Int J Clin Exp Med 2020;13(4):2807-2814
www.ijcem.com /ISSN:1940-5901/IJCEM0106803

Original Article

The effect of selective pterygoid canal neurotomy under nasal endoscopy on postoperative pain in patients with chronic sinusitis

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Received December 23, 2019; Accepted January 15, 2020; Epub April 15, 2020; Published April 30, 2020

Abstract: Objective: To investigate the effect of selective pterygoid canal neurotomy under nasal endoscopy on patients with chronic sinusitis and nasal polyps. Methods: Eight-six patients with chronic sinusitis and nasal polyps were randomly and evenly divided into control and research groups. The control group patients underwent conventional minimally invasive endoscopic nasal surgery, and the research group patients underwent selective pterygoid canal neurotomy under nasal endoscopy. The pain degree, stress-response indicators, Bruggemann comfort scale (BCS) scores, quality of life, duration of the hospitalization, surgical wound recovery time, incidence of adverse reactions, and curative effects in the two groups were compared. Results: The patients in the research group exhibited higher levels of pain than those in the control group ($P<0.05$). After treatment, the diastolic and systolic blood pressure and heart rate measurements of the control group patients were significantly higher than those of the research group patients, and the pulse oxygen saturation levels of the control group patients were significantly lower than the levels of the research group patients ($P<0.05$). The BCS scores of the control group patients at 1, 2, and 3 h after surgery were significantly lower than the scores of the research group patients ($P<0.05$). The duration of hospitalization and the surgical wound recovery times of the research group patients were longer than those of the control group patients ($P<0.05$). The total effective rate of the research group was significantly higher than the rate of the control group ($P<0.05$). Conclusion: Selective pterygoid canal neurotomy under nasal endoscopy is a safe and effective method for the treatment of chronic sinusitis with nasal polyps, with clear pain relief effects.

Keywords: Chronic sinusitis, nasal polyps, nasal endoscopy, selective pterygoid canal neurotomy, postoperative pain

Introduction

Chronic sinusitis refers to inflammation or swelling of the sinus cavities that blocks airflow and drainage for more than 12 weeks. Chronic sinusitis is one of the most common otorhinolaryngological diseases and significantly differs from acute sinusitis. The former is characterized by prolonged and refractory symptoms, while the symptoms of the latter are similar to a cold that can develop into a chronic disease without timely or proper treatment after onset, and it is generally easy to distinguish between the two [1, 2]. Most cases of chronic sinusitis occur when the nasal ostium is narrowed or the function of nasal mucosa clearance is impaired, which can cause local or diffuse inflammatory response stimulation in the nasal cavity. Long-term inflammatory stimulation can reverse the function of the nasal mucosa and the ostium of the nasal sinus, resulting in complex clinicopathological symptoms, increasing the difficulty of treatment and controllability of the condition [3, 4]. Patients with chronic sinusitis often present with discomfort, such as decreased olfactory function, dizziness, headache, nasal obstruction, and runny nose. Additionally, chronic sinusitis often induces the onset of nasal polyps, which can aggravate sinusitis deterioration. A patient's olfactory hyposmia and other manifestations can therefore be used to determine the severity of nasal polyps [5, 6].

Chronic sinusitis seriously reduces the quality of life of patients. Minimally invasive technolo-

gy used in otolaryngology has reduced trauma and shortened recovery times [7, 8]. The treatment of chronic sinusitis usually involves minimally invasive endoscopic nasal surgery. The lesion tissue can be visually observed using a nasal endoscope, and the polyps can be cleared, achieving the radical treatment of sinusitis, thereby alleviating inflammation, restoring sinus ventilation and induction/drainage function, and ensuring normal physiological sinus function [9, 10]. However, facial pain can be more intense than pain in the limbs and trunk, and as endoscopic sinus surgery is performed in the nasal cavity, postoperative pain and safety are receiving increased attention. This study set out to assess the effects of selective pterygoid canal neurotomy on postoperative pain and safety in patients with chronic sinusitis and nasal polyps.

Materials and methods

General information

A total of 86 patients with chronic sinusitis and nasal polyps treated at our hospital from February 2016 to March 2018 were randomly assigned to a control or research group, with 43 assigned to each group. The patients in the control group received conventional minimally invasive endoscopic nasal surgery. The research group patients were treated with selective pterygoid canal neurotomy under nasal endoscopy, the primary procedure of which involves severing the posterior nasal nerve and the pharyngeal branch of the pterygoid canal nerve. Of the patients, 47 were men and 39 women, with an average age of 43.45 ± 11.72 years.

Inclusion and exclusion criteria

The inclusion criteria were as follows, patients meeting: (1) the diagnostic criteria for chronic sinusitis with nasal polyps [11]; (2) the evaluation criteria for endoscopic sinus surgery [12]; and (3) patients presenting with nasal congestion, runny nose, facial distention and tightness, a decline in olfactory function, and other symptoms.

The exclusion criteria were as follows, patients with: (1) fungal sinusitis; (2) cystic fibrosis; (3) immunodeficiency diseases; (4) immune or blood system diseases; (5) cognitive or communication disorders; or (6) poor compliance.

This study was approved by the Medical Ethics Committee of our hospital, and written informed consent was obtained from all study participants or their legal guardians.

Reagents and materials

Nasal endoscopy equipment was purchased from Jiangsu Ouman Electronic Equipment Co. Ltd., and a dynamic electrocardiograph was purchased from Beijing Avantgarde Medical Equipment Co., Ltd.

Experimental methods

Surgical approaches: Minimally invasive endoscopic nasal surgery, which primarily includes endoscopic sinus surgery and nasal polypectomy, was performed on the control group patients according to the condition of each patient. The research group patients also received selective pterygoid canal neurotomy under nasal endoscopy. The surgical procedures were as follows: A wide-angle nasal endoscopy was dissected from the posterior fontanel of the open maxillary sinus to find the sphenopalatine foramen at the vertical plate of the jaw, and the periosteum of the sphenopalatine foramen was torn within 2 cm. The nerve fascicles from various sources, including the vascular nerve fascicles perforating from the sphenopalatine foramen and the nerve fascicles passing through the bone surface, were identified. The nerve fascicles were then separated by a slim bulbous probe and cut off by a needle-like electrode to protect the peripheral nerve arteries during the operation. Next, small nerves that may cause nerve-to-nerve connections were cut off using microscopic scissors. Finally, the pterygopharyngeal branch of the pterygoid nerve on the inferior bone surface of the anterior wall of the sphenoid sinus was found and separated from the palatal sheath canal. The free neurovascular fascicles were found through the bone of the anterior wall of the palatal sheath canal and were cut off using a plasma knife head or needle electrode.

Index detection method

All patients were monitored by electrocardiogram at 15 min, 3 min, and 1 h after surgery. The primary monitoring indicators included diastolic and systolic blood pressure, heart rate, and pulse oxygen saturation.

Table 1. General information about the patients in the two groups

Categories	Control group (n = 43)	Research group (n = 43)	X^2/t	P
Sex (cases)			0.047	0.829
Male	24 (55.81)	23 (53.49)		
Female	19 (44.19)	20 (46.51)		
Age (years)	43.28 ± 11.79	43.83 ± 11.58	0.218	0.828
History of illness (years)	2.43 ± 0.98	2.48 ± 0.94	0.241	0.810
Smoking (cases)			0.054	0.816
Yes	30 (69.77)	29 (67.44)		
No	13 (30.23)	14 (32.56)		
Drinking (cases)			0.191	0.662
Yes	24 (55.81)	26 (60.47)		
No	19 (44.19)	17 (39.53)		
Respiratory tract infection (cases)			0.341	0.559
Yes	6 (13.95)	8 (8.60)		
No	37 (86.05)	35 (81.40)		
Polyp size (cm)	1.83 ± 0.42	1.89 ± 0.45	0.639	0.524
Polyp site (cases)			0.232	0.972
Maxillary sinus	7 (16.28)	6 (13.95)		
Ethmoid sinus	4 (9.30)	4 (9.30)		
Middle nasal meatus	17 (39.53)	16 (37.21)		
Middle nasal meatus	15 (34.88)	17 (39.53)		

Observational indicators

(1) Each patient's degree of pain was assessed using the visual analog scale on the first day after surgery. The patients scored themselves according to their nasal condition on a scale ranging from 0 to 10, with mild pain given 1-3 points, moderate pain 4-6 points, and severe pain more than 7 points. The diagnoses were made based on whether there were symptoms such as nasal obstruction and runny nose in the left and right nasal passages, sneezing, nasal itching, eye itching, facial bloating, olfactory symptoms, etc. The final self-evaluation scores assigned by the patients were similar to those given by the specialist medical staff [13].

(2) Patient stress-response indicators, including diastolic blood pressure, systolic blood pressure, and the heart rate and pulse oxygen saturation of the two groups were observed and recorded before and after surgery.

(3) The comfort levels were assessed using the Bruggemann comfort scale (BCS) at 1, 2, and 3 h after surgery. The comfort levels of all the patients were monitored within 1 week, and the lower the score, the worse the comfort level of the patients [14].

(4) Quality of life was assessed using a chronic sinusitis-related quality of life questionnaire after treatment, including items related to daily activities, nasal symptoms, ophthalmic symptoms, inflammatory reactions, related behaviors, sleep, emotional reactions, etc. With a total score of 6 points for each observation indicator, the scores and corresponding diagnoses were as follows: 0 points: patients were not affected by nasal or ophthalmic symptoms; 1 point: basically unaffected; 2 points: slightly affected; 3 points: mildly affected; 4 points: moderately affected; 5 points: severely affected; 6 points: extremely severely affected. The lower the score, the better the quality of life [15].

(5) The duration of hospitalization and the surgical wound recovery time in the two groups were observed and recorded.

(6) The incidence of adverse reactions was compared between the two groups.

(7) The curative effects of the patients in the two groups were compared using specific terms-markedly effective: the symptoms and signs basically disappeared compared with those before the treatment; effective: the

Table 2. Postoperative pain in the two groups [n (%)]

Categories	Control group (n = 43)	Research group (n = 43)	X^2	P
Mild pain	13 (30.23)	29 (67.44)	11.911	<0.001
Moderate pain	26 (60.47)	12 (27.91)	9.241	0.002
Severe pain	4 (9.30)	2 (4.65)	<0.001	>0.999

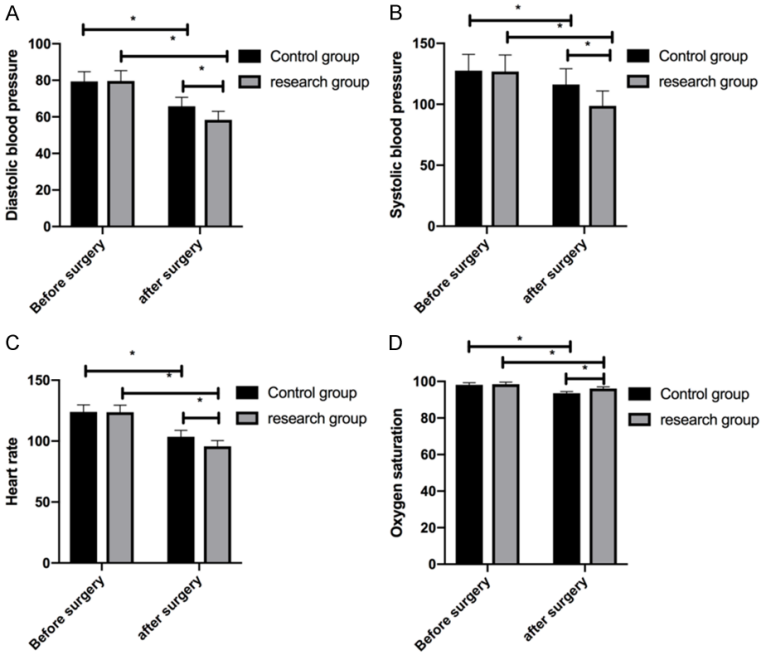

Figure 1. Comparison of the stress-response indicators in the two groups before and after surgery. A. The postoperative diastolic blood pressure in both groups decreased significantly compared with the levels before treatment, and the diastolic blood pressure in the control group was significantly higher than the level in the research group. B. The systolic blood pressure in both groups decreased significantly compared with the level before treatment, and the level in the control group was significantly higher than it was in the research group. C. After treatment, the heart rates of the patients in the two groups decreased significantly compared with the rates before treatment, and the rate in the control group was significantly higher than it was in the research group. D. The postoperative oxygen pulse saturation in the two groups decreased significantly compared with before treatment, and the level in the control group was significantly lower than it was in the research group. Note: * represents P<0.05.

symptoms and signs were reduced compared with those before the treatment; and ineffective: no significant improvement in the symptoms or signs or even further deterioration than before treatment. Total effective rate = (markedly effective + effective)/total number of cases * 100% [16].

Statistical methods

The statistical analysis was performed using SPSS 19.0 (Beijing NDTimes Technology Co., Ltd.), and the data were plotted using GraphPad Prism 8. The measurable values were analyzed using chi-squared tests, and the measurement data were expressed as the mean ± standard deviation. A one-way analysis of variance (ANOVA) was used to perform the comparisons between the groups, paired *t*-tests were used to perform the comparisons before and after treatment, and repeated-measures ANOVAs were used to compare results at multiple time points. P< 0.05 was considered statistically significant.

Results

No significant differences in the baseline data in the two groups

There were no significant differences in the general information between the two groups, including sex, age, smoking and drinking history, and respiratory tract infections (P>0.05) (**Table 1**).

No significant difference in the number of patients with severe pain in the two groups

The number of patients with mild pain in the control group was significantly lower than the number in the research group, and the number of patients with moderate pain in the control group was significantly higher than the number in the research group, with statistically significant differences (P<0.05). No significant difference in the number of patients with severe pain was seen between the two groups (P>0.05) (**Table 2**).

Both groups showed improved stress-response indicators after surgery

No significant difference was evident in terms of the preoperative stress-response indicators in the two groups (P>0.05). After treatment, the stress-response indicators in the two groups

Table 3. BCS scores at various postoperative time points in the two groups

Categories	Control group (n = 43)	Research group (n = 43)	t	P
1 h after surgery	2.46 ± 0.47	2.79 ± 0.52	3.087	0.003
2 h after surgery	2.71 ± 0.53	3.07 ± 0.56	3.062	0.003
3 h after surgery	3.09 ± 0.54	3.36 ± 0.58	2.234	0.028

Table 4. Quality of life in the two groups

Categories	Control group (n = 43)	Research group (n = 43)	t	P
Daily activities	1.53 ± 0.46	1.16 ± 0.41	3.937	<0.001
Nasal symptoms	2.26 ± 0.52	1.89 ± 0.51	3.331	0.001
Ophthalmic symptoms	2.01 ± 0.61	1.71 ± 0.54	2.415	0.018
Inflammatory reactions	1.57 ± 0.56	1.21 ± 0.47	3.229	0.002
Related behavior	1.87 ± 0.59	1.36 ± 0.51	4.288	<0.001
Sleep	3.11 ± 0.71	2.61 ± 0.65	3.406	0.001
Emotion	1.12 ± 0.43	0.87 ± 0.38	2.857	0.005

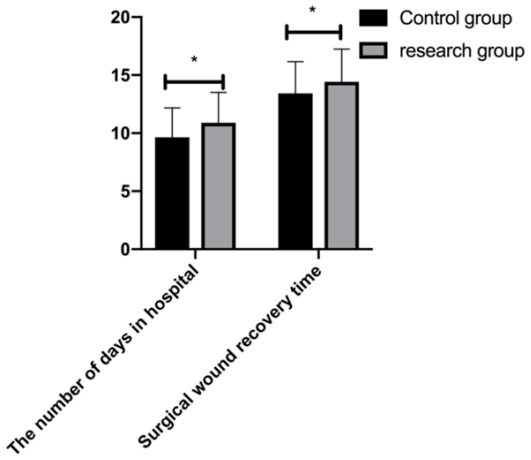

Figure 2. Comparison of the duration of hospitalization and wound recovery times in the two groups. The durations of hospitalization and the surgical wound recovery times in the research group were longer than they were in the control group. Note: * represents P<0.05.

decreased significantly. The diastolic blood pressure, systolic blood pressure, and heart rate measurements in the control group patients were significantly higher than they were in the research group patients, and the pulse oxygen saturation in the control group patients was significantly lower than it was in the research group patients, with a statistically significant difference (P<0.05) (**Figure 1A-D**).

The research group showed higher BCS scores

The BCS scores of the patients in the control group at 1, 2, and 3 h after surgery were significantly lower than the scores in the research group, with statistically significant differences (P<0.05) (**Table 3**).

The control group exhibited a higher quality of life

All the quality of life indicators in the control group were significantly higher than the corresponding indicators in the research group, with statistically significant differences (P<0.05), as shown in **Table 4**.

The research group had longer hospitalization and surgical wound recovery times

The duration of the hospitalization and the surgical wound recovery times in the research group were longer than they were in the control group, with statistically significant differences (P<0.05) (**Figure 2**).

No difference was observed in incidence of adverse reactions in the two groups

No significant difference in the total incidence of adverse reactions was seen between the research group and the control group (P>0.05) (**Table 5**).

The research group showed a better curative effect

The total effective rate in the research group was significantly higher than the rate in the control group, and the difference was statistically significant (P<0.05) (**Table 6**).

Discussion

Most people still suffer from chronic sinusitis [17]. The inflammatory persistence of chronic sinusitis often leads to more serious phenomena, such as polyp formation and postoperative cavity adhesion and obstruction [18]. Studies have shown that these symptoms are

Table 5. Adverse reactions in the two groups [n (%)]

Categories	Control group (n = 43)	Research group (n = 43)	X^2	P
Active hemorrhage	4 (9.30)	3 (6.98)	-	-
Postoperative cavity adhesion	3 (6.98)	2 (4.65)	-	-
Respiratory complications	2 (4.65)	2 (4.65)	-	-
Sinus obstruction	2 (4.65)	1 (2.33)	-	-
Total incidence of adverse reactions	11 (25.58)	8 (18.60)	0.608	0.436

Table 6. The curative effects in the two groups [n (%)]

Categories	Control group (n = 43)	Research group (n = 43)	X^2	P
Markedly effective	14 (32.56)	26 (60.47)	-	-
Effective	21 (48.84)	15 (34.88)	-	-
Ineffective	8 (18.60)	2 (4.65)	-	-
Total effective rate	35 (81.40)	41 (95.35)	4.074	0.044

caused by nasal hypersecretions, and the main factor leading to active nasal secretions is the parasympathetic nerve, which regulates nasal secretions by innervating the nasal glands [19]. The parasympathetic nerve innervating the nasal cavity originates at the superficial petrosal nerve and is collectively referred to as the pterygoid canal nerve [20]. Pterygoid canal neurotomy can therefore reduce the number of parasympathetic nerves distributed in the blood vessels, eliminate incentives leading to the increase of nasal secretions, reduce the sensitivity of nasal mucosa and other associated parts, adjust the nasal environment, and reduce the production of polyps [21].

In this study, the number of patients with mild pain in the control group was significantly lower than it was in the research group, the number of patients with moderate pain in the control group was significantly higher than it was in the research group, and the number of patients with severe pain in the control group was not significantly different from the number in the research group. This suggests that pain will generally decrease after recovery, and there were almost no patients with abnormal pain. Minimally invasive endoscopic nasal surgery and pterygoid canal neurotomy appear to be equally effective treatments for sinusitis, and the pain degree of patients undergoing selective pterygoid canal neurotomy is significantly lower than the pain degree of patients undergoing minimally invasive endoscopy nasal surgery alone. Studies [22, 23] have shown that patients with chronic sinusitis are prone to some degree of pain symptoms after surgery, mostly moderate pain, which is the key reason for delayed recovery and reduced quality of life. Based on our study results, selective pterygoid canal neurotomy can effectively relieve postoperative pain in patients with chronic sinusitis and nasal polyps. With further evaluation, it was found that the stress-response indicators of the two groups decreased significantly after treatment. Diastolic and systolic blood pressure and heart rates in the control group were significantly higher than those in the research group, and the pulse oxygen saturation measurements in the control group were significantly lower than those in the research group. Previous studies [24, 25] demonstrated that treating chronic sinusitis patients with surgical treatment stimulates a strong response by the sympathetic nervous system, resulting in a significant increase in catecholamine content in the body and affecting the expression of the stress-response indicators. Selective pterygoid canal neurotomy is a procedure that cuts off the mixed nerve innervating the nasal mucosa, preventing the regulation of the parasympathetic nerve's dominant function, thereby regulating vasoconstriction and gland secretion in the nasal cavity and sinuses and making the excitability of the cholinergic nerve endings disappear in the nasal cavity [26]. The above observations are consistent with our findings, which indicate that pterygoid canal neurotomy can reduce the postoperative stress-response and alleviate pain and other adverse reactions. In terms of comfort and quality of life, the BCS scores of the control group patients were significantly lower than those of the research group patients at 1, 2, and 3 h after surgery. The quality of life indicators in the control group were significantly higher than those in the research group. This suggests that the pati-

ents' quality of life improved after the pterygoid canal neurotomy, and the discomfort caused by the sinusitis and nasal polyps was significantly reduced. Furthermore, the recovery times, adverse reactions, and curative efficacy were observed and compared between the two groups. It was found that the duration of hospitalization and recovery times of the surgical wounds in the research group were longer than they were in the control group. The research group exhibited a higher effective rate than the control group. The recovery times of the patients undergoing selective pterygoid canal neurotomy under nasal endoscopy were slightly longer than those of the patients who received only conventional treatments. This may be because the selection of surgical sites for the former treatment is relatively large, which leads to prolonged recovery times. Nevertheless, the curative effect of selective pterygoid canal neurotomy is superior and is associated with no increase in postoperative adverse reactions. According to a literature review [27], surgical treatment for refractory chronic sinusitis accompanied by relatively stable postoperative recovery and overall curative effect may result in dry-eye symptoms, facial or palatal numbness, and other surgical risks, which are consistent with our findings. We found no significant increase in adverse reactions in our study, indicating that pterygoid canal neurotomy does not affect overall safety under reasonable and scientific conditions.

In conclusion, selective pterygoid canal neurotomy for chronic sinusitis with nasal polyps can significantly alleviate pain in patients, particularly in the nasal cavity, with higher safety and a superior curative effect. A major limitation of this study, however, is the study of adverse reactions. The grouping and timing of the postoperative adverse reactions were sporadic, and the statistical analysis of the adverse reactions was complicated. We recorded only those adverse reactions observed at a uniform time after surgery and only followed the patients' conditions for a short period of time. Further studies are necessary to evaluate the safety and effectiveness of selective pterygoid canal neurotomy for the treatment of patients with chronic sinusitis with nasal polyps.

Acknowledgements

This work was supported by Yuyao People's Hospital Youth Fund Project (No. 2018QA04) and Ningbo Science and Nature Fund Project (No. 2019A610324).

Disclosure of conflict of interest

None.

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References

[1] Sobol SE, Samadi DS, Ken K and Tom LW. Trends in the management of pediatric chronic sinusitis: survey of the American Society of Pediatric Otolaryngology. Laryngoscope 2010; 115: 78-80.

[2] Ziegler A, Patadia M and Stankiewicz J. Neurological complications of acute and chronic sinusitis. Curr Neurol Neurosci Rep 2018; 18: 5.

[3] Majima Y, Sakakura Y and Matsubara T. Possible mechanisms of reduction of nasal mucociliary clearance in chronic sinusitis. Clin Otolaryngol Allied Sci 2010; 11: 55-60.

[4] Min-man W, Hong S, Zhi-qiang X, Xue-ping F, Chang-qi L and Dan L. Differential proteomic analysis of nasal polyps, chronic sinusitis, and normal nasal mucosa tissues. Otolaryngol Head Neck Surg 2009; 141: 364-368.

[5] Platt MP, Soler ZM, Kao SY, Metson R and Stankovic KM. Topographic gene expression in the sinonasal cavity of patients with chronic sinusitis with polyps. Otolaryngol Head Neck Surg 2011; 145: 171-175.

[6] Ren J and Huangfu H. Analysis of olfactory rehabilitation after endoscopic sinus surgery in patients with chronic sinusitis and nasal polyps. Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi 2016; 30: 106-110.

[7] Atlas SJ, Metson RB, Singer DE, Wu YA and Gliklich RE. Validity of a new health-related quality of life instrument for patients with chronic sinusitis. Laryngoscope 2010; 115: 846-854.

[8] Bajaj Y, Sethi N, Carr S and Knight LC. Endoscopic sinus surgery as day-case procedure. J Laryngol Otol 2009; 123: 619-622.

[9] Zhang W, Xiao H and Huang H. Significance of treatment chronic sinusitis in children with adenoidectomy with nasal endoscope. Modern Hospital 2008.

[10] You X, Liu Z, Hu J, Gao Q and Cui Y. Rehabilitation therapy after nasal endoscopic surgery for nasal polyp and chronic sinusitis patients. Lin Chuang Er Bi Yan Hou Ke Za Zhi 2005; 19: 31-33.

[11] Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, Cohen N, Cervin A, Douglas R,

Gevaert P, Georgalas C, Goossens H, Harvey R, Hellings P, Hopkins C, Jones N, Joos G, Kalogjera L, Kern B, Kowalski M, Price D, Riechelmann H, Schlosser R, Senior B, Thomas M, Toskala E, Voegels R, Wang de Y and Wormald PJ. European position paper on rhinosinusitis and nasal polyps 2012. Rhinol Suppl 2012; 23: 3 p preceding table of contents, 1-298.

[12] Fischer M, Grobner C, Dietz A, Lueth TC and Strauss G. First clinical experiences with an endoscope manipulator system in endo- and transnasal surgery. Laryngorhinootologie 2012; 91: 487-493.

[13] Kahveci OK, Miman MC, Yucel A, Yucedag F, Okur E and Altuntas A. The efficiency of nose obstruction symptom evaluation (NOSE) scale on patients with nasal septal deviation. Auris Nasus Larynx 2012; 39: 275-279.

[14] Yang ZL, Sun SQ and Zhang KJ. Subjective evaluation model and system for sitting comfort based on gene expression programming. CIMS 2012; 18: 2138-2144.

[15] Linder JA and Atlas SJ. Health-related quality of life in patients with sinusitis. Curr Allergy Asthma Rep 2004; 4: 490-495.

[16] Kuhn FA, Melroy CT, Levine HL and Diamond AJ. Drug-eluting spacer for chronic ethmoid sinusitis treatment. Otolaryngology Head and Neck Surgery 2008; 139: P75.

[17] Ma M and Liu Y. Exploring of surgery solution for chronic sinusitis treatment and application of partial middle turbinectomy. Lin Chuang Er Bi Yan Hou Ke Za Zhi 2003; 17: 454-455.

[18] Conley DB, Tripathi A, Ditto AM, Reid K, Grammer LC and Kern RC. Chronic sinusitis with nasal polyps: staphylococcal exotoxin immunoglobulin E and cellular inflammation. Am J Rhinol 2004; 18: 273-278.

[19] Sapci T, Yazici S, Evcimik MF, Bozkurt Z, Karavus A, Ugurlu B and Ozkurt E. Investigation of the effects of intranasal botulinum toxin type A and ipratropium bromide nasal spray on nasal hypersecretion in idiopathic rhinitis without eosinophilia. Rhinology 2008; 46: 45-51.

[20] Inoue K and Kitada Y. Parasympathetic postganglionic nerve fibers in the fungiform papillae of the frog. Anat Rec 2010; 230: 131-135.

[21] Nishijima H, Kondo K, Toma-Hirano M, Iwasaki S, Kikuta S, Fujimoto C, Ueha R, Kagoya R and Yamasoba T. Denervation of nasal mucosa induced by posterior nasal neurectomy suppresses nasal secretion, not hypersensitivity, in an allergic rhinitis rat model. Lab Invest 2016; 96: 981-993.

[22] Finkensieper M, Poller K, Wittekindt C, Meissner W and Guntinas-Lichius O. Postoperative pain assessment after functional endoscopic sinus surgery (FESS) for chronic pansinusitis. Eur Arch Otorhinolaryngol 2013; 270: 157-166.

[23] Wu CL, Naqibuddin M, Rowlingson AJ, Lietman SA, Jermyn RM and Fleisher LA. The effect of pain on health-related quality of life in the immediate postoperative period. Anesth Analg 2003; 97: 1078-1085.

[24] El Mograbi A and Soudry E. Ocular cranial nerve palsies secondary to sphenoid sinusitis. World J Otorhinolaryngol Head Neck Surg 2017; 3: 49-53.

[25] Madden KS, Sanders VM and Felten DL. Catecholamine influences and sympathetic neural modulation of immune responsiveness. Annu Rev Pharmacol Toxicol 1995; 35: 417-448.

[26] Hwang PH, Lin B, Weiss R, Atkins J and Johnson J. Cryosurgical posterior nasal tissue ablation for the treatment of rhinitis. Int Forum Allergy Rhinol 2017; 7: 952-956.

[27] Low WK. Complications of the Caldwell-Luc operation and how to avoid them. Aust N Z J Surg 1995; 65: 582-584.