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Patient knowledge and perception of computed tomography scan in the management of chronic rhinosinusitis symptoms

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Abstract

Objective—The objective of this study was to report patients' knowledge and comfort level with CT imaging for sinus disease and evaluate patient willingness to undergo empiric medical therapy (EMT) versus CT-directed therapy (CTDT).

Study Design—Prospective survey study

Methods—A 22-item survey was administered to patients with nasal/sinus symptoms in a tertiary care rhinology clinic. Questions elicited patient demographics, imaging history, knowledge/comfort regarding imaging-related radiation exposure. Patients were presented with the theoretical choice of EMT vs CTDT, given the expected positive predictive value, in CRS management.

Results—Two hundred patients (52% female, age range 18–83) participated. Of these, 85% had symptoms for over three months. Only 91 patients (45.5%) were aware that CT imaging involved radiation exposure. Prior CT experience and past sinus surgery ($p < 0.05$), but not sex or education level, were associated with increased comfort with CT imaging. Most patients (78%) preferred CTDT over EMT. If a CT sinus was recommended, 77 patients (38.5%) had concerns, of which 26% identified radiation exposure as leading concern. The majority (70%) were unsure about the relative radiation dose of a conventional CT.

Conclusions—Patients with CRS symptoms prefer CTDT over EMT if a diagnosis cannot be established definitively using exam findings. While most patients deferred to the physician regarding the decision to utilize CT imaging, there is low awareness of CT-related radiation exposure and a significant minority of patients have radiation-related concerns with regard to medical imaging for nasal and sinus symptoms.

Keywords

chronic sinusitis; sinusitis; diagnosis; multidetector computed tomography; patient perception; radiation exposure

Introduction

The diagnosis of chronic rhinosinusitis (CRS) has evolved from an exclusively symptom driven diagnosis, to requiring appropriate symptoms and evidence of inflammation of the paranasal sinuses. Objective determination of inflammation may be performed via nasal endoscopy or radiographic imaging but neither are commonly available at the point of care. Since studies suggest that the sensitivity of nasal endoscopy is as low as 36% when compared to computed tomography (CT) imaging, CT is generally regarded as the gold standard imaging for confirmation of CRS.¹ In recent years, low radiation point-of-care (POC) CT has become more available and has the potential to avert unnecessary treatment and saving costs in the long run.^{2–5} Although there are protocol variations among institutions, a paranasal sinus CT typically involves a radiation dose of 0.6 to 1.1 milliSieverts (mSv) from a conventional multidetector CT (MDCT) and 0.04 to 0.17mSv in a cone beam CT (CBCT).^{6,7} Depending on a person's geographic location, these exposures are within, or below, estimated annual radiation from natural sources and cosmic radiation which vary from 1–10mSv.^{8,9}

Since its inception in 1970, the annual number of CT scans performed in the United States has increased from 2 million in 1980 to an estimated 72 million in 2007.¹⁰ This has spurred research, mathematical extrapolations, public commentary and government interest regarding the concomitant radiation exposure from medical imaging with emphases on suggested lifetime attributable risk of cancer and negative perceptions.^{6,8,10–12} These studies show significant variations in physician and patient-awareness concerning radiation dose and possible associated risks.¹³ Additionally, there is a paucity of literature evaluating patient perception of imaging in CRS diagnosis and treatment. In this study, we sought to investigate patient perception of the use of CT scans to diagnose nasal and sinus disease with a particular focus on in-office, cone beam/flat panel POC-CT scan screening services. In addition, patient willingness to undergo empiric medical therapy (EMT) versus CT-directed therapy (CTDT) in CRS treatment is also reported.

Methods

Consecutive patients presenting to a tertiary care rhinology clinic with a sinus and/or nasal complaint were screened for eligibility. Eligible subjects were between the ages of 18 and 89, English-speaking, and reported one or more of the major CRS symptoms for any duration. Authors developed a 22-item, self-administered questionnaire. Survey content was reviewed by three non-medical personnel for clarity and revised to layman language (Appendix 1). This questionnaire was completed by enrolled subjects prior to evaluation by an attending physician. Patients were enrolled only once and the anticipated performance of medical imaging was not required for inclusion. The questionnaire included items related to demographic and medical history, CRS and/or nasal symptoms, general CT scan knowledge,

prior CT scan exposure, and hypothetical clinical decision-making and comfort level of undergoing a sinus CT scan. In particular, we focused the questions on three aspects of CT utilization: 1) Awareness that CT scans involved radiation exposure and the relative exposure of different modalities; 2) Patient comfort level with CT imaging in CRS management and 3) Patient preferences in regard to EMT vs CTDT. Upon completion of the questionnaire, subjects were given an informational handout that described CT scans in layman's terms and provided details about office-based cone beam sinus CT scans regardless of whether imaging was obtained (Appendix 2). Treating Physicians were unaware of the individual patient responses to the questionnaire performed a standard clinical evaluation which may or may not have included a clinically indicated sinus CT scan.

Descriptive statistics were used to summarize responses. The χ^2 test of significance, with exact tests when indicated, was utilized to determine associations between subjects' demographic/historical variables and responses. The overall value for statistical significance was set at $p < 0.05$. The Institutional Review Board of Northwestern University approved this study.

Results

Study Population

Two hundred patients (96 male, 104 female) participated. Ages of participants ranged from 18–83 years (mean 42.2 ± 14.4 years). Table 1 provides a summary of participant demographics and presenting symptoms.

Patient awareness on CT imaging-related radiation exposure and relative exposure of different CT modalities

Out of 200 patients, 131 (65.5%) had prior CTs and 91 (45.5%) were aware that CT imaging involved radiation exposure. There was a significant relationship between personal history of any CT scan and knowledge of concomitant radiation exposure during CT imaging ($\chi^2 = 13.6$, $p < 0.001$). There was no significant relationship between radiation exposure awareness and sex, surgical history, education level, or type of previous CT (Selected data, Table 2). When informed that CT imaging involved concomitant radiation exposure, 176 (88%) were either unsure or overestimated the dose of radiation exposure associated with office based cone beam sinus CT compared to MDCT. Similarly, over 90% of were unsure or underestimated the radiation dose of MDCT compared to chest radiography (Figure 1). There was a weak relationship between number of previous CT scans and dose estimation of MDCT compared to CBCT (Spearman's $r = -0.075$).

Patient comfort level and concerns with CT evaluation

In analyzing patient reported comfort level with a recommended sinus CT, 60.5% of respondents were comfortable proceeding without any question while 64 (38.5%) had concerns and would proceed only if questions were answered by ordering physician. There were no patients who would categorically refuse a CT as part of workup of their sinus of nasal condition. Patients with prior CT experience ($p = 0.03$) and past sinus surgery ($p = 0.01$) were less likely to be concerned regarding the use of CT imaging for evaluating the

paranasal sinuses. Sex, education level, race or awareness of radiation exposure were not associated with patient concern with CT imaging. Of the patients with concerns regarding CT imaging, patients selected concerns in the following frequency: radiation exposure (26%), costs (16.5%), “unknown side effects”(10.5%), anxiety (6%) and time constraints (4%). Of note, each patient was allowed to list multiple concerns and make additional notes in case their concerns were unlisted in the survey. Further ranking of concerns (from most concerning to least concern) revealed 32 patients (16%) ranked radiation exposure as top concern.

Patient preferences of CTDT vs EMT

The survey item that elicited patient preference for CTDT or EMT was preceded by the following sentence, “If you knew that only using symptoms to diagnose a chronic sinus infection leads to a correct diagnosis less than half of the time and treatment usually requires a medication course (3 weeks of antibiotics, sometimes with oral steroids), would you rather: 1) take the medications...or 2) Take the medications only after confirming the diagnosis with a sinus CT scan or examination with a nasal scope even though there may be additional costs for testing and the CT scan involves radiation (Appendix 1). This statement was based on prior studies that have repeatedly shown the positive predictive value of CRS symptoms for objectively confirmable disease ranges from 20–66% with most studies reporting a value less than 50%. In response to this question, 156 (78%) preferred CTDT over empiric medical therapy (EMT) with prior CT experience identified as the only significant past medical history with associated with preference for CTDT ($\chi^2=4.26$, $P=0.04$).

Discussion

This study offers information on patient perspective on the role of CT in diagnosis of CRS and preferences regarding the decision to obtain medical imaging to guide therapy. Our findings demonstrate that approximately half of new patients presenting to a sinus/nasal specialist are unaware of ionizing radiation involved in CT imaging. However, even after provision of information regarding concomitant radiation exposure, a majority of these patients are willing to undergo CT imaging as part of their workup. Furthermore, our study finds that the majority of patients with CRS symptoms prefer CTDT in CRS management over EMT when presented with the expected positive predictive value of symptoms alone for confirming a CRS diagnosis.

This study of patient attitudes towards the use of imaging technologies in the care of CRS patients is important as it identifies knowledge gaps and areas where communication may be improved with patients. It also informs physicians of patient preferences in care algorithms. Patient perception of CT imaging has been researched across specialties for multiple reasons.^{11,13,14} In a cross-sectional study among patients with acute abdominal pain in an emergency care setting, Baumann et al found that patients had poor comprehension of radiation risk involved in medical imaging and 70% of their 1,168 study population underestimated the risk of an abdomen pelvis-CT compared to chest x-ray.¹⁴ The source of the knowledge gap is more evident in a study by Lee et al.¹² Lee studied informed consent

practices regarding diagnostic CT scans at U.S. academic medical centers and found that only 15% of centers mentioned radiation exposure to patients and only one center provided actual dose exposure. The impetus for documenting perceived risk from CT imaging may be traced to the Food and Drug Administration's (FDA) proposed development of a patient medical imaging history card in 2010 in response to controversy regarding increase in CT imaging.¹⁵ This initiative to increase patient awareness appears intuitive as patients should be able to track their imaging history and present this information to physicians as needed. However, the direct impact of this initiative has not been studied. In addition, there is a lack of public health or physician-directed endeavor(s) dedicated to this topic that evaluate and address knowledge gaps, patient expectations and comfort level. Carrying a card without an understanding of the value of imaging in specific contexts or efforts aimed at reducing concomitant radiation may not enhance patient awareness, comfort or autonomy.

The proportion of patients in this study who expressed knowledge of ionizing radiation (45.5%) is similar to parental awareness of 46.8% in surveys of the pediatric population.¹⁶ Contrary to our hypothesis, sex and education level did not have a significant effect on changing patient awareness regarding imaging associated radiation exposure. Comparison of our results with well cited studies is difficult because these studies investigated patient dose-estimation or education by physician versus baseline knowledge before encountering any physician.^{11,14} However, the finding that prior CT experience was associated with a knowledge of radiation exposure may be an indicator of education from referring physicians or radiology technicians. This may also be a result of self-directed education following prior CT imaging. Nevertheless, this number is low in the context of media and government attempts at public education.

The poor level of patient awareness of risks involved in CT imaging did not negatively impact their decision to receive a CT sinus to diagnosis their sinus/nasal symptoms. However, there is still considerable debate about the timing of CT sinus in CRS. Currently, the American College of Radiology appropriateness criteria only achieved high level consensus on use of CT for CRS in the setting of complicated rhinosinusitis, presurgical planning, nasal polyposis or suspected nasal mass.¹⁷ Fewer guidelines exist on the timing and utilization of CT for initial evaluation of patients with CRS symptoms, with limited information on the threshold of previous empiric medical therapy needed prior to imaging. Due to the poor positive predictive value of the cardinal symptoms of CRS, up-front CT imaging for establishing initial diagnosis and dictating care of the patient with sinusitis symptoms results in significantly lower antibiotic use, less costly care and improves patients compliance with prescribed medical care.^{2,5,18}

Our study finds that most patients trust their physician's opinion regarding the use of CT for evaluating CRS symptoms rather than perpetual EMT although 38.5% would have some reservations. The most common reservation expressed by patients related to the associated radiation exposure. Discussion of dose estimates and alternatives to MDCT may increase patient comfort level as illustrated by the fact that a majority of subjects were unsure of the relative doses of ionizing radiation involved in chest radiography, MDCT and CBCT. Even among patients who were aware that CT imaging involved ionizing radiation exposure, most underestimated the amount of exposure involved. The Biological Effects of Ionizing

Radiation (BEIR) Committee of the National Academy of Sciences, along with other studies, have issued consensus statements that there is a linear risk of cancer with radiation exposure.^{8,19} Thus, given the implicit trust most patients place in their physician's decision to obtain imaging, otolaryngologists should be aware of available alternatives to MDCT in their community and select imaging modalities using the principle of as low as reasonably achievable for specific indications. For example, in diagnosis confirming uncomplicated CRS, an office-based cone beam or flat panel sinus CT scan delivers about 17% of the radiation as a MDCT scan in the radiology department in the setting for this study. It is conceivable that patient education about alternatives will only enhance their experience rather than nurture fear instigated by media hyperbole regarding the risks associated with CT radiation.

Patients have been reported to have a higher confidence in their care when imaging is involved in their diagnostic algorithm.¹⁴ The results from this study also suggest that the majority of subjects opted for accurately chosen therapy rather than empiric based therapy based on medical history and physical examination. CRS is estimated to account for 7% of all adult outpatient antibiotic prescriptions United States while other studies suggest that most CRS in primary care are made without confirmatory CT or endoscopy.^{20,21} These findings, coupled with poor specificity of symptoms in CRS diagnosis, suggests that many patients may likely be receiving unnecessary antibiotics. The findings regarding patient preferences for CTDT over EMT should encourage physicians to employ this modality earlier in treatment for patients with chronic symptoms of sinusitis in order to confirm diagnosis prior to embarking on empiric trials of antibiotics or possible oral corticosteroids. This recommendation, in addition to more widely accepted indications for preoperative planning or after multiple failed medical therapies, will reduce overtreatment, facilitate prompt diagnosis and ultimately save costs for the patient and the system.

It is important to acknowledge possible response bias from the structure of the survey question that addressed the preference of EMT vs CTDT. We had based the statement on previously published rates of CT-confirmable CRS among a symptomatic population, including one study published using patients drawn from the same practice that found the positive predictive value of symptoms is less than 50%.^{22–24} However, in writing this manuscript, we found there are several publications reporting a higher positive predictive value for symptoms (60–69%)^{1,25,26}. Thus, the statement asking patients to choose between CTDT and EMT may have biased our participants' preferences. It is important to acknowledge as well that all these prior studies have been done in tertiary care academic centers using clinically indicated CT scans. The positive predictive value in each practice may subsequently also depend on the diagnostic acumen of referring practitioners and the threshold/indications for which an individual practitioner recommends a CT scan. Overall, the need to develop better diagnostic algorithms in CRS should include original research such as the present study that investigate the perception of an educated patient regarding available diagnostic and therapeutic tools. Participants are able to provide realistic answers if they have meaningful information in layman's terms about the sensitivity and specificity of options involved in diagnosis and treatment.

Even in the context of a positive patient perception, it should be stressed that CT imaging is not advocated for every symptomatic patient but rather one in whom diagnosis cannot be formally established by exam with the possible addition of nasal endoscopy. Thus far, utilization of CT imaging for sinonasal diagnoses among otolaryngologists in an ambulatory setting has been shown to be consistent from 2005 to 2010 despite wide availability of imaging and updates in guideline recommendations for objective documentation of inflammation for diagnosis of adult CRS.²⁷ Concerns that CT utilization rates may increase from up-front CT imaging should be weighed against the significant reduction in unnecessary antibiotic prescriptions and increased diagnostic accuracy using this treatment algorithm.

Conclusion

Most patients accept CT imaging as part of their diagnostic work up for sinusitis and would agree to confirmatory imaging to more accurately direct therapy if recommended by their physician. A history of any CT imaging is associated with knowledge of ionizing radiation involved in CT imaging but a significant portion of patients have radiation-related concerns and lack accurate estimates of radiation exposure involved in medical imaging. Patients with prior CT and prior nasal/sinus surgery are more likely to prefer CTDT for CRS treatment. Responsible stewardship from physicians is required to educate patients regarding these concerns and obtain imaging only during times when it affects management of the patient with sinusitis symptoms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Patient understanding of relative radiation caused by sinus CT versus chest radiography

Table 1

Participant characteristics (n =200)

Characteristic	Frequency	%
Age		
18–30	49	24.5
31–50	95	47.5
>50	56	28
Gender		
Male	96	48
Female	104	52
Education level		
High school or less	9	4.5
Some College	129	64.5
Professional degree	62	31.0
Presenting complaint*		
Nasal obstruction	162	81
Facial pain	65	32.5
Facial pressure	93	46.5
Smell loss	41	20.5
Runny nose/discharge	98	49
Post nasal drip	135	67.5
Duration of symptoms		
<3months	30	15
3–6months	28	14
7–12months	17	8.5
1–4years	35	17.5
>5years	89	44.5
Self-identified ethnicity		
White	146	73
Black	19	9.5
Hispanic	16	8
Asian	6	3
Other/undisclosed	13	6.5

* Patient reported more than 1 symptom thus frequency for presenting complaint exceeded 200.

Table 2

Selection of factors that may affect patient knowledge/awareness of radiation exposure in computed tomography (CT scan).

N (% of row)	Survey question: “does a CT scan involve radiation exposure?”			
	Group description	Yes	No	Unsure
History of sinus/nasal surgery($\chi^2=3.395$, $p=0.18$)				
	Prior surgery	17 (60.7)	2 (7.1)	9 (32.1)
	No surgery	72 (43.4)	28 (16.9)	66 (39.8)
History of prior CT ($\chi^2=13.6$, $p<0.001$)				
	No CT	18 (27.7)	15 (23.1)	36 (49.2)
	Prior CT	72 (55.0)	15 (11.5)	44 (33.6)
Education level ($\chi^2=5.87$, $p=0.21$)				
	High school or less	3 (33.3)	1(11.1)	5(55.6)
	College education (2–4yrs)	54 (42.5)	19 (14.2)	56 (43.3)
	Advanced/professional degree	33 (55.0)	10 (18.3)	16 (26.7)