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Pediatric turbinate radiofrequency ablation improves quality of life and rhinomanometric values. A prospective study

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ABSTRACT

Objective: turbinate surgery in pediatric patients is gradually increasing in popularity amongst pediatric otolaryngologists. However, despite this, there is scarce information regarding this surgical procedure in children. The present research is designed with the aim of assessing changes in nasal resistance, nasal airflow and quality of life in pediatric patients undergoing turbinate radiofrequency ablation.

Methods: A prospective uncontrolled intervention clinical trial design was followed. Children between 4 and 15 years old undergoing turbinate radiodiofrequency ablation (TRA) were consecutively selected. Children were examined preoperatively and 1, 3, 6 and 12 months after turbinate surgery. Anterior active rhinomanometry with and without nasal decongestant and examination of the turbinates and adenoid size were carried out in each follow-up visit. The SN5 quality of live survey was answered by parents.

Results: 81 children were included, 28 with associated adenoidectomy. A significant improvement in quality of life was demonstrated since the first month after TRA. Regarding nasal resistance, there was an improvement 1 month after surgery, but it only reached statistical significance for the whole sample ($p < 0.001$)) and for the cohort of isolated turbinate surgery ($p < 0.001$) at 3 months, while the values for the cohort of children who underwent adenoidectomy reached significance at 6 months after surgery ($p = 0.04$). The difference in nasal resistance before and after decongestant was compared to the change in nasal resistance after surgery. It demonstrated a strong correlation with the change in nasal resistance at 1 month ($R = 0.985$; $p < 0.001$), 3 months ($R = 0.995$; $p < 0.001$), 6 months ($R = 0.98$; $p < 0.001$) and 12 months ($R = 0.98$; $p < 0.001$) after surgery.

Conclusions: turbinate surgery in pediatric patients seems to be a safe procedure which objectively and subjectively improves the symptoms of children suffering from nasal obstruction.

1. Introduction

Nasal obstruction is a common complaint in pediatric otolaryngology either directly or indirectly because of its consequences, such as facial growth alterations, otitis media with effusion, or sleep disturbances, among others. In pediatric patients (not adjusted by age), it is mainly caused by turbinate enlargement (TE), in 43% of cases, and adenoid hyperplasia (AH) in 41% [1]. Both causes often coexist in the same patient, as adenoid hypertrophy is usually associated with rhinitis [2]. Specifically, Cassano et al. found that 77% of their sample of children with severe adenoid hypertrophy had muco-purulent rhinitis [2].

As TE is often related to impaired nasal breathing in children,

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turbinate surgery for pediatric patients is gradually increasing in popularity amongst pediatric otolaryngologists [3]. In fact, 81% of them (pediatric otolaryngologists) report performing turbinate surgery in children [3]. However, despite it being increasing common and the abundant available evidence from adults, there is scarce evidence in children. A recent systematic review could not perform a metanalysis of changes in rhinomanometry or quality of life after turbinate surgery in pediatric patients given the lack of available studies [4].

The present research is designed with the aim of assessing potential changes in nasal resistance, nasal airflow and quality of life in pediatric patients undergoing turbinate radiofrequency ablation. The h1 hypothesis is that, turbinate radiofrequency ablation decreases nasal resistance in children suffering from nasal obstruction due to turbinate enlargement comparing before and after surgery results.

2. Patients and METHODS

2.1. Sample

A prospective uncontrolled intervention clinical trial design was followed. Two cohorts of children were consecutively selected from a third level referral hospital from January 2019 to March 2020. Inclusion criteria consisted of children aged between 4 and 15 years old undergoing turbinate radiofrequency ablation with or without adenoidectomy. Cohort A consisted of children on whom only turbinate radiofrequency ablation (TRA) is performed, according to the indications of the main Spanish position paper on nasal obstruction, which consists on recommending surgery only after medical treatment has failed and nasal steroids have been administered for three months [5]. There is no specific description of surgical technique, as each intervention was performed by a different surgeon.

Cohort B consisted of children undergoing adenoidectomy and TRA, according to the indications of a consensus document by the Spanish Society of ORL and the Spanish Society of Pediatrics, which includes severe sleep apnea, suspicion of malignancy, or nasal obstruction associated with one or more of the following: sleep apnea, facial growth alterations, persistent otitis media with effusion, recurrent acute otitis or chronic rhinosinusitis [6].

All children had been treated with nasal steroids for three months before surgery, following the guideline's recommendations.

Exclusion criteria were craniofacial malformations, nasal infections in the 2 weeks prior to surgery, deviated nasal septum, choanal atresia, septal perforation, and velopharyngeal insufficiency.

Children were examined preoperatively and 1, 3, 6 and 12 months after turbinate surgery. Anterior active rhinomanometry and examination of the turbinates and adenoid size were conducted in each follow-up visit, and the SN5 quality of live survey was answered by parents. All physical examinations were carried out by the same examiner (the otolaryngologist in charge of the rhinology consultation), despite the fact that the surgeries were performed by different surgeons.

2.1.1. Surgical technique

Surgery was performed by different specialists following the same surgical technique. Radiofrequency was carried out with a radiofrequency generator (Celon, Olympus Europe; Hamburg-Germany) at 8 power setting. All procedures were performed under the direct vision of a straight, 4 mm-diameter, 30° endoscope (Karl Storz, Germany). No nasal packing was used. Adenoidectomy was performed using cold curettage and the complete removal of the adenoids was ascertained using the endoscope.

2.1.2. Physical examination

The direct examination by nasofibroscope is currently considered the Gold Standard test in adenoid and turbinate hypertrophy [7]. The turbinates were classified according to Camacho's classification system [8], and the adenoids according to Cassano's [2]. [9].

2.1.3. Allergy testing

As allergy is related to TE and AH [10], all children were tested for allergy by a blinded pediatric allergologist by means of the prick test study.

2.1.4. The Sinus and Nasal Quality of Life Survey SN5

In this study we have used the validated Spanish version of the SN5 questionnaire [11]. The Sinus and Nasal Quality of Life Survey (SN-5) evaluates 5 clusters of symptoms (sinus infection, nasal obstruction, allergy, emotional distress, and activity limitations) [12]. Each cluster has symptoms selected to help parents understand the nature of what is being assessed and is rated on a 7-point Likert scale, from 0 (never) to 6 (all the time). In addition to the symptomatic evaluation, caregivers evaluate the child's overall QOL on a visual analog scale (VAS) from 0 (worst possible) to 10 (best possible).

2.1.5. Rhinomanometry with and without nasal decongestant

The recommendations of the international Committee on Standardization of Rhinomanometry were followed [13]. Rhinomanometry was performed after 30 min of acclimatization, in a room where humidity was constant and the temperature controlled with a thermostat. The test was repeated 10 min after the subjects were administered nasal decongestant (xylometazoline chlorhydrate, 0.05%), 2 puff/nostril and the airflow and nasal resistance values were registered before and after its use. The results were assessed using a reference pressure gradient across the nose of 150 Pa.

Children so severely obstructed that rhinomanometry could not be performed were considered missing values.

2.1.6. Complications

Parents were asked to indicate if their child had experienced any complications. The questions included mild bleeding (no need to visit an emergency room or ask for medical assistance), moderated bleeding (which required medical assistance), severe bleeding (requiring revision in the operating room or hospitalization), disturbing crusting, infection (requiring antibiotics), olfaction impairment, or others. The presence of synechia was explored through nasal endoscopy.

2.1.7. Ethics statement

This study was performed in accordance with the ethical standards laid down in the Declaration of Helsinki. The Research and Ethics Committee of the Hospital Complex of Santiago de Compostela approved the study protocol (reference 2018/198).

3. Statistical analysis

All quantitative variables were tested for normality with the Shapiro Wilk test. Comparisons between quantitative variables and dichotomic variables were performed with the *t*-test when a normal distribution was demonstrated and with the non-parametric variation rank sum test when they did not follow a normal distribution (preoperative comparison of age; comparison between nasal resistance and nasal airflow between cohorts; comparison of postoperative values of nasal resistance and nasal airflow after surgery; comparison of SN5 scores after surgery). The relationship between qualitative variables was studied using the chi-square test (preoperative comparison of sex and allergy distribution and postoperative comparison of prevalence of hyposmia regarding the alcohol sniff test). The correlation between quantitative variables was performed through the Spearman correlation analysis (correlation between SN5 scores and nasal resistance or nasal airflow; correlation between changes in nasal resistance after decongestant test and changes in nasal resistance after surgery).

4. RESULTS

4.1. Participants

The description of the sample is summarized in Table 1. The total sample size was 81 participants, 53 patients were submitted to isolated turbinate radiofrequency ablation while 28 underwent associated adenoidectomy. Mean age was 10.3 ± 2.5, being 4.4 the minimum and 14.8 the maximum. There were 46 males (57.5%) and 34 females (42.5%). Overall, there were no statistically significant differences between cohorts regarding age and sex. However, there were differences regarding allergies, there being proportionally more allergic patients in the isolated turbinate surgery cohort.

4.2. Complication rate

The complication rate was 15.8%. Individually, parents reported 7% mild bleeding; 3.5% crusting; 3.5% infection; 1.8% pain. No severe complications were reported.

In cohort A (only radiofrequency ablation) the complication rate was 18%. Individually, parents reported 5.1% mild bleeding; 5.1% crusting; 5.1% infection; 2.6% pain. No severe complications were reported. In cohort B (turbinate radiofrequency ablation and adenoidectomy) it was 9.5%. Individually, parents reported 9.5% mild bleeding. No severe complications were reported either.

4.3. Nasal resistance and nasal airflow

Data is summarized in Fig. 1 (nasal resistance) and Fig. 2 (nasal airflow), which is a graphical representation of their evolution in time. There was an improvement after 1 month of surgery in both cohorts which reached statistical significance at 3 months for the whole sample and the cohort of isolated turbinate surgery (cohort A), but not for the cohort of children who underwent adenoidectomy (cohort B), which reached significance at 6 months after surgery. This improvement was maintained at least at 12 months after surgery for both cohorts and the whole sample.

There are no significant differences in any of the follow-up visit between the subgroup of isolated turbinate surgery and the associated adenoidectomy.

Likewise, there is no statistically significant difference between allergic and non-allergic patients in any of the follow-up visit.

Lastly, taking 0.4 Pa s/cm3 as reference value, there is a prevalence of impaired nasal breathing of 89.9% before surgery, 67.4% at 1 month, 45% at 3 months, 39.5% at 6 months and 44% at 12 months.

Table 1
Description of the sample. Bold and asterisk if the difference between groups is statistically significant.

	Age	Sex	Allergy
Total (n=81)	10.27 ± 2.51	47 M (58.02%), 34 F (41.98%)	61.11% (animals 13.89%; pollen 29.17%; acari 55.56%)
Isolated turbinate surgery (n=53)	10.60 ± 2.45	35 M (66.04%), 18 F (33.96%)	71.74% (animals 19.57%; pollen 30.43%; acari 63.04%)
Associated adenoidectomy (n=28)	9.65 ± 2.55	12 M (42.86%), 16 F (57.14%)	42.31% (animals 3.85%; pollen 26.92%; acari 42.31%)
Statistical analysis	P = 0.08	**P=0.04*** Chi2 = 4.04	**P=0.01*** Chi2 = 6.05

4.4. Predictive value of the decongestant test

The difference in nasal resistance before and after the use of nasal decongestant was compared to the change in nasal resistance after surgery in order to explore the ability of the decongestant test to predict the results of surgery. The difference in nasal resistance with the decongestant test was strongly correlated with the change in nasal resistance at 1, 3, 6 and 12 months after surgery. This association was statistically significant for the whole group, cohort A and cohort B, but higher for cohort A. The results are reported in Table 2.

4.5. SN5

Table 3 summarizes the evolution of the SN-5 score over time. The greatest improvement is reached at 3 months and maintained at 12 months.

There was no significant correlation between the SN5 total score (p = 0.4) or any of its items and nasal resistance or nasal airflow. An attempt to stablish a cutoff value for the SN5 questionnaire so as to identify nasal obstruction through rhinomanometry was made, but a receiver operating characteristic curve (ROC curve) could not demonstrate good performance neither in the preoperatory (AUC = 0.5) nor in the follow up visits (AUC 1 month = 0.4; AUC 3 months = 0.6; AUC 6 months = 0.6; AUC 12 months = 0.5).

4.6. Turbinate and adenoid size

There is a statistically significant association between the size of the turbinates and the total score in the SN5 questionnaire (chi = 10.5; p = 0.03) as well as with the basal nasal resistance (chi = 10.4; p = 0.04). In cohort B, a correlation between the size of the adenoids and the total score in the SN5 questionnaire (chi = 4.2; p = 0.12) or the basal nasal resistance (chi = 1.3; p = 0.52) could not be demonstrated.

The size of the turbinates (using Camacho's classification; right plus left) changed from 6.4 in the whole group, 6.7 in cohort A and 6 in cohort B preoperatively to 3.6, 3.6 and 3.5 respectively at 1 month. These values remained similar at 3 months (3.3, 3.2, 3.6), 6 months (3.1, 3, 3.1) and 12 months (3.2, 3.1, 3.4).

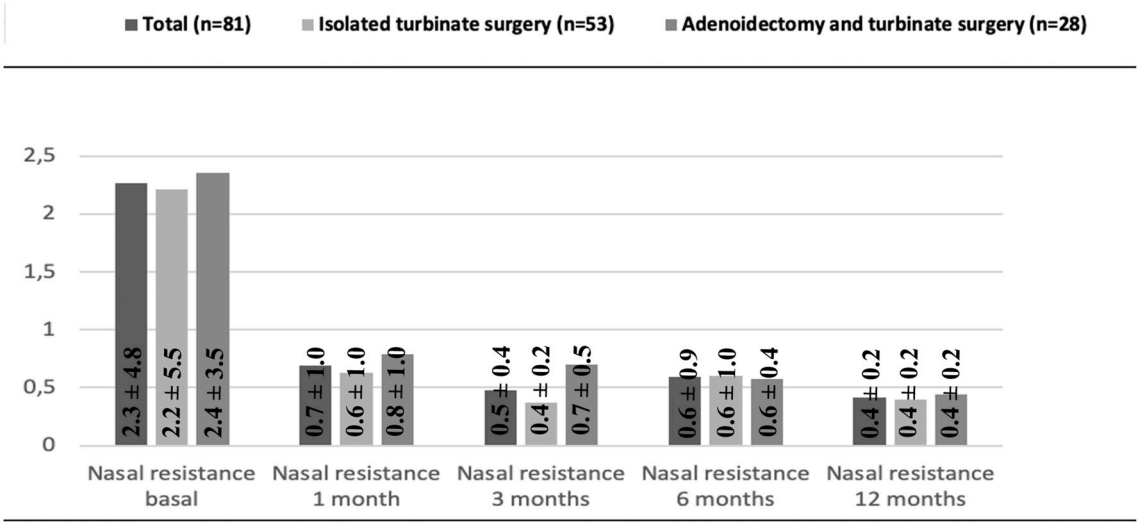
The size of the adenoid changed from 3.4 in the whole group, 0.7 in cohort A and 3.4 in cohort B preoperatively to 0.5, 0.5 and 0.4 respectively at 1 month. These values remained similar at 3 months (0.3, 0.3, 0.4), 6 months (0.3, 0.3, 0.2) and 12 months after surgery (0.3, 0.4, 0.3).

5. Discussion

This study has demonstrated an improvement in nasal resistance, nasal airflow and quality of life after turbinate surgery in pediatric patients which lasted for at least a year. Furthermore, the result of turbinate surgery can be preoperatively estimated by means of the decongestant test with rhinomanometry.

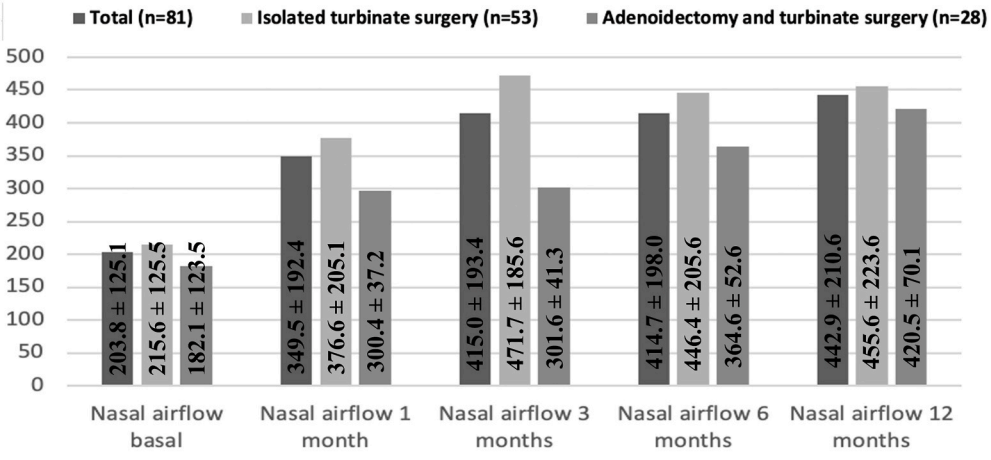
In detail, this study has shown a decrease in nasal resistance after turbinate surgery. Up to the present, there are only two previous studies reporting data on rhinomanometry after isolated turbinate surgery in children [14,15] although none of them performed TRA. Even with that limitation, our results are similar to theirs. The highest decrease is found at 1 month, with a progressive decrease in the following 3 months [14, 15] and 6 months [14]. In our study, cohort B (adenoidectomy associated to TRA) reached statistically significance later than cohort A (isolated TRA) and the whole group. We believe that it was due to a combination of the lower sample size with the large standard deviation in the initial group as both affect the ability of a test to detect difference regardless of the fact that it may exist.

Rhinomanometry is relevant in the initial diagnosis of TE as well as in its follow up after treatment. It should be used as complementary information and never as a substitute for physical examinations or anamnesis.



P value Total	**T=1.58; p=0.12**	**T=3.68; p<0.001***	**T=2.62; p=0.01***	**T=3.35; p=0.001***
P value Adenoidectomy	**T=0.41; p=0.34**	**T=1.17; p=0.12**	**T=1.86; p=0.04***	**T=2.62; p=0.01***
P value Isolated TRA	**T=1.59; p=0.11**	**T=3.58; p<0.001***	**T=2.10; p=0.04***	**T=2.55; p=0.01***

Fig. 1. Results of the nasal resistance in rhinomanometry preoperatory, 1, 3, 6 and 12 months after surgery. In the bars, mean ± standard deviation (Pa/s cm^3). Behind bars: p value and association value of scores at 1, 3, 6 and 12 months compared against basal values. Bold and asterisk if statistically significant.



P value Total	**T=-5.11; p<0.001***	**T=-7.47; p<0.001***	**T=-8.10; p<0.001***	**T=-8.10; p<0.001***
P value Adenoidectomy	**T=-2.84; p=0.007***	**T=-2.72; p=0.009***	**T=-3.70; p<0.001***	**T=-4.18; p<0.001***
P value Isolated TRA	**T=-4.25; p<0.001***	**T=-7.72; p<0.001***	**T=-7.34; p<0.001***	**T=-5.55; p<0.001***

Fig. 2. Results of the nasal airflow in rhinomanometry preoperatory, 1, 3, 6 and 12 months after surgery. In the bars, mean ± standard deviation (ml/s). Behind bars: p value and association value of scores at 1, 3, 6 and 12 months compared against basal values. Bold and asterisk if statistically significant.

In this study we have not obtained a significant association between quality-of-life scores and rhinomanometry variables. This is a highly discussed aspect regarding rhinomanometry [16]. However, it is not a valid argument against its use, as it is not meant to be a substitute for anamnesis, only a complement. Furthermore, the objective of surgery is not only to increase quality of life, but also, and mainly, to guarantee adequate nasal ventilation in order to prevent complications related to nasal obstruction. Children often provide inadequate assessments of their own nasal breathing and, therefore, an objective test is needed [17].

The second major complaint about the use of rhinomanometry in children is that reference values vary with age, decreasing with the increase in age [18]. This can be overcome with the use of relative measurements instead of absolute values. Applying the decongestant test

Table 2
Decongestant test. Correlation between preoperative difference in nasal resistance with the decongestant test and postoperative results of nasal resistance.

	Whole sample	Cohort A (Isolated turbinate surgery)	Cohort B (Associated adenoidectomy)
1 month	Rho = 0.76 (p < 0.001)	Rho = 0.89 (p < 0.001)	Rho = 0.68 (p = 0.01)
3 months	Rho = 0.75 (p < 0.001)	Rho = 0.91 (p < 0.001)	Rho = 0.66 (p = 0.02)
6 months	Rho = 0.73 (p < 0.001)	Rho = 0.92 (p < 0.001)	Rho = 0.70 (p = 0.02)
12 months	Rho = 0.80 (p < 0.001)	Rho = 0.89 (p < 0.001)	Rho = 0.69 (p = 0.03)

Table 3
SN5 score (mean ± standard deviation), in each column the individual domains of the questionnaire. Bold and asterisk if the difference between observations is statistically significant. T (Total sample). A (Cohort A). B (Cohort B).

	1 - Infection	2 - Obstruction	3 - Allergy	4 - Emotional	5 – Activity limitation	VAS score	Total score
Basal	T = 2.97 ± 1.55	T = 4.33 ± 1.46	T = 2.62 ± 1.72	T = 1.90 ± 1.81	T = 0.74 ± 0.99	T = 5.65 ± 1.93	T = 12.56 ± 5.04
	A = 2.88 ± 0.23	A = 4.34 ± 0.22	A = 2.84 ± 0.27	A = 2.04 ± 0.28	A = 0.74 ± 0.15	A = 5.78 ± 0.28	A = 12.84 ± 0.82
	B = 3.14 ± 0.28	B = 4.32 ± 0.25	B = 2.21 ± 0.25	B = 1.64 ± 0.29	B = 0.75 ± 0.16	B = 5.43 ± 0.34	B = 12.07 ± 0.63
1 month	T = 2.42 ± 1.49	T = 2.3 ± 1.99	T = 2.02 ± 1.78	T = 1.00 ± 1.28	T = 0.60 ± 0.90	T = 7.48 ± 1.73	T = 8.34 ± 5.21
	A = 2.62 ± 0.26	A = 2.35 ± 0.33	A = 2.35 ± 0.30	A = 1.11 ± 0.22	A = 0.59 ± 0.15	A = 7.38 ± 0.29	A = 9.03 ± 0.92
	B = 1.78 ± 0.30	B = 2.22 ± 0.43	B = 1.33 ± 0.34	B = 0.72 ± 0.27	B = 0.50 ± 0.20	B = 7.61 ± 0.38	B = 6.56 ± 0.88
3 months	T = 1.58 ± 1.32	T = 1.61 ± 1.36	T = 1.54 ± 1.38	T = 1.24 ± 1.39	T = 0.34 ± 0.57	T = 7.49 ± 1.63	T = 6.32 ± 4.75
	A = 1.62 ± 0.26	A = 1.69 ± 0.26	A = 1.59 ± 0.25	A = 1.31 ± 0.25	A = 0.24 ± 0.09	A = 7.48 ± 0.31	A = 6.45 ± 0.83
	B = 1.29 ± 0.32	B = 1.50 ± 0.34	B = 1.57 ± 0.40	B = 1.07 ± 0.40	B = 0.50 ± 0.17	B = 7.43 ± 0.45	B = 5.93 ± 1.38
6 months	T = 1.79 ± 1.40	T = 1.87 ± 1.55	T = 1.50 ± 1.43	T = 1.29 ± 1.39	T = 0.34 ± 0.67	T = 7.97 ± 1.55	T = 6.79 ± 5.22
	A = 1.81 ± 0.30	A = 1.67 ± 0.30	A = 1.37 ± 0.23	A = 1.26 ± 0.27	A = 0.22 ± 0.11	A = 8.11 ± 0.28	A = 6.33 ± 0.99
	B = 1.31 ± 0.27	B = 1.88 ± 0.36	B = 1.63 ± 0.43	B = 1.06 ± 0.34	B = 0.44 ± 0.18	B = 7.88 ± 0.41	B = 6.31 ± 1.35
12 months	T = 1.55 ± 1.26	T = 1.86 ± 1.55	T = 1.45 ± 1.47	T = 1.00 ± 1.48	T = 0.45 ± 0.74	T = 7.91 ± 1.60	T = 6.32 ± 5.33
	A = 1.29 ± 0.27	A = 1.52 ± 0.26	A = 1.43 ± 0.25	A = 0.76 ± 0.29	A = 0.24 ± 0.14	A = 8.48 ± 0.25	A = 5.24 ± 0.94
	B = 1.50 ± 0.40	B = 1.90 ± 0.60	B = 1.20 ± 0.51	B = 1.10 ± 0.46	B = 0.70 ± 0.26	B = 7.70 ± 0.63	B = 6.40 ± 2.02
P value Basal - 1	**T=2.00; p=0.04***	**T=6.66; p < 0.001***	T = 1.88; p = 0.06	**T=3.06; p=0.003***	T = 0.83; p = 0.41	**T=-5.43; p < 0.001***	**T=4.57; p < 0.001***
P value Basal - 3	**T=4.87; p < 0.001***	**T=9.92; p < 0.001***	**T=3.47; p < 0.001***	**T=2.02; p=0.04***	**T=2.40; p=0.02***	**T=-5.18; p < 0.001***	**T=6.57; p < 0.001***
P value Basal - 6	**T=3.98; p < 0.001***	**T=8.39; p < 0.001***	**T=3.45; p < 0.001***	T = 1.83; p = 0.07	**T=2.27; p=0.03***	**T=-6.45; p < 0.001***	**T=5.73; p < 0.001***
P value Basal - 12	**T=3.96; p < 0.001***	**T=6.92; p < 0.001***	**T=2.88; p=0.005***	**T=2.13; p=0.04***	T = 1.27; p = 0.21	**T=-5.00; p < 0.001***	**T=5.07; p < 0.001***

with rhinomanometry allows us to explore the variations in nasal resistance and nasal airflow after turbinate decongestion [19]. This test has pre-defined cutoff values for adults [20] and children [21] and shows a similar behavior in both age subgroups, being the defined cutoff value 40% improvement in nasal resistance. In this study we found a significant correlation and predictive value of the decongestant test in children. This means that the postoperative values of nasal resistance were closely related to those of the decongestant test. However, it is noteworthy that the results were better (higher) for those children without adenoid hypertrophy. This is a logical finding, as decongestants have no effect on the adenoids. In fact, previous researchers have suggested that the children who do not show improvement with the decongestant test are the best candidates for adenoidectomy [22].

Finally, the third major debate involving rhinomanometry in children is whether to use anterior (AAR) or posterior active rhinomanometry (PAR). When AAR is used, nasopharyngeal pressure is determined above the adenoids, rather than below, as is the case when resorting to PAR. According to previous reports, the cooperation of children is considerably higher for anterior rhinomanometry [23]. Therefore, despite the fact that PAR would be an ideal method, in this study and in every day practice we use AAR. In this study, a significant association between the size of the turbinates and nasal resistance was established, but not with adenoid size. This is in line with previous reports, which suggest that there is little association between the size of the adenoids and nasal resistance in rhinomanometry, except for the extremes (none, or complete obstruction) [24]. It could also be the result of performing AAR instead of PAR.

In regards to the SN5 questionnaire, it has been widely popularized since its publication and has been used in research to evaluate pediatric turbinate surgery [25], adenoidectomy [26,27], balloon catheter sinuplasty [27–31], endoscopic sinus surgery [32,33], and for the medical treatment of chronic rhinosinusitis [30,34,35]. Recently, a systematic review assessing it demonstrated a good internal and external validity for this test [36]. In this study we found a statistically significant association between the size of the adenoids and turbinates and the quality of life when using the SN5 questionnaire, which supports its use in daily practice.

However, despite its popularity, a recent systematic review revealed that only 4 studies have used quality-of-life questionnaires after turbinate surgery in children [14,25,37,38], and only one of them used a questionnaire specifically designed to assess quality of life including sinonasal symptoms, SN-5 [25]. In this study we have also used SN5, which allowed us to compare our results. We have found a significant improvement in the global score and all its individual domains. Our results are lower than Manzi et al.'s, who report an improvement in the overall quality of life score of 3.13 points while we obtained 1.83. This cannot be explained due to our basal scores, as Manzi et al. reported 5.21; while our score was 5.65. It could, however, be explained by the different surgical techniques employed, as they used microdebrider assisted inferior turbinoplasty (MAIT) and we chose turbinate radiofrequency ablation. We preferred TRA for its better control of the turbinates' head, which causes the greatest resistance to airflow. Nevertheless, future studies comparing both techniques are encouraged.

The domain with the highest improvement was nasal obstruction, which is in line with previous reports [25], and the second was allergy symptoms. Despite turbinate surgery not changing the allergenic process as children will continue to be allergic, it improves nasal symptoms related to allergy as well as asthma given that these children will be nasal breathers [39].

Interestingly, we had a 61.1% of allergic patients. In our sample, and similarly to other authors [25], we found no differences regarding changes in nasal resistance between cohorts of children with and

without allergy. Contrary to us, Argranbright et al. reported worse results in allergic children [40]. This difference might be explained by the follow-up period, as Arganbright et al. followed their sample for 4.5 years [40]. This is an important aspect in order to accurately select the surgical technique to be employed. If relapse were higher in allergic patients, then it would be appropriate to choose surgical techniques appropriate to these cases, as Arganbright et al. recommended. However, to date, there are no clinical trials comparing techniques in allergic children and this is only a working hypothesis.

We identified a considerably higher complication rate than previously reported, 3.1% [4]. This can be explained by the fact that we, unlike other authors, have specifically asked parents about possible complications. Parents have reported symptoms that could be better explained as secondary to surgery, instead of complications. For example, crusting is a common occurrence after turbinate surgery. In the same way, mild bleeding at the time of sneezing is a standard eventuality. These experiences were probably considered complications by parents, however, even with this high reported complication rate, they were all mild cases.

This study has some weakness. First, it is an uncontrolled study. Therefore, it is prone to some bias, especially regarding the SN5 questionnaire, as there is a placebo effect that should not be discarded. The second potential weakness is its mixing data of children who had and had not experienced adenoidectomy. We decided to include them as there were no differences between groups, and we have performed a subgroup analysis in order to prevent mixing information. We believe that, as almost 80% of surgeons perform turbinate surgery associated to adenoidectomy [3], this study should include that cohort. A third weakness is that we have not included acoustic rhinometry. This procedure offers anatomic information, so it is complementary to rhinomanometry. Although it is less reliable after 5 cm, which could limit its use in children, it has been previously used in pediatric turbinate surgery [4]. However, it has not been included as it is not an adequate tool in assessing the adenoids and, in our cohort, nasal adaptors were too big for our patients. Finally, comorbid conditions such as neurologic abnormalities, asthma, or endocrine diseases could act as confounding factors as they could be related to nasal symptoms. In this study we have not controlled these variables. As they have a low prevalence, it is not expected a noticeable effect in this study. However, it cannot be discarded.

A possible criticism to this study might be that our sample might not be representative in every case, as our mean age was 9.7 years for children undergoing adenoidectomy with turbinate radiofrequency ablation, as it is usually performed in younger children. However, turbinate surgery is usually performed in this age range [4], and this explains the increased mean age.

Our work has strengths as well. This is one of the largest prospective cohorts of turbinate surgery in pediatric patients [4]. It is also the only study where SN5 was administered at the same time as rhinomanometry, and the only one performing rhinomanometry with and without nasal decongestant.

In conclusion, turbinate surgery in pediatric patients seems to be a safe procedure which objectively and subjectively improves the symptoms of children suffering from nasal obstruction.

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Compliance with ethical standards

- Founding source: none
- All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflicts of interest

This work is part of the research completed by Christian Calvo-Henriquez, MD, to obtain a PhD degree. The rest of authors declare no disclosure or conflict of interest.

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