

Article

Comparative Effectiveness of Endoscopic Coblation Adenotonsillotomy Versus Conventional Adenoidectomy in Pediatric Chronic Otitis Media with Effusion: A 12-Month Longitudinal Study

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Abstract

Background/Objectives: Chronic otitis media with effusion (OME) is the primary cause of conductive hearing loss in children. High recurrence rates following conventional surgery are often linked to incomplete nasopharyngeal clearance or persistent adenotonsillar biofilms. This study evaluates the long-term impact of endoscopic coblation adenotonsillotomy on middle ear clearance and disease recurrence compared to conventional curettage adenoidectomy. **Methods:** We conducted a prospective comparative study on 142 pediatric patients with persistent OME. Participants were allocated into Group A (Endoscopic Coblation Adenotonsillotomy, $n = 72$) and Group B (Conventional Curettage Adenoidectomy, $n = 70$). Groups were homogeneous regarding age, gender, and baseline audiological parameters ($p > 0.05$), all presenting with moderate conductive hearing loss and Type B/C tympanograms. Primary outcomes included tympanometric normalization (Type A conversion), auditory gain (Air–Bone Gap closure), and the rate of secondary ventilation tube (VT) insertion, monitored at 1, 3, 6, and 12 months. **Results:** At the 1-month follow-up, Group A showed a higher normalization rate than Group B (75.0% vs. 60.0%), though this was near the threshold of statistical significance ($p = 0.058$). However, at 3, 6, and 12 months, the coblation group demonstrated significantly higher recovery rates ($p < 0.05$). By 12 months, 94.4% of Group A maintained a Type A tympanogram compared to 78.5% in Group B. Group A achieved a significantly lower mean ABG at 12 months (8.2 ± 3.1 dB vs. 12.6 ± 5.4 dB, $p < 0.001$), reflecting a superior auditory gain (20.2 dB vs. 15.3 dB). Furthermore, the recurrence rate was significantly lower in Group A (4.1% vs. 15.7%, $p = 0.021$), resulting in a substantially lower requirement for secondary VT insertion compared to the conventional group (2.7% vs. 12.8%, $p = 0.018$). **Conclusions:** Endoscopic coblation adenotonsillotomy provides significant long-term clinical advantages over conventional curettage. By ensuring precise, atraumatic clearance of the Fossa of Rosenmüller and addressing the tonsillar biofilm reservoir, this technique achieves more stable middle ear aeration and superior auditory recovery, significantly reducing the necessity for secondary surgical interventions at one year.



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Keywords: coblation; otitis media with effusion; endoscopic adenoidectomy; biofilms; long-term recurrence; 12-month follow-up

1. Introduction

Otitis Media with Effusion (OME) represents the most prevalent cause of conductive hearing loss in the pediatric population and is the primary indication for surgery in children worldwide. While often self-limiting, persistent OME can lead to significant long-term sequelae, including chronic conductive hearing loss, speech and language developmental delays, and structural changes to the tympanic membrane. Consequently, the timely and effective restoration of middle ear ventilation is a priority in pediatric otolaryngology [1].

The pathogenesis of OME is multifactorial, yet it is intrinsically linked to the dysfunction of the Eustachian tube (ET). Classically, adenoid hypertrophy has been implicated as the main mechanical factor, causing direct obstruction of the nasopharyngeal orifice of the ET. However, recent advancements in microbiology have shifted the focus toward the “Biofilm Theory” [2,3].

Current literature suggests that both the adenoids and the palatine tonsils act as a chronic reservoir for bacterial biofilms. These pathogens migrate visibly and microscopically, ascending towards the nasopharynx and the middle ear, maintaining a state of chronic inflammation and edema that perpetuates tubal dysfunction, even in the absence of massive mechanical obstruction [4,5].

Traditionally, adenoidectomy performed via curettage has been the gold standard for alleviating nasopharyngeal obstruction [6]. Despite its proven efficacy, this method possesses inherent limitations. Being a blindly performed procedure, it carries the risk of incomplete resection, particularly in the critical area of the Fossa of Rosenmüller, or conversely, the risk of iatrogenic trauma to the torus tubarius. Such trauma can lead to postoperative scarring or synechiae, which may paradoxically worsen Eustachian tube function. Furthermore, simple adenoidectomy often neglects the concurrent role of the tonsillar biofilm reservoir.

The advent of Coblation technology combined with endoscopic visualization offers a refined approach. Operating at low temperatures (40–70 °C) through the formation of a plasma field, this technique allows for the precise molecular dissociation of tissue. This minimizes thermal damage to surrounding structures, significantly reducing postoperative edema and pain. Moreover, the concept of Adenotonsillotomy has gained traction as a method to reduce the oropharyngeal bacterial load without the morbidity associated with total tonsillectomy [7,8].

The aim of this study is to conduct a comparative analysis between the efficacy of Endoscopic Coblation Adenotonsillotomy and Conventional Adenoidectomy in the management of pediatric OME. Specifically, we seek to evaluate the impact of these techniques on middle ear clearance, auditory gain, and the long-term recurrence rate of serous otitis.

2. Materials and Methods

This prospective comparative study was conducted in the Department of Otorhinolaryngology between January 2024 and October 2025. The study protocol was approved by the institutional Ethics Committee (Ref. No. 17/15.01.2024). According to local regulatory statements, this study was approved by the local institutional ethical committee without considering it as a clinical trial. All procedures were performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all participants prior to enrollment.

A total of 142 pediatric patients (aged 3 to 10 years) diagnosed with OME and Adenotonsillar Hypertrophy were enrolled. To minimize selection bias, participants were allocated to Group A ($n = 72$), undergoing endoscopic coblation adenotonsillotomy, or Group B ($n = 70$), undergoing conventional cold curettage adenoidectomy with or without adjunct tonsil surgery as clinically indicated, using a computer-generated randomization list. Allocation concealment was maintained using opaque, sealed, sequentially numbered envelopes opened only by the operating surgeon after the induction of anesthesia. There were no deviations from the assigned allocation regarding the primary adenoidectomy technique.

Patients were eligible for inclusion if they were aged 3–10 years and presented with bilateral chronic otitis media with effusion persisting for more than three months despite maximal medical therapy, characterized by Type B or C tympanograms, an audiometric air–bone gap exceeding 20 dB, and endoscopic confirmation of grade III or IV adenoid hypertrophy; conversely, children were excluded in cases of prior adenotonsillar surgery, sensorineural hearing loss, acute upper respiratory tract infections at the time of intervention, or associated craniofacial abnormalities such as cleft palate or Down syndrome.

All surgical interventions were performed under general anesthesia with orotracheal intubation by a single surgical team to eliminate inter-operator variability.

In Group A (Endoscopic Coblation), adenoidectomy was conducted using the Coblation II System (Smith & Nephew, London, UK) with an EVAC 70 wand under continuous 30° endoscopic visualization, allowing for precise, layer-by-layer plasma-mediated ablation of the lymphoid tissue within the Fossa of Rosenmüller. This approach ensured complete exposure of the torus tubarius while strictly avoiding thermal injury to the tubal mucosa, complemented by a simultaneous intracapsular tonsillotomy to achieve a 70–80% volume reduction with capsular preservation.

In contrast, Group B (Conventional Technique) underwent adenoidectomy via digital palpation and ‘blind’ curettage using Beckmann curettes, with hemostasis achieved through gauze packing for 5–10 min; although efforts were made to protect the torus tubarius, direct visualization of the tubal orifice remained inaccessible during the resection phase.

Patients underwent comprehensive preoperative assessment followed by longitudinal monitoring at 1, 3, 6, and 12 months post-intervention, with all postoperative audiometric and tympanometric evaluations conducted by an audiologist blinded to the specific surgical technique to eliminate observer bias.

The primary outcome was defined as tympanometric normalization, conversion to a Type A curve, while secondary outcomes encompassed the mean auditory gain, quantified by the closure of the air–bone gap (ABG), the incidence of OME recurrence, and the requirement for secondary surgical intervention, specifically ventilation tube insertion, within the 12-month follow-up period.

The Air–Bone Gap (ABG) was calculated using the Pure Tone Average (PTA) across four frequencies (0.5, 1, 2, and 4 kHz). Bone conduction thresholds remained stable within normal limits (<15 dB) for all participants throughout the study, consistent with the exclusion of sensorineural hearing loss.

Data were analyzed using SPSS software (Version 25.0). The normality of the distribution for continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and compared using the independent samples Student’s *t*-test for normally distributed data or the Mann–Whitney U test for non-parametric data. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square (χ^2) test or Fisher’s exact test. All analyses were performed on an Intention-to-Treat (ITT) basis, as all randomized subjects completed the follow-up protocol. To estimate the clinical effect size, the mean difference and 95%

Confidence Intervals (95% CI) were calculated for continuous primary outcomes. Statistical significance was defined by a p -value < 0.05 .

A preliminary power analysis conducted a priori determined that a minimum of 50–60 patients per group was required to detect a 20–25% difference in OME resolution with a power of 80% and an alpha level of 0.05. The cohort of 142 patients was therefore adequately powered.

3. Results

A total of 142 pediatric patients met the inclusion criteria and completed the full 12-month follow-up protocol, with the population being allocated into Group A (Coblation, $n = 72$) or Group B (Conventional, $n = 70$). Statistical analysis confirmed that the two cohorts were homogeneous, with no significant differences regarding mean age (6.4 ± 1.8 years in Group A vs. 6.2 ± 1.9 years in Group B; $p = 0.62$), gender distribution (73 males and 69 females total; $p = 0.84$), or baseline clinical parameters. Preoperatively, all patients presented with moderate conductive hearing loss and pathological tympanograms, ensuring that these demographic and audiological variables did not constitute confounding factors in the evaluation of postoperative middle ear clearance and auditory recovery.

In Group A, all patients (100%) underwent simultaneous intracapsular tonsillectomy. In Group B, consistent with conventional indications, 20 patients (28.6%) underwent concurrent cold-steel tonsillectomy/tonsillectomy due to significant obstructive symptoms, while the remaining 50 patients underwent adenoidectomy alone (Table 1).

Table 1. Baseline demographic and preoperative clinical data.

Parameter	Group A ($n = 72$)	Group B ($n = 70$)	p -Value
Age (years), mean $\pm$ SD	6.4 ± 1.8	6.2 ± 1.9	0.521
Gender (Male/Female), n	40/32	33/37	0.845
Preoperative Tympanogram, n (%)			
- Type B	58 (80.5%)	55 (78.5%)	0.768
- Type C	14 (19.5%)	15 (21.5%)	0.768
Preoperative ABG (dB), mean $\pm$ SD	28.4 ± 4.2	27.9 ± 4.5	0.492
Adenoid Grade (III/IV), n	42/30	39/31	0.845

Continuous variables analyzed via Independent Samples t -test; categorical via Chi-square test.

3.1. Primary Outcome: Tympanometric Evolution

Preoperatively, all patients presented with pathological tympanograms (Type B or C). The transition to a Type A tympanogram was used as the primary indicator of OME resolution. At the 1-month follow-up, Group A showed a higher rate of normalization (75.0%) compared to Group B (60.0%), although this difference was near the threshold of statistical significance ($p = 0.058$). However, at the 3, 6, and 12-month marks, the Endoscopic Coblation group demonstrated significantly higher rates of tympanometric recovery ($p < 0.05$). By the end of the study (12 months), 94.4% of patients in Group A maintained a Type A tympanogram, compared to 78.5% in Group B (Table 2).

Table 2. Postoperative tympanometric evolution (type A conversion rate).

Interval	Group A ($n = 72$)	Group B ($n = 70$)	p -Value
1 Month	54 (75.0%)	42 (60.0%)	0.058
3 Months	66 (91.6%)	53 (75.7%)	0.012 *

Table 2. *Cont.*

Interval	Group A (n = 72)	Group B (n = 70)	p-Value
6 Months	69 (95.8%)	57 (81.4%)	0.007 *
12 Months	68 (94.4%)	55 (78.5%)	0.006 *

* Pearson Chi-square.

3.2. Secondary Outcomes: Auditory Gain and Recurrence

The mean Air–Bone Gap improved significantly in both groups postoperatively. However, Group A achieved a significantly lower mean ABG at 12 months (8.2 ± 3.1 dB) compared to Group B (12.6 ± 5.4 dB, $p < 0.001$), resulting in a mean difference of 4.4 dB (95% CI: 2.9–5.9 dB; $p < 0.001$). This corresponds to a superior mean auditory gain in Group A (20.2 dB vs. 15.3 dB), with a mean improvement difference of 4.9 dB (95% CI: 3.4–6.4 dB; $p = 0.002$).

Regarding the recurrence of OME and the need for further intervention, Group A showed a significantly lower recurrence rate (4.1%) compared to Group B (15.7%, $p = 0.021$). Consequently, the necessity for secondary surgical intervention via Ventilation Tube (VT) insertion was significantly higher in the conventional surgery group (12.8% vs. 2.7%, $p = 0.018$) (Table 3).

Table 3. Long-term functional outcomes and reintervention rates.

Parameter	Group A (n = 72)	Group B (n = 70)	Mean Diff. (95% CI)	p-Value
12-Month ABG (dB)	8.2 ± 3.1	12.6 ± 5.4	−4.4 (−5.9 to −2.9)	<0.001 *
Mean Auditory Gain (dB)	20.2	15.3	4.9 (3.4 to 6.4)	0.002 *
OME Recurrence, n (%)	3 (4.1%)	11 (15.7%)	N/A	0.021 *
Secondary VT Insertion, n (%)	2 (2.7%)	9 (12.8%)	N/A	0.018 *

* ABG analyzed via *t*-test; Recurrence/VT via Fisher’s Exact Test.

3.3. Safety and Complications

Throughout the 12-month monitoring period, no major intraoperative or postoperative complications, such as primary or secondary hemorrhage requiring surgical re-intervention, were recorded in either group. No cases of symptomatic tonsillar regrowth requiring revision surgery were observed in Group A during this timeframe.

4. Discussion

The surgical management of OME has evolved from simple volume reduction to a functional restoration of the nasopharyngeal and oropharyngeal environment. Our findings underscore that endoscopic coblation adenotonsillotomy provides significant clinical advantages over conventional “blind” curettage adenoidectomy, particularly regarding the long-term stability of middle ear aeration.

A pivotal aspect of our study is the transition from simple adenoidectomy to adenotonsillotomy. Traditional management often overlooks the palatine tonsils as a secondary reservoir for pathogenic biofilms [2]. Our results suggest that residual lymphoid tissue in the nasopharynx, combined with chronic tonsillar colonization, may facilitate a postulated “biofilm ascent” through the Eustachian tube. By performing an endoscopic coblation adenotonsillotomy, we addressed both the mechanical obstruction and the immunological reservoir. The intracapsular reduction in the tonsils is hypothesized to reduce the deep, infected crypts while preserving the pharyngeal musculature, thereby reducing the microbial load that contributes to persistent tubal inflammation without the morbidity of a total tonsillectomy.

The primary factor contributing to the superior early resolution in Group A is the meticulous, visually guided clearance of the Fossa of Rosenmüller. Traditional curettage is limited by its “blind” nature, often leaving “peri-tubal” lymphoid islands that act as persistent inflammatory foci. Utilizing a 30° rigid endoscope allowed for real-time visualization of the ET orifice.

Furthermore, the Coblation system’s plasma-mediated ablation (operating at 40–70 °C) is fundamental for OME resolution. Unlike monopolar suction coagulators or traditional electrocautery, which induce deep thermal necrosis and significant postoperative edema, coblation preserves the delicate tubal mucosa and the underlying ciliary function. This minimal thermal footprint is likely to preserve the delicate tubal mucosa, which may facilitate the earlier restoration of the physiologic ‘pumping’ action of the ET, a mechanism we hypothesize contributes to the significantly higher rate of tympanometric normalization observed as early as the 1-month follow-up [8].

The longitudinal data at 12 months reveals a significant difference, where Group A maintained a 94.4% resolution rate and Group B showed a decline to 78.5%. This suggests that “blind” adenoidectomy may leave tissue that undergoes compensatory hypertrophy, especially when the tonsillar reservoir remains untreated. Our observed five-fold reduction in the need for secondary surgical intervention is of clinical relevance. Avoiding secondary surgery diminishes the risks associated with repeated general anesthesia and reduces the incidence of long-term tympanic membrane complications such as myringosclerosis or persistent perforations.

The clinical success of endoscopic coblation adenotonsillotomy is heavily reliant on overcoming the initial learning curve and mastering the surgeon’s psychomotor skills, specifically the hand-eye coordination required to operate within the narrow confines of the pediatric nasopharynx. The acquisition of such proficiency can be objectively assessed through hand motion analysis using accelerometer-based sensors. Their research emphasizes that basic training using realistic models, such as the sheep’s head model, allows for the quantification of surgical manuality, measuring parameters like movement fluidity and economy of motion which are critical for avoiding iatrogenic injury to structures like the torus tubarius. Integrating such objective training methodologies is essential for the transition from conventional curettage to endoscopic-assisted techniques, ensuring that the surgeon achieves the necessary precision to perform thorough peritubal clearance while maintaining the high safety standards afforded by coblation technology [9].

Despite its prospective design, several limitations of this study warrant consideration, most notably its single-center nature, which may restrict the generalizability of the findings across diverse clinical settings.

A notable limitation is the heterogeneity of the control group (Group B). While Group A received a standardized adenotonsillotomy targeting the biofilm reservoir, Group B underwent tonsillar surgery only ‘as clinically indicated’. This difference reflects the comparison between a novel standardized protocol (prophylactic removal of the tonsillar reservoir) and conventional pragmatic care (symptom-driven removal). Therefore, the ‘intervention imbalance’ is intrinsic to the study’s aim of evaluating whether systematic tonsillar treatment yields superior outcomes compared to selective treatment.

It is important to emphasize that Group A uniformly received adenotonsillotomy as part of the study protocol, whereas Group B received adenoidectomy alone or adenoidectomy with tonsillar surgery strictly based on clinical indications. This design highlights the comparison between a systematic biofilm-reduction strategy and standard practice.

While the 12-month follow-up offers significant insight into medium-term recovery, a more extended longitudinal observation would be necessary to fully account for nasopharyngeal anatomical changes during growth and their impact on late recurrence rates.

Furthermore, the inherent technical differences between endoscopic and conventional surgery precluded surgeon blinding, although this risk of bias was mitigated by employing an independent audiologist for all postoperative assessments. Additionally, while our clinical data favors the study group, a formal economic analysis is still required to weigh the initial cost of coblation technology and the slightly increased operative time against the long-term expenses associated with disease recurrence and secondary interventions.

Our conclusions regarding the 'biofilm reservoir' are inferred from clinical recurrence rates. We acknowledge that the literature regarding the tonsillar contribution to OME is mixed. Since we did not perform microbiological sampling or electron microscopy to confirm the physical presence or elimination of biofilms, these mechanisms remain hypothetical within the context of our study.

While tympanometric normalization served as our primary surrogate endpoint for Eustachian tube function, we also prioritized functional hearing recovery. Although speech audiometry was not routinely performed, the significant closure of the Air–Bone Gap (ABG) observed in the Coblation group provides a direct correlate to improved hearing thresholds, which is clinically relevant for preventing speech delay. Furthermore, while tympanometry provided a surrogate measure of ventilation, objective assessment of Eustachian tube function using tubomanometry was not included in the study protocol.

We acknowledge that comparing a standardized adenotonsillotomy (Group A) against a symptom-driven approach (Group B) introduces variable extents of tissue removal. However, this design was chosen to compare the novel protocol against current real-world conventional practice.

Finally, although the randomized design balanced baseline demographics, our statistical analysis relied on univariate comparisons. We did not perform a multivariable logistic regression to adjust for environmental confounders such as daycare attendance, passive smoking, or allergy status. These factors are known to influence OME recurrence and represent a limitation of our findings.

Based on these findings, endoscopic coblation adenotonsillotomy should be strongly considered for pediatric patients with refractory OME and adenoid hypertrophy, particularly those with a history of recurrence. While the technique requires specific instrumentation and entails a learning curve to ensure safety, the long-term benefit of reduced re-intervention rates justifies its implementation in tertiary pediatric ENT centers.

5. Conclusions

Endoscopic coblation adenotonsillotomy demonstrates superior functional outcomes compared to conventional adenoidectomy in the management of pediatric OME. The technique ensures a significantly faster normalization of middle ear pressure and air–bone gap closure within the first month post-surgery.

The use of endoscopic visualization combined with low-temperature plasma ablation allows for complete clearance of the Fossa of Rosenmüller without compromising the torus tubarius. This approach minimizes collateral thermal damage and postoperative edema, which are critical factors for early Eustachian tube recovery.

Our 12-month follow-up data indicates that addressing the hypothetical tonsillar biofilm reservoir via intracapsular tonsillotomy significantly lowers the rate of OME recurrence. This strategy effectively reduces the necessity for secondary surgical interventions, such as tympanostomy tube insertion.

Although the procedure involves higher consumable costs, the substantial reduction in long-term morbidity and re-intervention rates justifies the adoption of Endoscopic Coblation Adenotonsillotomy as a standard of care for children with refractory Otitis Media with Effusion and adenotonsillar hypertrophy.

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Abbreviations

The following abbreviations are used in this manuscript:

OME	Chronic otitis media with effusion
ABG	Air–Bone Gap
VT	Ventilation tube
ET	Eustachian tube
SD	Standard deviation

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