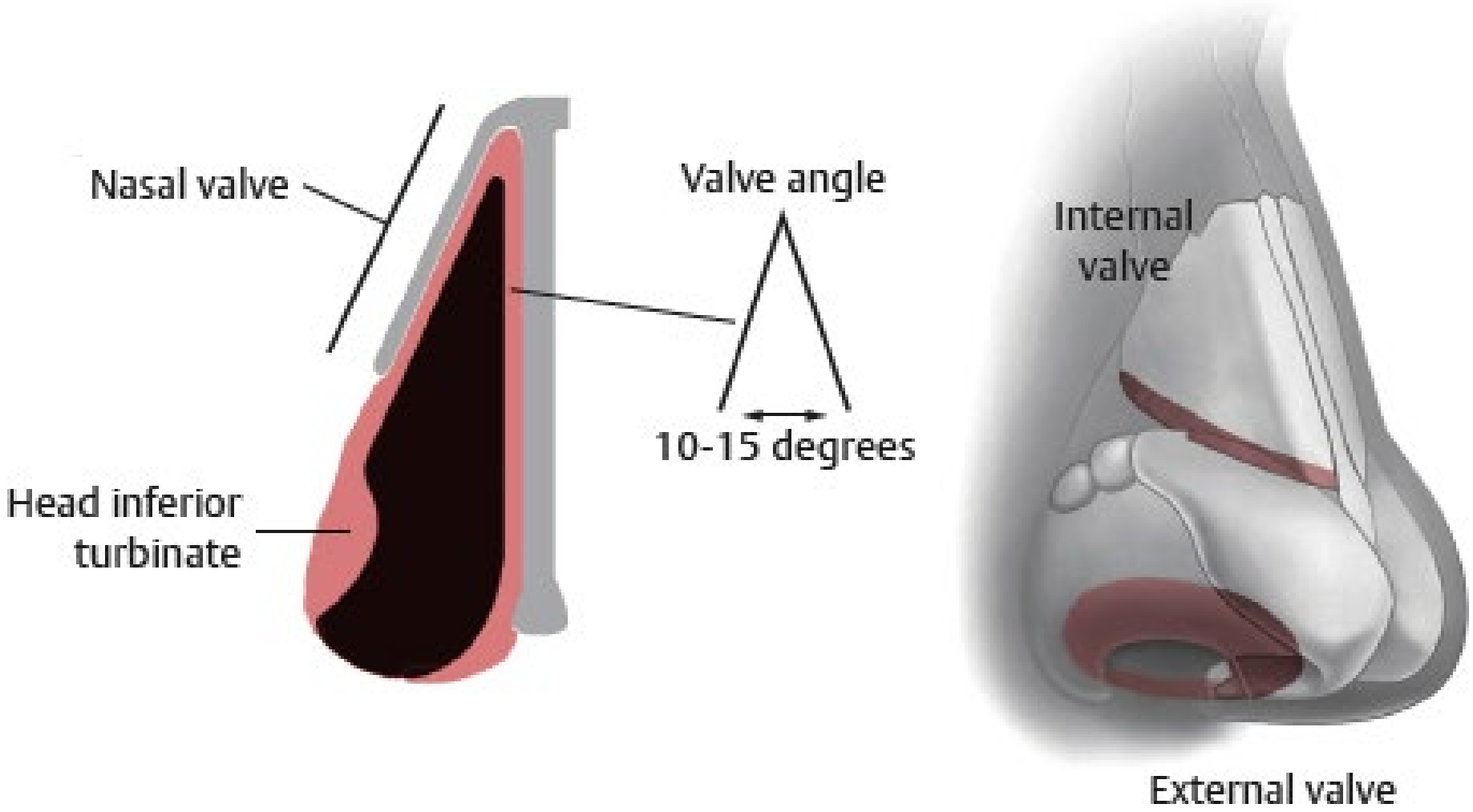
Nasal Anatomy





Nasal Anatomy

Internal & External Nasal Valve



Medical Therapy and Nasal Obstruction/Sleep

Authors	Treatment	Control	Posttreatment	Comments
Acar et al	Mometasone furoate and/or desloratidine	AHI 28, ESS 10	AHI 26.5[a], ESS 6[a]	Data given as median and interquartile range
An et al	Oxymetazoline	AHI 31.65, MinSaO$_2$ 95.6	AHI 22.64[a], MinSaO$_2$ 96[a]	
Braver et al	Oxymetazoline	AHI 34.4	AHI 34.2	Only 10 patients (AHI $\geq$ 5) were included in the review and analysis out of the total of 20 patients
Clarenbach et al	Xylometazoline	AHI 33.2, ODI 30.1	AHI 29.3, ODI 23.8	Significant effect when controlled for maximal effect of decongestant
Kiely et al	Fluticasone	AHI 30.3	AHI 23.3[a]	Data given as median and interquartile range
Koutsourelakis et al	Tramazoline HCl + dexamethasone	AHI 31.1, ESS 9.9	AHI 25.0[a], ESS 8.9	No standard deviation given for posttreatment
Lavigne et al	Mometasone	AHI 28.4, ESS 11.4	AHI 22.4[a], ESS 9.52[a]	Data reported in 2 groups (allergic vs nonallergic patients)
Wijesuriya et al	Phenylephrine	AHI 62.02	AHI 55.66	Tetraplegic patients

Influence of postural changes on nasal resistance in patients with obstructive sleep apnea

	Control ($n=26$)	OSAsNO ($n=38$)	OSAwNO ($n=34$)
Sex (male/female)	12/14	34/4*	29/5*
Age (years)	31.7 ± 7.9	41.6 ± 10.2*	38.2 ± 10.0*
BMI (kg/m^2)	22.9 ± 4.5	29.4 ± 4.8*	27.4 ± 4.6*
AHI (events/h)	0.7 ± 1.1	35.6 ± 19.7*	39.7 ± 24.8*
NOSE score	10 (0, 20)	15 (10, 25)	45 (35, 55)*†

*$p<0.05$ compared with control group; †$p<0.05$ compared with OSA without nasal obstruction (OSAsNO) group. *AHI*, apnea–hypopnea index; *BMI*, body mass index; *NOSE score*, The Nasal Obstruction Symptom Evaluation questionnaire score (0 ~ 100); *OSAsNO*, OSA without (sans) nasal obstruction group; *OSAwNO*, OSA with nasal obstruction group

Table 2 Nasal resistance (inspiration and expiration; Pa/cm^3/s) in the three groups in the different postures

Posture	Control		OSAsNO		OSAwNO	
	Inspiration	Expiration	Inspiration	Expiration	Inspiration	Expiration
Sitting	0.20 (0.16,0.22)	0.21 (0.17,0.25)	0.21 (0.17,0.23)	0.21 (0.17,0.24)	0.24 (0.17,0.33)	0.25 (0.18,0.33)
Supine	0.26 (0.20,0.38) †	0.29 (0.21,0.41)†	0.20 (0.17,0.25)*	0.21 (0.19,0.25)*†	0.25 (0.19,0.29)	0.27 (0.18,0.30)
Lateral (left)	0.28 (0.23,0.37) †	0.29 (0.23,0.37)†	0.23 (0.20,0.28)†‡	0.24 (0.20,0.29)*†	0.26 (0.20,0.39)†	0.27 (0.21,0.45)†
Lateral (right)	0.31 (0.23,0.42) †‡	0.32 (0.25,0.47)†‡	0.25 (0.20,0.31)†‡	0.28 (0.20,0.32)*†‡	0.27 (0.21,0.34)†	0.27 (0.22,0.34)†

*$p<0.05$ compared with control group; †$p<0.05$ compared with sitting posture; ‡$p<0.05$ compared with supine posture. *OSAsNO*, OSA without (sans) nasal obstruction group; *OSAwNO*, OSA with nasal obstruction group

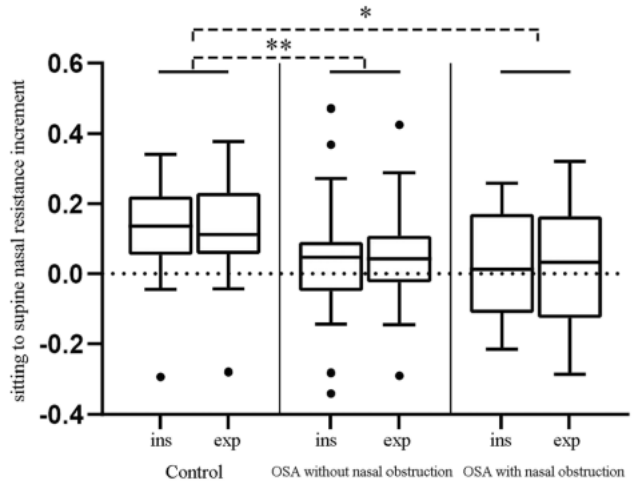


Fig. 3 Nasal resistance increment during sitting to supine postural change. *$p<0.05$ compared with control; **$p<0.01$ compared with control; ins, inspiration; exp, expiration

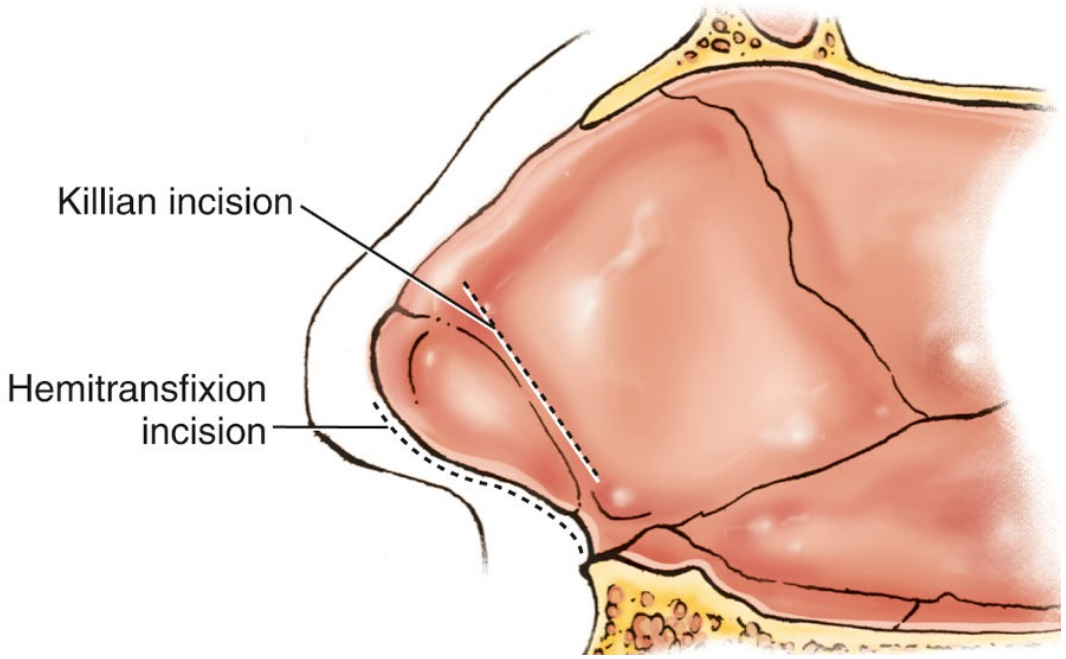
Other works on postural and nasal resistance

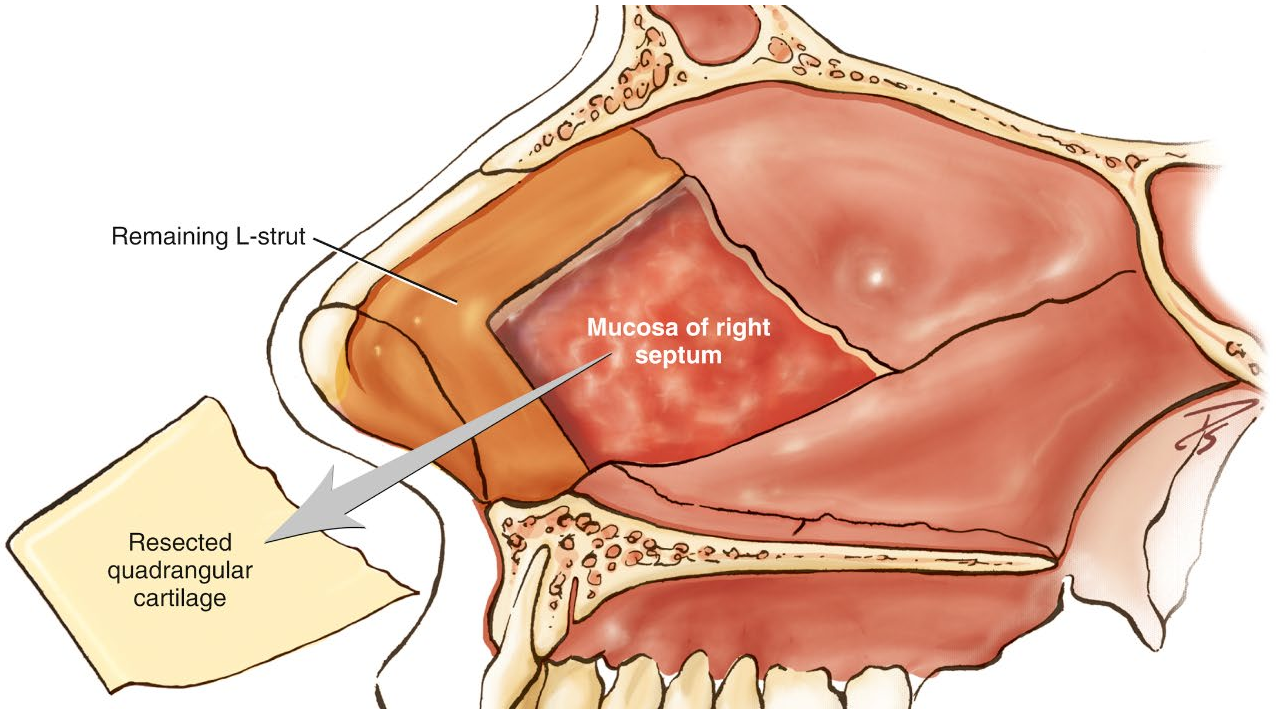
Table 6 Research on posture-related nasal resistance in OSA

Authors	Publication year	Sample size	Study group	Sitting to supine NR increment	Total NR in supine posture	Total NR in sitting posture
This study	2022	98	CON vs OSA	NR increment in OSA less than in control	OSA < CON	No difference
Huang et al. [21]	2021	62	Mild OSA vs moderate-severe OSA	Both increased significantly	No difference	No difference
Tong et al. [13]	2020	39	OSA patients	Increased, but less than previously reported		
Karlsson et al. [39]	2020	37	High total NR vs normal total NR (< 0.3 Pa/cm^3/s)		No difference in sleep parameter	
Masdeu et al. [22]	2011	14	OSA patients	Not significantly increased		
Hellgren et al. [19]	2009	40	CON vs OSA (acoustic rhinometer)	NR increment in OSA less than in control	OSA < CON	No difference
Virkkula et al. [20]	2009	41	CON vs OSA	No difference	Positive correlation with AHI and ODI	No difference
De Vito et al. [40]	2001	36	High total NR vs normal total NR (< 0.5 Pa/cm^3/s)		No difference in AHI	
Desfonds et al. [28]	1998	81	CON vs OSA	OSA > CON		

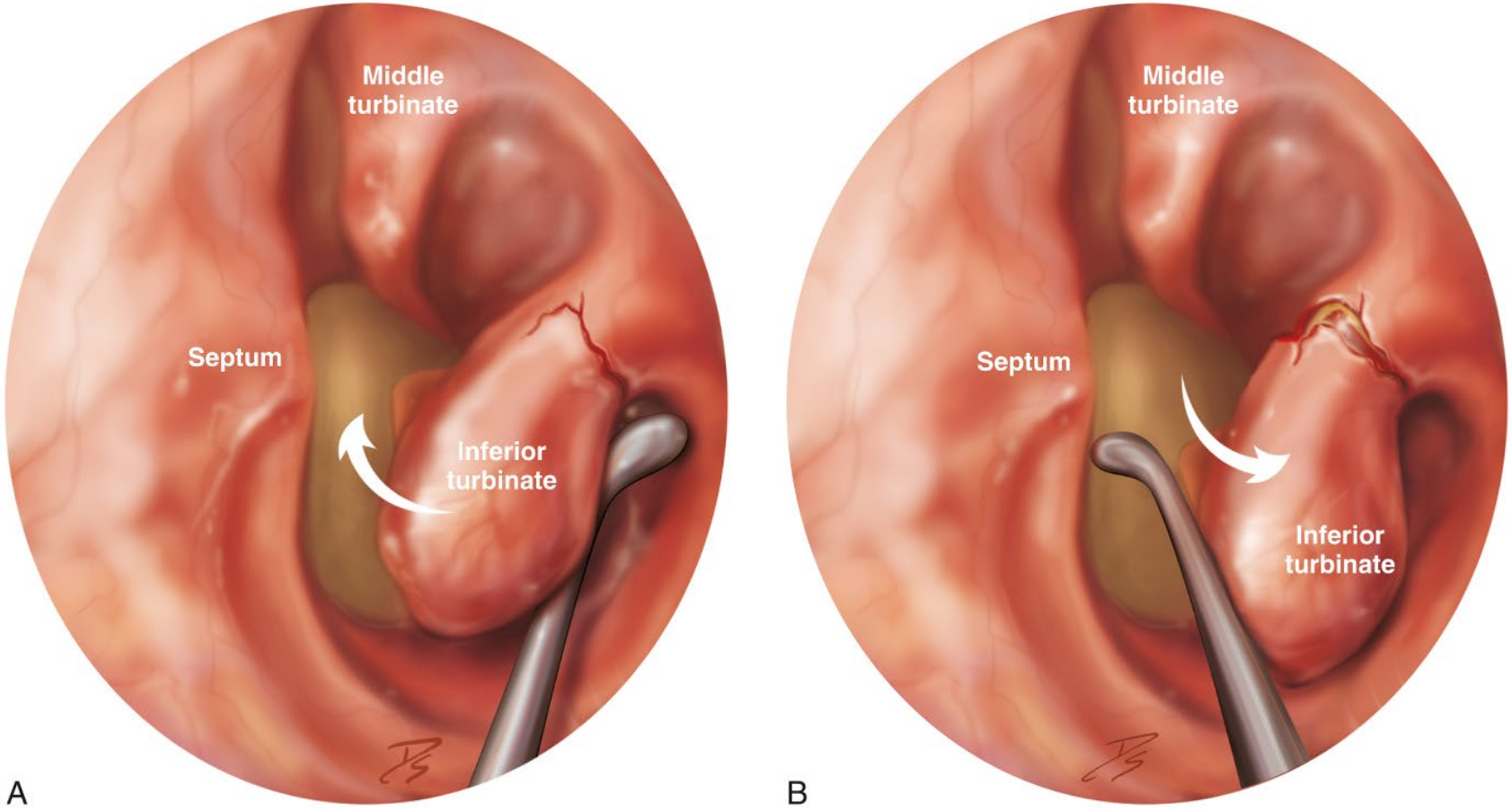
AHI, apnea–hypopnea index; *CON*, control group; *ODI*, oxygen desaturation index; *OSA*, obstructive sleep apnea group; *NR*, nasal resistance; *No difference*, no significant difference between groups

Septal Surgery

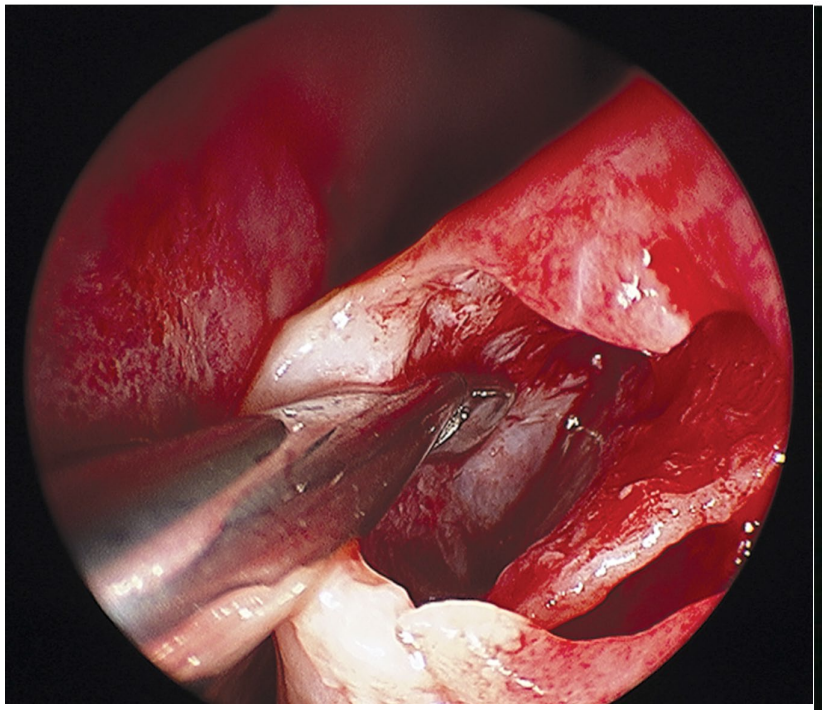


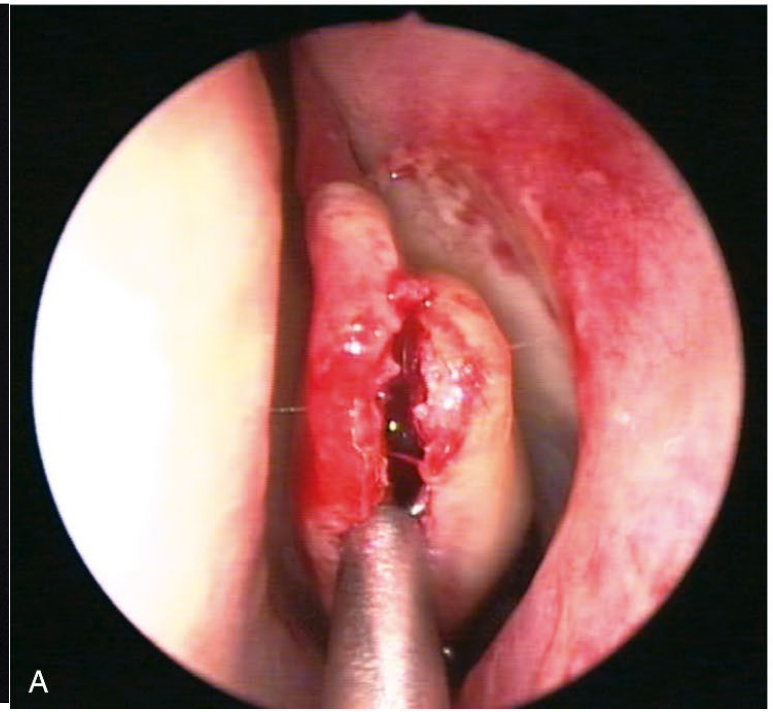


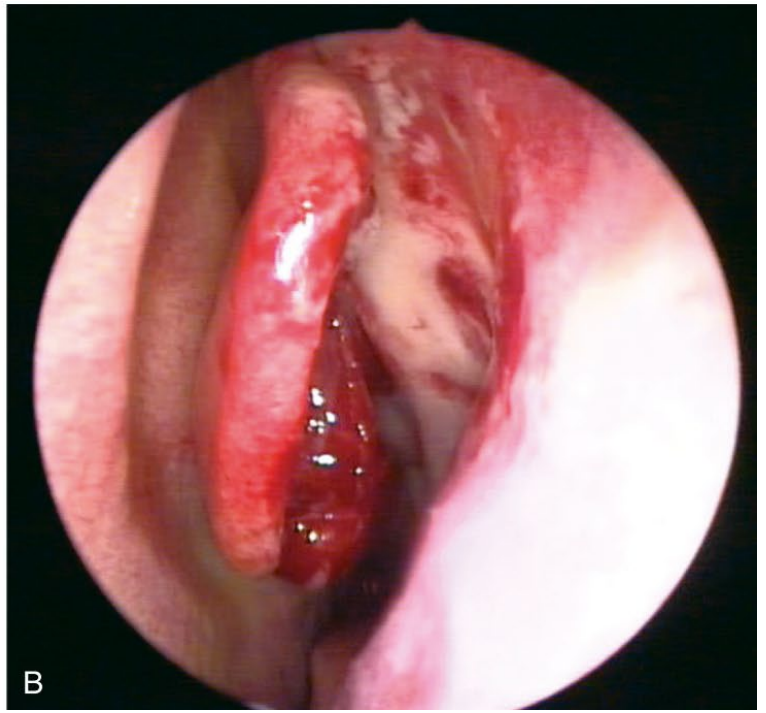
Turbinate Surgery



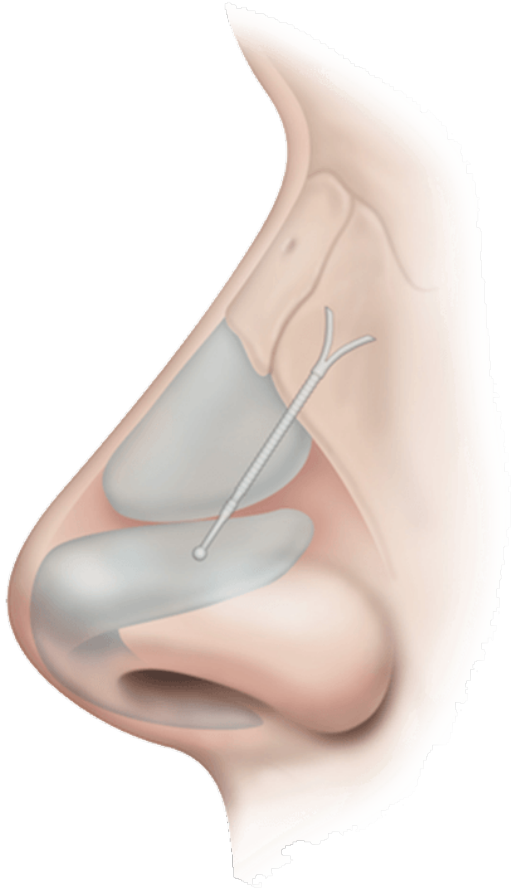
Turbinate Surgery

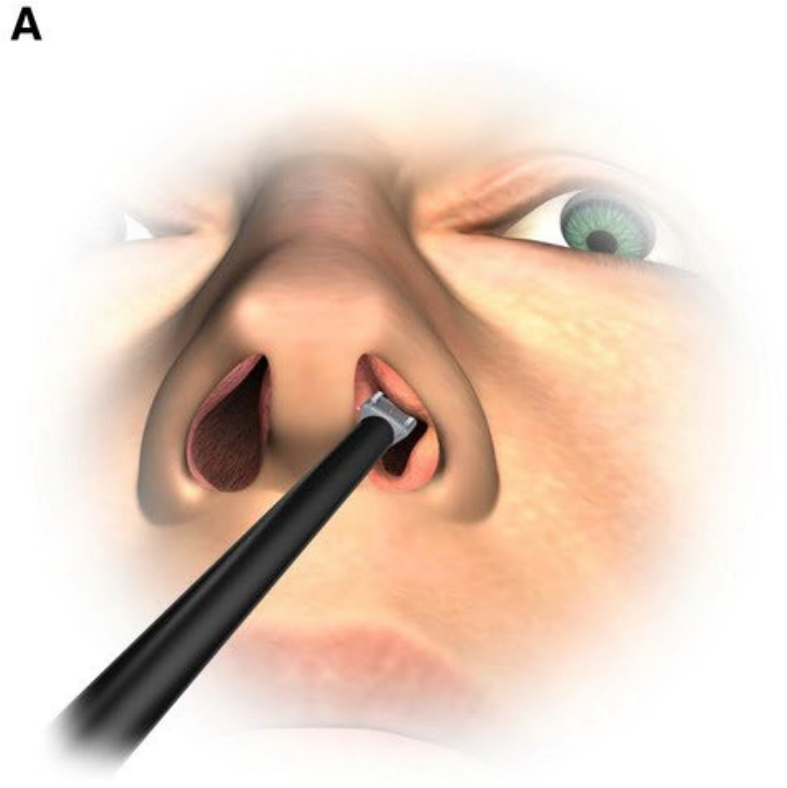


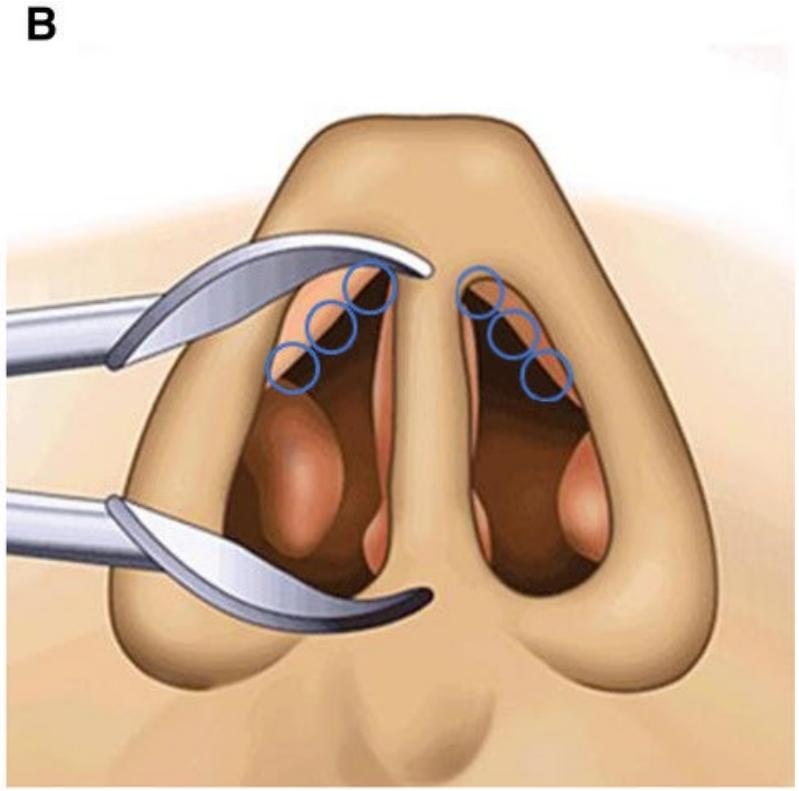




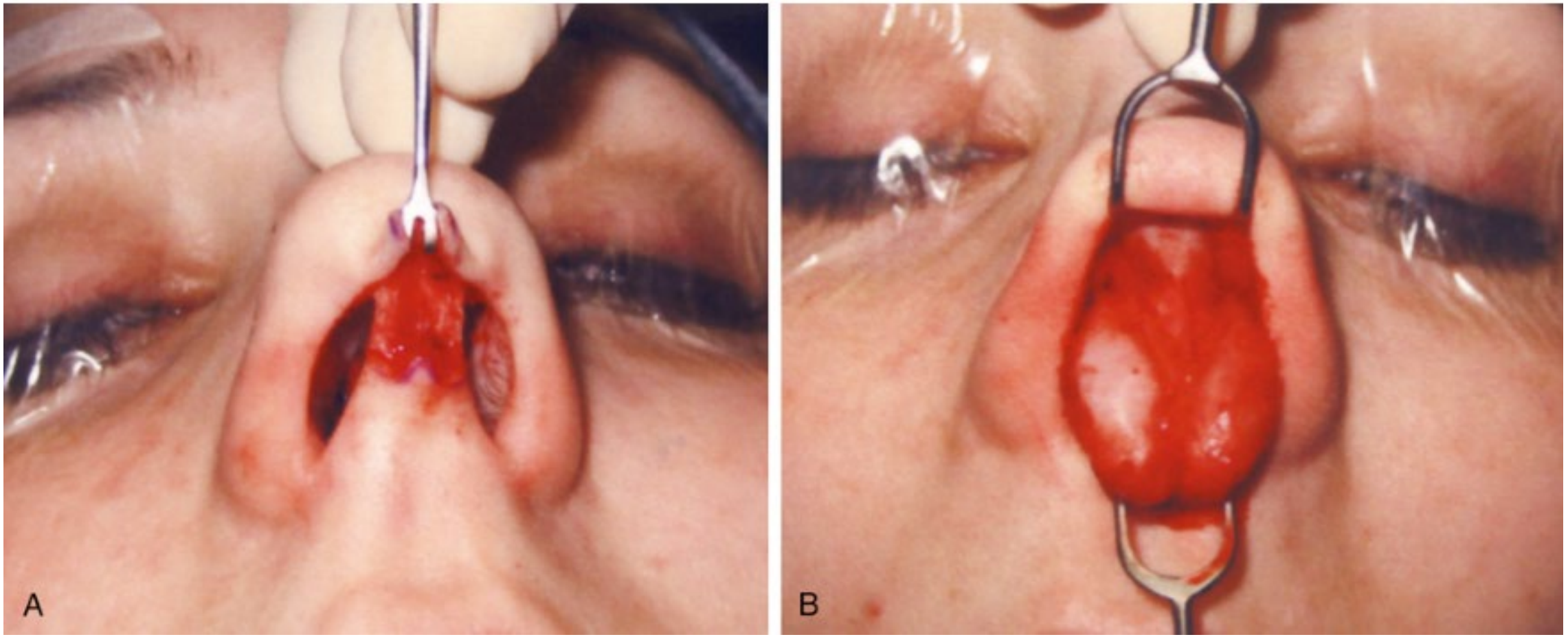
Valve Procedures







Rhinoplasty



Author and Year	Sample Size (*n*)	Apnea–Hypopnea Index			Epworth Sleepiness Scale		
		AHI Preoperative	AHI Postoperative	Significance	ESS Preoperative	ESS Postoperative	Significance
Li et al., 2022 [22]	30	24.5 (13.7)	22.7 (14.6)	NS ($p = 0.492$)	12.7 (1.2)	8.6 (2.9)	$p < 0.000$
Elwany et al., 2022 [28]	49	48.9 (2.2)	44.1 (1.4)	NS	10.45 (1.67)	4.98 (0.88)	$p < 0.001$
Wu et al., 2022 [14]	100	12.1 (3.7) [d] 24.5 (4.5) [e] 51.1 (10.3) [f]	7.1 (2.6) [d] 22.6 (4.5) [e] 50.6 (14.5) [f]	$p < 0.05$ [d] NS [e,f]	4.4 (4.9) [d] 4.8 (5.2) [e] 3.9 (3.9) [f]	-	$p < 0.01$ [d,e,f]
Kim et al., 2021 [26]	35	28.5 (22.3)	18.5 (19.8)	$p < 0.001$	7.9 (4.9)	5.3 (3.8)	$p < 0.001$
Bosco et al., 2020 [30]	34	26.7 (22.4)	19	NS ($p > 0.05$)	8.4 (5)	6.5 (5)	$p < 0.05$
Abd El-Aziz et al., 2018 [32]	30 [g] /30 [h]	14.21 (4.56)	12.29 (4.63)	$p = 0.001$	12.02 (2.46)	11.15 (2.64)	$p < 0.001$
Tagaya et al., 2017 [17]	40	52.6 (18.9)	49.5 (17.8)	NS ($p = 0.11$)	11.0 (4.0)	5.1 (2.3)	$p < 0.001$
Xiao et al., 2016 [13]	30	49.67 (19.49)	43.07 (21.86)	$p < 0.01$	-	-	-
Hisamatsu et al., 2015 [27]	43 *	51.06 (17.71)	38.60 (17.75)	$p < 0.05$	14.76 (2.39) **	8.06 (3.33) **	$p < 0.0001$
Shuaib et al., 2015 [19]	26	24.7 (18.8)	16 (16.1)	$p = 0.013$	11.5	7.5	$p = 0.003$
Yalamanchali et al., 2014 [12]	56	33.5 (22)	29.4 (20.8)	$p = 0.009$	-	-	-
Victores et al., 2012 [15]	24	27.3 (18.1)	24.4	NS ($p > 0.05$)	12.3 (6.2)	6.6 (4.2)	$p < 0.05$
Sufioğlu et al., 2012 [18]	28	32.5 (22.6)	32.4 (24.6)	NS ($p = 0.69$)	9.3 (5.1)	5.9 (3.9)	$p < 0.001$
Choi et al., 2011 [29]	22	28.9 (20.4)	26.1 (21.9)	NS ($p = 0.445$)	8.8 (3.3)	6.3 (3.3)	$p = 0.001$
Bican et al., 2010 [31]	20	43.1 (27.1)	24.6 (22.2)	$p < 0.05$	17.1 (2.7)	11.1 (2.8)	$p < 0.01$
Li et al., 2009 [24]	44	36.4 (29.1)	37.5 (31.6)	NS	10.6 (3.9)	7.6 (4.5)	$p = 0.02$
Koutsourelakis et al., 2008 [25]	27	31.5 (16.7)	31.5 (18.2)	NS	13.4 (2.9)	11.7 (3.4)	$p < 0.01$
Nakata et al., 2008 [21]	49	44.6 (22.5)	42.5 (22)	NS	10.6 (4.1)	4.5 (2.6)	$p < 0.001$
Li et al., 2008 [23]	51	37.4 (28.9)	38.1 (32.7)	NS	10	8	$p < 0.001$
Verse et al., 2002 [16]	26	31.57 (25.6)	28.93 (24.73)	NS	11.87 (4.7)	7.73 (4.96)	$p < 0.004$
Sériès et al., 1993 [20]	14	17.0	6.5	$p < 0.025$	-	-	-

Author and Year	Sample Size (*n*)	Apnea–Hypopnea Index			Epworth Sleepiness Scale		
		AHI Preoperative	AHI Postoperative	Significance	ESS Preoperative	ESS Postoperative	Significance
Li et al., 2022 [22]	30	24.5 (13.7)	22.7 (14.6)	NS ($p = 0.492$)	12.7 (1.2)	8.6 (2.9)	$p < 0.000$
Elwany et al., 2022 [28]	49	48.9 (2.2)	44.1 (1.4)	NS	10.45 (1.67)	4.98 (0.88)	$p < 0.001$
Wu et al., 2022 [14]	100	12.1 (3.7) [d] 24.5 (4.5) [e] 51.1 (10.3) [f]	7.1 (2.6) [d] 22.6 (4.5) [e] 50.6 (14.5) [f]	$p < 0.05$ [d] NS [e,f]	4.4 (4.9) [d] 4.8 (5.2) [e] 3.9 (3.9) [f]	-	$p < 0.01$ [d,e,f]
Kim et al., 2021 [26]	35	28.5 (22.3)	18.5 (19.8)	$p < 0.001$	7.9 (4.9)	5.3 (3.8)	$p < 0.001$
Bosco et al., 2020 [30]	34	26.7 (22.4)	19	NS ($p > 0.05$)	8.4 (5)	6.5 (5)	$p < 0.05$
Abd El-Aziz et al., 2018 [32]	30 [g] /30 [h]	14.21 (4.56)	12.29 (4.63)	$p = 0.001$	12.02 (2.46)	11.15 (2.64)	$p < 0.001$
Tagaya et al., 2017 [17]	40	52.6 (18.9)	49.5 (17.8)	NS ($p = 0.11$)	11.0 (4.0)	5.1 (2.3)	$p < 0.001$
Xiao et al., 2016 [13]	30	49.67 (19.49)	43.07 (21.86)	$p < 0.01$	-	-	-
Hisamatsu et al., 2015 [27]	43 *	51.06 (17.71)	38.60 (17.75)	$p < 0.05$	14.76 (2.39) **	8.06 (3.33) **	$p < 0.0001$
Shuaib et al., 2015 [19]	26	24.7 (18.8)	16 (16.1)	$p = 0.013$	11.5	7.5	$p = 0.003$
Yalamanchali et al., 2014 [12]	56	33.5 (22)	29.4 (20.8)	$p = 0.009$	-	-	-
Victores et al., 2012 [15]	24	27.3 (18.1)	24.4	NS ($p > 0.05$)	12.3 (6.2)	6.6 (4.2)	$p < 0.05$
Sufioğlu et al., 2012 [18]	28	32.5 (22.6)	32.4 (24.6)	NS ($p = 0.69$)	9.3 (5.1)	5.9 (3.9)	$p < 0.001$
Choi et al., 2011 [29]	22	28.9 (20.4)	26.1 (21.9)	NS ($p = 0.445$)	8.8 (3.3)	6.3 (3.3)	$p = 0.001$
Bican et al., 2010 [31]	20	43.1 (27.1)	24.6 (22.2)	$p < 0.05$	17.1 (2.7)	11.1 (2.8)	$p < 0.01$
Li et al., 2009 [24]	44	36.4 (29.1)	37.5 (31.6)	NS	10.6 (3.9)	7.6 (4.5)	$p = 0.02$
Koutsourelakis et al., 2008 [25]	27	31.5 (16.7)	31.5 (18.2)	NS	13.4 (2.9)	11.7 (3.4)	$p < 0.01$
Nakata et al., 2008 [21]	49	44.6 (22.5)	42.5 (22)	NS	10.6 (4.1)	4.5 (2.6)	$p < 0.001$
Li et al., 2008 [23]	51	37.4 (28.9)	38.1 (32.7)	NS	10	8	$p < 0.001$
Verse et al., 2002 [16]	26	31.57 (25.6)	28.93 (24.73)	NS	11.87 (4.7)	7.73 (4.96)	$p < 0.004$
Sériès et al., 1993 [20]	14	17.0	6.5	$p < 0.025$	-	-	-

Evaluation of the clinical efficacy of nasal surgery in the treatment of obstructive sleep apnoea

Table 4
PSG, Acoustic reflection and Upper airway 3D-CT before and after surgery.

Objective monitoring		Simple snoring group		Mild OSA group		Moderate OSA group		Severe OSA group	
		Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
PSG	AHI	3.3 ± 1.2	3.4 ± 1.1	12.1 ± 3.7	7.1 ± 2.6*	24.5 ± 4. 5	22.6 ± 4.5	51.1 ± 10. 3	50.6 ± 14.5
	Average SaO_2	95.7 ± 1.5	96.3 ± 1.3	88.3 ± 2.2	88.4 ± 2.5	85.3 ± 3.1	85.3 ± 2.1	82.3 ± 5.1	84.3 ± 6.8
	$LSaO_2$	94.5 ± 5.4	94.7 ± 6.8	76.3 ± 3.5	83.3 ± 1.6*	70.3 ± 5.5	72.3 ± 8.5	62.3 ± 10.5	61.3 ± 12.8
	Arousal index	5.44 ± 4.9	4.36 ± 3.9	16.2 ± 5.9	6.36 ± 2.9*	25.1 ± 6.8	12.4 ± 5.1*	30.2 ± 10.9	31.5 ± 8.5
	CT90	1.3 ± 1.1	0	15.0 ± 8.6	12.1 ± 5.6	20.0 ± 10.6	19.6 ± 9.6	28.0 ± 20.6	23.7 ± 20.1
	NCV/cm^3	8.31 ± 1.29	9.45 ± 1.53*	7.42 ± 1.32	8.54 ± 1.53*	7.04 ± 1.55	8.34 ± 1.51*	6.93 ± 1.28	8.32 ± 1.50*

Surgical correction of nasal obstruction in the treatment of mild sleep apnoea: importance of cephalometry in predicting outcome.

Table 2 Mean (SE) results of the sleep studies obtained before (baseline) and after nasal surgery

	Baseline		*After surgery*	
Cephalometry	*Normal*	*Abnormal*	*Normal*	*Abnormal*
Age (y)	50 (4)	51 (2)		
Body mass index (kg/m²)	29·5 (1·0)	29·3 (1·2)	28·9 (1·4)	30·4 (1·3)
Sleep period time (h)	6·9 (0·4)	7·0 (0·2)	7·0 (0·5)	7·5 (0·2)
Total sleep time (h)	5·6 (0·4)	6·1 (0·3)	6·1 (0·4)	6·9 (0·2)
Sleep efficiency (%)	78 (4)	80 (3)	84 (4)	87 (2)
Sleep stages shift index (no/h TST)	20·1 (2·8)	19·8 (4·3)	12·9 (1·9)*	26·3 (6·2)
Arousals (no/h TST)	23·9 (3·3)	26·3 (2·9)	10·6 (2·5)*	25·0 (2·6)
Stage 1–2 (% TST)	67·2 (3·8)	68·3 (4·3)	63·2 (4·6)	68·9 (6·2)
Stage 3–4 (% TST)	18·2 (2·6)	16·4 (2·6)	19·6 (4·0)	16·3 (3·9)
Stage REM (% TST)	14·4 (2·2)	15·3 (2·6)	17·2 (2·1)	14·7 (2·6)
Apnoea + hypopnoea index (no/h TST)	17·0 (1·3)	18·5 (1·7)	6·5 (1·0)*	25·4 (2·9)
Total apnoea time (% TST)	7·9 (1·1)	8·9 (1·4)	2·2 (0·2)*	13·9 (1·4)

Polysomnographic effect of nasal surgery on positional and non-positional obstructive sleep apnea/hypopnea patients

Table III. Preoperative and postoperative nasal resistance and PSG data based on the severity level of the AHI.

	Mild OSAHS		Moderate OSAHS		Severe OSAHS	
Characteristic	Pre	Post	Pre	Post	Pre	Post
NR	0.95 ± 0.20	0.31 ± 0.07*	0.84 ± 0.16	0.30 ± 0.08*	0.90 ± 0.13	0.32 ± 0.05*
AHI	11.7 ± 2.8	7.0 ± 3.9*	24.6 ± 5.2	22.9 ± 6.9	46.8 ± 10.4	48.9 ± 11.3
Supine time	0.42 ± 0.06	0.44 ± 0.07	0.39 ± 0.07	0.43 ± 0.08	0.36 ± 0.08	0.38 ± 0.06
Supine AHI	19.4 ± 4.5	9.0 ± 5.8*	36.6 ± 10.9	32.4 ± 8.7	66.9 ± 22.1	63.7 ± 16.8
Non-supine time	0.58 ± 0.06	0.56 ± 0.07	0.61 ± 0.07	0.57 ± 0.08	0.64 ± 0.08	0.62 ± 0.06
Non-supine AHI	5.8 ± 3.2	5.3 ± 2.3	17.5 ± 9.2	15.3 ± 9.7	38.1 ± 18.2	38.0 ± 18.2
ArI	13.4 ± 5.6	8.9 ± 3.6*	22.6 ± 5.2	22.1 ± 7.9	45.6 ± 11.7	43.5 ± 9.7
Lowest SpO_2	75.4 ± 5.5	82.6 ± 6.5*	72.2 ± 7.9	76.1 ± 10.5	70.7 ± 11.2	72.4 ± 11.1
Mean SpO_2	90.6 ± 5.8	90.5 ± 5.1	86.7 ± 5.7	87.8 ± 6.6	83.9 ± 6.5	84.0 ± 5.6

Data for supine and non-supine sleep time represent the proportion of total sleep time. AHI, apnea and hypopnea indexes; ArI, arousal indexes; OSAHS, obstructive sleep apnea/hypopnea syndrome; PSG, polysomnographic. Statistical differences are expressed as $*p < 0.01$.

Polysomnographic effect of nasal surgery on positional and non-positional obstructive sleep apnea/hypopnea patients

Table I. Demographic data of patients.

	All patients		Mild OSAHS		Moderate OSAHS		Severe OSAHS	
Characteristic	PP	NPP	PP	NPP	PP	NPP	PP	NPP
n (%)	42 (53.2)	37 (46.8)	19 (70.4)	8 (29.6)	16 (61.5)	10 (38.5)	7 (26.9)	19 (73.1)
Gender (M/F)	33/9	30/7	15/4	7/1	12/4	8/2	6/1	15/4
Age (years)	41.79 ± 11.81	43.21 ± 8.06	36.9 ± 7.73	36.20 ± 8.17	45.62 ± 10.41	44.63 ± 5.73	42.75 ± 11.50	45.36 ± 9.27
BMI	26.64 ± 2.56	29.77 ± 3.31*	24.05 ± 1.28	26.54 ± 1.60†	27.51 ± 1.86	29.38 ± 1.06†	28.18 ± 2.21	31.98 ± 1.80†
Neck circumference	42.36 ± 1.56	43.65 ± 1.46*	41.21 ± 1.04	42.51 ± 1.16†	42.22 ± 1.34	43.75 ± 1.44†	43.13 ± 0.63	44.32 ± 0.84†

BMI, body mass index; NPP, non-positional OSAHS patients; OSAHS, obstructive sleep apnea/hypopnea syndrome; PP, positional OSAHS patients. Statistical differences are expressed as $*p < 0.01$ and $\dagger p < 0.05$.

Table III. Preoperative and postoperative nasal resistance and PSG data based on the severity level of the AHI.

	Mild OSAHS		Moderate OSAHS		Severe OSAHS	
Characteristic	Pre	Post	Pre	Post	Pre	Post
NR	0.95 ± 0.20	0.31 ± 0.07*	0.84 ± 0.16	0.30 ± 0.08*	0.90 ± 0.13	0.32 ± 0.05*
AHI	11.7 ± 2.8	7.0 ± 3.9*	24.6 ± 5.2	22.9 ± 6.9	46.8 ± 10.4	48.9 ± 11.3
Supine time	0.42 ± 0.06	0.44 ± 0.07	0.39 ± 0.07	0.43 ± 0.08	0.36 ± 0.08	0.38 ± 0.06
Supine AHI	19.4 ± 4.5	9.0 ± 5.8*	36.6 ± 10.9	32.4 ± 8.7	66.9 ± 22.1	63.7 ± 16.8
Non-supine time	0.58 ± 0.06	0.56 ± 0.07	0.61 ± 0.07	0.57 ± 0.08	0.64 ± 0.08	0.62 ± 0.06
Non-supine AHI	5.8 ± 3.2	5.3 ± 2.3	17.5 ± 9.2	15.3 ± 9.7	38.1 ± 18.2	38.0 ± 18.2
ArI	13.4 ± 5.6	8.9 ± 3.6*	22.6 ± 5.2	22.1 ± 7.9	45.6 ± 11.7	43.5 ± 9.7
Lowest SpO_2	75.4 ± 5.5	82.6 ± 6.5*	72.2 ± 7.9	76.1 ± 10.5	70.7 ± 11.2	72.4 ± 11.1
Mean SpO_2	90.6 ± 5.8	90.5 ± 5.1	86.7 ± 5.7	87.8 ± 6.6	83.9 ± 6.5	84.0 ± 5.6

Data for supine and non-supine sleep time represent the proportion of total sleep time. AHI, apnea and hypopnea indexes; ArI, arousal indexes; OSAHS, obstructive sleep apnea/hypopnea syndrome; PSG, polysomnographic. Statistical differences are expressed as $*p < 0.01$.

Nasal Surgery Doesn’t cure OSA

Table 1 Effects of nasal surgery on sleep apnea

	Before	After	95% CI (difference)	*p* Value
AI (/hr.)	23.1 ± 24.5	22.0 ± 23.4	-1.1-3.1	n.s.
AHI (/hr.)	44.6 ± 22.5	42.5 ± 22.0	-2.0-5.8	n.s.
Nadir SpO_2 (%)	76.2 ± 10.9	78.8 ± 8.1	-4.2-1.0	<0.01
ODT (min.)	58.0 ± 78.0	43.7 ± 58.9	2.3-24.3	<0.05

Table 2 Effects of nasal surgery on sleep quality

	Before	After	95% CI (difference)	*p* Value
Maximum apnea duration	61.1 ± 46.0	47.3 ± 36.1	7.5-20.4	<0.01
Mean apnea/hypopnea duration	33.5 ± 7.3	28.8 ± 7.4	2.5-6.9	<0.05
% Stage I	38.4 ± 20.6	32.8 ± 16.5	2.5-8.7	<0.01
% Stage II	43.7 ± 18.9	47.0 ± 18.4	-6.4-0.2	<0.05
% Stage III + IV	0.6 ± 1.7	1.1 ± 0.7	0-0.6	n.s.
% REM	15.4 ± 4.8	17.9 ± 5.1	-4.2-0.8	<0.01
Ar-I (/hr)	36.8 ± 17.0	36.1 ± 16.5	-2.3-3.7	n.s.
Sleep efficacy (%)	84.0 ± 11.3	89.7 ± 6.0	-7.1-2.5	<0.01
TST (min)	410.5 ± 56.7	440.8 ± 35.8	-37.6-13.4	<0.001

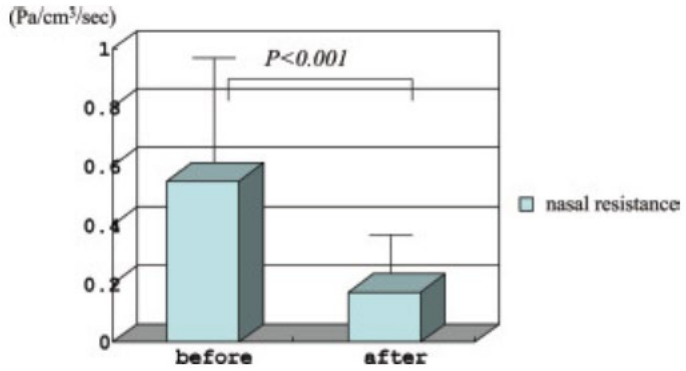


Figure 1 Nasal resistance before and after nasal surgery

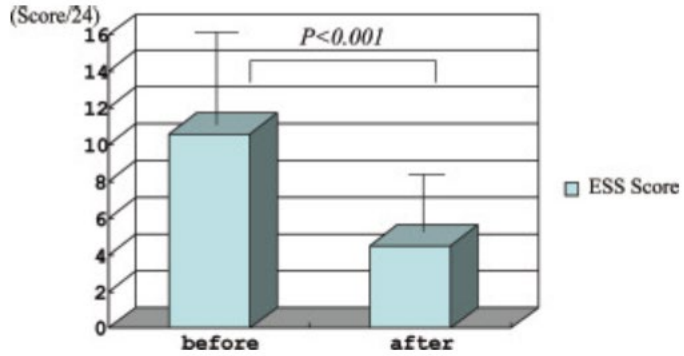


Figure 2 ESS score before and after nasal surgery.

Palate Surgery on Nasal Resistance

Table 1. Summary of demographic and baseline data.

	mild OSA	moderate-severe OSA	p value
n	30	32	
Gender (male/female)	22/8	27/5	>0.05[a]
Age (years)	46.7±13.0	47.9±8.3	>0.05[b]
BMI (kg/m2)	24.8±3.0	28.2±4.0	<0.05[b]
FPP I-II/III-IV	28/2	3/29	<0.05[a]
UPPP/UPPP+TBS	30/0	3/29	<0.05[a]

OSA = obstructive sleep apnea; BMI = body mass index; FPP = Friedman palate position; UPPP = uvulopalatopharyngoplasty; TBS = tongue base suspension; Data were expressed as mean ± SD; [a] Chi-square analysis; [b] t-test.

Table 2. Data concerning sleep before and after surgery.

	Preoperative	Postoperative	p value
mild OSA (n=30)			
AHI (/h)	8.9±3.3	6.4±1.8	<0.05
MOS (%)	84.9±7.1	88.1±6.5	>0.05
BMI (kg/m2)	24.8±3.0	25.2±3.6	>0.05
VAS of NO*	2.8±1.5	3.0±1.7	>0.05
moderate-severe OSA (n=32)			
AHI (/h)	48.8±19.3	24.1±15.3	<0.05
MOS (%)	71.0±9.1	79.2±10.1	<0.05
BMI (kg/m2)	28.2±4.0	28.3±4.5	>0.05
VAS of NO*	6.5±2.3	2.7±1.5	<0.05

OSA = obstructive sleep apnea; AHI = apnea-hypopnea index; MOS = minimal oxygen saturation; BMI = body mass index; VAS = visual analog scale; NO = nasal obstruction; Data were expressed as mean ± SD.
*Nasal obstruction was evaluated in recumbency during sleep.

Table 3. Preoperative and postoperative rhinomanometric findings in patients with mild OSA and moderate-severe OSA.

	Preoperative (Pa/cm³/s for TNR)	Postoperative (Pa/cm³/s for TNR)	p value
mild OSA (n=30)			
Ant. sitting TNR	0.192±0.066[a]	0.227±0.090	>0.05
Ant. supine TNR	0.257±0.211[a]	0.265±0.188	>0.05
Post. sitting TNR	0.244±0.194[b]	0.237±0.152	>0.05
Post. supine TNR	0.287±0.150[be]	0.269±0.188	>0.05
moderate-severe OSA (n=32)			
Ant. sitting TNR	0.201±0.148[c]	0.205±0.115	>0.05
Ant. supine TNR	0.296±0.303[c]	0.219±0.122	>0.05
Post. sitting TNR	0.320±0.259[d]	0.274±0.169	>0.05
Post. supine TNR	0.425±0.343[de]	0.292±0.301	<0.05

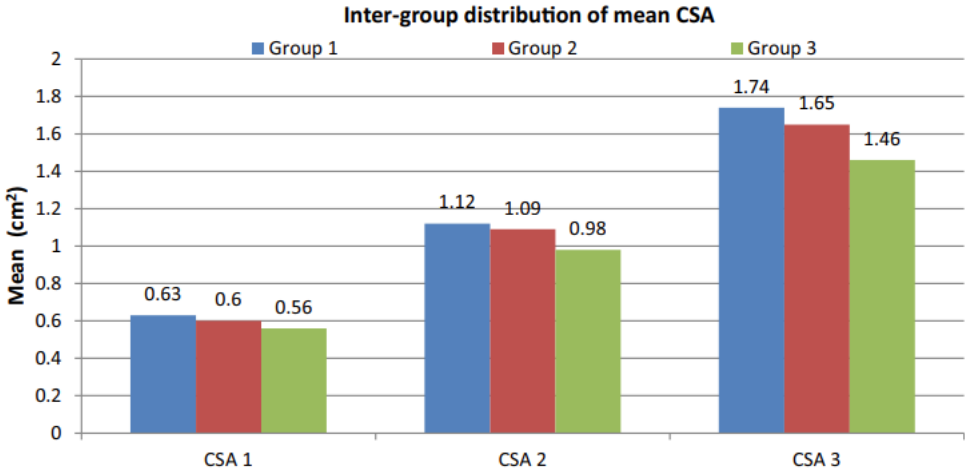
OSA= obstructive sleep apnea; TNR=total nasal resistance; Data were expressed as mean ± SD; The same letter indicates significant differences ($p<0.05$).

Nasal patency in Obese vs Non-obese patients with OSA

Table 2 Comparison of mean nasal CSA (CSA1, 2 & 3) and mean volume in three groups

Parameter	Group 1 n = 25 (Non obese without OSA, BMI < 30)	Group 2 n = 25 (Non obese with OSA, BMI < 30)	Group 3 N = 25 (Obese with OSA, BMI > 30)	*P* value (Group 1 Vs. Group 2)	*P* value (Group 1 Vs. Group 3)	*P* value (Group 2 Vs. Group 3)
Mean Nasal CSA in Cm^2 (mean of right and left nostrils)						
CSA1	0.63	0.60	0.56	0.548^{NS}	0.028^{*}	0.009^{**}
CSA2	1.12	1.09	0.98	0.412^{NS}	0.031^{*}	0.007^{**}
CSA3	1.74	1.65	1.46	0.642^{NS}	0.041^{*}	0.008^{**}
Volume in Cm^3 (mean of right and left nostrils)	25.18	24.22	21.02	0.609^{NS}	0.029^{*}	0.033^{*}

*P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically non-significant



Nasal Surgery on CPAP Tolerance

Table 1. Patient Characteristics and PSG data between CPAP tolerant group and intolerant group.

	CPAP intolerant	CPAP tolerant	*p* value
Age	46.6 ± 11.1	48.7 ± 10.5	n.s.
BMI(kg/m^2)	26.7 ± 3.2	27.8 ± 4.7	n.s.
AI(hr.)	28.0 ± 24.5	27.2 ± 21.0	n.s.
AHI(hr.)	49.8 ± 19.5	48.6 ± 17.2	n.s.
Nadir SpO_2(%)	74.4 ± 10.1	76.8 ± 13.1	n.s.
nasal resistance(Pa/cm^3/*sec*)	0.57±0.38	0.24±0.16	<0.01
ESS score	10.7 ± 4.0	7.9 ± 6.5	<0.05

Table 2. Patient Characteristics and PSG data between before and after nasal surgery in CPAP intolerant group.

	Before	After	*p* value
BMI(kg/m^2)	26.7 ± 3.2	26.5 ± 3.2	n.s.
AI(hr.)	28.0 ± 24.5	26.4 ± 23.4	n.s.
AHI(hr.)	49.8 ± 19.5	45.6 ± 20.2	n.s.
NadirSpO_2(%)	74.4 ± 10.1	77.7 ± 7.7	<0.01
nasalresistance	0.57±0.38	0.17±0.09	<0.01
DT(min.)	65.8 ± 78.3	48.0 ± 59.7	<0.05
ESSscore	10.7 ± 4.0	4.8 ± 2.5	<0.001
%stage1	47.8 ± 17.6	37.7 ± 15.8	<0.05
%stage2	35.1 ± 17.1	36.8 ± 14.3	n.s.
%stage3	1.3 ± 1.2	0.6 ± 0.7	n.s
%REM	15.2 ± 3.7	18.1 ± 5.5	<0.01
Ar-I(hr.)	34.7 ± 17.2	33.1 ± 14.5	n.s.
SleepEfficacy(%)	82.6 ± 13.3	87.6 ± 8.8	<0.01
TST(min)	413.0 ± 71.2	451.9 ± 49.5	<0.01

Definition of abbreviations: BMI = body mass index, AHI = apnea-hypopnea index SpO_2 = oxygen saturation levels, ODT = oxygende saturation time with SpO2 < 90%, ESS = Epworth sleepiness scale, CPAP = continuous positive airway pressure, REM = rapid eye movement, Ar-*I* = arousal index, TST = total sleep time.

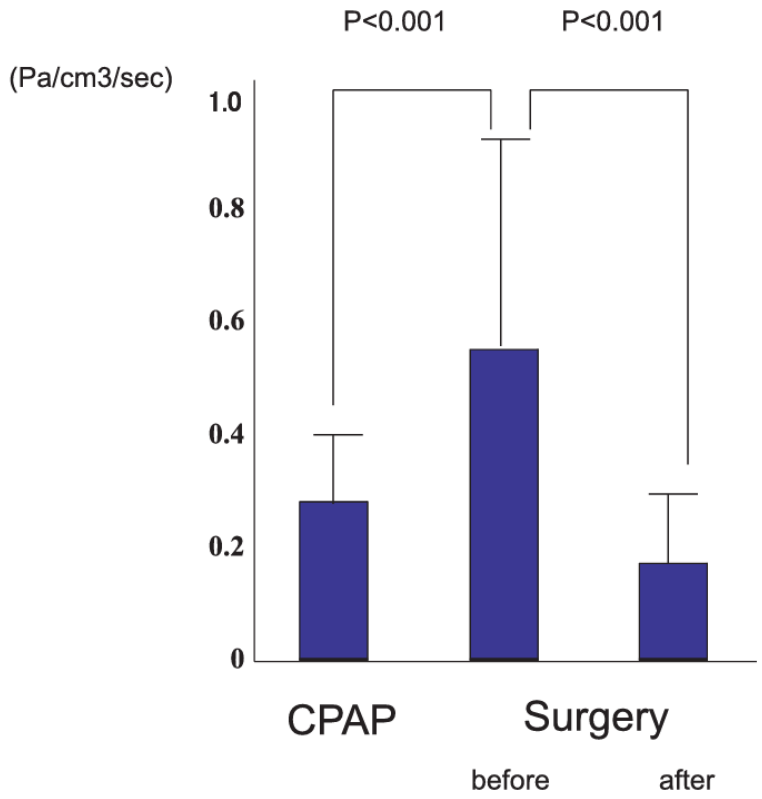


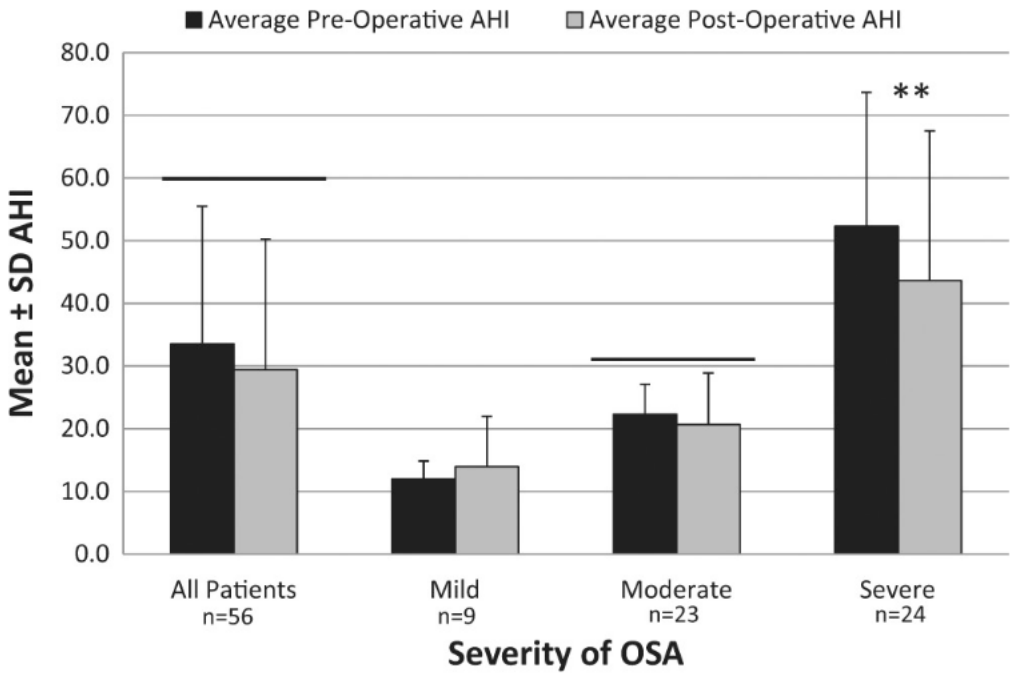
Fig. 1. Nasal resistance on CPAP intolerance and CPAP tolerance patients. CPAP : nasal resistance before CPAP in CPAP tolerance patients. Surgery: nasal resistance before and after nasal surgery in CPAP intolerance patients.

Nasal and Sinus Surgery didn't help

Table 1. Summary of Results of PSG before and after Nasal Surgery and ESS.

	AHI, Mean ± SD		Lowest SaO_2, %, Mean ± SD		Mean SaO_2, %, Mean ± SD	
Group	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
All patients (n = 56)	33.5 ± 22.0	29.4 ± 20.8	83.5 ± 8.9	83.4 ± 7.6	94.4 ± 2.0	94.7 ± 1.8
Severe OSA (n = 24)	52.3 ± 21.4	43.6 ± 23.9	79.3 ± 9.5	80.3 ± 7.9	93.6 ± 2.2	94.3 ± 2.2
Moderate OSA (n = 23)	22.3 ± 4.8	20.7 ± 8.2	85.1 ± 7.5	84.4 ± 7.1	94.9 ± 1.7	94.8 ± 1.6
Mild OSA (n = 9)	12.0 ± 2.8	14.0 ± 8.0	90.7 ± 2.4	89.3 ± 2.3	95.4 ± 1.4	95.4 ± 0.9
Polyps (n = 30)	37.3 ± 25.5	33.2 ± 22.9	84.8 ± 8.1	83.9 ± 7.8	94.6 ± 2.3	95.0 ± 1.7
No polyps (n = 26)	29.2 ± 16.5	25.1 ± 17.6	82.0 ± 0.10	82.8 ± 0.07	94.2 ± 0.02	94.3 ± 0.02

Abbreviations: AHI, apnea-hypopnea index; ESS, endoscopic sinus surgery; OSA, obstructive sleep apnea; PSG, polysomnography; SaO_2, oxygen saturation.



Minimal Change with Nasal Surgery

Table 4
PSG, Acoustic reflection and Upper airway 3D-CT before and after surgery.

Objective monitoring		Simple snoring group		Mild OSA group		Moderate OSA group		Severe OSA group	
		Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery	Before surgery	After surgery
PSG	AHI	3.3 ± 1.2	3.4 ± 1.1	12.1 ± 3.7	7.1 ± 2.6*	24.5 ± 4. 5	22.6 ± 4.5	51.1 ± 10. 3	50.6 ± 14.5
	Average SaO_2	95.7 ± 1.5	96.3 ± 1.3	88.3 ± 2.2	88.4 ± 2.5	85.3 ± 3.1	85.3 ± 2.1	82.3 ± 5.1	84.3 ± 6.8
	$LSaO_2$	94.5 ± 5.4	94.7 ± 6.8	76.3 ± 3.5	83.3 ± 1.6*	70.3 ± 5.5	72.3 ± 8.5	62.3 ± 10.5	61.3 ± 12.8
	Arousal index	5.44 ± 4.9	4.36 ± 3.9	16.2 ± 5.9	6.36 ± 2.9*	25.1 ± 6.8	12.4 ± 5.1*	30.2 ± 10.9	31.5 ± 8.5
	CT90	1.3 ± 1.1	0	15.0 ± 8.6	12.1 ± 5.6	20.0 ± 10.6	19.6 ± 9.6	28.0 ± 20.6	23.7 ± 20.1
Acoustic reflection	NCV/cm^3	8.31 ± 1.29	9.45 ± 1.53*	7.42 ± 1.32	8.54 ± 1.53*	7.04 ± 1.55	8.34 ± 1.51*	6.93 ± 1.28	8.32 ± 1.50*
	NMCV/cm^2	0.51 ± 0.16	0.66 ± 0.14*	0.36 ± 0.18	0.46 ± 0.16*	0.29 ± 0.17	0.48 ± 0.15*	0.25 ± 0.14	0.48 ± 0.15*
	DCAN/cm	2.22 ± 0.59	2.43 ± 0.37	2.42 ± 0.47	2.53 ± 0.35	2.11 ± 0.57	2.25 ± 0.37	2.12 ± 0.50	2.21 ± 0.48
Velopharyngeal cavity	Cross-sectional area	122.13 ± 35.31	131.42 ± 27.13	123.44 ± 30.11	132.34 ± 29.92	89.70 ± 32.19	97.03 ± 27.22	68.74 ± 18.45	69.52 ± 18.53
	Anteroposterior diameter	8.65 ± 1.57	8.93 ± 1.27	8.01 ± 1.32	8.89 ± 1.46*	7.31 ± 1.22	7.46 ± 1.23	5.75 ± 1.34	5.83 ± 1.52
	Left-to-right diameter	16.35 ± 2.14	16.42 ± 2.36	16.42 ± 2.51	16.35 ± 2.47	11.29 ± 3.91	11.33 ± 3.52	8.87 ± 2.24	8.91 ± 2.33
Oropharyngeal cavity	Cross-sectional area	332.12 ± 24.44	327.33 ± 21.25	331.05 ± 26.14	328.74 ± 19.32	289.73 ± 43.23	281.23 ± 41.10	249.76 ± 29.73	242.94 ± 25.32
	Anteroposterior Diameter	17.24 ± 1.13	16.83 ± 1.81	17.14 ± 1.25	16.98 ± 1.75	17.02 ± 3.27	17.12 ± 2.52	18.23 ± 2.85	17.89 ± 2.21
	Left-to-right diameter	28.46 ± 2.34	29.25 ± 2.91	28.70 ± 2.84	29.15 ± 2.93	25.71 ± 3.58	24.65 ± 3.77	19.46 ± 3.41	19.71 ± 3.58
	Length	40.24 ± 0.97	40.42 ± 1.22	39.45 ± 1.02	40.13 ± 1.68	38.39 ± 0.86	38.65 ± 1.14	39.65 ± 1.82	39.29 ± 1.93
Soft palate	Thickness	9.98 ± 0.76	9.11 ± 0.51*	9.87 ± 0.55	9.02 ± 0.65*	10.14 ± 0.78	9.88 ± 0.66	10.55 ± 0.64	10.38 ± 1.24
	Cross-sectional area	334.89 ± 26.73	323.34 ± 24.82	331.29 ± 28.35	315.27 ± 23.86*	327.31 ± 29.34	319.55 ± 27.56	299.23 ± 18.74	295.47 ± 17.46

Nasal Surgery on Sleep in Allergic Patients

Table 4. Pre- and postoperative polysomnographic data.

Parameter	Preop	Postop	*p*-Value
AHI	28.5 ± 22.3	18.5 ± 19.8	<0.001
Supine	43.0 ± 28.8	28.3 ± 25.2	0.0
Non-supine	28.0 ± 35.9	20.8 ± 23.8	0.298
RDI	32.3 ± 20.1	21.1 ± 17.7	<0.001
Snoring (%)	60.2 ± 28.7	53.8 ± 33.0	0.199
Mean SaO2 (%)	94.9 ± 1.9	95.0 ± 2.3	0.056
Minimal SaO2 (%)	81.0 ± 9.2	83.4 ± 9.0	0.295
CT90 (%)	20.9 ± 29.6	10.8 ± 20.4	0.014

Parameter		Success	Failure	Success rate (%)	*p*-Value
AR	+	4	4	50.0	0.026
	–	1	26	3.8	

Yes and No, Impact on AHI

Impact on RDI

Impact on CPAP compliance

Nasal surgeries, minimal to most invasive