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Site of origin of nasal polyps: relevance to pathogenesis and management*

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SUMMARY

The site of origin of sino-nasal polyps was documented in 113 consecutive patients undergoing functional endoscopic sinus surgery (FESS). These patients were assigned pre-operatively to 4 clinical groups according to the out-patient recorded endoscopic appearance of their nasal cavities; chronic rhinosinusitis without polyps (CRSS) n=35, grade 1 polyps n=28, grade 2 polyps n=30 and grade 3 polyps n=20.

In the group of patients diagnosed with polyps pre-operatively, 97.4% had polyps originating in the anterior ethmoid complex, of which 89.7% had polyps originating in the anterior ethmoidal cells and over 60% had polyps specifically originating from each of the following sites: the uncinate or infundibulum, the posterior ethmoid sinus, the frontal recess and the face of the bulla ethmoidalis.

In the group diagnosed pre-operatively as CRSS without polyps, polyps were found in 60% of patients within the sinuses during surgery.

In summary, our findings suggest that polyps originate from the middle meatus, and may be found at surgery when undetectable at pre-operative endoscopy.

Key words: nasal polyps, site of origin, pathogenesis, FESS

INTRODUCTION

Information about the site of origin of nasal polyps is of interest for several reasons. Firstly, from a surgical standpoint it is useful to be aware of the most common sites for polyps and the likely sites for polyps that are not visible on initial endoscopic examination. This can help plan surgery. Secondly, the anatomical site of origin may provide insight into the pathogenesis and mechanisms of polyp formation.

Only a few studies have been performed to assess the site of origin of nasal polyps. These include post mortem studies, [1-3] which are technically difficult and time consuming, and therefore only small numbers of subjects have been included. Their relevance to the symptomatic patient population may be limited. Other nasal polyp studies tend to be site – olfactory cleft [4] or disease specific [5]. The latter author also looked at the numbers of polyps originating in the nasal cavity and paranasal sinuses as a whole [6], and surmised that polyps originated mainly from outside the ethmoid cells and paranasal sinuses. There is therefore still disagreement amongst rhinologists as to whether polyps arise predominantly from nasal mucosa, the surface mucosa of paranasal sinuses or from within the paranasal sinus cells.

Functional endoscopic sinus surgery (FESS), therefore, presents an ideal scenario for detailed documentation of sites of origin of polyps in symptomatic patients who have not responded to medical treatment.

MATERIALS AND METHODS

Endoscopic sinus surgery was carried out on 113 patients, over a one-year period, for chronic rhinosinusitis with or without nasal polyposis. The age of the patients ranged from 19-60 years, with a mean of 41 – and these consisted of 74 male and 39 female patients, ratio: 2 : 1. These patients had failed to respond to medical therapy consisting of topical nasal steroids and antibiotics with or without systemic steroids if indicated, for 6 weeks. They all had mucosal abnormalities on CT scan. The details of CT changes were described according to Lund and McKay scoring of preoperative CT [7].

Pre-operatively each patient had nasal endoscopy, using 0 degree and 30 degree endoscopes after application of local anaesthetic and decongestant spray as necessary. They were assigned to one of four clinical groups according to the endoscopic appearance of their intra-nasal disease. The groups were chronic rhinosinusitis without nasal polyps (CRSS) n=35, grade 1 polyps (confined to the middle meatus) n=28, grade 2 polyps (extending below the middle turbinate) n=30 and grade 3 polyps (widespread diffuse polyposis filling the nasal cavity) n=20. All patients with polyps had bilateral disease which tend-

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ed to be of equal grade on either side. Where there were differences, the patient was assigned a grade based on the worst side. Patients with complex frontal sinus disease or solitary polyps were excluded.

Forty-four out of 113 patients, (38.9%) had undergone 91 previous sinus operations (Table 1).

Table 1. Frequency of previous operations in 44 patients.

FESS	12
Intranasal Polypectomy (Bilateral/ Unilateral)	37
Bilateral Intranasal Antrostomies	8
Submucus Resection	8
Septoplasty	4
Bilateral Antral Washout	12
Cautery to Inferior turbinate	1
Trimming of Inferior turbinate	5
Middle meatal antrostomy	2
Caldwell Luc	2
Total	91

During each surgical procedure, the absence or presence of polyps and the site of origin was recorded according to a modification of the Anatomic Terminology Group and Nomenclature [8]. In primary cases when all anatomical structures were present and intact the precise, named site(s) of polyp origin was described. When previous surgery or the polypoid disease process with associated de-mineralization had resulted in loss of anatomically named bony structures, the region of origin such as anterior or posterior ethmoid sinus was used to describe polyp location. Anterior and posterior ethmoid sinus as a location also refers to polyps found arising within these sinus cells. Polyp origin was described as medial to the middle turbinate or more specifically from the superior meatus when more accurate localisation was not possible. Surgery was performed according to the technique of Stammberger [5] and Kennedy [9]. Surgery was performed in a step by step fashion. Each anatomical region was opened in turn until normal mucosa was found.

RESULTS

Pre operatively diagnosed polyps, n = 78

Table 2 shows the most common sites for sino-nasal polyps. The anterior ethmoid sinus cell / region was the commonest with 89.7% of patients having polyps arising from this area. Eight patients did not have polyps in the anterior ethmoid sinus cells or region, but 6 of these had polyps in other parts of the anterior ethmoid complex, implying 97.4% polyposis in this complex. Of the 6 patients who had polyps in other parts of the anterior ethmoid complex, 1 patient had polyps in the bulla, 1 in the fronto-ethmoidal recess, 2 on the uncinate process / in the infundibulum, 1 in uncinate process / infundibulum and fronto-ethmoidal recess and 1 in the uncinate/ infundibulum and bulla. Patients without polyps in the anterior ethmoid sinus cells / region were found only amongst those with grade I polyposis, hence indicating 100% polyposis in the anterior ethmoid sinus cells or region in both grades 2 and 3 disease.

Over 64% of patients had polyps in the posterior ethmoid sinus and 20.5% in the sphenoid sinus. No patient had a polyp in the sphenoid sinus without polyps in the posterior ethmoid sinus. And, all patients with polyps in the posterior ethmoid complex had polyps also in the anterior complex. The least common sites of origin of polyps were the olfactory cleft (5.1%) and nasal septum (12.8%).

Grades

When the origin of polyps was looked at by grade, it was found that for each anatomical site, the percentage of patients with polyps at that site increased as grade of polyposis increased for 9 out of 13 sites; except for the uncinate process/infundibulum, face of ethmoid bulla and frontal recess and middle turbinate. In these sites, there were a higher percentage of patients with

Table 2. Site distribution of pre op diagnosed polyps according to grades.

Site of nasal polyps	**Grade 1**	**Grade 2**	**Grade 3**	**Total**	
	N = 28	**30**	**20**	**78**	**(%)**
(a) Anterior ethmoid complex	26	30	20	76	(97.4)
1. Anterior ethmoid sinus cells / region	20	30	20	70	(89.7)
2. Uncinate Process/ infundibulum	17	23	12	52	(66.7)
3. Fronto-ethmoidal recess	9	29	12	50	(64.1)
4. Sinus lateralis	3	9	10	22	(28.2)
5. Face of ethmoid bulla	11	26	11	48	(61.5)
(b) Posterior ethmoid sinus cells /region	9	22	19	50	(64.1)
(c) Sphenoid sinus	2	5	8	16	(20.5)
(d) Septum	1	3	6	10	(12.8)
(e) Superior Meatus	4	16	16	36	(46.2)
(f) Olfactory Cleft	0	1	3	4	(5.1)
(g) Maxillary Antrum	5	11	17	33	(42.3)
(h) Medial to middle Turbinate	5	19	15	39	(50.0)
(i) Middle turbinate	8	18	10	36	(46.2)

grade 2 than grade 3 polyposis. We also found that, the higher the grade of polyps, the greater the number of anatomical sites with polyps - Table 3. These ranged from a median of 1 in grade 0 polyposis to 9 in grade 3.

Chronic Sinusitis without Polyps - Grade 0

Twenty-one out of 35 patients in this group (60%) were found during FESS to have polyps. Of these, the most common site was also the anterior ethmoid sinus, location being within the anterior ethmoid cells – 76.1% (Figure 1). Five out of 6 who had previous operations and 11 out of 15 who had no previous operations, had their polyps in this site. Fewer patients had antral (14.3%) or sphenoidal polyps (4.8%). Patients in this group (grade 0) tended to have fewer anatomical sites when compared to the other grades (Table 3).

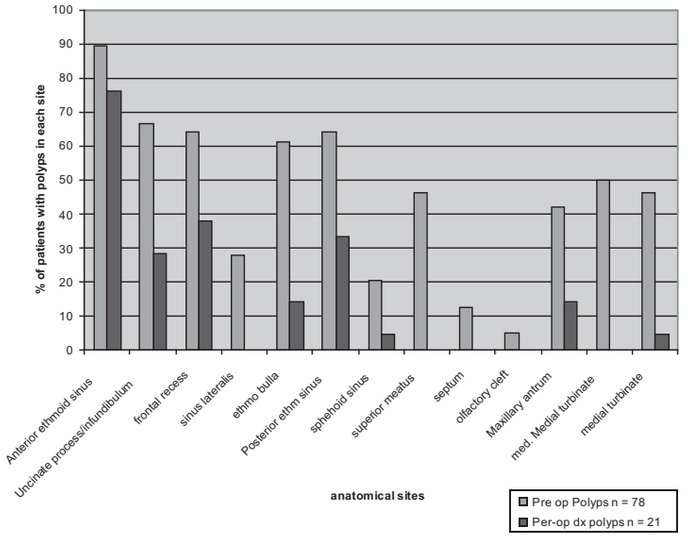

Figure 1. Chart showing % of patients with polyps arising from different anatomical sites.

Table 3. Median no of anatomical sites per grade of polyps.

Grade of Polyps	Median no of sites	No of patients with polyps
0	1 (range 1 – 5)	21
1	2.5 (range 1 -9)	28
2	7 (range 3 – 11)	30
3	9 (range 4 – 11)	20

Previous surgery

Out of 113 patients, 44 patients (38.9%) had had previous surgery. These ranged from bilateral intranasal polypectomy (BINA), FESS, Cadwell Luc, Septoplasties, Antral washout and Antrostomies (Table 1). Thirteen patients had one previous operation; 14 had 2; 6 had 3; 4 had undergone 4; and 7 patients had more than 5 previous operations. Those who had multiple operations tend to have multiple intranasal polypectomies and or antrostomies – unilateral or bilateral. These accounted for 48% of previous procedures, followed by FESS – 13%. Detailed statistical analysis of this group who had previous operations did not show any significant difference in site distribution of polyps across the grades when compared to the general population, ($p>0.05$) (Table 5). Patients with higher grade disease tended to have higher rates of previous operations, 55% in grade 3 disease compared to 32.1 in grade 1 (Table 4).

Table 4. Patients who had previous surgery across different grades.

Grade	No of patients	(%)
0	13/35	(37.1)
1	9/28	(32.1)
2	11/30	(36.7)
3	11/20	(55.0)

DISCUSSION

There have only been a small number of studies previously conducted that examine the anatomical origin of nasal polyps. Larsen and Tos [1] screened 300 cadavers with anterior rhinoscopy and systematically examined the nasoethmoidal complexes of the 6 found to have nasal polyposis on initial screening. They found that most of the nasal polyps arose in the middle meatus and most of these from the lateral wall of the anterior half of the middle meatus. No polyps were found arising from ethmoidal cells. In their later study [2], nasoethmoidal blocks were removed from 19 cadavers, none of whom had had preceding rhinoscopy. Five of these had nasal polyps. All the polyps were found in the superior or middle meatus with 89% closely related to the ethmoid sinus ostia. Again they did not find any polyps originating inside the ethmoid or other paranasal sinuses. These authors, in a later study found 'preclinical' polyps in the frontal recess and middle meatus [3]. These were small and presumably non symptomatic polyps. They surmised that pre-operative endoscopy tended to overlook this kind of polyps, and therefore could not definitively confirm their initial theories of origin of nasal polyposis.

In contrast we found that the most common site of origin for nasal polyps was from the anterior ethmoidal complex and more specifically within the anterior ethmoid cells or from this region when more specific landmarks were absent, with 89.7% of patients having polyps originating here. Our current study, compared to these cadaver studies, appears to be looking at the different extremes of the spectrum of nasal polyposis. We studied patients who presented with CRSS which was not responding to medical treatment, and this in itself may represent the

Table 5. Site distribution of polyposis according to grade and previous operations.

		Grade 0 + polyps N = 21/35		Grade 1 N = 28		Grade 2 N = 30		Grade 3 N = 20	
		Prev Op 6/13	No Prev Op 15/22	Prev Op 9	No Prev op 19	Prev Op 11	No Prev Op 19	Prev Op 11	No Prev Op 9
A	Anterior ethmoid complex	6	12	9	17	11	19	11	9
1	Anterior ethmoid sinus cells / region	5	11	8	12	11	19	11	9
2	Uncinate Process/infundibulum	2	4	3	14	9	14	3	9
3	Front- ethmoidal recess	4	4	3	6	11	18	3	9
4	Sinus lateralis	0	0	1	2	3	6	2	8
5	Face of ethmoid bulla	0	3	4	7	11	15	2	9
B	Posterior ethmoid sinus cells / region	1	6	3	6	7	15	10	9
C	Sphenoid sinus	0	0	2	0	2	3	4	3
D	Septum	0	0	0	1	3	0	6	0
E	Superior meatus	0	0	2	2	6	10	8	7
F	Olfactory cleft	0	0	0	0	1	0	3	0
G	Maxillary antrum	1	2	3	2	7	4	8	9
H	Medial to middle turbinate	0	0	2	3	9	10	6	9
I	Middle turbinate	1	0	4	4	7	11	5	5
	p value = Students t test (unpaired)	0.68		0.56		0.46		0.1	

worst clinical end of the spectrum. We also found patients with grade 0 polyposis, who tended to have fewer anatomical sites, the commonest site of origin was within the anterior ethmoid cells.

Our findings support theories that polyps tend to arise in the middle meatus related to the anterior ethmoid complex [6], and arise less commonly further from this area. Polyps were found in all other paranasal sinuses; (a) posterior ethmoid sinus 50/78 (64.1%), (b) sphenoid sinus 16/78 (20.5%); it is therefore important to specifically examine these sites perioperatively. The only specific sites of origin of polyps, which were not related to the middle or superior meatus, and were specifically identifiable, were the septum and the roof of the olfactory cleft.

Our findings are therefore broadly similar to those of Larsen and Tos [1] in that a large proportion of polyps arise within the middle meatus or superior meatus, however they differ in that they found no polyps within the paranasal sinuses whereas, we found significant numbers. Larsen and Tos acknowledge that they looked at only a small numbers of cadavers, that the population was elderly because it was a post mortem study and that the polyps may well have been asymptomatic at the time of death with the underlying pathology long since resolved. This may explain the differences found [1].

Stammberger [6] described the origin of nasal polyps in 200 patients undergoing endoscopic sinus surgery. He similarly found that they mainly originated from the middle meatus and also that polyps originated from anterior ethmoidal cells in 30% of patients and posterior ethmoidal cells in 27% of patients.

Masaki and Tanaki [4] looked at the numbers of olfactory cleft polyps that were present in 84 patients undergoing functional endoscopic sinus surgery. They found 143 polyps of which 52 (36.4%) arose from the olfactory cleft. Unfortunately direct comparison with our study is not possible as we looked at the percentage of patients with polyps in different regions whereas they looked at the percentage of polyps arising from a region. There have been numerous theories proposed as to the pathogenesis of nasal polyps. Those pertaining to the site of origin include the aerodynamic theory which states that polyps arise in regions of the nose where there is turbulent air flow, i.e. the upper 2/3 of the nose, and not from the inferior turbinate or septum where the flow of air is much smoother [10].

This is thought to be because turbulent airflow leads to the deposition of irritant agents resulting in inflammation and the development of polyps. Our findings would support the fact that a large number of polyps originate from the upper 2/3 of the nose, however, turbulent airflow is unlikely to be a significant factor in the paranasal sinuses where we found polyps to occur most frequently.

Krajina and Markov [11] suggest that nasal polyps develop in regions where the thinner sinus mucosa turns into thicker nasal mucosa. They suggest that at this interface stagnation of oedema or transudate occurs resulting in swellings and protrusions of mucosa. Again this theory cannot explain our findings that large numbers of polyps arise within the paranasal sinuses.

Larsen and Tos [1] suggest that since the middle meatus is the most common site of origin of nasal polyps and since this is the area into which both the anterior ethmoidal and maxillary sinuses drain then perhaps this area is particularly exposed to pathological stimuli from the sinuses.

This would be in keeping with our findings because any factor acting on the mucosa in the region where the sinuses drain will also act on the sinus mucosa. It is likely that there are several different factors that act to initiate the process of nasal polyp formation and that any one or more of these may act in any predisposed patient.

The other interesting finding in our study was the number of

patients who did not have polyps on initial endoscopic examination, but at endoscopic sinus surgery were found to do so. This suggests that polyps tend to be under diagnosed and that studies looking at the management of polyps tend to exclude patients with less extensive disease [12]. It also lends weight to arguments that suggest patients undergoing FESS for symptomatic disease, present on CT scans, in the absence of intra-nasal polyposis must not be considered as always having infection as the cause of their sinusitis [13].

We also found that the higher the grade of polyps, the greater the number of patients with polyp at each site and the greater the number of anatomical sites involved except for the uncinate process / infundibulum and face of bulla specifically. These might be because with more extensive disease, these landmarks may not have been identifiable.

In conclusion, we have shown in a large patient population with nasal polyps, that the majority of patients have polyps originating in the anterior ethmoids and middle meatus but also that a significant number have polyps originating in other paranasal sinuses. It is necessary therefore that any theories about factors that initiate nasal polyp formation must account for polyps originating from the lateral nasal wall mucosa and from within the paranasal sinuses.

Rhinologists should also be aware that nasal polyps tend to be under-diagnosed and that a significant number of patients with CRSS but no polyps on endoscopic examination will in fact have small polyps found within the sinuses at surgery.

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