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Diagnostic algorithm for unilateral sinus disease: a 15-year retrospective review

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Abstract

Background—Patients presenting with unilateral sinus symptoms or nasal polyps raise concerns about sinister pathology. Yet despite the relatively common occurrence of this presentation, and its potential severity, an organized diagnostic approach to unilateral sinus disease (USD) has never been defined. The purpose of this work was to propose a diagnostic algorithm for managing patients with USD based on prior experience.

Methods—We performed a retrospective review of the medical records of all patients with USD who underwent surgical intervention and had pathological specimens during a 15-year period at an urban academic center. Nasal endoscopy and computed tomography (CT) scan findings, demographic characteristics, presenting symptoms, medical histories, and previous treatments were analyzed.

Results—A total of 191 patients met the inclusion criteria, 153 of whom were initially diagnosed at our center. Among the latter group, 51 (33%) presented with a nasal mass or polyp observed by endoscopy. Inverted papilloma was present in 16% of those cases, and malignant tumors comprised 14%. In contrast, of patients without an obvious nasal polyp ($n = 102$), 2% had inverted papilloma and 3% had malignancies. Overall, chronic rhinosinusitis was the most common diagnosis both in patients with polyps (67%) and those without nasal polyps (69%).

Conclusion—Although USD is most likely to represent chronic inflammation, there exists a fair likelihood of finding malignant pathology, particularly in cases where patients have a unilateral polyp. Based on this review, we propose a strategy for the management of new presentations of USD.

Keywords

sinusitis; CT; endoscopy; inverted papilloma; fungus; chronic; unilateral

Unilateral sinus disease (USD) represents a common concern for otolaryngologists, and it is much more likely than bilateral disease to represent sinister pathology. Indeed, some authors suggest that any unilateral nasal mass should always be considered neoplastic until proven

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otherwise.¹ Patients usually have unilateral symptoms such as nasal congestion/obstruction, anterior or posterior nasal drainage, purulent discharge, epistaxis, a foul odor, headaches, and facial or cheek swelling.² Yet despite being relatively common—Lee² argues that unilateral rhinosinusitis occurs in 23% of cases—this condition has not been extensively studied.

To date, several investigators have attempted to describe the general characteristics of USD. Shin³ studied the demographic characteristics and evolution of 640 cases of chronic rhinosinusitis (CRS) and showed that USD was more common in males (65.8%) than in females. Nasal polyps were present in 11.1% of the USD patients, and the maxillary sinus was the most commonly affected anatomic site in the USD group.³

To our knowledge there is no single management strategy for the workup of patients presenting with USD. Here, we review our 15-year experience with USD and suggest a diagnostic algorithm for the evaluation of patients with this presentation.

Patients and methods

We performed a retrospective review of the medical records of patients who presented with USD at the University of Chicago Section of Otolaryngology–Head and Neck Surgery and underwent surgical intervention (with pathologic specimens taken) over a 15-year period at a single, urban, academic medical center. Nasal endoscopy (NE) and computed tomography (CT) scan findings, demographic characteristics, presenting symptoms, medical histories, and previous treatments were all reviewed individually.

To identify patients with USD, we reviewed all sinus CT scans of patients undergoing sinus surgery and included only subjects who had normal sinuses on 1 side. Subjects referred in from other institutions were eliminated.

Descriptive statistics were used for measurement of clinical metrics. A comparison of the incidence of different pathologies in the groups with and without polyps was performed by use of a Fisher's test with 2-tailed *p* values.

The Institutional Review Board of The University of Chicago approved this study.

Results

A total of 191 patients met the inclusion criteria of presenting with USD and subsequently undergoing endoscopic sinus surgery with available pathology findings. One hundred and fifty-three (153) cases were initially diagnosed at our medical center and 38 cases were patients who had been initially evaluated outside our institution and then referred for further management. The cases that were referred in were excluded related to referral bias and will not be alluded to from here on in the manuscript. Those diagnosed at the University of Chicago Medical Center were 153 adult patients between the ages of 18 and 77 years (mean, 49 years). Ninety-seven (63%) were female. Overall, CRS was the most common diagnosis in both patients with (67%) and those without (69%) nasal polyps/masses, and a malignancy was diagnosed in 7% of the cases. Of the 153 patients diagnosed in our center, 51 (33%)

presented with a nasal mass or polyp that was observable by NE. Of those patients, 66.7% were diagnosed with CRS, 2% had fungal disease (defined as the presence of fungus on staining or in culture), 15.7% had inverted papilloma (IP), and 13.7% had malignant tumors. Among the 102 patients without a visible mass on endoscopy, 68.6% were found to have CRS, 24.5% had fungal disease, 2% had IP, and 2.9% had malignant disease (Table 1). When we compared the diagnoses in the group with polyps vs without polyps, there was no difference in the incidence of CRS between the 2 groups ($p = 0.86$). In contrast, patients who had polyps were significantly less likely to have fungal disease ($p = 0.0002$) and more likely to have a diagnosis of IP ($p = 0.0025$) and malignant tumors ($p = 0.016$) compared to the group without polyps (Table 2).

We then examined the 51 subjects who presented with a unilateral polyp or mass to determine whether common clinical or imaging characteristics were present. In this group, 16 (31.4%) showed evidence of lateral maxillary sinus wall, orbital, or intracranial bone erosion on CT scan or they demonstrated neurologic involvement upon clinical examination, such as severe facial pain, numbness, swelling, or cranial nerve involvement. In 10 of the 16 patients, diagnostic magnetic resonance imaging (MRI) was obtained prior to surgery. In only 2 of the 10 cases (in which an MRI was obtained) were biopsies performed in the clinic. The pathology results for these cases were IP and adenocarcinoma. In both cases the histologic analysis after the definitive surgery was the same.

Eight patients went directly to surgery after MRI. A frozen section was obtained from 2 of these patients and both showed squamous cell carcinoma (SCC). In both cases the masses were debulked endoscopically and additional therapies were decided upon postoperatively. In the remaining 6 patients operated on following MRI, the final pathology showed CRS in 3 cases, 1 case was an encephalocele, and 2 were malignancies (SCC and verrucous carcinoma). Of the remaining 6 patients out of the group of 16—showing either lateral wall erosion on the CT scan and/or neurological findings who did not undergo an MRI but instead went directly to surgery—subsequent pathologies showed 6 cases of CRS and 1 verrucous carcinoma.

Of the 10 cases with nasal polyps for which MRI was obtained following a CT scan showing evidence of bone erosion in the lateral wall or skull base, or central nervous system (CNS)/orbital involvement, in only 4 patients did MRI provide new information that was not available to the clinician from the initial CT. One case showed a previously unknown presence of fluid in the orbits. Another case showed a dehiscence of the lamina papyracea (where the initial CT showed only a thinning of the structure), a third yielded additional information unavailable during the initial CT scan by showing a mass effect in the orbit, and the last refuted apparent signs of bone erosion that had shown up during earlier imaging. In the remaining cases, MRI merely confirmed the absence of erosion in 3 cases, and confirmed the presence of such erosion in 3 others.

Among the 102 patients without a nasal polyp or mass, 26 (25.5%) had lateral maxillary wall, orbital, or skull-base bone erosion discernible through CT imaging or had neurologic involvement on clinical examination. For these, an MRI was ordered in 10 cases prior to deciding on a surgical approach, and a frozen section was obtained at the time of surgery

from 1 patient showing SCC. Another 2 patients underwent surgery with frozen section without preoperative MRI. Intraoperative pathology revealed 1 case of fungal disease and 1 case of lymphoma. Not surprisingly, given the absence of a visible mass in this group, no clinic biopsies were performed in these 102 patients.

Of the remaining 16 patients showing lateral wall erosion on the CT scan but not undergoing MRIs prior to going directly to surgery, pathology showed 11 cases of CRS, 3 fungal sinusitis cases, 1 malignancy, and 1 dentigerous cyst.

From the total sample of 153 individual patients included in our study, on examination, 42 presented with lateral maxillary sinus bone involvement or other orbital and/or intracranial involvement or neurologic abnormalities. Twenty-six of these had no nasal polyps, whereas 16 presented with nasal polyps. In the group of patients without polyps, 2 were found to have malignancies. In contrast, among the group with polyps, 6 were found to have malignancies and 1 was diagnosed as having IP.

CT scan findings suggested fungal disease (high/heterogeneous attenuation) in 25 (16%) of the 153 patients. Fungal disease was demonstrated by final pathology or culture in 15 patients (60%) in this group. The most common CT scan finding in patients with an IP was a sinus mass in 80%; only 3 (30%) had hyperostosis, and only 1 (10%) had bone erosion other than around the osteomeatal opening. Mucoperiosteal thickening was present in 100 (65%) of the 153 patients.

In our study, the most common individual symptom for the CRS group was nasal obstruction (77.8%), followed by sinus pressure (58.6%). The same symptom frequencies were found to be the case in the fungal group, with 76.9% and 53.8%, respectively. It is worth noting that 90% of the patients in the IP group complained of nasal congestion, and that headaches and postnasal drip were present in 30% of these patients. Among the patients with malignancies, 60% presented with nasal congestion, 40% with sinus pressure and 30% with headaches. Even when only 10% presented with epistaxis, this symptom was more frequent than in the others groups, but these numbers are small. Numbness was present in 20 (13%) of the 153 patients, and, of those, 4 (20%) had malignant disease demonstrated in the final pathology (Table 3). Overall, 22% were asymptomatic (Table 4).

In our review, we found that analysis of 26 frozen sections was performed. Of these, 18 led to the correct diagnosis, 1 was inconclusive, and 7 showed a result that was different than in the final pathology report. Among this latter group, 4 cases were diagnosed as chronic inflammation on frozen section and fungal disease on final pathology, 1 SCC was interpreted as IP on frozen section, 1 adenocarcinoma was interpreted as CRS, and 1 CRS was interpreted as IP.

Diagnostic algorithm

Based on these findings, we have constructed a diagnostic algorithm to guide clinicians in the workup and management of USD (Fig. 1).

Our algorithm begins after USD has been initially diagnosed, following the standard workup: medical history, physical examination, NE, and CT scan.

Further evaluation and management of patients depends on the presence of nasal polyps/masses, lateral maxillary sinus bone, orbital or intracranial involvement, and neurologic abnormalities on examination.

In some cases, such findings strongly suggest particular pathologies. For example, a large mass prolapsing posteriorly in the mouth indicates antrochoanal polyp (ACP); calcifications, bone remodeling, or bone thinning visible on CT scan is indicative of fungal disease.

MRI can distinguish a tumor from an obstructed sinus but, generally speaking, this will rarely lead to a change in the surgical approach over what can be learned during endoscopic surgery.

In our algorithm, we propose the use of MRI for diagnosis of USD (with or without polyps) in cases where CT scan results show the presence of bone erosion in the lateral walls or skull, intracranial or orbital involvement, or when neurologic abnormalities are found on examination. In these cases, appropriate consultation with specialists in the fields of neurosurgery, ophthalmology, or neuroradiology is recommended.

Although in-office biopsies may produce accurate positive results, we do not recommend their use in standard cases (without evidence of bone erosion on CT or neurologic abnormalities on physical exam). Our reasoning is based on the following:

1. Negative results for malignancy must still be confirmed with an operative biopsy, requiring additional investments of cost and time.
2. Positive results for malignancy will generally necessitate surgical debulking regardless, for symptomatic relief, obviating the need for an in-office biopsy. The only exception to this statement is cases in which there is a clinical suspicion for a malignancy, which would require more radical resection that would not be feasible endoscopically. Information gleaned from in-office biopsy will provide a useful guide to surgery; for example, by supporting more aggressive removal of malignancies in specific anatomic areas.
3. In our whole series, we performed in-office biopsies in only 1.5% of the patients, and the results did not affect the clinical management.

Discussion

Nasal polyps are described as abnormal lesions from any portion of the nasal mucosa or the paranasal sinuses extending into the nose. The condition is estimated to be present in roughly 1% to 4% of the population: more commonly among adults than in children, and among males rather than females.⁴ The vast majority of nasal polyps are bilateral and inflammatory in nature. However, USD is a common challenge faced by rhinologists worldwide.

Although they are far less frequent than bilateral disease, unilateral polyps raise suspicion for neoplasms. Conventional wisdom posits that USD with or without nasal masses/polyps should be approached with an underlying assumption of neoplasia until proven otherwise. In

this view, unilateral masses should always be studied comprehensively even when the representation might seem benign (ie, CRS, fungal or bacterial disease, or mucocoeles).⁵ Our study supports this notion. We found that 14% of new patients presenting with a unilateral nasal mass or polyps were found to have a malignancy.

In our study, the most common individual symptom for all the groups was nasal obstruction. Patients with IP had a higher frequency of reporting complaints of headaches than did any other group, and epistaxis was highest among those patients with malignancy. Based on our experience, the presence or absence of a specific symptom does not change the approach in the evaluation of USD. In contrast, some investigations have proposed that certain symptoms reported by patients suggest either benign or malignant pathology. Tritt et al.⁶ did a retrospective review of 44 patients identified with unilateral nasal polyps who underwent endoscopic sinus surgery in order to correlate the clinical presentation with the pathology of the disease; they concluded that the most common presenting symptoms were unilateral sinus congestion (65%), epistaxis (18%), and headaches (12%). The most common presenting symptom for allergic fungal sinusitis (AFS) was unilateral congestion (93%), followed by epistaxis (7%). Mucocoeles and human papillomavirus (HPV)-related papilloma both presented with congestion without epistaxis in 100% of the cases. Patients with neoplastic processes presented with epistaxis (45%) and with congestion, headache, seizures, or other symptoms (55%). Sixty-seven percent of malignant processes such as SCC and esthesioneuroblastoma presented with epistaxis, and 57% of IP presented with epistaxis.⁶

NE has a longstanding record of improving the diagnostic accuracy and increased differentiation among rhinologic pathologies.⁷ In some cases, characteristic findings on NE strongly suggest certain pathologies (eg, evidence of a large mass prolapsing posteriorly from the lateral nasal wall into the nasopharynx suggests an ACP). But even to the extent that our data might seemingly support such conclusions, we contend that although endoscopic examination may serve to arouse suspicions of a tumor, it would be impossible to reach an accurate diagnosis with use of this tool alone.⁸

The next diagnostic tool in the workup of USD is imaging. Lee² and Rudralingam et al.⁹ argue that although CT imaging is helpful for pointing out worrisome features such as bone erosion or cases where etiologies such as fungal disease and ACP can be easily differentiated, accurately distinguishing between different pathologies based only on symptoms, NE, and CT imaging is often challenging.

Although in some cases findings such as the presence of a large solitary mass arising from the sinus without bone destruction suggest ACP, and calcifications or heterogeneous tissue density on CT scan suggest fungal disease, we agree with Lee² that these tools are not sufficient to pinpoint the diagnosis in all cases of USD. Our review supports that statement because the vast majority of cases of USD had no distinguishing features. Joshua et al.¹⁰ retrospectively evaluated information present in preoperative CT scan images to help guide physicians evaluating the benign causes of USD. They examined the CT scans of 38 patients who underwent endoscopic sinus surgery and had a radiologist, who was blinded to the pathologic diagnosis, assess whether wall thickness might be used as an index for evaluation

of USD and its severity. In 97.7% of cases, patients had thicker bony walls in the diseased sinus than in the healthy one. The authors concluded that rhinologists tended to minimize CT scan evidence of chronic osseous changes secondary to CRS and that they tended to focus their attention instead on the mucosal changes.¹⁰

Many surgeons order adjunct imaging following suspicious findings on CT scan. For example, Rudralingam et al.⁹ recommended that MRI be ordered every time bone erosion/destruction is found on a CT scan. Harvey and Dalgorf¹¹ stated that both CT and MRI should be done in most cases because the studies are complementary and can offer the physician more information regarding the likely pathology than either one would on its own. For example, they concluded that involvement of the periorbital can be best determined by mutual signs of bone loss on CT and fat enhancement on MRI, whereas dural/brain involvement is best defined by way of bone loss on CT scan and dural enhancement on the MRI.¹¹ In another study, Younis et al.¹² found that MRI proved to be superior to CT in detecting intracranial infections and other brain abnormalities that are not easily identifiable on a CT. MRI was also more accurate for identifying the location and extension of pathology intracranially.¹² Our algorithm recognizes the need for obtaining MRI scans in certain situations, but not in the majority of cases.

Ikeda et al.¹³ evaluated 130 patients with USD presenting without detectable changes to their bone structure. In each case, the authors assigned a qualitative preoperative diagnosis through CT scans, MRI, and endoscopic nasal biopsies. Preoperative diagnoses of CRS, mucocoeles, and neoplasms were subsequently assessed via surgical pathology reports as a gauge of the success rates of these initial diagnostics. Accurate preoperative diagnoses were made for only 75% of those patients presenting with chronic sinusitis (with or without polyps) when diagnosed by means of CT scans alone, and for 85% of patients with mucocoeles. When used, preoperative diagnoses for all fungal and vascular conditions were more accurate when MRI was performed, although, in 17 patients, a preoperative biopsy in addition proved necessary because the imaging was inconclusive.

Some investigators have proposed the use of an in-office biopsy in cases where a unilateral nasal mass is encountered. Harvey and Dalgorf¹¹ recommended that an in-office biopsy should be performed whenever malignant pathology is suspected. They considered this to be a critical step prior to any therapeutic decisions, but only after a CT scan and MRI have been obtained to avoid biopsy of encephaloceles, aneurysms, or nasal angiofibromas. They also recommend avoiding in-office biopsies for masses located beyond the middle turbinate.

Although we agree that biopsy may lead to a definitive result in some cases, in the end most patients will proceed on to surgery regardless of the result, for the following reasons: (1) to obtain definitive pathology because in-office biopsies can sample only superficial parts of the mass and negative results will still prompt operative biopsy; and (2) these cases generally require surgical debulking for symptomatic relief, even in cases of malignancy that will ultimately require adjunctive chemotherapy or radiation.

In our review, some results initially obtained from frozen sections differed from those of the final pathology report, just as with in-office biopsies. However, in all cases permanent

pathology samples were taken and results were reviewed as guides for subsequent management.

Our algorithm recommends that—after the 4 standard components of the initial diagnostic workup (medical history, physical examination, NE, and CT imaging)—patients be evaluated further depending on the presence of nasal polyps/masses and lateral maxillary sinus bone, orbital and/or intracranial involvement, or neurologic findings on examination. Although MRI can be used as an additional tool for distinguishing tumor from obstructed sinus, delineating extrasinus extension, and helping guide preoperative planning, in the majority of cases this will likely not lead to a change in the surgical approach. Thus, although some would recommend MRI to distinguish tumor from obstructed sinus, we fail to find this information as having much utility because it will not change the surgical management. For example, in cases of suspected IP and, indeed, of the majority of neoplasms, the goal is to find the origin of the mass. As we begin to remove these surgically, we can search for the origin and deal appropriately with this site: all blocked sinuses are opened, guided by the CT scan. In cases where erosion is present, and MRI subsequently confirms extrasinus involvement, appropriate consultation with specialists in the fields of neurosurgery, ophthalmology, or radiology should likewise be obtained to better plan the therapeutic approach.

The findings from this review have changed our approach to the use of in-office biopsies and MRI scans. We do not recommend the routine use of in-office biopsies. Although such procedures may, at times, produce correct positive results, they generally add additional steps and costs without changing the condition's management. However, a positive biopsy for malignancies will generally necessitate more invasive surgical procedures.

Conclusion

Following a careful review of USD patients at our center, we noted differences in the diagnoses between patients with and without polyps. Patients with polyps compared to those without polyps were more likely to have malignancies and IPs and were less likely to have fungal disease. Based on our experience with managing patients with USD, we propose a more efficient clinical approach. All patients require a medical history, physical examination, NE, and a sinus CT scan. It is our view that in-office biopsies are nearly always unnecessary because they do not change subsequent management. An exception to this statement is for the few cases in which clear indicators of malignancy are uncovered during preliminary exams and where a confirmatory biopsy might alter the surgical approach. MRI scans can provide useful information in cases of bony erosion or examination findings consistent with extrasinus extension, but should be used sparingly because, in the majority of cases, they will not alter the approach. If adopted, our algorithm for evaluating these patients should save costs, avoid patient discomfort, and streamline the treatment of patients with USD.

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FIGURE 1.

Diagnostic algorithm for the workup and management of USD. USD = unilateral sinus disease.

TABLE 1

Pathology: new presentations at UCMC *

Final pathology	Total	With polyps	Without polyps
CRS	104 (68)	34 (66.7)	70 (68.6)
Fungal	26 (17)	1 (2)	25 (24.5)
IP	10 (7)	8 (15.7)	2 (2)
Malignant tumors	10 (7)	7 (13.7)	3 (2.9)
Others ^a	3 (2)	1 (2)	2 (2)
Total	153	51	102

* Values are n (%).

^aOthers: 1 encephalocele; 1 foreign body; 1 dentigerous cyst.

CRS = chronic rhinosinusitis; IP = inverted papilloma; UCMC = University of Chicago Medical Center.

TABLE 2

Comparison and *p* values of cases presenting with polyps vs without polyps among different pathologies.

Pathology	With polyps (%) vs without polyps (%)	<i>p</i>
CRS	66.7 vs 68.6	0.855
Fungal	2 vs 24.5	0.0002
IP	15.7 vs 2	0.0025
Malignant tumors	13.7 vs 2.9	0.0164

CRS = chronic rhinosinusitis; IP = inverted papilloma.

TABLE 3

Unilateral sinonasal complaints*

Sinonasal complaints	CRS (n = 104)	Fungal (n = 26)	IP (n = 10)	Malignancies (n = 10)	Others (n = 3) ^a
Nasal obstruction	81 (77.8)	20 (76.9)	9 (90)	6 (60)	3 (100)
Postnasal drip	36 (34.6)	10 (38.5)	3 (30)	3 (30)	1 (33.3)
Rhinorrhea	38 (36.5)	8 (30.8)	2 (20)	5 (50)	2 (66.6)
Epistaxis	3 (2.8)	1 (3.8)	1 (10)	1 (10)	0
Sinus pressure	61 (58.6)	14 (53.8)	1 (10)	4(40)	1 (33.3)
Headaches	24 (23)	7 (26.9)	3 (30)	3 (30)	0

* Values are n (%).

^a Others: 1 encephalocele; 1 foreign body; 1 dentigerous cyst.

CRS = chronic rhinosinusitis; IP = inverted papilloma.

TABLE 4

Symptomatic vs asymptomatic patients per group

Final pathology	Total (n)	Asymptomatic ^a	Symptomatic ^a
CRS	104	26 (25)	78 (75)
Fungal	26	4 (15)	22 (85)
IP	10	2 (20)	8 (80)
Malignant tumors	10	2 (20)	8 (80)
Others ^b	3	0 (0)	3 (100)
Total	153	34 (22)	119 (78)

^aValues are n (%).^bOthers: 1 encephalocele; 1 foreign body; 1 dentigerous cyst.

CRS = chronic rhinosinusitis; IP = inverted papilloma.