ORIGINAL RESEARCH

Comparing Safety Profiles: Low-Temperature Plasma Excision vs. Traditional Adenoidectomy for Adenoid Hypertrophy

Xilan Gu, MM; Fang Liu, MM; Wenbin Wang, MM; Fei Ye, MM; Xiaodong Yin, MM

ABSTRACT

Objective • This study compares the efficacy of low-temperature plasma excision and adenoidectomy performed under a nasal endoscope (NE) to treat adenoid hypertrophy (AH). The goal is to offer valuable insights and guidance for future treatments.

Methods • We selected a cohort of 83 children diagnosed with AH admitted to our hospital between August 2019 and August 2022. The observation group included 45 children treated with low-temperature plasma excision under NE, while the control group consisted of 38 children treated with adenoidectomy under NE. We compared various parameters, including operative time, intraoperative bleeding, the time for white film disappearance, and the duration of hospitalization between the two groups. Additionally, we assessed levels of superoxide dismutase (SOD), malondialdehyde (MDA), glutathione peroxidase (GSH-Px), C-reactive protein (CRP), tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), nasal pharyngeal volume (NPV), total inspiratory resistance (TIR), and total expiratory resistance (TER). Pain and sleep were evaluated using the Visual Analogue Scale (VAS) and the Pittsburgh Sleep Quality Index (PSQI). Finally, we recorded perioperative complications in both groups.

Results • No significant difference was observed in the time of albuginea regression between the two groups ($P > .05$). However, the observation group demonstrated shorter operative time, quicker dietary recovery, and reduced hospital stay compared to the control group ($P < .05$). After treatment, the two groups had no significant differences in NPV, TIR, and TER ($P > .05$). Nevertheless, the observation group exhibited higher levels of SOD and GSH-Px, while MDA, CRP, TNF-α, IL-6, VAS, and PSQI scores were lower ($P < .05$). Furthermore, the incidence of complications in the observation group was significantly lower than in the control group ($P < .05$).

Conclusions • Low-temperature plasma excision performed under NE for AH demonstrates superior outcomes and improved surgical safety and is strongly recommended for the treatment of adenoid hypertrophy. (*Altern Ther Health Med.* 2024;30(6):208-213).

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INTRODUCTION

Adenoid hypertrophy (AH) is a condition characterized by the enlargement of the adenoid tissue, primarily due to inflammatory factors. AH commonly observed in children, can also manifest in certain adults.[1] According to World Health Organization (WHO) statistics, the prevalence of AH is notably high, ranging from approximately 10% to 30% among individuals under the age of 10 years.[2]

Mild AH may naturally regress with age as it is gradually less stimulated by inflammation. However, in cases of severe hypertrophy, it can obstruct the nasopharyngeal cavity, leading to symptoms such as open-mouth breathing, snoring, and potential inflammation of surrounding tissues, which may impact proper jaw development.[3] Due to the inherently narrow nasopharyngeal cavity in children, this condition has the potential to obstruct both the posterior nostril and the pharyngeal orifice of the eustachian tube. Consequently, it can significantly affect children's breathing, disrupt their sleep patterns, and have implications for their overall development and health.[4]

Surgery stands as the primary intervention for AH, with commonly employed clinical procedures encompassing adenoidectomy and low-temperature plasma excision conducted under nasal endoscopy (NE).[5] Adenoidectomy performed under NE provides a clear surgical field, enabling precise and comprehensive removal of the adenoid tissue. This approach minimizes the risk of residual glandular issues.[6,7]

Low-temperature plasma offers several advantages in treating AH, including providing a clearer surgical field for the

surgeon. This method employs bipolar low-temperature radiofrequency energy for resection, ensuring safety and effective hemostasis.[8,9] However, there remains a limited body of research on the comparative efficacy and surgical safety of NE low-temperature plasma excision versus adenoidectomy for AH, with clinical data still in the process of compilation.

Therefore, this study compared the efficacy and safety of low-temperature plasma excision and adenoidectomy for adenoid hypertrophy, filling the existing research gap. Through a careful investigation, we aim to offer comprehensive insights and serve as a reliable reference for future clinical treatments.

MATERIALS AND METHODS

Study Design

This retrospective study included a cohort of 83 pediatric cases diagnosed with AH who had been admitted to our hospital during the period spanning from August 2019 to August 2022. The study adhered to the ethical standards outlined by the Medical Ethics Committee and obtained review and approval from our hospital.

Inclusion and Exclusion Criteria

Patients eligible for inclusion in this study were those: (1) who received a diagnosis of AH through NE examination; (2) met the diagnostic criteria for AH [10]; (3) they were required to be classified as Grade III or IV; (4) considered suitable for surgical resection; (5) possess complete case data; (6) exhibit good compliance; and (7) have obtained informed consent from their families. Exclusion criteria were as follows: (1) Patients who displayed abnormal coagulation profiles; (2) contraindications to surgery; (3) known allergies to anesthetic drugs, a history of prior pharyngeal surgeries; or (4) communication disorders or psychiatric abnormalities were excluded from the study.

Study Participants

The observation group consisted of 45 children who underwent low-temperature plasma excision under NE, while the control group comprised 38 children who received adenoidectomy under NE.

Control Group: Adenoidectomy Under NE

Children in the control group underwent intravenous general anesthesia with tracheal intubation. A Davis opener (Beijing Belevor Medical, China) was employed to maintain an open mouth. Two thin silicone tubes were inserted into the nasal cavity, exiting through the mouth. The soft palate and uvula were retracted to expose the nasopharynx, and a nasal endoscope (YKD-9100 Nasal Endoscope, Xuzhou YKD Electronic Technology, China) was inserted.

The adenoids were excised using the power system's adenoid suction cutter head, starting from the lower edge of the adenoids and progressing from bottom to top, left to right, and from superficial to deep. Compression hemostasis or electrocoagulation was applied for any active bleeding.

Observation Group: Low-Temperature Plasma Excision Under NE

Preoperative Preparation. The preoperative preparation in the observation group mirrored that of the control group.

Nasal Endoscopy Setup. A silicone tube was inserted into the 70° NE via the oral cavity after retracting the soft palate. The endoscope's orientation was adjusted to ensure clear visualization of all nasopharyngeal areas.

Utilization of Low-Temperature Plasma. The low-temperature plasma tip was employed with cutting energy set at 7 levels and hemostatic energy set at 3 levels.

Ablation Procedure. The excision started at the junction of the lower edge of the adenoids and the posterior pharyngeal wall, progressing from bottom to top, left to right, and from superficial to deep, gradually ablating the hypertrophied adenoids.

Procedure Completion Criteria. The procedure concluded when there was no hypertrophic lymphoid tissue around the round pillow of the eustachian tube on both sides, and the posterior nostril was fully exposed without evident bleeding.

Postoperative Care

Postoperative care involves close monitoring of patients in both groups. This care includes vigilant observation for any signs of infection and providing guidance on dietary requirements, ensuring the best possible recovery and health outcomes. Children in both groups received prophylactic anti-infection treatment and a semi-liquid diet after surgery.

Outcome Measures

Perioperative Indexes. The perioperative indexes of the two groups were compared, including operation time, intraoperative blood loss, white film disappearance time, and hospital stay.

Clinical Parameters. Different clinical parameters were compared between the two groups. (1) Fasting venous blood was collected both before (pre-surgery) and after surgery (3 days post-surgery). (2) Enzyme-linked immunosorbent assay (ELISA) was performed to evaluate stress indicators and inflammatory factors in both groups. This included assessments of superoxide dismutase (SOD), malondialdehyde (MDA) levels, glutathione peroxidase (GSH-Px), C-reactive protein (CRP), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6), with analysis conducted using Solarbio Biotechnology, Beijing, China.

Respiratory Function and Pain Assessment. Nasal pharyngeal volume (NPV), total inspiratory resistance (TIR), and total expiratory resistance (TER) of children were measured before and after treatment using respiratory function meters (Medikro Breathing Star Spirometer, Finland). Pain levels in both groups were evaluated before and after treatment using the Visual Analogue Scale (VAS).

Sleep Quality Evaluation. Sleep quality of children in both groups was assessed utilizing the Pittsburgh Sleep Quality Index (PSQI),[11] with higher scores indicating more severe sleep disturbances.

Incidence of Complications. A comparative analysis of complications between the two groups was also conducted.

Statistical Analysis

The data results underwent statistical analysis using SPSS 23.0 statistical software. Counting data were expressed as rates and compared using the chi-square test. Measurement data were presented as mean ± standard deviation ($\bar{x} \pm s$), with group comparisons performed using the *t*-test. Additionally, paired *t* tests were employed for before-and-after treatment comparisons. A significance level of $P < .05$ was considered indicative of statistical significance.

RESULTS

Comparison of Baseline Data Between Two Groups

Statistical analysis results indicated no statistically significant differences between the two groups concerning age, disease duration, body mass index (BMI), gender distribution, or disease classification ($P > .05$). The groups were considered comparable. Refer to Table 1.

Comparison of Perioperative Indicators

Within the observation group, the operation time and hospitalization duration were notably shorter than those observed in the control group ($P < .05$). Furthermore, intraoperative bleeding was significantly reduced in the observation group compared to the control group ($P < .05$). However, it is worth noting that the difference in white film disappearance time between the two groups did not reach statistical significance ($P > .05$); see Figure 1.

Comparison of Ventilatory Function Before and After Treatment

There were no statistically significant differences in ventilation function indexes between the two groups before treatment ($P > .05$). However, post-treatment, both groups exhibited notable improvements: NPV increased ($P < .05$), while TIR and TER decreased ($P < .05$). It is noteworthy that the differences between the groups remained statistically insignificant ($P > .05$); refer to Figure 2.

Perioperative Complications

Regarding the occurrence of perioperative complications in both groups, the observation group experienced one case of intraoperative infection, resulting in an overall adverse reaction incidence of 2.22%. In contrast, the control group encountered two cases of intraoperative infection, bleeding, and pendulous edema, leading to an overall adverse reaction incidence of 15.79%. Statistical analysis demonstrated that the total incidence of adverse reactions in the observation group was significantly lower than that in the control group ($P < .05$) refer to Table 2.

Comparison of Stress Indicators Before and After Treatment

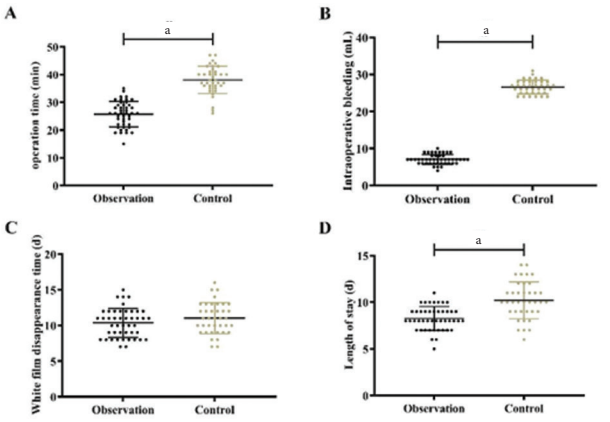
Before treatment, there were no statistically significant differences in the levels of SOD, MDA, and GSH-Px between the two groups ($P > .05$). However, following treatment, the levels of SOD and GSH-Px decreased in both groups ($P < .05$), with the control group exhibiting lower levels compared

Table 1. Comparison of Basic Data

Group	Age	Duration of Disease (months)	BMI (kg/m²)	Male/Female	Grading III/IV
Observation Group (n = 45)	6.9±2.2	14.3±2.3	16.5±1.7	25(59.5)/20(44.4)	22(48.9)/23(51.1)
Control Group (n = 38)	7.1±1.9	14.2±2.5	16.6±1.4	20(52.6)/18(47.4)	22(57.9)/16(42.1)
χ^2/t	0.439	0.190	0.289	0.385	0.671
P value	.662	.850	.773	.535	.413

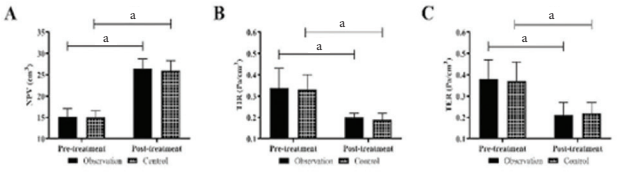
Note: Data is presented as mean ± standard deviation ($\bar{x} \pm s$) for continuous variables and as [n (%)] for categorical variables. Grading III/IV represents the severity of adenoid hypertrophy. *P* values were calculated using the chi-square test (χ^2) for categorical variables and the independent samples *t* test (*t*) for continuous variables. A $P < .05$ was considered statistically significant.

Figure 1. Comparison of Perioperative Indicators. (A) Operative Time; (B) Intraoperative Bleeding; (C) Time to Disappearance of White Membranes; (D) Length of Hospital Stay.



[a]$P < .05$ indicates statistical significance.

Figure 2. Improvement in Ventilatory Function Before and After Treatment. (A) Nasal Pharyngeal Volume (NPV); (B) Total Inspiratory Resistance (TIR); (C) Total Expiratory Resistance (TER).



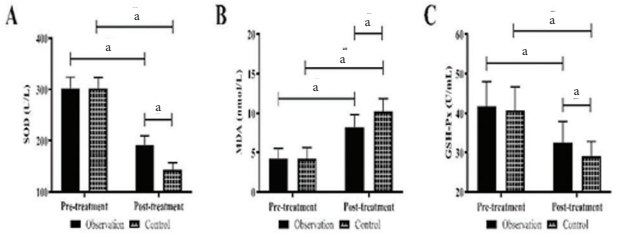
[a]$P < .05$ indicates statistical significance.

Table 2. Perioperative Complications

Group	Surgical Area Infection	Hemorrhage	Uvulopalatine Edema	Total Incidence
Observation Group (n = 45)	1(2.22)	0(0)	0(0)	2.22
Control Group (n = 38)	2(5.26)	2(5.26)	2(5.26)	15.79
χ^2/t				4.911
P value				.027

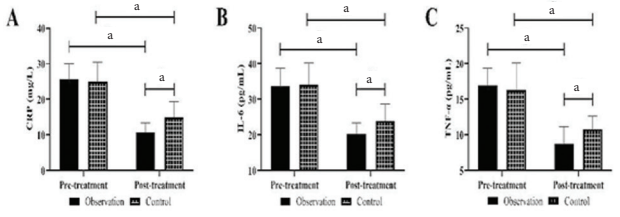
Note: Data is presented as [n (%)] for categorical variables. The total incidence represents the overall occurrence of complications in each group. *P* values were calculated using the chi-square test (χ^2). A $P < .05$ was considered statistically significant.

Figure 3. Comparison of Stress Indicators Before and After Treatment. (A) Superoxide Dismutase (SOD); (B) Malondialdehyde (MDA); (C) Glutathione Peroxidase (GSH-Px).



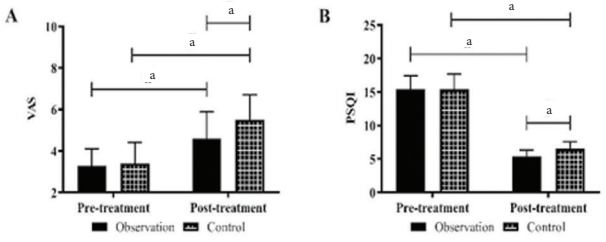
[a]$P < .05$ indicates statistical significance.

Figure 4. Comparison of Inflammatory Response Before and After Treatment. (A) C-Reactive Protein (CRP); (B) Interleukin-6 (IL-6); (C) Tumor Necrosis Factor-α (TNF-α). The symbol



[a]$P < .05$ indicates statistical significance.

Figure 5. Pain and Sleep Quality Assessment Before and After Treatment. (A) Visual Analogue Scale (VAS); (B) Pittsburgh Sleep Quality Index (PSQI). The symbol



[a]$P < .05$ indicates statistical significance.

to the observation group ($P < .05$). In contrast, the levels of MDA increased post-treatment ($P < .05$) and were higher in the control group than in the observation group ($P < .05$), refer to Figure 3.

Comparison of Inflammatory Response Before and After Treatment

No statistically significant differences were observed in the levels of inflammatory factors between the two groups before treatment ($P > .05$). However, post-treatment, both groups exhibited increased levels of CRP, TNF-α, and IL-6 ($P < .05$), with the observation group showing lower levels compared to the control group ($P < .05$), see Figure 4.

Pain and Sleep Quality Assessment Before and After Treatment

Before treatment, there were no statistically significant differences in VAS and PSQI between the two groups ($P > .05$). However, after treatment, VAS increased in both groups compared to the pre-treatment levels ($P < .05$). Notably, the control group exhibited higher VAS scores compared to the observation group ($P < .05$). Conversely, PSQI scores decreased post-treatment compared to pre-treatment levels ($P < .05$), with the control group also displaying higher PSQI scores compared to the observation group ($P < .05$), refer to Figure 5.

DISCUSSION

Adenoids are integral components of the immune system in children, playing a crucial role in protecting against the infiltration of pathogenic microorganisms.[12] However, when these adenoids are subjected to recurrent irritation, often resulting from factors like infections, they can undergo hypertrophy, a condition known as adenoid hypertrophy. This ailment may lead to severe complications, profoundly impacting the physical and mental well-being of children.[13] Understanding the immune function of adenoids and the implication of their hypertrophy is critical in managing and preventing these health concerns, ensuring the overall well-being of children.

Surgical resection stands as the most effective and direct approach for treating AH. Considering that the affected areas are relatively concealed and challenging to reach with local medication, surgical intervention is often necessary.[14] Traditional surgical methods, like scraping the adenoids, carry the risk of damaging surrounding tissues, pharyngeal constricting muscles, and deep blood vessels. Additionally, they may leave residual tissue, which can contribute to recurrences, significantly affecting children's prognoses.[15]

In recent times, low-temperature plasma technology has gained significant attention in clinical practice, particularly in the management of ear, nose, and throat conditions. However, its impact on thermal injury and inflammation aspects remains a subject of debate.[16,17] As a result, additional research is needed to establish strong evidence affirming the safety and effectiveness of employing low-temperature plasma knife applications.

This study demonstrated that there were no significant differences in NPV, TIR, and TER among the two groups of children after treatment. This outcome affirms that both low-temperature plasma excision and adenoidectomy under NE yield consistent and effective results in improving symptoms associated with AH. Low-temperature plasma knife technology, considered a high-tech innovation in the realm of modern medicine, operates by utilizing bipolar low-temperature radiofrequency to generate energy. This energy effectively disrupts molecular bonds within cells, leading to cell hydrolysis in target tissues and facilitating tissue coagulation and necrosis. Therefore, this approach proves to be highly effective in tissue resection.[18]

Previous research has revealed that low-temperature plasma excision at a depth of 1 mm into subcutaneous tissue

maintains a temperature approximately 10°C lower than the surface temperature. This finding supports that the use of a low-temperature plasma knife results in minimal thermal damage to the surrounding tissues in the surgical region.[19]

In this study, we have also observed that the operative time, intraoperative bleeding, dietary recovery time, and hospitalization duration for children with AH who underwent low-temperature plasma excision were notably shorter in comparison to those who underwent adenoidectomy. These findings offer preliminary confirmation that low-temperature plasma excision is a less traumatic method for treating AH and holds potential advantages in terms of postoperative functional recovery for patients. These results align with the findings of a previous study.[20]

It is speculated that the reason behind these findings may be attributed to the multifunctional nature of the low-temperature plasma cutter head, which can perform tasks such as cutting and hemostasis without the need for frequent instrument changes during the surgical procedure. Additionally, it offers point hemostasis capabilities, reducing the level of trauma and demonstrating an effective hemostatic effect. These advantages collectively promote postoperative recovery.[21]

Insenser et al.[22] reported that patients undergoing cryogenic plasma tonsillectomy experienced a significantly prolonged time for complete albuginea regression. It was attributed to thermal damage caused by plasma, leading to trauma in the surrounding tissues and resulting in connective tissue and collagen necrosis. In contrast, our study observed no significant difference in the time required for complete albuginea regression between the two groups of children. This difference in thermal injury is believed to be associated with the chosen surgical method.

The findings suggest that surgical procedures should be conducted methodically, layer by layer, positioning the tip between the muscle tissue and the tegument, ensuring that the tip remains oriented towards the tegument while maintaining a quasi-contact state. It is essential to avoid bringing the tip too close to the tissue or entering the tissue directly, as this can result in thermal injury.[21]

Furthermore, our study revealed that the overall postoperative complication rate in the observation group was notably lower compared to the control group. This difference is attributed to the potentially greater trauma caused by traditional adenoid aspiration, which can disrupt the local mucosal barrier, making it more susceptible to pathogenic invasion and infection, ultimately leading to a higher incidence of postoperative complications.[23]

Similarly, the reduced levels of SOD and GSH-Px, along with the increase in MDA in children from the observation group after treatment, further validate that low-temperature plasma excision inflicts less stress damage and offers a higher level of surgical safety.

During the excisional operation with the low-temperature plasma knife under NE, the procedure was carefully carried out in a layered manner, with the tip oriented towards the tegument and positioned between the tegument and muscle tissue. This approach prevents thermal injury, while simultaneous hemostasis during cutting enhances the clarity of the operative field. Additionally, the immediate formation of a protein pseudo-membrane over the wound helps reduce postoperative pain and enhances the overall postoperative experience for patients.

We postulate that these factors constitute the primary reason for the reduced postoperative VAS and PSQI scores in the observation group. Moreover, we propose that the lower levels of inflammatory factors in the observation group are attributable to the low-temperature plasma cutter head's ability to expel 4°C ice saline during cutting. This mechanism leverages physical heat exchange to extract a portion of heat from the surgical site, ultimately mitigating the inflammatory response in postoperative tissues.

In this study, low-temperature plasma excision demonstrated several advantages, including shorter operative times, reduced intraoperative bleeding, and faster recovery times. This study also revealed that low-temperature plasma excision caused less stress damage, resulting in higher surgical safety. Moreover, it was associated with fewer postoperative complications. These findings suggest that low-temperature plasma excision may be a preferable treatment option for AH in children due to its improved surgical outcomes and reduced patient discomfort. The study's results provide valuable guidance for clinicians and researchers in the field of pediatric otolaryngology.

Study Limitations

Several limitations should be acknowledged in this study. The relatively small sample size may introduce a potential bias in the findings, limiting the generalizability of the results. A longer follow-up period is essential to assess the long-term prognosis of the children post-surgery comprehensively. Furthermore, the clinician's surgical experience plays a significant role in treatment outcomes, and it is crucial to consider this variable when interpreting the results. To improve the consistency and reliability of treatment, it may be essential to establish training programs that focus on equipping clinicians with the necessary skills for performing low-temperature plasma resection for AH. Addressing these limitations in future research can further refine our understanding of the efficacy and safety of different surgical approaches for AH in pediatric patients.

CONCLUSION

In conclusion, this study demonstrates that low-temperature plasma excision under NE is a safer and more effective treatment option for AH in children when compared to adenoidectomy. The approach significantly minimizes postoperative stress and inflammation, enhancing the overall postoperative experience for pediatric patients. The findings emphasize the clinical significance of low-temperature plasma excision as a preferred treatment choice for AH, highlighting its potential to offer more reliable and improved outcomes for this condition.

CONFLICTS OF INTEREST

The authors report no conflict of interest.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

Not applicable.

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