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The use of cone beam computed tomography of paranasal sinuses in the investigation and management of rhinosinusitis: a national survey and our 'one-stop' rhinology clinic experience

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Main Article

Dr A Munnings takes responsibility for the integrity of the content of the paper

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Abstract

Objective. Cone beam computed tomography is an imaging technique that can be used for the paranasal sinuses. This study assessed how widely it is used and the impact it has on chronic rhinosinusitis management in the ENT department of one hospital.

Method. A nationwide survey was conducted to assess the use of cone beam computed tomography throughout ENT UK members. A retrospective analysis of four-year rhinology clinic data for patients presenting with chronic rhinosinusitis symptoms was subsequently performed to assess how many scans were achieved the same day and the subsequent patient management.

Results. The survey results indicated that a majority of staff do not use cone beam computed tomography to image sinuses (86.5 per cent), and this was largely because of lack of access (92 per cent). This study assessed 355 cone beam computed tomography requests. Overall, 306 cases had a cone beam computed tomography scan on the same day as their clinic appointment with the majority seen back in clinic during the same hospital attendance for the results. Overall, 97 patients were discharged on the same day.

Conclusion. This study suggested a lack of awareness and understanding of cone beam computed tomography in managing rhinosinusitis. The 'one-stop' rhinology clinic model offers benefits including reduced patient hospital attendance.

Introduction

Chronic rhinosinusitis disease in adults is diagnosed on symptoms, including nasal blockage or discharge as well as facial pain or reduction in smell. In addition to symptoms, it is based on the presence of endoscopic evidence (polyps, mucopus, oedema of the middle meatus) or computed tomography (CT) scan changes (of the ostiomeatal complex or sinuses). This is reiterated in the new European Position Paper on Rhinosinusitis and Nasal Polyps.[1] Therefore, radiological imaging can form an important part of diagnosis. Moreover, functional endoscopic sinus surgery is usually the choice technique for addressing rhinosinusitis and skull base diseases. A fine understanding of the individual's anatomy is key prior to undertaking such surgery given the critical structures that the operator must navigate in order to avoid complications, including haemorrhage, oculomotor deficits, blindness and cerebrospinal fluid leak.[2]

Standard CT is the usual choice for imaging of suspected sinonasal disease and preoperative imaging. It has a high specificity and sensitivity and provides high resolution and accurate evaluation of images.[3] However, it brings with it high radiation, high cost and often a further appointment to the hospital, frequently after a wait. Subsequently, a third visit to the ENT department is then needed to discuss the results of the CT scan.

Cone beam CT was introduced into ENT radiology some years ago. Unlike a standard CT scan, which uses a fan-shaped X-ray beam and one-dimensional detectors, cone beam CT uses a cone-shaped X-ray beam and two-dimensional detectors. This gives a very high spatial resolution in a single revolution, which subsequently leads to less radiation exposure. However, it does compromise the dynamic range translating to less soft tissue resolution.

There is scepticism of cone beam CT for use in rhinological conditions compared with the accuracy and resolution delivered by a standard CT scan of the paranasal sinus. However, cone beam CT findings have been shown to correlate well with sinus endoscopy findings,[4] and studies do suggest that cone beam CT offers a 'quick and efficient alternative to conventional CT' for chronic rhinosinusitis, with more advanced and complicated conditions warranting the use of standard CT.[5] The use of cone beam CT in our rhinology clinics has been operational since 2016. We consulted various stakeholders, got approval and established the protocol for using cone beam CT for sinus disease management. The scanner is installed in the Oral Surgery Department and is operated by the oral

surgery staff; at our request, a cone beam CT scan of the sinuses can be performed instantly.

We surveyed the knowledge and use of cone beam CT in UK ENT departments. We then compared this to our own experience using cone beam CT in rhinology clinics for evaluation of sinonasal disease and its effectiveness.

Materials and methods

Survey

Initially, we did a survey of the hospitals in the erstwhile Severn and Oxford deaneries and found that none of the ENT departments used cone beam CT. Later in 2017, a telephonic survey of 151 hospitals nationwide showed that 75 had oral surgery departments; 18 of these had cone beam CT, and only 1 used this for ENT. In addition, 11 radiology departments had cone beam CT, with only one using it for sinus patients. Subsequently, a survey was sent to ENT UK for nationwide distribution to members via e-mail. The first e-mails were sent out on 23 November 2018 to 1196 recipients. Two further reminder e-mails were sent out to the recipients who had not undertaken the survey. The survey closed on 12 January 2019 (therefore it was available to complete for a total of 51 days). It consisted of 10 questions, 9 of which were multiple choice answers with options to state 'other' if the respondent's answer did not fit into the suggested options. Question 10 allowed the respondents to write their own subjective responses regarding the use of cone beam CT in rhinology clinics. There were 186 responses from a total of 1196 e-mails sent.

Our experience

We analysed 400 paranasal sinus cone beam CT scan requests from 2016 to 2019 inclusively from our ENT out-patient department in patients 18 years or older. Indications for the cone beam CT scan were screened for chronic rhinosinusitis symptoms: nasal obstruction or rhinorrhoea with facial pain or reduced sense of smell with or without endoscopic evidence of polyps, mucopus, or oedema of the middle meatus. Scans requested for anything other than these symptoms were excluded. We also excluded any scans that were requested from an evening clinic (i.e. after 16:45) as the Oral Surgery Department only operates until 17:00 and therefore later requests would unfairly affect our results. Our primary outcome measures were to see how many patients had their scan on the same day, and whether they were: (1) discharged, (2) listed for the operating theatre or (3) booked for further follow up. We also looked at the grade of clinician seeing the patient and if further imaging was thought necessary after the cone beam CT scan results.

Results

Survey

Table 1 shows the summarised results from our ENT UK survey. In regard to the last survey question asking for general comments on the use of cone beam CT by ENT professionals, 48 recipients responded.

Negative comments included the concerns over requiring good ENT radiologists to interpret the cone beam CT as opposed to the standard CT, that it is a useful adjunct but

Table 1. ENT UK survey results

Question	Response
Do you have a specialist rhinology practice?	185 responses. Yes – 70 (40.5%), no – 110 (59.5%)
Do you use CBCT of the sinuses?	185 responses. Yes – 25 (13.5%), no – 160 (86.5%)
Please select/identify all of the reasons why not	121 responses. No access to scanner – 111, poor image quality for diagnosis – 6, poor image quality for surgical planning – 9, medico-legal issues as there is no radiologist's report – 4, use of CBCT creates undue pressure on an out-patient clinic as patients return to see you after their CBCT increasing the number in clinic – 9, other – 18
Is it a walk-in service or part of a one-stop clinic?	37 responses. Yes – 8 (21.6%), no – 29 (78.4%)
How frequently do you find that supplementary scanning (standard CT/MRI/other) is required in your practice following CBCT?	33 responses. 0% of the time – 12 (36.4%), <10% of the time – 9 (27.3%), 10–50% of the time – 9 (27.3%), >50% of the time – 3 (9%)
Where is the CBCT scanner located?	34 responses. ENT department – 1 (3%), oral surgery – 12 (35.3%), radiology – 9 (26.5%), other – 12 (35.3%)
Have you unsuccessfully tried to get funding?	139 responses. Yes – 16 (11.5%), no – 123 (88.5%)
Is there a CBCT scanner in the oral surgery department of your hospital?	142 responses. Yes – 29 (20.4%), no – 41 (28.9%), do not know – 61 (43%), no oral surgery department in the hospital – 11 (7.8%)
If 'yes' to the question above, what are the reasons for not using the oral surgery CBCT scanner for ENT (please select all that apply)?	Not aware that the CBCT scanner can be programmed for ENT imaging – 12 (30%), cumbersome paperwork – 2 (5%), no money to organise – 0 (0%), interpersonal relationships with radiologists or oral surgeons – 2 (5%), other – 23 (57.5%)
Please give any other comments relating to the use of CBCT sinus imaging	48 responses

CBCT = cone beam computed tomography; CT = computed tomography; MRI = magnetic resonance imaging

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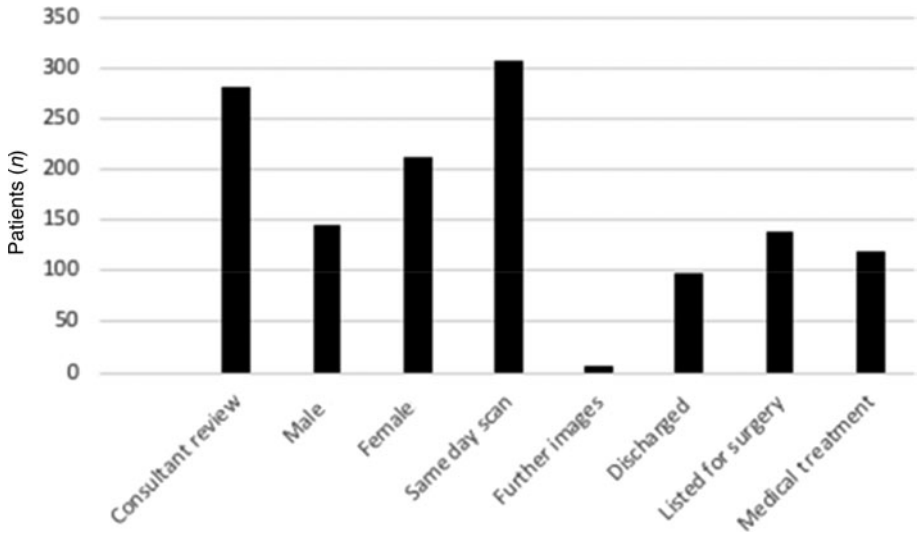

Fig. 1. Cone beam computed tomography audit results.

not for sole imaging and that there is still little specific literature available on cone beam CT in paranasal sinuses.

Eleven respondents were interested in using cone beam CT for rhinology clinics if their department had access to this. Nine respondents were using cone beam CT in their departments and were positive in their reviews. They liked the reduced radiation, the quick access to the scan and were happy with the reliability of the results. Interestingly, two commented on their use of it in the private sector as it was cheaper than the standard CT alternative, and one reported that following the survey, they would submit a business plan to their National Health Service (NHS) department to get one. Similarly, eight further respondents stated that they were currently in the process of applying for a scanner.

Our experience

From our own experience of aiming to develop a 'one-stop' rhinology clinic for rhinosinusitis disease, we found the following results. We analysed 400 cone beam CT scan requests over the period from 2016 to 2019. Of these, 29 patients were excluded because of the following reasons: 12 had missing electronic notes, 11 scans were requested for reasons other than looking for rhinosinusitis disease and 3 were patients seen privately at the NHS facility. A further 16 patients were excluded as they were seen by our senior rhinology consultant in his evening clinic, and therefore getting a cone beam CT scan was not possible as it was out of hours.

Indicative symptoms for requesting a cone beam CT scan for suspected chronic rhinosinusitis were as follows. Three patients were found to have nasal obstruction only as the indicative symptom for the cone beam CT scan; however, they were found to have polyps or mucopus on endoscopy. On examination, 158 patients were seen to have polyps, mucopus or oedema at the middle meatus overall.

Therefore, a total of 355 patients were reviewed. Of these, 281 were seen by a consultant, with 252 having been seen by our department's rhinologist (we have a small team of four consultants in our department, one of whom is a sub-specialist rhinologist which partly explains this). The average age of the patients seen was 48 years, with a male to female ratio of 144:211. Of the 355 patients, 306 had their scan on the same day as their clinic appointment (86 per cent). Of the 355 scans ordered, 7 required further imaging investigations (2 had repeat cone beam CT scans ordered after medical treatment, 2 had CT sinus scans, 2 had magnetic resonance imaging (MRI) scans requested for anosmia and 1 had a CT scan of temporal bone ordered for additional otological symptoms). In regard to outcomes following the cone beam CT scan, 97 people were discharged from the clinic on the same day, and 138 were listed for surgery, namely functional endoscopic sinus surgery, septoplasty, turbinate reduction or a combination of the three. The remaining 120 patients were advised to trial medical treatment with a follow-up appointment. The audit results are summarised in Figure 1.

Discussion

It was evident from our study that the majority of patients obtained their scan on the same day it was requested (306 of 355). This therefore avoided a further 306 patient visits to the hospital. Of these 306 patients, if they had not had their cone beam CT scan on the initial visit, the 245 patients discharged or listed for surgery would have needed a third visit to the ENT department for a discussion of the results of their CT sinus scan. This is helped furthermore by our polyp protocol: patients with grade 2 polyps who have already tried topical or oral steroids may often be listed for surgery, given further oral steroids and topical steroid drops, and told that they can cancel surgery if their symptoms resolve.

Moreover, of these 306 patients, 97 of them then went on to be discharged. Their preceding symptoms are summarised in Table 3. Of these 97 cone beam CT scans, 14 scans showed mild, patchy mucosal thickening, 2 showed maxillary sinus cysts only, and one showed a tooth infection and was referred to the maxillofacial team for further management. The remainder showed clear sinuses. These patients were reassured regarding their sinuses and were discharged back to the care of their general practitioner.

Efficient decision making, fewer hospital visits and follow ups, and early discharges are of even more relevance in the current climate of the coronavirus disease 2019 (Covid-19) pandemic with a stretched NHS out-patient waiting list and chances of infection; not only are there wider economic advantages for the NHS and the patient, there is a positive environmental impact as well. Furthermore, there is the lower cost of cone beam CT.[6] Interestingly, in our trust, there did not appear to be a separate cost bundle in regard to a standard

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Table 2. Indicative symptoms for cone beam computed tomography requests

Parameter	Facial pain (*n*)	Reduced smell (*n*)	Facial pain, reduced smell (*n*)	Rhinorrhoea, facial pain, reduced smell (*n*)	Obstruction, facial pain, reduced smell (*n*)
Obstruction	121	60	17	7	–
Rhinorrhoea	77	56	10	–	6

Table 3. Indicative symptoms for cone beam computed tomography requests of patients who were discharged

Parameter	Facial pain (*n*)	Reduced smell (*n*)	Facial pain, reduced smell (*n*)
Obstruction	51	6	3
Rhinorrhoea	22	11	4

CT scan and a cone beam CT scan, with both being paid for by the clinical commissioning group at £70 for the scan and £20 for reporting. As far as the hospital is concerned, this is a significant cost saving as the cone beam CT machine is cheaper, the scan takes less time, and the oral surgery scanner and staff had sufficient spare capacity to absorb the ENT scans; this of course decreased the load on the main CT machine with excessive demand. In addition, the released follow-up slots, which are a precious resource, get replaced with new patients and get paid more by the clinical commissioning groups.

A commonly stated benefit of using cone beam CT scans is the reduced radiation. However, this depends on the age of the respective machine as the newer machines give less and less exposure. When we started six years ago, the cone beam CT radiation exposure was significantly less than the standard CT exposure. Since then, however, the cone beam CT machine is the same, but we have a new standard CT machine and now the exposure of both the older cone beam CT machine and the newer CT machine is the same.

Conventional CT scans have improved with time and can be operated using a low radiation dose protocol for imaging the sinuses; this therefore presents an alternative to cone beam CT. Some departments may have access to a conventional CT scanner as part of a one-stop rhinology clinic. However, given common pressures on CT scan appointment slots, we expected that the vast majority of units do not have this facility. Certainly, the benefit of the cone beam CT in our hospital is that it can be operated by oral surgery nurses, with the patient receiving the scan immediately after the clinic without significantly impacting on the oral surgery nurses' other demands. There is no extra cost for a radiographer because the oral surgery nurses are operating in their own clinics and find the time to scan for us in and around their own duties. We can usually then see the patient the same day with the cone beam CT results.

It is interesting to note that the vast majority (86.5 per cent) of clinicians in our survey do not use a cone beam CT scan to assess their rhinology patients. Various reasons can be extrapolated from our study as to why that is the case. One reason noted was the understanding that a cone beam CT scan has poorer image quality for diagnosis and surgical planning. As we know, the benefit of cone beam CT having lower radiation also has the disadvantage of reduced soft tissue resolution. The definition and resolution of cone beam CT scans can be altered, but improving the resolution comes with increased radiation. Although it is true that a standard sinus CT scan has a higher accuracy for advanced sinus disease[7] in cases of standard rhinosinusitis, our experience suggests cone beam CT is sufficient for management. This reflects various studies that agree that a cone beam CT scan is sufficient for management of chronic rhinosinusitis disease.[4,5] However, this view is not shared by a small number of colleagues.

Of our 355 patients, only 7 went on to have further scans requested, and only 2 of these were in the form of CT sinus scans (2 had a second cone beam CT scan ordered to look at disease resolution after steroids, 2 had MRI scans to assess alternative causes of anosmia and 1 had a CT scan of temporal bone for accompanying otological presentation). The CT sinus scans were ordered by a locum consultant who may not have been used to the cone beam CT availability in our department. Moreover, no patient over the course of our study had a surgical complication as a result of cone beam CT scanning. This supports previous studies that in cases of rhinosinusitis, cone beam CT imaging is sufficient.[7]

The survey results confirm our anecdotal experiences regarding barriers to the use of cone beam CT for sinus disease. These include: (1) lack of awareness about cone beam CT and existing cone beam CT in their oral surgery departments (and the ability to configure these units for sinus use with minimal expenditure); (2) bureaucracy (disinclination to deal with the bureaucracy to bring about the change); (3) unhappiness with the image quality; (4) time pressure, as the same patient is seen twice (before and after the scan) in the same clinic, effectively creating two consultations and putting undue time pressure on the clinician (9 of 121 responses); (5) medico-legal worries including reluctance to read a scan and take responsibility and action without a radiological report. This of course brings up another issue of whether CT or cone beam CT scans need radiological reporting at all or whether it can or should be reported by rhinologist.[8] We have been told by our radiology department that every radiograph needs a formal report on the system, and they are duty bound to provide this. One option could be for the requesting the ENT doctor to formally report the cone beam CT scan, but there is a reluctance among our colleagues to take that responsibility. Currently, even though the cone beam CT scan is read, and action is taken by the requesting ENT doctor, the cone beam CT scan still gets reported by a radiologist over the next few days; (6) extra time is needed by the patient in the hospital, but this is only rarely an issue; and (7) oral surgery staff availability because a significant number of requests can hamper the process as the Oral Surgery Department is also using the scanner.

- Many ENT specialists appear to be unaware of the use of cone beam computed tomography (CT) in evaluating rhinosinusitis disease
- Barriers to use include access to and location of scanners, funding, concerns over accuracy and resolution, and reluctance to read a scan in the absence of a report
- Cone beam CT of the paranasal sinuses is a useful alternative to standard CT sinus techniques
- 'One-stop' rhinology clinics lead to same-day decision making, thus decreasing the number of follow ups
- This reduces the number of hospital visits for the patient, which has additional economic and environmental benefits

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Another aspect affecting the amount of time taken in a 'one-stop' clinic includes the location of the scanner. In our hospital, the cone beam CT scanner is two floors below the ENT clinic but is relatively easy to get to. However, our survey reflects that in other units the scanner may be further away and hence its use is more difficult.

In regard to future consideration, the recent European Position Paper on Rhinosinusitis and Nasal Polyps 2020 guidance[1] provides clear treatment pathways for a patient suspected to have rhinosinusitis, with pharmacists offering first line treatment and then primary care to commence formal medical treatment with steroids and continuing nasal saline rinses. Therefore, in theory, by the time a patient arrives in an ENT specialist clinic, they should have already had medical treatment for suspected rhinosinusitis. If the suspected diagnosis was correct, then it could be argued that patients should be getting CT scans earlier in a speciality clinic. With an effective 'one-stop' clinic model, using cone beam CT of the sinuses can make that process even more efficient. Of course, easy accessibility of the scanner can arguably lead to excessive use of these scans. This will have to be balanced against greater patient satisfaction in being discharged after having seen a normal scan.[9]

Limitations

We recognise from our survey questions that some members who answered 'no' to using a cone beam CT scan may have had access to a same day conventional CT scan and this may have biased the results; however, nobody mentioned this in the open comments in section 10. We performed a retrospective analysis of rhinology clinic data. We started by looking at the cone beam CT scan requests and further investigated these. In doing so, we did not take into account the number of appointments that patients had attended prior to the decision that a cone beam CT scan was needed. We also did not investigate the follow-up management of those patients who were sent away with further medical treatment and a future follow up. Finally, for the purpose of this study, we did not assess the reasons why a cone beam CT scan was not performed on the same day. Although this is likely because of the reasons discussed above (e.g. time constraints, trainee clinics, patient could not wait, unavailability of oral surgery nurses), a future study could be performed to assess these specifically in order to further optimise the concept of a 'one-stop' clinic.

Conclusion

Our survey suggests an unawareness of the potential of cone beam CT in rhinosinusitis patients. Those who are aware have barriers to this facility in regard to cost of the scanner, infrastructure issues with oral surgery departments being too far away from the ENT clinic to make this functionally viable and a belief that it does not provide adequate resolution.

Our own experience indicates the benefits of using cone beam CT in suspected rhinosinusitis patients in being able to reduce patient hospital attendance. It also highlighted that registrars, as opposed to consultants, were less likely to use the 'one-stop' function of seeing patients back the same day after their scan. This indicates that trainees need to be supported in undertaking such activity and that reduced clinic numbers need to be weighed against the benefits of a conclusive decision being taken the same day.

Overall, we believe our experience supports the use of cone beam CT in rhinosinusitis patients and that a move to 'one-stop' rhinology clinics may be the future, especially given the new European Position Paper on Rhinosinusitis and Nasal Polyps guidelines that ask general practitioners to commence medical treatment prior to referral and shifts the focus of the ENT clinician to consolidate this diagnosis with endoscopy or imaging.

Competing interests. None declared

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