

Inferior Turbinate Hypertrophy: A Review of the Evolution of Management in Children

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Abstract

Background: Historically, there has been uncertainty in the treatment of inferior turbinate hypertrophy (ITH) in children. Although management always begins with medical therapy, the decision to offer surgery in resistant cases is becoming more widely practiced. In the pediatric population, turbinate reduction can be achieved with turbinectomy, electrocautery, lasers, submucous microdebridement, and radiofrequency volumetric tissue reduction (RVTR). However, there remains a lack of consensus on the preferred approach to treatment.

Objective: To compare how the efficacy, duration, and complications of different surgical methods has changed the management of inferior turbinate hypertrophy in children over time.

Methods: In March 2018, a comprehensive literature search was performed in PubMed for all inferior turbinate hypertrophy management-related studies in children. Inclusion criteria included children (age, 1–17 years). Exclusion criteria included reviews and abstracts.

Results: Each technique has experienced a period of popularity over the last 30 years in parallel with the technology available at the time as well as evidence from studies in adults. The literature for ITH management in children has largely followed these trends, with a recent improvement in the quality of studies mirroring the overall increase in surgical practice. Of all methods currently used, RVTR and submucous microdebridement offer the least invasive and most efficacious relief of nasal obstruction.

Conclusion: This review provides an overview of the evolution of ITH management in children and, based on historic and current evidence, proposes the following graduated recommendation to treatment: (1) a 3-month trial of medical management, (2) evaluation for adenoid hypertrophy for consideration of concurrent adenoidectomy, and (3) RVTR or submucous microdebridement as the first-line surgical approach.

Keywords

pediatric airway, pediatrics, pediatric rhinology, inferior turbinate hypertrophy, surgical management

Introduction

Inferior turbinate hypertrophy (ITH) is a common cause of nasal obstruction in children. Chronic obstruction due to ITH can negatively affect a child's quality of life and may lead to rhinorrhea, mouth breathing, obstructive sleep apnea (OSA), and craniofacial deformity.¹ Medical therapy with antihistamines and intranasal steroids is generally the first-line treatment. Nevertheless, patients frequently do not respond to conservative measures.² In cases of medical failure, surgical reduction of the turbinates should be considered.

The goal for inferior turbinate surgery is to maximize nasal airflow through the reduction of the bony

turbinate and erectile submucosal tissue while concurrently preserving turbinate mucosa in order to preserve the humidification and warming of inspired air. It is due to this risk of damaging the mucosa and the resulting functional disruption that surgery is generally offered

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only after unsuccessful attempts at conservative management. In adults, there are specific indications for surgical management. These include symptoms refractory to 3 months of medical treatment, insufficient treatment of OSA with conservative options, persistent rhinitis medicamentosa, and measured turbinate hypertrophy in patients who are simultaneously scheduled for septoplasty, rhinoplasty, or endoscopic sinus surgery.^{3,4}

There are no such guidelines for when to offer inferior turbinate surgery in children for a number of reasons. Historically, otolaryngologists have been conservative in the management of inferior turbinate hypertrophy in children due to the fear of disrupting facial growth via midface surgery, as demonstrated in an animal model by Maier et al. and by others.^{5–7} Furthermore, the adenoids are often involved in pediatric nasal obstruction and make it difficult to assess the degree to which the inferior turbinates contribute to air flow impediment. As such, the decision to perform inferior turbinate reduction has generally been made based on insufficient restoration of nasal flow following adenoidectomies.^{8,9}

More recently, turbinate surgery is being offered to a wider cohort of pediatric patients with inferior turbinate hypertrophy.¹⁰ There is growing evidence that concomitant inferior turbinate surgery strongly improves symptoms of nasal obstruction relative to adenoidectomy alone without increasing risk for complications. Simultaneous operations also decrease the likelihood for a future episode of general anesthesia. Moreover, other studies have demonstrated the utility of turbinate surgery without a preceding adenoidectomy.¹¹ Similarly, patients with OSA who underwent turbinate reduction had a superior apnea-hypopnea index (0.8 vs 3.5 per hour) and snoring index (104 vs 158 per hour) compared to children who underwent adenoidectomy alone.^{12,13} Thus, inferior turbinate surgery is more commonly being performed in children with nasal obstruction alone and with OSA who have not responded to medical management.

Over the course of the past few decades, various surgical options have been described in the treatment of ITH resistant to medical management in children, including turbinectomy, diathermy, laser cautery, submucous microdebridement, and radiofrequency volumetric tissue reduction (RVTR). A few studies have compared techniques in terms of outcomes and frequency of use.^{14–16} However, to our knowledge, no study has examined the evolution of ITH management in a pediatric population. Our review aims to offer a comprehensive comparison of the efficacy, duration, and complications of different methods over time to investigate how the perception and practice of surgical management has transformed since its introduction in children.

Methods

A literature search of PubMed was undertaken through March 2018 using MESH terms “inferior turbinate hypertrophy,” “children,” and “surgery.” Abstracts and titles were evaluated for relevance. Retrospective and prospective case series and cohort studies were included. Articles with an adult or mixed-aged cohort where the pediatric population could not be analyzed separately were excluded. The bibliographies of relevant studies were searched for other publications. A total of 82 citations were reviewed, of which 16 fulfilled the inclusion criteria for this study.

Selected studies were then evaluated for outcomes of the various surgical methods. Subjective outcomes based on parental questionnaires and interviews, postoperative follow-up, and complication rates were collected from each study and combined into a pooled outcome data set for each technique. These outcomes were chosen for pooling because their reporting was consistent among the majority of studies. Objective measures of nasal obstruction relief were not included in our analysis due to inconsistent methodologies of data collection among studies as well as an overall lack of objective data collection. A formal statistical comparison of efficacy, duration of effect, and complication rates between techniques was not possible due to varying follow-up and differing outcome measures among studies.

Results

Sixteen studies met the inclusion criteria from the years of 1989–2018 with a total of 1012 patients aged between 1 and 17 years (Table 1). Seven of the studies were retrospective case series, 2 were retrospective comparative case series of different techniques, 4 were prospective case series, and 3 were prospective cohort studies. The various surgical methods assessed were turbinectomy (5 studies, 372 patients), submucosal diathermy (2 studies, 58 patients), laser cautery (3 studies, 50 patients), submucous microdebridement (4 studies, 233 patients), and RVTR (5 studies, 299 patients).

Outcomes from the different studies were pooled to compare turbinate reduction techniques (Table 2). Turbinectomy was associated with 68% to 93.4% subjective improvement of symptoms at 12- to 26-month follow-up. Postoperative complications included bleeding (0%–2.6%), crusting (0%–3.1%), synechia (0%–6.6%), and facial bone malformation (0%–0.44%). Submucosal diathermy was associated with 36% to 51% improvement and postoperative complications including bleeding (13%–18%), pain (4%), and anosmia (7%) at 23- to 72-month follow-up. There was 50% to 90% subjective improvement following laser cautery at 18- to 32-month follow-up and 93%

Table 1. Overview of Study Characteristics.

Method	Number of Studies	First Author	Year	Study Types ^a	Number of Patients	Patient Age Range
Turbinectomy	5	Thompson	1989	1	22	9–15
		Percodani	1996	1	38	9–16
		Weider	1998	1	64	3–15
		Segal	2003	1	227	3–10
		Arganbright	2015	2	21	1–17
Submucosal diathermy	2	Rejali	2004	2	11	6–16
		Montgomery	2011	1	47	3–14
Laser cautery	3	Pang	1995	1	20	6–15
		Araki	2001	3	22	9–15
		Rejali	2004	2	8	6–16
Submucous microdebridement	4	Chen	2007	3	120	9–14
		Cheng	2008	4	51	3–12
		Arganbright	2015	2	19	1–17
		Manzi	2017	1	43	5–17
Radiofrequency volumetric tissue reduction	5	O'Conner-Reina	2007	3	93	2–9
		Sullivan	2008	4	86	1–17
		Simeon	2010	3	9	6–16
		Bitar	2014	4	32	6–17
		Arganbright	2015	2	79	1–17

^a(1) Retrospective case series, (2) retrospective comparative case series, (3) prospective case series, and (4) prospective cohort study.

Table 2. Pooled Outcomes for Each Surgical Technique.

Method	Subjective Improvement ^a	Follow-up	Complications
Turbinectomy	68%–93.4%	12–26 months	Bleed (0%–2.6%) Crusting (0%–3.1%) Synechia (0%–6.6%) Facial bone malformation (0%–0.44%)
Submucosal diathermy	36%–51%	23–72 months	Bleed (13%–18%) Pain (4%) Anosmia (7%)
Laser cautery	50%–90%	18–32 months	—
Submucous microdebridement	93%	3–12 months	—
Radiofrequency volumetric tissue reduction	93.6%–100%	6 weeks–12 months	Bleed (0%) Crusting (0%–8.6%) Synechia (0%)

^aOutcomes are from reports from parental questionnaires and interviews.

improvement at 3- to 12-month follow-up after submucous microdebridement. In the included studies, there were no data on postoperative complications for either method. Finally, radiofrequency volumetric tissue reduction was associated with 93.6% to 100% subjective improvement, crusting (0%–8.6%), and no bleeding or synechia at 1.5- to 12-month follow-up.

Evolution of Techniques

Partial or total inferior turbinectomy, electrocautery, lasers, submucous microdebridement, and RVTR have

all been used for the surgical treatment of ITH in children. Over the past few decades, the practice of pediatric inferior turbinate surgery has changed with the introduction of new techniques providing greater efficacy and minimizing postoperative complications.

Turbinectomy

Turbinectomy was first described in the late 19th century and was one of the first surgical methods used for the management of ITH. It has historically been thought to be particularly advantageous in cases of ITH due to

bony hypertrophy. Despite concerns about postoperative atrophic rhinitis, ozena (a chronic disease of the nose marked by fetid discharge and atrophic changes), intranasal adhesions, and hemorrhage, turbinectomy was the most common treatment in the 1970s and 1980s, with 1 study showing a 50% to 70% practice rate (adults and children) during that time.¹⁷ Thompson in 1989 was the first to provide evidence on the efficacy and safety of the procedure in children, showing 68% subjective improvement in nasal airway and 0% persisting postoperative complications at 2-year follow-up.¹⁸ Other studies have since produced similar results (Table 2).^{9,19,20} Notably, this technique has substantially waned in popularity over the past 30 years with the advent of newer, mucosal preserving operative methods with seemingly superior complication profiles. Recent studies have shown rates of use at or lower than 19%, far below that of other techniques.^{15,16,21}

Electrocautery

Electrocautery was the first method recorded to treat ITH and has steadily evolved in practice since its introduction almost 2 centuries ago.²² Electrocautery is typically offered to patients with mucosal abnormalities of the turbinates, as it causes fibrosis and contraction of this layer. Of the various techniques produced over the years, diathermy, either submucosal or surface, is the most commonly utilized method of electrocautery currently in children.

To date, only 2 studies have assessed the effects of submucosal diathermy in children. Rejali et al. report poor long-term outcomes, with recurrent obstructive symptoms in 64% of patients at 2-year follow-up as well as high rates of postoperative bleeding (18%).²³ Meanwhile, Montgomery et al. found relief of symptoms in 51% of patients at 6-year follow-up and comparatively lower rates of postoperative epistaxis (13%), anosmia (6%), and facial pain (4%).²⁴ The evidence for durational efficacy as well as severity of complications is similarly mixed in adult studies.^{25–27} Despite these outcomes, submucosal diathermy has been historically associated with rapid healing and early restoration of mucosal function and was one of the most common surgical methods for ITH reduction in children in the 1990s before steadily declining in practice with the introduction of other techniques.¹⁴

Lasers

Since the introduction of an Argon laser for adults in 1977, the use of carbon dioxide (CO₂), diode, and Holmium-Yttrium-Aluminum garnet (Ho:YAG) lasers has been described in the treatment of ITH in

children.^{23,28–30} In 2 small prospective studies, both Pang et al. and Araki et al. demonstrated strong short-term efficacy, with 90% 18-month and 86% 2-week subjective improvement in obstructive symptoms, respectively, preserved mucosal function and no postoperative hemorrhage after both CO₂ and diode laser treatment. Meanwhile, Rejali et al. showed only 50% improvement of nasal obstruction at 3-year follow-up with the Ho:YAG laser.²³ However, in comparison to submucosal diathermy, the Ho:YAG laser had superior efficacy as well as lower rates of postoperative pain, crusting, and bleeding.

Despite a limited complications profile, laser cautery has never been a commonly used technique in the pediatric population, likely because of the more extensive record of evidence in adults.^{15,16} In adults, laser treatment has produced similarly variable efficacy, with studies demonstrating a direct association between the volume of turbinate reduction and degree of mucosal destruction.²² Thus, more recently developed techniques including submucous debridement and radiofrequency volumetric tissue reduction offer more consistent results with greater preservation of functional mucosal tissue.

Submucous Microdebridement

Due to the added benefit of mucosal preservation, submucosal resection of the hypertrophied turbinate has been a popular alternative to inferior turbinectomy since the mid-20th century.²² In fact, Passali et al. found that submucosal resection with lateral displacement provided superior long-term efficacy, preservation of mucosal function, and lower rates of postoperative complications relative to other commonly practiced techniques in adults in the 1990s.³¹ When first introduced at the turn of the century, the microdebrider-assisted technique was expected to offer even better mucosal preservation and overall outcomes due to more precise and incremental tissue removal.³²

Submucous microdebridement has indeed proven to be effective in the treatment of pediatric ITH. Chen et al. were the first to compare short-term outcomes of classic submucosal resection and microdebridement in children. Despite significant subjective symptomatic pre- to postoperative improvement in both groups ($P < .05$), the microdebrider-assisted cohort demonstrated superior nasal airflow ($P < .05$ on rhinomanometry) as well as quicker restoration of mucosal function ($P < .05$ on saccharin test).³³ Long-term patency of submucous microdebridement was 93% at 2 years.³⁴ Meanwhile, Cheng et al. showed that microdebrider-assisted treatment provided significant symptomatic improvement in children with OSA relative to adenoidectomy alone (AHI 0.8 vs 3.5), with no increased risk for postoperative bleeding, crusting, synechia, or atrophic changes.¹² Despite these perceived benefits in mucosal preservation and long-term efficacy,

microdebridement is currently used in under 18% of ITH reduction procedures in children, well behind the current method of choice, RVTR.^{15,16}

Radiofrequency Volumetric Tissue Reduction

A recent survey of pediatric otolaryngologists revealed that radiofrequency coblation is currently the technique of choice for ITH surgery in children and is used in 47% of cases.¹⁶ This represents a dramatic change in practice, as RVTR was only introduced as an alternative to conventional electrocautery in the early 2000s.³⁵ As early studies in adults demonstrated long-lasting improvements in nasal volume, subjective improvement of the nasal airway, and low complication rates due to mucosal preservation, RVTR steadily gained acceptance as a low-risk method in children as well.³⁶

Along with inferior turbinectomy, RVTR is perhaps the best studied technique for ITH management in children. O'Conner-Reina et al. were the first to report both objective (Podoshin plate 3.4–7.0) and subjective (94%) symptomatic improvements in nasal conductance as well as 0% rate of postoperative complications in children at 1-year follow-up.³⁷ Since then, multiple other studies have confirmed long-lasting improvement of nasal symptoms with low rates of postoperative crusting and epistaxis and no reports of synechiae or ozena (Table 2).^{13,38,39} Furthermore, there is evidence that preoperative assessment may help differentiate patients who would most benefit from radiofrequency coblation. Yilmaz et al. showed that the response to a preoperative topical vasoconstrictor drop test may predict long-term efficacy of RVTR in pediatric patients.⁴⁰ Also, the patients with more severe preoperative nasal obstruction may derive the greatest benefit from the procedure.⁴¹

Although RVTR and submucous microdebridement have both been described as long lasting and mucosal sparing alternatives to conventional turbinate reduction, it remains unclear whether one method has advantages over the other. Although RVTR is more commonly practiced, direct comparisons in the efficacy of the 2 techniques have only been made in 1 study in children. Arganbright et al. stated no difference between methods in postoperative recurrence ($P=.10$) but did not compare rates of subjective or objective relief of symptoms, duration of relief, or complications.¹⁵ Adult studies provide clearer evidence on this matter and have found no difference in nasal airflow improvement or disruption of nasal physiology between the 2 methods.^{42,43}

Discussion

As relatively newer, less invasive, and mucosal sparing methods such as submucous microdebridement and RVTR have overtaken older techniques including

turbinectomy and diathermy for the treatment of nasal obstruction in the pediatric population, ITH surgery is more commonly perceived to offer long-lasting results at reduced risks (Table 2). Consequently, the threshold to move past conservative options and to pursue surgical management has shifted significantly over the last few decades.¹⁰ Still, no guidelines currently exist to help guide the escalation of management in children.

The quality of evidence in the literature is likely the major reason for this void. Historically, there has been a relative lack of research on the topic of pediatric ITH management, likely reflecting the practice at a time when ITH was not routinely surgically managed. Furthermore, since the first publication in the 1980s through the early 2000s, most reports were of small retrospective case series that presented subjective findings with differing outcome measures and varying follow-up, making it difficult to draw comparisons between results. The few studies that did compare different surgical methods did not include all available techniques and failed to assess objective measures for comparison.²³ These findings reflect those of a 2010 systematic review in which Leong et al. reported only low-level evidence to support turbinate reduction in children.¹⁴

Nevertheless, the choice of surgical management in the treatment of ITH in children has changed drastically in the last 30 years. Because of a lack of a consistent means of comparison between techniques in children, we believe that these trends are largely influenced by the higher quality evidence of studies in adults, which currently support the use of RVTR and submucous resection over other methods.⁴⁴ In fact, the literature on pediatric turbinate reduction mostly parallels the practice of ITH management in adults over time, with studies of each technique published around the period of popular use in adults (Table 1).²²

As these trends have changed, so has the quality of publications. Since 2007, there have been 7 prospective and 2 retrospective comparative studies published, compared to 1 of each previously. Furthermore, objective outcomes were much more commonly reported than previously, though different studies used different methods to measure relief of obstruction. In combining the new evidence with that of previous reports, we have noticed a number of common themes:

1. First, not all symptomatic ITH in children is amenable to medical management.
2. Of those patients who fail medical management, ITH reduction is generally more efficacious than adenoidectomy alone.
3. Although all surgical techniques offer benefit and improve nasal obstruction, less invasive surface sparing procedures tend to have fewer complications while

Table 3. Graduated Approach to ITH Management in Children.

Graduated Approach to ITH Management in Children

1. Three-month trial of medical management.
2. Evaluate for adenoid hypertrophy. If present, we recommend planning for concurrent adenoidectomy and turbinate reduction surgery.
3. RVTR^a or submucous microdebridement as the first-line surgical approach.
4. Consider turbinectomy when (a) previous steps fail, (b) in cases of bony turbinate hypertrophy, or (c) as primary surgical treatment for severe ITH.

^aRadiofrequency volumetric tissue reduction.

submucosal removal of tissue may have longer lasting effects (Table 2).

Based on these findings as well as the recommendations of practice in adult patients, we suggest the following graduated treatment approach of ITH in children (Table 3). This is the first study that, according to the authors' knowledge, offers an algorithm in the treatment of pediatric turbinate hypertrophy. However, it should be noted that while this proposed protocol is supported by trends in the literature, it is limited by several factors. As aforementioned, direct comparisons between study outcomes were difficult to make due to widespread variability in objective data collection methods. Previous reports attribute these inconsistencies to imperfect nasal obstruction measuring tools in children.⁹ Similarly, the variable follow-up between studies reduced the quality of our comparisons in efficacy and complications. For instance, studies of outcomes in RVTR had significantly shorter follow-up than those of other techniques. Either a randomized clinical trial or high-quality prospective study evaluating currently practiced surgical techniques at equal, and ideally long-term, follow-up is necessary to bring clarity to these deficiencies. Finally, a cost-effectiveness analysis would help further support the practice of efficacious but more expensive techniques, such as microdebridement, over other less costly methods.

Conclusion

The last 30 years have seen a drastic change in the practice of ITH management in children. As pediatric otolaryngologists have increasingly adopted the practice of surgical management for this issue, the turbinate reduction method of choice has evolved from the historical practice of turbinectomy to mucosal sparing procedures such as RVTR and submucous microdebridement. These trends toward newer technologies have been

spearheaded by their reduced complication profile and improving long-term outcomes. As we move into an era of increased surgical management of pediatric ITH, well-designed prospective studies comparing procedural options are needed to establish a clear guideline in management.

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