

Original Article

Efficacy of tonsillectomy and adenoidectomy for the treatment of snoring in children

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Abstract: Objective: To investigate the feasibility and effectiveness of tonsillectomy and adenoidectomy in children with snoring. Methods: A total of 68 children who snore were admitted to our hospital, they were selected as the study subjects and were divided into a study group ($n = 34$) who received tonsillectomy and a control group ($n = 34$) who received tonsillectomy and adenoidectomy. The treatment efficiency, surgical indicators, sleep indicators, changes in growth hormone (GH), Epworth Sleepiness Scale (ESS) and snoring questionnaire (SOS, BPS) scores before and after intervention as well as the incidence of various complications were compared between the two groups. Results: In the study group, there were 30 cases with a significant response to treatment; 3 cases with treatment response, with a total effective rate of 97.06%; and in the control group, the corresponding numbers were 20 and 8 respectively, with a total effective rate of 82.35% ($P < 0.05$). The operation time in the study group was greater than that in the control group ($P < 0.05$). The study group exhibited a lower respiratory disturbance index and longer apnea duration at 7 days postoperatively ($P < 0.05$), higher minimum and mean oxygen saturation, and higher GH levels at 7 days and 3 months after surgery than the control group ($P < 0.05$). The study group showed lower ESS and higher SOS and BPS than the control group at 1 week after surgery ($P < 0.05$). After surgery, children in the study group had lower ESS and higher SOS and BPS than the control group ($P < 0.05$). Conclusion: Tonsillectomy and adenoidectomy has a high feasibility and remarkable clinical treatment effect in children with snoring, with the postoperative sleep monitoring index in the children significantly improved, a GH level that gradually recovered and optimized sleep quality scale scores.

Keywords: Tonsillectomy, adenoidectomy, children with snoring, treatment effectiveness, investigation

Introduction

An increase of 60 dB in loudness of snoring after an individual falls asleep is clinically known as snoring, and about 5% of snoring patients will have different degrees of breathlessness during sleep, namely obstructive sleep apnea-hypopnea syndrome (OSAHS) [1]. Epidemiology indicates that the incidence of snoring and OSAHS has shown a annually increasing rate of growth, and differences in region, age and other factors will lead to certain differences in the prevalence of OSAHS. The data show that the prevalence of snoring in different regions of China ranges from 16.7%-59.7%, and its incidence in children remains high. An adult OSAHS study conducted in the United States in 2016 showed that the prevalence of OSAHS in American males and females were 14% and 5% respectively [2, 3].

Patients with snoring often experience abnormal sleep architecture, and clinical symptoms such as dry mouth, throat discomfort, breathlessness, sleepwalking, and daytime sleepiness are relatively common. Some patients will also have secondary symptoms of the cardiovascular and respiratory systems, such as hypertension and arrhythmia, etc. A survey of 89 patients who snore shows that about 30% have chronic lung damage to varying degrees, and in addition, bad moods and memory loss are also relatively common [4]. Recent research points out that mild snoring does not affect individual health, but snoring may lead to hypoxia during sleep, and over time, patients may also develop multi-system and multi-organ damage, such as hypoxemia due to hypoxia, coronary heart disease, cerebral infarction, myocardial infarction, etc. Therefore, early correction, especially in children, is clinically rec-

ommended to minimize the impact of the disease on their physical and mental development [5].

Clinical studies have shown that the causes of snoring in children are mostly due to the hypertrophy of tonsils or adenoids, which block the upper respiratory tract. Therefore, removal of the tonsils or adenoids is a way to treat snoring. Currently, tonsillectomy has achieved good results in clinical practice in the treatment of snoring in children. A study on 50 cases of children who snore showed that the snoring symptoms in 45 cases were significantly improved, with parental satisfaction reaching 98.00% [6]. The adenoids, also known as pharyngeal tonsils, are a group of lymphoid tissues attached to the nasopharynx. Adenoid hypertrophy can also trigger snoring, and removal of the adenoids is one of the means to improve snoring in children [7]. However, there are few studies on the application of tonsillectomy combined with adenoidectomy in children with snoring. The aim of this study was to investigate the feasibility of the combined application of tonsillectomy and adenoidectomy in children who snore, so as to provide a clinical basis for improving the clinical symptoms of snoring in children.

Materials and methods

General information

A total of 68 children who snore were admitted to our hospital from May 2019 to March 2020, they were selected and divided into a study group (n = 34) and a control group (n = 34) according to the differences in the treatment procedures.

Inclusion criteria: (1) the enrolled children all met the clinical diagnostic criteria for snoring [8]; (2) the course of the disease was ≥ 3 months; (3) patients were aged between 2-14 years; (4) the presence of adenoid hyperplasia was confirmed by imaging; (5) their consciousness was clear with good compliance. This study was approved by ethics committee of Qingdao Women and Children's Hospital. The parents of the children were informed of the treatment and signed the consent form.

Exclusion criteria: patients with (1) severe nasal septum deviation (2) significant nasal swelling;

(3) immunodeficiency or asthma; (4) recent acute sinusitis or upper and lower respiratory tract infections; (5) systemic or topical glucocorticoid use within the past month; (6) combined severe hepatic and renal dysfunction; (7) psychiatric disorders; and (8) poor study compliance.

Intervention methods

In the control group, only tonsillectomy was performed, and the child was anesthetized before surgery. The child was placed flat on their back with a thin pillow under their shoulder. After anesthesia took effect, epinephrine was used to contract the mucous membrane of the nasal cavity bilaterally, and then a cheek retractor was used to expose the tonsils and the tonsils were removed completely along the tonsil membrane using plasma knife while avoiding the uvula. After tonsillectomy, bleeding was stopped by cauterizing the tonsil beds and antibacterial drugs were applied to prevent infection.

The study group was additionally treated with adenoidectomy. The plasma knife entered the nasopharynx through the mouth, and at the same time the nasal endoscope went through the nasal cavity into the nasopharynx. The surgical field was fully exposed to identify the location of the eustachian tubes. Adenoid tissues were separated from top to bottom using a plasma knife. The torus tubarius and soft palate were avoided during the resection process, and the nursing care after surgery was the same as that of the control group.

Observation indicators and evaluation criteria

Comparison of treatment efficiency: At 7 days after surgery, the treatment efficiency was categorized as markedly effective, effective and ineffective. Markedly effective refers to the disappearance of clinical symptoms, and the children were able to sleep quietly and the symptoms of apnea and breathless disappeared after treatment. Effective means that under normal sleeping patterns, the loudness of snoring was significantly reduced, and mouth breathing was significantly improved. Ineffective refers to no significant improvement in snoring-related symptoms after treatment compared to before treatment. Treatment effi-

ciency = (markedly effective + effective)/total number of cases \times 100%.

Comparison of differences in general surgical indicators: Intraoperative bleeding and operative time were measured by the nurses in the operating room, and the pain at 7 days after surgery was assessed by the Visual Analogue Scale (VAS), which was composed of a 0-10 cm scale, and the subjects marked the scale according to their own subjective pain degree, with a higher number on the scale representing more obvious pain [9].

Analysis of changes in sleep indicators before and after treatment: The sleep indicators of the two groups of children were monitored before and at 7 days after surgery. The sleep indicators mainly included respiratory disturbance index, minimum oxygen saturation and average oxygen saturation, in which the respiratory disturbance index represented the sum of the number of bouts of apnea and hypopnea per hour. Apnea indicated the complete cessation of oronasal and nasal airflow for > 10 s, and hypopnea represented a decrease in airflow of $\geq 50\%$ for more than 10 s. The minimum oxygen saturation and average oxygen saturation were assessed with an oximeter for 1 day [10].

Analysis of GH levels before and after treatment in the two groups: Blood samples of children in the two groups were tested for GH levels before surgery, 7 days and 3 months after surgery. The blood samples were collected in the morning in a fasting state. Each index was tested three times, and the average value was the final result.

Changes in sleep scale scores before and after treatment: The sleep conditions of the two groups of children were evaluated before and 7 days after surgery using ESS, SOS and BPS. The ESS scale can assess the subjects' sleepiness in the past week. It is a self-administered questionnaire with 8 questions. Respondents are asked to rate, on a 4-point scale (0-3 points), their usual chances of dozing off or falling asleep while engaged in eight different activities. The ESS score (the sum of 8 item scores, 0-3 points) can range from 0 to 24. A higher ESS score indicates a higher average sleep propensity (ASP) of the patients in daily life, or their 'daytime sleepiness'. Both the SOS scale and the BPS scale

are parts of the Chinese version of the snoring questionnaire, and are commonly used clinically to evaluate snoring. The SOS has 6 items, and BPS has 3 items. A lower score stands for more serious snoring [11, 12].

The incidence of complications: The incidence of various complications such as local adhesions, eustachian tube injury and scars during the treatment were compared between the two groups.

Statistical analysis

The collected data were input into SPSS 20.0 software for statistical analysis. The measurement data were expressed as mean \pm SD. The differences between groups were compared by student's *t* test. For the enumeration data in the form of [n (%)], the differences between groups were compared by chi square test, and the differences before and after continuous variables were also compared by student's *t* test. The graph of experimental results was illustrated by GraphPad Prism 8.0, and the difference was statistically significant when $P < 0.05$ [13].

Results

Comparison of baseline data

We found that the two groups of children had little difference in clinical data such as gender, age, average weight, average course of disease, and clinical symptoms ($P > 0.05$), as such the groups were comparable (**Table 1**).

Comparison of treatment efficiency

The study group had 30 cases of markedly effective and 3 cases of effective treatment, with a total effective rate of 97.06%; while the control group had 20 cases of markedly effective and 8 cases of effective, with a total effective rate of 82.35%. A significant difference was found in treatment efficiency between the two groups ($P < 0.05$) (**Table 2**).

Comparison of differences in surgical indicators

No significant difference was found between the study group and the control group in terms of surgical indicators such as intraoperative bleeding and 7-d postoperative pain ($P > 0.05$),

Table 1. Comparison of baseline data between the two groups ($\bar{x} \pm s$)/[n (%)]

General information		Study group (n = 34)	Control group (n = 34)	t/ χ^2	P
Genders	Male	18	19	0.059	0.808
	Female	16	15		
Average age (years)		5.81 \pm 1.22	5.79 \pm 1.31	0.065	0.948
Average weight (kg)		22.98 \pm 2.31	23.04 \pm 1.99	0.115	0.909
Average duration of illness (months)		4.11 \pm 0.43	3.98 \pm 0.51	1.136	0.26
Clinical symptom	Snoring	20	21	0.981	0.278
	Mouth breathing	14	17		
	Hearing loss	9	6		
	Runny nose	15	13		
	Sore throat	10	11		
	Aural fullness	13	13		
	Nasal obstruction	10	11		
	Allergic rhinitis	6	8		
	Sinusitis	4	6		

Table 2. Comparison of treatment efficiency [n (%)]

Grouping	Number of cases	Markedly effective	Effective	Ineffective	Effective rate
Study group	34	30 (88.24)	3 (8.82)	1 (2.94)	33 (97.06)
Control group	34	20 (58.82)	8 (23.53)	6 (17.65)	28 (82.35)
χ^2	-	-	-	-	3.981
P	-	-	-	-	0.046

but children in the study group had longer operative time than those in the control group ($P < 0.05$) (**Figure 1**).

Changes in sleep indicators before and after treatment

No significant difference was found in sleep indicators between the two groups before surgery ($P > 0.05$). After treatment, the respiratory disturbance index of the two groups appeared significantly lower than that before treatment, and the minimum and mean oxygen saturation were significantly higher than those before treatment ($P < 0.05$). The study group showed a lower respiratory disturbance index and higher minimum and mean oxygen saturation than those of the control group ($P < 0.05$) (**Figure 2**).

GH levels before and after treatment

There was little difference in GH levels between the two groups preoperatively, and the GH levels in the study group were significantly higher than those in the control group at 7 days and 3 months postoperatively ($P < 0.05$). GH levels in

the study group were higher than those in the control group at 7 days postoperatively ($P < 0.05$) (**Figure 3**).

Changes in sleep scale scores before and after treatment

There was no significant difference in the scores of ESS, SOS, and BPS scales between the two groups before surgery ($P > 0.05$). The children in the study group had lower ESS scores and higher SOS and BPS scores than the control group at 7 days postoperatively ($P < 0.05$) (**Figure 4**).

The incidence of complications

It was found that the study group had one case of local adhesion, one case of eustachian tube orifice injury, and one case of scarring, with a total incidence rate of 8.82%; while the control group had one case of eustachian tube orifice injury and one case of scarring, with a total incidence rate of 5.88%. There was no significant difference in the incidence of complication rates between the two groups ($P > 0.05$) (**Table 3**).

Discussion

Snoring is common among children, and research data show that the incidence of snoring among children is about 1.0%-1.8%. The main causes of snoring in children include enlarged palatine tonsils and adenoids, etc.,

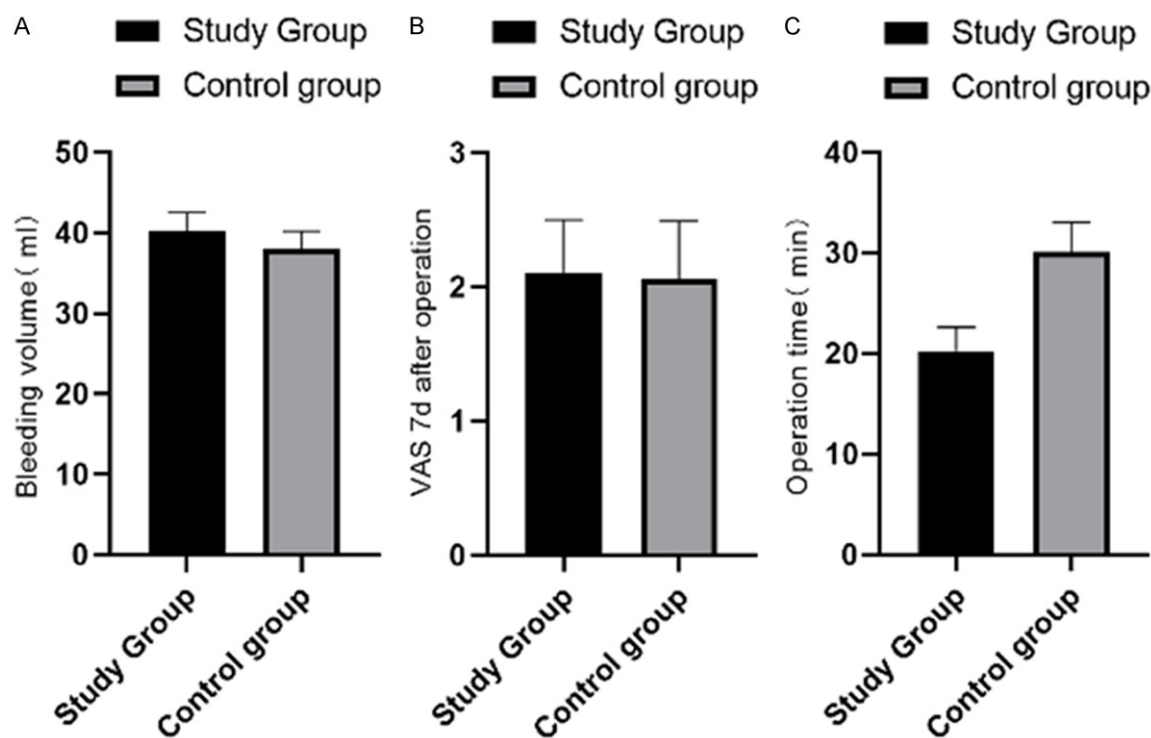


Figure 1. Comparison of the differences in general surgical indicators. There was no significant difference between the two groups in terms of intraoperative bleeding (A) and postoperative pain at 7 days (B) ($P > 0.05$). However, the operative time of the children in the study group (C) was significantly higher than that of the control group, with significant difference between the two groups ($P < 0.05$). * $P < 0.05$.

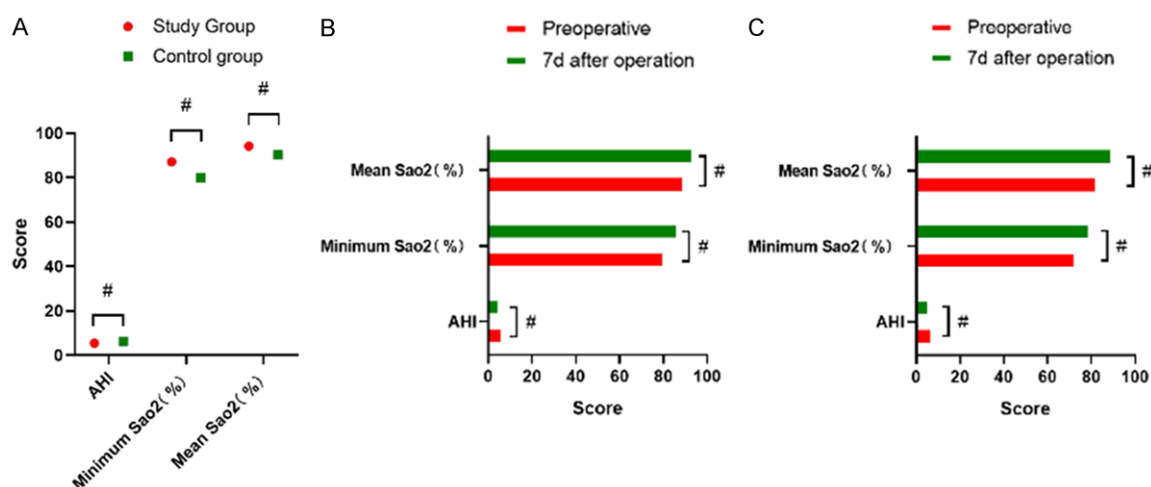


Figure 2. Analysis of changes in sleep index before and after treatment in the two groups of children. The minimum oxygen saturation and mean oxygen saturation (A); the minimum and mean oxygen saturation and the respiratory disturbance index in study group (B); the minimum oxygen saturation and mean oxygen saturation and the respiratory disturbance index in the control group ($P < 0.05$) (C).

which leads to obstruction of airflow in the upper airways of children, causing snoring, breathlessness, and nocturnal apnea in chil-

dren [14]. Between 6-7 years of age is the peak period of adenoid growth in children, and respiratory obstruction is rare. As a result of

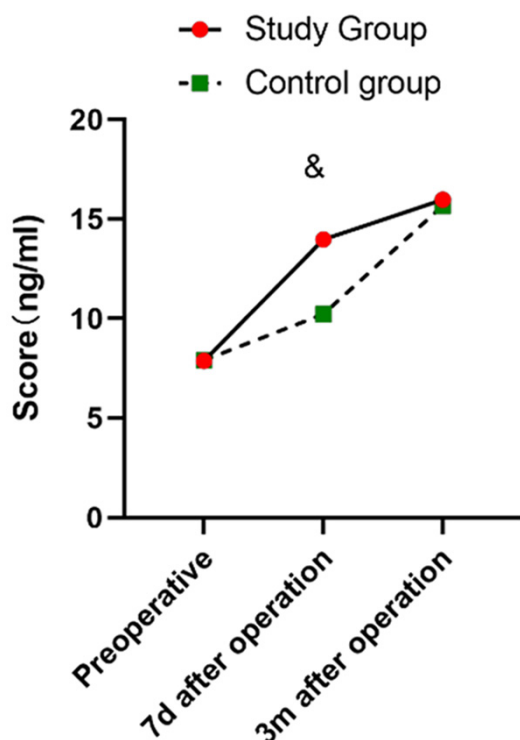


Figure 3. Analysis of changes in GH levels before and after treatment in the two groups of children. The GH levels in the study group were significantly higher than those in the control group at 7 days post-operatively ($P < 0.05$), and there was no significant difference in GH levels between the two groups at 3 months postoperatively ($P > 0.05$); & $P < 0.05$.

the influence of bacterial infections and strain diseases, some children may show pathological enlargement of adenoids and tonsils, which is characterized by snoring at night, mouth breathing and even apnea [15]. According to an epidemiological survey on children aged 5-13 years, the probability of snoring in children is about 31.6%, with habitual snoring accounting for 26.4% and occasional snoring accounting for 5.2%, and such children often have symptoms such as being sleepy during the day, poor concentration and memory loss. If the hypertrophic glands block the nostrils, children may also show symptoms such as runny nose and nasal congestion [16]. Some scholars have conducted long-term follow-up on the effects of snoring on the growth and development of children, and the results show that prolonged mouth breathing will affect the development of maxillofacial bones and lead to adenoid face in children [17].

The current treatment options for snoring include surgical treatment and non-surgical treatment. Non-surgical treatment mostly relies on external force to forcefully correct the sleeping posture of snorers, which is not suitable for children, while surgical treatment has been clinically proven to have better clinical efficacy. Some studies have shown that the cure rate of snoring in children can reach more than 90% with tonsillectomy, and some studies have shown that their sleep quality and quality of life have also been significantly improved, indicating that adenoidectomy has a good clinical efficacy in the treatment of snoring [18].

This study investigated the feasibility and effectiveness of combined application of tonsillectomy and adenoidectomy in children with snoring by setting up different subgroups. The results showed that compared with the control group with tonsillectomy alone, the effective rate of the study group with tonsillectomy and adenoidectomy was 97.06%, far higher than the 82.35% of the control group, showing a significant difference between the two groups. A comparative study of 90 children with obstructive sleep apnea showed that tonsillectomy and adenoidectomy resulted in an overall treatment efficiency of 100%, much better than that of tonsillectomy alone, which is similar to the results in this study [19]. Surgical removal of the tonsils is a common procedure for treating snoring. However, in-depth research in children's snoring has found that adenoid hypertrophy will also increase the prevalence of snoring in children, so the combined removal of tonsil and adenoids should be more effective than tonsil removal alone. The current clinical controversy mainly focuses on whether the combined procedure will increase the trauma of children and delay the postoperative recovery [20, 21]. A study of children with snoring showed that the pain scores in the two groups were (6.02 ± 1.31) and (6.04 ± 0.21) before treatment and (3.01 ± 0.43) and (2.98 ± 0.41) after surgery, respectively, with little difference between the two groups, suggesting that the combined treatment did not increase the intraoperative trauma [22]. It also suggested that the combined procedure did not increase the incidence of adhesion, eustachian tube orifice injury or scarring in the children.

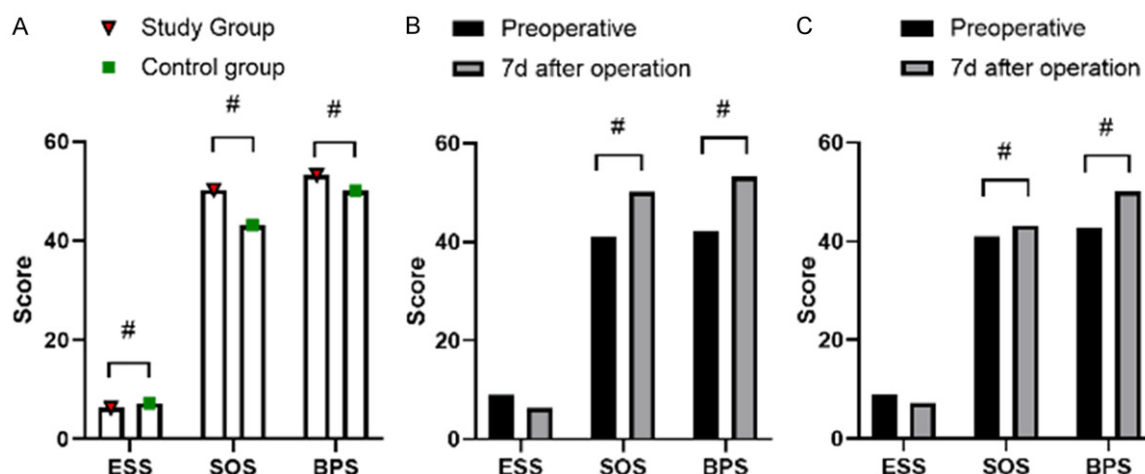


Figure 4. Changes in sleep scale scores before and after treatment. After 7 days of intervention, the ESS scores of children in the study group were significantly lower than those in the control group ($P < 0.05$), and SOS and BPS scores were significantly higher than those in the control group ($P < 0.05$) (A). The ESS of the children in the study group (B) and the control group (C) decreased after treatment, and SOS and BPS scores increased in both groups compared with those before treatment, with statistically significant difference ($P < 0.05$). # represents $P < 0.05$.

Table 3. Comparison of intraoperative complication rates between the two groups [n (%)]

Grouping	Number of cases	Local adhesion	Eustachian orifice injury	Scarring	Total incidence rate
Study group	34	1 (2.94)	1 (2.94)	1 (2.94)	3 (8.82)
Control group	34	0 (0.00)	1 (2.94)	1 (2.94)	2 (5.88)
χ^2	-	-	-	-	0.216
P	-	-	-	-	0.642

It also showed that breathing disorders in the study group were significantly improved, the children's minimum and mean oxygen saturation showed a significant increase, which were better than the control group. Some scholars have analyzed the changes in sleep monitoring indices of 43 children with obstructive sleep apnea hypopnea syndrome before and after treatment, and results showed that the longest apnea time of children after tonsillectomy and adenoidectomy was decreased from (86.57 ± 3.13) s to (35.14 ± 4.45) s, and the respiratory disorder index was reduced from (12.98 ± 9.78) to (5.12 ± 4.97) , which is similar to the results of this study [23]. We speculated that children with less frequent and shorter duration of apnea may be ignored by parents, and snoring is often treated as a simple issue. In fact, snoring will affect the oxygen supply to children's brain and increase the incidence of cerebral infarction, hypertension and other cardiovascular diseases, which should be given sufficient attention. Tonsillectomy and

adenoidectomy can improve the symptoms of upper airway obstruction, which is significant in relieving the breathing obstruction of snoring children, and is also helpful to improve the sleep quality of children after surgery [24, 25]. GH plays an important role in the growth and devel-

opment of children, and GH secretion is closely related to the sleep quality. As snoring children wake up more often at night, their GH secretion will be relatively reduced, thus affecting their normal growth and development. The combined treatment can effectively improve the sleep quality of children with snoring, and thus correspondingly regulate the secretion of GH in children, which will contribute to their healthy growth in the long run [26].

In summary, the combined application of tonsillectomy and adenoidectomy for children with snoring has a high feasibility and significant clinical treatment effect, with the postoperative sleep quality significantly improved, and the GH level gradually recovered. The innovation of this study lies in the fact that children with snoring were used as the research subjects, and through group comparison, the effects of combined surgery on sleep indicators, GH level, sleep quality and complication rate in children with snoring were analyzed,

and the advantages and disadvantages of combined surgery were explored comprehensively, which provided reliable theoretical data for clinical treatment. However, the present study has the following limitations: (1) the small sample size leads to a lack of certain comprehensiveness of the results obtained; (2) as well as a lack of follow-up of the children to confirm the long term efficacy. Our chosen clinical metrics of recovery were also not compared in non-surgical treatment of snoring in children. In view of the above-mentioned shortcomings, it is proposed to conduct further research with a larger sample size and more adequate follow-up indicators in order to provide a clinical basis for improving the sleep quality of children with snoring.

Disclosure of conflict of interest

None.

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