Impact of Nasal Polyps on Quality of Life of Chronic Sinusitis Patients

Lakshmi Vaid • Seema Khanna • P.P. Singh

Abstract

Objective To study the significance of nasal polyps on the symptoms of chronic rhinosinusitis (CRS) and their influence on surgical outcomes.

Methods Retrospective analysis of prospectively collected data comparing two groups of patients diagnosed with CRS with and without polyps who underwent surgery with a minimum of 3 month follow up period. Subjective scoring was performed using the Sino-nasal Outcome Test (SNOT-20) questionnaire. Computed tomography (CT) scans were compared using the Lund–Mackay scoring system. Endoscopic findings were graded according to Lanza and Kennedy staging system. The two groups were analyzed for the need of revision surgery.

Results 30 patients underwent surgical management of CRS over a period of one year. 20 were male, 10 were female and the average age was 26 years (range 15-55years). Polyps were present in 15 patients with CRS while, the other 15 did not have polyps. The average CT score was 10.13 for the polyp group and 9.79 for patients without polyp. The Polyp group SNOT-20 preoperative scores averaged 20.27 with improvement to 3.80 at 2 weeks, 2.67 at 1 month and 2.93 at 3 months (86.21% improvement $p=0.001$). Non-polyp group SNOT-20 scores were 18.80 preoperatively with improvement to 4.67 at 2 weeks, 3.40 at 1 month and 3.27 at 3 months

(81.83% improvement). Preop diagnostic endoscopy on polyp group was 5.27 which improved to 2.13 in 2 weeks, 1.33 in 1 month and 1.53 in 3 months (73% improvement). In the non polyp group it was 4.53 pre-operatively which improved to 1.20 in 2 weeks, 0.93 in 1 month and to 1.13 in 3 months (69% improvement). 6 patients required revision surgery (20%), 3 (10%) belonging to polyp group and 3 (10%) who did not have polyps.

Conclusion Nasal Polyp has a significant negative impact on the patients with CRS. Patients with polyps have higher symptom scores, worse objective findings compared with patients without polyp, but patients with polyp show more improvement after surgical intervention and need for revision surgery is equal in both groups.

Keywords Chronic sinusitis • Polyp • Quality of Life • FESS

Introduction

Chronic rhinosinusitis is a group of disorders characterized by inflammation of the mucosa of nose and paranasal sinuses. Although, the exact pathogenesis of chronic rhinosinusitis remains unclear, but various etiologies have been implicated including bacterial infection, viral infection, sinus outflow obstruction, deviated nasal septum, allergy, helicobacter pylori, decreased levels of trace element and functional disorders of leucocytes¹.

An operational definition of chronic rhinosinusitis is disease in which sinuses fail to return to normal despite adequate therapy with appropriate effective antibiotic².

Criteria for diagnosing chronic rhinosinusitis in adults is: 8 weeks of persistent symptoms and signs or 4 episodes per year of recurrent acute sinusitis, each lasting at least 10 days in association with persistent changes on computed tomography (CT) 4 weeks after medical therapy without intervening acute infection³.

The most prevalent and studied pathologic entity associated with chronic rhinosinusitis is nasal polypoidosis. Numerous

Lakshmi Vaid (✉)
Professor

F-22, Kirti Nagar, New Delhi -15
E-mail: drlvaid@rediffmail.com

Seema Khanna
Resident

P P Singh
Professor and Head

Department of Otorhinolaryngology
University College of Medical Sciences & GTB Hospital,
Delhi -110095

basic science investigations are underway to improve our understanding of the cause and mechanism of formation of nasal polyps. Multiple studies have reported on the efficacy of surgical and medical management of patients with chronic sinusitis and nasal polyps⁴.

Chronic rhinosinusitis causes significant physical symptoms and negatively affects Quality of Life (QOL) and can substantially impair daily function. To help evaluate the effect of various treatments on patients status, Meltzer et al² have chosen to perform an independent evaluation of SNOT-20 (Sinonasal Outcome Test-20) which was developed by Piccirillo et al⁵. The SNOT-20 asks patient to rate the severity of their symptoms and social/emotional consequences of their rhinosinusitis. It is scored so that a higher SNOT-20 score indicates worse health related Quality of Life and functional status².

Anterior rhinoscopy is a basic tool of physical examination. Nasal endoscopy is further more than anterior rhinoscopy. It helps identify erythema, edema, polyp or polypoid swelling, crusting and mucopus or frank pus deep in nasal cavity². Endoscopic physical findings here are scored according to Lanza & Kennedy⁶.

Endoscopy alone cannot be used to determine normalcy because rhinosinusitis (RNS) can occur in sinus areas that endoscopy cannot detect. Imaging studies are an absolute requirement in patients undergoing functional endoscopic sinus surgery (FESS). The Lund-Mackay staging system, which is based on a simple numeric score derived from CT scan has been used for some years in the quantification of inflammatory disease before surgical intervention⁷.

Endoscopic sinus surgery has yielded excellent subjective and objective outcome with a very low complication rate. The high success rate, the low incidence of complications and technological advances in presence of poor documentation of medical therapy has made endoscopic sinus surgery the primary therapy for chronic rhinosinusitis⁶.

The goal of the present study is to elucidate the impact of sinonasal polyposis on patients with CRS based on symptoms, objective findings and surgical outcome.

Materials and Methods

The present prospective study was carried out in Department of Otorhinolaryngology at UCMS & GTB Hospital, for a period of one year from March 2005 to Feb 2006.

Thirty patients of chronic rhinosinusitis who consented to participate in the study were taken – 15 were with polyp and 15 without polyp and comparison was made in the severity of symptoms and improvement after operative intervention.

The present study involved selection of patients of CRS by diagnostic procedures like: Routine ENT examination, anterior and posterior rhinoscopy, Presenting complaints using visual

Table 1 SNOT-20 score in the study groups

	Symptoms in polyp group		Symptoms in non-polyp group	
	No. of patients	VAS mean	No. of patients	VAS mean
TND	15	3.6±1.40	15	2.93±.88
PND	15	3.0±1.19	14	3.00±.255
Need to blow	15	3.8±0.77	13	2.27±1.62
Runny nose	9	1.10±0.52	4	1.27±1.22
Sneezing	13	1.33±0.82	4	1.53±1.13
Cough	10	0.67±0.49	6	0.84±.35
Ear fullness	2	0.33	8	0.60±.63
Dizziness	0	0	0	0
Facial pain	12	1.27±1.07	8	0.453±.453
Reduced productivity	11	0.73±0.46	8	0.60±.63
Reduced concentration	9	0.60±0.63	4	0.27±.46
Fatigue	7	0.60±0.74	8	0.60±.63
Difficulty in falling asleep	9	0.80±0.77	5	1.11±.34
Waking up at night	13	1.20±0.68	11	0.93±0.90
Lack of good night sleep	12	0.93±0.59	12	1.07±0.80
Waking up at tired	7	0.60±0.74	1	2
Ear pain	1	1	0	0
Frustrated	6	0.53±0.64	2	0.40±0.1
Embarrassed	3	0.27±0.59	1	1
Sad	9	0.60±0.51	2	0.47±0.52

SNOT: Sino Nasal Outcome Test; TND: Thick Nasal Discharge; PND: Post nasal discharge; VAS: Visual Analogue Scale

Table 2 Improvement in SNOT-20 score

		Preop	2 wks	1 month	3 month
Polyp group	Average score	20.27±3.97	3.80±2.14	2.67±4.38	2.93±2.78
	% improvement		80.36%	88.15%	86.21%
Non-polyp group	Average score	18.80±4.87	4.67±2.99	3.40±1.88	3.27±1.75
	% improvement		74.23%	81.11%	81.83%

analogue scale (0 to 5) for SNOT-20 questionnaire, Routine blood investigations including absolute eosinophilic count, X-ray PNS water's view, CT paranasal sinuses – axial, coronal, sagittal views, Diagnostic nasal endoscopy.

All the patients were first treated for chronic rhinosinusitis using antibiotics and if purulence was present in middle meatus, an intranasal steroid spray, nasal saline and mucolytics for at least 3 weeks. If the patients continued to be symptomatic despite this medical therapy, paranasal sinus

Table 3 Improvement in diagnostic endoscopy score

		Preop	2 wks	1 month	3 month
Polyp group	Average score	5.27±1.79	2.13±0.99	1.33±1.49	1.53±1.95
	% improvement		55.55%	77%	73.33%
Non-polyp group	Average score	4.53±1.80	1.20±0.77	0.93±1.16	1.13±0.74
	% improvement		70.88%	72.71%	69.15%

CT, 3 mm coronal sections was performed, and the patients returned for follow up.

Each participant completed the SNOT-20 (Sino Nasal Outcome Test-20) questionnaire at the preoperative visit. This validated rhinosinusitis specific health related quality of life instrument was used in the study. The patients were asked to score a list of 20 symptoms and their social and emotional consequences. Severity of the symptoms was graded according to visual analogue scale. Findings on sinus coronal CT scans were graded using the Lund-Mackay CT scoring system. Each sinus group is graded as: 0 – No abnormality, 1 – partial opacification, 2 – complete opacification, osteomeatal complex is scored as : 0 (not occluded) or 2 (occluded).

Total score can range from 0 to 24. Anatomical variants were graded as 0 (absent) or 1 (present). Endoscopy physical findings were scored according to Lanza and Kennedy. The following parameters were graded : Presence or absence and extent of the nasal polyps, edema, discharge, crusting and scarring. For nasal polyps: 0 – was given for absence of polyps, 1 – for polyps present within middle meatus, 2 – for polyps present beyond middle meatus. For edema, scarring and crusting : 0 – was given if the finding was absent, 1 – if it was mild, 2 – if it was of severe extent. For discharge : 0 – was given if there was no discharge present, 1 – for clear, thin discharge, 2 – for thick purulent discharge. Each side was graded separately and the scores from each side were then added to determine the overall endoscopy score.

Exclusion criteria included cases of fungal sinusitis, patients undergoing revision surgery, Those cases whose postoperative histology did not confirm with the diagnosis of nasal polyp, Children (<15 yrs old) and asthmatics. FESS was carried out under general anaesthesia in patients of chronic rhinosinusitis if they had persistent symptoms and radiological evidence of sinusitis on sinus CT^{8,9,10}.

Postoperatively patient were prescribed analgesics and antibiotics for 7 days, the nasal pack was removed on third postoperative day, followed by nasal douching 3 times a day for 2 weeks, and steroid nasal spray for about 2 months. Patients underwent diagnostic endoscopy under LA after 2 weeks, 1 month and after 3 months of surgery to see for and remove any granulation, crusts, synechia and debris, the patency of the ostium was confirmed, the sinus mucosa was

Graph 1 Comparison of endoscopy, CT Score & preop SNOT-20 in Polyp and Non Polyp **Graph 2** Comparison of % improvement in SNOT-20 in Polyp and Non-Polyp **Graph 3** Comparison of % improvement in endoscopy in Polyp and Non-Polyp

seen for any remnant or recurrence of disease, for outcome measures, patient symptoms were again rated using SNOT-20. The data was collected and analyzed in terms of details of history, clinical examination, radiological findings and preoperative and postoperative findings.

Statistical analysis was performed using SPSS Statistical Package Software. F-test (ANOVA) was used for comparison between SNOT-20 scores, endoscopy scores and CT scores within the groups. Correlation test (relationship) was used to find out the r-value and p-value.

Observations and results

30 patients clinically and radiologically diagnosed as cases of chronic rhinosinusitis were divided into polyp and non-polyp group (15 each) and operated upon for FESS and data analyzed. The average age at the time of presentation was 26 years with a range of 15 to 55 years. There were 20 males and 10 females. The mean duration of symptoms at the time of presentation was 2½ years with a range of 10 months to 5 years. All the cases were fresh cases with no history of previous surgical intervention.

X-ray PNS (water's view) revealed complete or partial opacification of paranasal sinuses in all cases. Routine blood investigations were normal. Raised absolute eosinophilic count in 9 cases (30%). 6 in polyp group and 3 in non-polyp group. The SNOT-20 scores of both the groups were added together and averages obtained. Mean preoperative SNOT-20 score of polyp group was 20.27 ± 3.97 with a range of 14 to 27. In non-polyp it was 18.80 ± 4.87 with a range of 16 to 34 (Table. 1).

In each group, CT scores of all 15 cases were added and averages obtained. In polyp group mean preop CT score was 10.13 ± 3.56 with a range from 6 to 16. In non-polyp group it was 9.79 ± 4.84 with a range from 3 to 17.

Endoscopy scores of all the patients in each group were added and averages obtained. Preoperative diagnostic endoscopy score was 5.27 ± 1.79 in the polyp group with a range 3 to 10. It was 4.53 ± 1.80 with a range from 2 to 7 in the non polyp group (Graph 1).

There was significant improvement in most of the nasal symptoms in patients of polyp group after FESS. Overall SNOT-20 score at 2 weeks was 3.80 ± 2.145 with a range 1 to 8. This is 80.36% improvement from preoperative value. At 1 month, it further improved with a mean score 2.67 ± 4.386 with a range 0 to 18. This is 88.15%. At 3 months it was 2.93 ± 2.789 with a range 0 to 10. Thus there was 86.21% improvement in SNOT-20 after 3 months of follow-up.

Mean postoperative SNOT-20 score in non-polyp group at 2 weeks after the surgery was 4.67 ± 2.992 with a range 2 to 12. This is 74.2% improvement. Mean postoperative score at 1 month was 3.40 ± 1.882 , range 0 to 7. This is 81.11% improvement. It further reduced to 3.27 ± 1.751 at 3 months of follow-up with a range 1 to 7. Thus there was 81.83% improvement in 3 months after FESS (Table 2, Graph 2).

Mean diagnostic endoscopy score at 2 weeks in polyp group, was 2.13 ± 0.99 with a range of 1 to 4, 55.55% improvement in 2 weeks after FESS. In non-polyp group, it was 1.20 ± 0.77 with a range 0 to 2, 70.88% improvement. At 1 month in polyp group it was 1.33 ± 1.49 with a range 0 to 6, 77% improvement. In non-polyp group it was 0.93 ± 1.16 with a range 0 to 4, 72.71% improvement. At 3 months in polyp group it was 1.53, 73% improvement. In non-polyp group it was 1.13 ± 0.743 with a range 0 to 3, 69.15% improvement (Table 3, Graph 3).

None of the patients had excessive intraoperative or postoperative bleeding. None of them had intraoperative or postoperative CSF rhinorrhoea or had any ophthalmic complications. Six patients had development of synechiae postoperatively which was divided and resected subsequently during diagnostic endoscopy. These synechiae were most commonly seen between septum and inferior turbinate.

3 out of 15 patients in polyp group and 3 out of 15 in non-polyp group patients might require revision surgery after a few more months of follow up. There was no significant correlation demonstrated between CT grade and SNOT-20 scores in both polyp and non-polyp group of patients. Also there was no significant correlation demonstrated between CT grade and percentage improvement of SNOT-20 scores. There was significant correlation demonstrating between CT grade and endoscopy score in both the groups and also between endoscopy and SNOT-20 score.

Discussion

CRS results in significant patient morbidity and larger expenditure of health care money. Patients with this diagnosis can be difficult to treat successfully and the subjective nature of disease makes quantifying success difficult. A confounding problem is the presence of nasal polyps that can further complicate the treatment of these patients⁶.

The disease itself is defined by signs and symptoms, it is logical to use the presence and severity of sinonasal symptom as a primary outcome measure for sinusitis. However symptoms are by definition subjective and the measurement of symptoms require that the patients completes a self-assessment instrument.

In this study the SNOT-20 questionnaire was used. Commonest symptom, patients presented to us was thick nasal discharge which was present in 100% of polyp group and 100% of non-polyp group. The other common symptoms were the complaint of postnasal discharge which was present in all 100% of cases of polyp group and in 93% of non-polyp group. Persistent complaint of need to blow the nose was also present in all 100% of patients of polyp group while it was seen in 87% of cases of non-polyp group.

Other common symptoms seen in majority of 30 cases of CRS were facial pain and cough which was more common in polyp group. Allergic symptoms were seen more commonly in polyp group (86% had complaint of sneezing and 60% had runny nose) as compared to non-polyp group (53% had complaint of sneezing and runny nose). This supports the view that allergy has an important role in formation of nasal polyps. CRS significantly affected the quality of life in our patients more in polyp group than in non polyp group. 87% of patients of polyp had sleep disturbances compared to 54% in non-polyp group.

CRS also has impact on social and emotional life of the patients as can be seen from the observation that patients had reduced concentration and reduced productivity in their routine work which also is more common in polyp group. Also few of them were sad, frustrated and embarrassed due to this disease. The average SNOT-20 score of 15 cases of polyp group was 20.27 ± 3.97 with a range of 14 to 27 and in non-polyp group was 18.80 ± 4.87 with a range of 11 to 34 while in study done by Deal and Kountakis mean preoperative SNOT-20 in polyp group was 32.2 ± 1.2 and non-polyp was 26.5 ± 1.0 .

In our study and study done by Deal and Kountakis, it is seen that polyp group had higher SNOT-20 scores. Several reasons have been postulated for this finding. Firstly, patients with nasal polyps tend to have a higher degree of nasal airway obstruction because of the mass effect of the polyps themselves. Second, polyps do not have ciliated surfaces, which results in decreased mucociliary transport leading to thicker postnasal drip and retained secretions. Patients with polyposis also have increased mucosal edema and inflammation. This inflammatory process can further lead to patient discomfort^{6,11}. This shows that nasal polyp has a significant negative impact on the patients on chronic rhinosinusitis.

In our study polyp group had mean preoperative CT score 10.13 ± 3.56 with a range from 6 to 16 and in non-polyp group it was 9.79 ± 4.84 with a range from 3 to 17, while in study by Deal and Kountakis, it was 18 ± 0.6 in polyp group and 9.5 ± 0.5 in non-polyp group. In both these studies polyp group have a higher preoperative CT score because nature of polypoid mucosa makes the appearance of the CT scans worse with a corresponding higher score assigned^{7,12}. In our study in polyp group, maxillary sinus opacification, osteomeatal complex blockage, anterior ethmoids and posterior ethmoids was observed in CT scan of all the 100% cases. While in non polyp group only anterior ethmoids maxillary sinus opacification and osteomatal complex blockage was seen in 100% cases but posterior ethmoids opacification was seen in slightly lesser number of cases i.e. in 80% cases (n=12). In both the cases sphenoid sinus and frontal sinus were involved in less number of cases.

Diagnostic endoscopy findings were graded according to Lanza and Kennedy. In our study polyp group had mean pre-op diagnostic endoscopy score 5.27 ± 1.79 with a range of 3 to 10 and in non-polyp group it was 4.53 ± 1.80 with a range from 2 to 7. While in study done by Deal and Kountakis⁶ it was 9.7 ± 0.4 in polyp group and 3.3 ± 0.3 in CRS group, explaining the higher endoscopy scores in polyp group. There was significant improvement in all nasal symptoms in both the groups after endoscopic sinus surgery as shown in previous study by Stewart et al¹³. A meticulous follow up was done to evaluate the results with regards to improvement of symptoms and findings on diagnostic endoscopy. All the 30 patients returned for follow up at 2 weeks and SNOT-20 score was evaluated.

This shows that in our study, patients with polyps experienced 80.36% improvement in SNOT-20 at 2 week with further improvement to 88.15% at 1 month and changed to 86.21% improvement at 3 months. In non polyp it was 74.23% improvement at 2 week, 81.11% at 1 month and 81.83% improvement in SNOT-20 score at 3 months. Several authors have suggested that inhalant allergy in polyp group is often a predisposing factor in development of CRS¹⁴. Lavigne et al¹⁵ concluded that worsening of symptoms in some patients of CRS after sinus surgery could be the result of an exposure to environmental allergies.

In study done by Deal and Kountakis⁶ the patients with polyp had an 81% improvement in SNOT-20 scores at 12 months postoperatively compared with 85% in non-polyp group.

In study done by Deal and Kountakis percentage improvement in SNOT-20 is higher in non polyp group as compared to polyp group which is not coinciding with our observation which shows higher improvement (86%) in polyp group than in non polyp group (81%), but our study had postoperative follow-up of only three months. In their study it was observed that there was higher rate of need for revision surgery in polyp versus non-polyp patients. In polyp group 8 patients (10%) required revision surgery and in non-polyp group 1 (0.8%) patient required revision surgery.

In a study done by Ragab et al³ there was 53.7% reduction in symptoms at 6 months in patients of CRS with polyp and 46.6% reduction in non-polyp group in patients who were treated by endoscopic sinus surgery and at 12 months there was 54.7% reduction in polyp group and 48.7% in CRS without polyposis. These results are similar to results in our study which show higher improvement in polyp group as compared to non-polyp group.

Diagnostic endoscopy findings in our study also show higher percent improvement 73.33% at 3 months in polyp group than non-polyp group (69.15%). This is similar to the study done by Ragab et al³, which also shows higher percentage change in endoscopy score (63.7%) in polyp group than in non-polyp group 54.8%.

There was no significant correlation demonstrated between preoperative CT grade and SNOT-20 scores ($p < 0.05$) as demonstrated by Stankiewicz and Chow¹⁶ as well as in several other studies. Furthermore no correlation was demonstrated between preoperative CT grade and overall percentage of improvement of symptoms. This was similar to study done by Deal and Kountakis⁶ and Bradley and Kountakis¹⁷ and study done by Giger et al¹⁸ and Arango et al¹⁹. However, Giger et al¹⁸ also demonstrated that there was a significant correlation between preoperative CT grade proposed by Kennedy⁶ and need for revision surgery. It was opposite to the study done by Stewart et al¹³ who showed correlation between the two.

However there was significant correlation demonstrated between CT grade and preoperative diagnostic endoscopy in both the groups ($p < 0.05$) and also between endoscopy and SNOT-20 score.

Patients with polyp have higher symptom scores, worse objective finding compared with patients without polyp, but patients with polyp show more improvement after surgical intervention and need for revision surgery is equal in both the groups. High rate of improvement, low incidence of complications and less rate of recurrence supports the view that endoscopic sinonasal surgery is an effective and efficient modality of treatment of chronic rhinosinusitis with or without polyps. Similar success after endoscopic sinus surgery was reported by various studies^{3,4,6,17}.

It can be compiled after analysing the results of our study that higher SNOT-20 scores in patients of nasal polyp demonstrated a significant negative impact on nasal polyp on different aspect of quality of life. This was further documented by higher CT scores and higher endoscopy score in patients of nasal polyp. In addition to discomfort and lowered quality of life experienced by the patients with chronic rhinosinusitis, a significant increase in sleep disorder was shown suggesting a risk of suffering further chronic diseases and complications.

Conclusion

There was no significant correlation demonstrated between CT grade and SNOT-20 scores. Also there was no significant correlation between CT grade and percentage improvement in SNOT-20 scores ($p < 0.05$). There was significant correlation demonstrated between CT grade and endoscopy scores and also between endoscopy scores and SNOT-20 scores ($p < 0.05$). It can be concluded that nasal polyp has a significant negative impact on patients of chronic rhinosinusitis. Patients with nasal polyps have higher symptoms scores, worse objective findings compared to patients without polyp, but patients with polyp show more improvement after surgical intervention and need for revision surgery is equal in both the groups.

References

1. Ray NF, Baraniuk JN, Thamer M, Rinehart CS, Gergen PJ, Kaliner M, et al. Healthcare expenditures for sinusitis in 1996: contributions of asthma, rhinitis, and other airway disorders. *J Allergy Clin Immunol* 1999; 103: 408-14.
2. Meltzer EO, Hamilos DL, Hadley JA, Lanza DC, Marple BF, Nicklas RA, et al. Rhinosinusitis: Establishing definitions for clinical research and patient care. *Otolaryngol Head Neck Surg.* 2004; 131: S1-62.
3. Ragab SM, Lund VS, Scadding G. Evaluation of the medical and surgical treatment of chronic rhinosinusitis: a prospective, randomised, controlled trial. *Laryngoscope* 2004; 114: 923-930.
4. Bonfils P, Nores JM, Halimi P, Avan Paul. Corticosteroid treatment in nasal polyposis with a three year follow-up period. *Laryngoscope* 2003; 113: 683-687.
5. Bhattacharya T, Piccirillo J, Wippold FN. Relationship between patient based descriptions of sinusitis and paranasal sinuses computed topographic findings. *Arch Otol Head Neck Surg* 1997; 123: 1189-1192.
6. Deal RT, Kountakis SE. Significance of nasal polyps in chronic rhinosinusitis: symptoms and surgical outcomes. *Laryngoscope* 2004; 114: 1932-35.
7. Lund VJ, Kennedy DW. Staging for rhinosinusitis. *Otolaryngol Head Neck Surg* 1997; 117: 535-540.
8. Rice DH. Basic surgical techniques and variations of endoscopic sinus surgery. *Otolaryngol Clin North Am* 1989; 22(4): 714-716.
9. Stammberger H. Functional endoscopic sinus surgery, The Messerklinger Technique, Chapter 2; 17-22.
10. Kennedy DW, Senior BA. Endoscopic sinus surgery. *Otolaryngol Clin North Am* 1997; 30(3): 313-323.
11. Drake-Lee AB. Nasal polyps. In: Mackay IS, Bull TR (eds). *Scott-Brown's Otolaryngology*, 6th ed. Oxford: Butterworth-Heinemann. 1997; 4/10/1-4/10/15.
12. Zinreich J. Imaging of inflammatory sinus disease. *Otolaryngol Clin North Am* 1993; 26(4): 535-547.
13. Stewart MG, Donnovan DT, Parke RB Jr, Bautisa MH. Does the severity of sinus computed tomography findings predict outcome in chronic sinusitis? *Otolaryngol Head Neck Surg* 2000; 123: 81-4.
14. Krause HF. Allergy and chronic rhinosinusitis. *Otolaryngol Head Neck Surg* 2003; 128: 14-6.
15. Lavigne F, Nguyen CT, Cameron L, Hamid Q, Renzi PM. Prognosis and prediction of response to surgery in allergic patients with chronic sinusitis. *J Allergy Clin Immunol* 2000; 105(4): 746-51.
16. Stankiewicz JA, Chow JM. Nasal endoscopy and definition and diagnosis of chronic rhinosinusitis. *Otolaryngol Head Neck Surg* 2000; 123(1 pt 1): 81-84.
17. Bradley DT, Kountakis SE. Correlation between computed tomography scores and symptomatic improvement after endoscopic sinus surgery. *Laryngoscope* 2005; 115.
18. Giger R, Dulgeurov P, Quinodoz D, Leuba D, Landis BN, Lacroix JS, Friedrich JP. Chronic panrhinosinusitis without nasal polyps: long term outcome after functional endoscopic surgery. *Otolaryngol Head Neck Surg* 2004; 131: 534-41.
19. Arango P, Kountakis SE. Significance of computed tomography pathology in chronic rhinosinusitis. *Laryngoscope* 2001; 111: 1779-1782.