

Defining appropriateness criteria for endoscopic sinus surgery in management of adult dental implant patients with incidental maxillary sinus findings on cone beam computed tomography.

ABSTRACT

Objectives

Cone beam computed tomography (CBCT) imaging is commonly requested by dental implant surgeons, pre-operatively, for patients being considered for dental implants. Incidental maxillary sinus findings often result in otolaryngology (ENT) referral for further assessment.

CBCT findings include transient and benign mucosal changes that may not require any intervention and therefore unnecessarily delay implant surgery.

We aim to define appropriateness criteria for ESS in the management of adult dental implant patients with incidental maxillary sinus findings on CBCT and provide guidance to both dental implant and ENT surgeons.

Design

The RAND/UCLA appropriateness methodology was used to develop and define the appropriateness criteria.

Setting

A virtual panel of 13 international experts in ESS.

Participants

The expert panel completed two rounds of a modified Delphi ranking process for nine clinical scenarios, considering various factors affecting decision-making processes.

Main outcome measures

To define appropriateness criteria for ESS in adult dental implant patients who have incidental maxillary sinus findings on CBCT.

Results

Patients with clinical symptoms and endoscopic findings of chronic rhinosinusitis together with an obstructed ostiomeatal complex (OMC) and concentric mucosal thickening of the ipsilateral maxillary sinus or pansinusitis were deemed appropriate candidates for ESS prior to their dental implant. ESS was not appropriate in asymptomatic patients with a patent OMC and mucosal thickening isolated to floor of the ipsilateral maxillary sinus.

For uncertain scenarios, further discussion between dental implant and ENT surgeon should be considered.

Conclusions

This study has developed and reported a list of appropriateness criteria to offer ESS in adult dental implant patients with incidental maxillary sinus findings on CBCT.

KEYPOINTS

1. CBCT are often performed as part of the pre-operative work-up for dental implants patients.
2. Incidental maxillary sinus findings may result in inappropriate referrals to ENT resulting in unnecessary delay to implant surgery.
3. Patients with clinical symptoms and endoscopic findings of CRS together with an obstructed OMC and concentric mucosal thickening of the ipsilateral maxillary sinus or pansinusitis are appropriate candidates for ESS prior to their dental implant.
4. Asymptomatic patients or those symptomatically managed on appropriate medical treatment together with a patent OMC and mucosal thickening isolated to floor of the ipsilateral maxillary sinus are not appropriate for ESS prior to dental implantation
5. In uncertain scenarios, such those with symptoms not specific for CRS and unremarkable clinical findings on nasoendoscopy but an isolated obstructed OMC together with otherwise clear paranasal sinuses should further discussions between ENT and dental implant surgeon to decide appropriateness.

INTRODUCTION

It is estimated that more than 200,000 dental implants are performed per year in the United Kingdom (UK) ¹. Dental implant surgeons often request cone beam computed tomography (CBCT) imaging in patients being considered for dental implants as part of their pre-operative investigative work-up. CBCT allows for accurate treatment planning, identification of anatomical variations, including the inferior alveolar nerve canal, and any irreversible or reversible contraindications to dental implantation, such as underlying bone disease or loss of bone volume, that may result in dental implant failure ²⁻⁴.

Dental implant patients may subsequently be referred for otolaryngology (ENT) assessment if sinonasal pathology is seen on these scans, particularly related to the maxillary sinus. However, CBCT may also detect transient and benign mucosal changes that do not require any intervention and therefore ENT referral may unnecessarily delay implant surgery ⁴.

The incidental finding of paranasal sinus opacification is very common, affecting up to half of patients undergoing CT scanning for other primary reasons, with the majority of these cases involving the maxillary sinus ^{4,5}. Incidental maxillary sinus findings can vary from physiological mucosal thickening or mucosal retention cysts, to more concerning features of solitary polyps or localised sinusitis ⁶.

The role of Endoscopic Sinus Surgery (ESS), in otherwise asymptomatic patients who are undergoing dental implant surgery, is both to delineate the nature of single sinus opacification (i.e. to distinguish between benign and malignant disease) and also to address underlying sinonasal disease based on an assumption that it may predispose to an increased rate of complications and failure of dental implant osseointegration secondary to untreated chronic rhinosinusitis (CRS) and pre-existing maxillary sinus disease ⁷.

The lack of clear appropriate indications for ESS in patients with incidental maxillary sinus findings on CBCT contributes to a large variation in clinical practice amongst both ENT surgeons and the referring dental implant surgeons.

A strategy to achieve consensus includes creating appropriateness criteria to help clinicians in their decision making process, where 'appropriateness' is defined as the balance of benefits against harm of a healthcare intervention ⁸.

We aim to define appropriateness criteria for ESS in management of adult dental implant patients with incidental maxillary sinus findings on CBCT and provide guidance to both dental implant and ENT surgeons. We aim to improve care standards for these patients by creating defined surgical indications.

MATERIALS AND METHODS

Ethical considerations

The study was registered with our local clinical audit department (ref:11098).

Study design

The RAND/UCLA appropriateness methodology step-by-step process was used to develop and define the appropriateness criteria for endoscopic sinus surgery in management of adult dental implant patients with incidental maxillary sinus findings on CBCT (Figure 1) ⁹.

Review and synthesis of the literature

The current literature was reviewed and synthesised (see Appendices) ¹⁰. With appropriateness studies the purpose of the literature review was to allow us to assess the current information available on the topic rather than perform a systematic analysis.

Developing definitions

ESS was defined as a surgical intervention where the paranasal sinuses are opened using endoscopes for visualisation and endoscopic instruments. The purpose of surgery is to reconstitute the physiology of the sinonasal tract through creating a sinus cavity incorporating the natural ostium and allow adequate sinus ventilation and facilitate both mucociliary clearance and delivery of topical intranasal medication ^{8,11}.

The expert panel

An international panel of 13 experts in ESS were invited to provide an expert panel with representation from the United Kingdom, Spain and Australia. Panel members were chosen to include those with clinical expertise in ESS, understanding of evidence-based medicine, demonstrable research interest and those without a conflict of interest that could influence the study outcomes.

Contact was established to ascertain interest and availability by email, with telephone or direct consultation where necessary. We collated information on each member of the panel on their job classification, the number of years performing ESS and an approximation of the number of ESS performed per year.

The rating process for appropriateness

The development of appropriateness criteria consisted of two rounds of a modified Delphi ranking process, as per the RAND/UCLA appropriateness methodology ⁹.

Rating appropriateness: First round

Panellists were initially provided with a literature review on whether maxillary sinus findings on CBCT affects dental implants ¹⁰. An online questionnaire was created with nine varied clinical scenarios, constructed by the senior author, that took into consideration the variables considered by surgeons regarding appropriateness for ESS in this patient cohort. This included patient demographics, clinical symptoms, findings on nasoendoscopy, status of the ostiomeatal complex (OMC), measurements related to maximal mucosal thickening and at least one coronal slice of CBCT of the paranasal sinuses at the level of the maxillary sinus/OMC. Cases were carefully selected to demonstrate cases with varying degrees of mucosal thickening, with or without obstruction of the OMC, with or without accompanying symptoms.

All scenarios were based on actual presentations of patients being considered for dental implants that had been referred to our tertiary centre for consideration of ESS prior to implantation. CBCT images of referred patients were anonymised prior to presentation to the assessors (see Figure 2).

Using a 9-point Linkert scale, the expert panel was asked to independently state the appropriateness to surgically address the maxillary sinus (assuming CT performed after appropriate medical therapy, or that symptoms or signs persist after medical treatment ¹¹) from the information provided. They were asked to rank appropriateness based on the literature review ¹⁰, ESS guidelines ¹¹ and their clinical expertise. A ranking of 1 indicated the panellist would not perform surgery prior to implantation and would be comfortable for patient to proceed with dental implantation. A ranking of 9 indicated that the panellist would surgically address the maxillary sinus prior to dental implantation.

Further information was sought relating to the importance of the following factors in guiding their decision making: (1) clinical history; (2) findings on nasoendoscopy; (3) status of OMC (obstructed versus patent); (4) degree of maxillary sinus mucosal thickening; (5) extent of mucosal thickening (confined to floor of the maxillary sinus versus concentric); (6) status of the other paranasal sinuses; and (7) presence of secretions. Panellists were also encouraged to provide additional relevant information related to their decision-making process through free-text. Panellists were asked to rank their answers irrespective of the source of funding (NHS or privately funded).

After completion of the first round of ranking the panel moderator (NA), who was not involved in the ranking process, entered the results into a clinical database and analysed the results.

Appropriateness for proceeding with ESS prior to dental implantation was classified into three levels, using the following definitions ⁹:

- Appropriate: panel median of 7-9, without disagreement
- Uncertain: panel median of 4-6; or any median with disagreement
- Inappropriate: panel median of 1-3, without disagreement

NB: "Disagreement" for a clinical scenario was classified as when at least 1 panellist rating fell in the lowest 3-point region (1-3) and at least one falls in the highest (7-9), regardless of the median score ⁹.

Rating appropriateness: Second round

A second round was used to focus on scenarios and information where there was considerable dispersion in ratings from the first round.

Panellists were provided with the average ratings for all the scenarios and their individual first round ratings. The members of the panel were asked to re-rank cases where consensus was not reached in the first round, taking into consideration the group's first round results. The panel were asked, in cases where they disagreed with the majority, to state reasons behind their decision to challenge the other panellist's perspective. After completion of the second round, results were entered into a clinical database and analysed by the panel moderator (NA).

RESULTS

The expert panel

Thirteen members completed both rounds of the ranking process. All 13 classified their job title as a specialist rhinologist, with 8/13 (61.5%) having performed ESS for greater than 10 years. The other 5/13 (38.5%) have been performing ESS for between 5-10 years. The majority of the panel (84.6%) perform >100 ESS procedures a year.

Rating appropriateness

Each member ranked nine clinical scenarios in round 1. After the first round, there were two scenarios (22.2%) where there was a disagreement. Both these scenarios went into a second round of ranking but still resulted in an uncertain appropriateness for ESS. After the two rounds of a modified Delphi ranking process, the expert panel were able to reach a consensus on the majority of clinical scenarios identifying both appropriate and inappropriate indications to perform ESS in management of adult dental implant patients with incidental maxillary sinus findings on CBCT (Table 1).

Appropriateness criteria for ESS

Patients undergoing dental implantation who have clinical symptoms and endoscopic findings of CRS together with an obstructed OMC and concentric mucosal thickening of the ipsilateral maxillary sinus or pansinusitis were deemed appropriate candidates for ESS prior to their dental implant. The consensus was that the history; nasoendoscopy findings; and OMC status were very important when considering ESS.

Inappropriate criteria for ESS

Our findings summarised that ESS was not appropriate prior to dental implantation if the patient is asymptomatic or symptomatically managed on appropriate medical treatment together with a patent OMC and mucosal thickening isolated to floor of the ipsilateral maxillary sinus.

Uncertain criteria for ESS

Uncertainty regarding appropriateness to perform ESS occurred in patients with symptoms not specific for CRS and unremarkable clinical findings on nasoendoscopy but had an isolated obstructed OMC together with otherwise clear paranasal sinuses. The panel noted when considering ESS, the degree or mucosal thickening or status of other paranasal sinuses was of uncertain importance in the decision-making process.

DISCUSSION

Summary of current evidence

Dental implant surgeons often perform CBCT pre-operatively to assess for radiological evidence of sinus disease to rule out pre-existing maxillary sinus disease that is thought to be associated with an increased rate of post-operative complications ^{3,4,7}.

The incidental finding of sinus opacification is common in patients who undergo CT imaging for other primary reasons. One study looking at patients undergoing septoplasty or septorhinoplasty noted sinus opacification in nearly 30% of patients, and of these cases over two-thirds have evidence of some extent of maxillary sinus opacification ⁵.

A recent study, looking at patients undergoing sinus lift and dental implant procedures, noted abnormal maxillary sinus findings on imaging in nearly half of cases despite patients having no sinonasal symptoms preoperatively ⁴. The extent and nature of incidental sinus opacification covers a spectrum ranging from small cyst to complete sinus opacification associated with OMC obstruction. The most common reported incidental radiological findings are peripheral mucosal thickening (20.2-37.9%) and sinus floor cyst/polyps (13.1-22.6%) ^{4,6,12}. Interestingly, however, the OMC was obstructed in only 1% of cases ⁴.

Although there is a lack of clarity on what constitutes an adequate medical treatment trial, the current guidance for ESS with CRS is that it should be considered in those who are refractory to medical treatment. The principal aim of surgical intervention with ESS is to improve the severity of patients' symptoms and therefore patients should generally be symptomatic unless they have actual or imminent complications ¹¹.

With dental implant surgery the main aim of any surgical intervention would be to treat CRS that could potentially lead to an increased rate of dental implant failure or complication ^{4,7}. There is currently a lack of clear appropriate indications for ESS in patients with incidental maxillary sinus findings on CBCT.

Appropriateness criteria for ESS prior to dental implant surgery

The RAND/UCLA appropriateness methodology is well described and has previously been utilised defining appropriateness criteria for ESS during management of uncomplicated adult CRS and adult recurrent acute rhinosinusitis ^{9,11,13}. No such criteria or high-quality evidence for the management of our cohort of patients has been described in the literature to date.

Our findings determined that patients who fit the established criteria for ESS in CRS should be offered surgical intervention prior to dental implantation ^{8,11}. Similarly, any patient with suspected malignant disease or fungal sinusitis should also proceed to ESS ¹¹. The presence of pre-operative sinusitis is a strong predictive factor for post-operative sinusitis. Such sinusitis should be managed as per current guidelines to reduce risk of potential complications post-operatively although a recent meta-analysis demonstrated that pre-operative sinusitis did not increase likelihood of implant failure ¹⁴.

An important factor identified in determining appropriateness for ESS was the presence of OMC obstruction especially when combined with clinical symptoms and endoscopic findings of CRS.

Conversely, patients who were either asymptomatic or symptomatically managed on appropriate medical treatment together with a radiological finding of a patent OMC were deemed to be inappropriate for ESS prior to dental implantation. Ritter et al. demonstrated that both mucosal thickening and OMC/maxillary ostium obstruction were not associated

with increased post-operative CRS following dental procedures in asymptomatic patients and that overall pre-operative CT findings did not correlate with postoperative complications or surgical outcomes ⁴.

The status of the OMC was felt to be of particular importance as it demonstrated that the appropriate maxillary sinus mucociliary clearance and ESS would not provide any significant added advantage, especially if there was only a minor degree of isolated mucosal thickening. The panel commented that in cases where the nasoendoscopy examination was normal but the CBCT fit the appropriateness criteria above, there would still be a tendency towards surgical intervention, as although cross-sectional imaging provides a “snapshot” image, if the patient’s symptoms persist, the state of the maxillary sinus cannot be confirmed without further CT imaging.

Patients with significant maxillary sinus thickening (i.e. involving the majority or all of the ipsilateral maxillary sinus versus an isolated polyp/cyst on the floor of the maxillary sinus) were deemed more appropriate for surgical intervention. This is in keeping with recommendations from a recent cohort study where patients with incurable CRS and large polyps or cysts were suggested to have assessment for ESS ¹².

It was noted that the ‘extent’ of mucosal thickening is a subjective measurement and varied pneumatisation of the maxillary sinus would alter likelihood of natural ostium obstruction with differing extent of mucosal thickening. However, it was felt that the clinician would be able to differentiate between minor and significant mucosal thickening. Although maxillary mucosal thickening appears to be increased in those with periodontal disease, implant success rate has not been demonstrated to be correlated with extent of mucosal thickening alone ¹⁵.

The presence of mucosal thickening of other sinuses and the presence of secretions were deemed to be of uncertain clinical significance in the decision-making process. The expert panel commented that the presence of pus rather than mucosal secretion in the middle meatus on the side of the proposed dental implant would lead to advice for ESS. Patients with pansinusitis should also be managed as per CRS regardless of dental implant considerations ¹¹.

There were two cases of uncertain appropriateness that involved patients with symptoms not specific to CRS and had unremarkable findings on nasoendoscopy but did have an obstructed OMC and some minor degree of mucosal thickening. During the second round, an increased percentage of the expert panel tended towards offering ESS prior to dental implantation, although the criteria for appropriateness was not reached. It was decided by the team that a third round of ranking would not add any further clarity on these clinical scenarios.

The expert panel commented on the importance of ensuring patients receive appropriate topical medical therapy prior to considering surgical intervention especially in uncertain cases. Particularly in cases where there is uncertain appropriateness of ESS, it was felt important to discuss the case further with the dental implant surgeon.

Examples of this may include patients with asymptomatic sinus disease or history of failed dental implants with previous uncertain appropriateness criteria for ESS prior to implant and the patient did not undergo any ESS.

Clinical implications

Defining appropriateness criteria for ESS in this cohort of patients suggests parameters to be applied to future studies looking at the appropriate role of ESS in such patients.

Dissemination of this information to otolaryngologists, dental implant surgeons and primary care physicians will allow for identification of appropriate patients requiring a hospital visit to see an otolaryngologist for consideration of ESS. Through definition of the above criteria we hope to ensure that future decision-making processes are patient-centred and aim to reduce unnecessary hospital visits, delays to patient's dental implant care pathway and inappropriate use of hospital resources.

Where dental surgeons feel confident in reviewing the CBCT, they may include the OMC within the field of view. In an asymptomatic patient, where mucosal thickening is restricted to the floor of the sinus or in the presence of a simple maxillary cyst, and the ipsilateral OMC remains patent, implantation may proceed without need for ENT referral. In other settings the patient may be referred for further assessment and endoscopy. Transfer of relevant imaging will likely facilitate timely decision making and minimise need for further scans.

We would recommend in cases of clinical uncertainty the case management options should be discussed with the patient and the dental implant surgeon, with specialist otolaryngologist input as required. It is important to consider the reasoning behind why the patient is having dental implants. Up to 40% of unilateral maxillary sinusitis is odontogenic in origin¹⁶. Patients with periapical dental disease can lead to a breach of the Schneiderian membrane resulting in inflammatory mucosal disease and subsequent maxillary sinusitis¹⁷. Odontogenic sinus disease refractory to treatment with antimicrobial therapy involves definitive treatment of the underlying dental pathology. In such patients, dental extraction of affected tooth root alone may suffice in managing the sinusitis without the requirement of ESS^{18,19}.

The panel stressed that although a patient may fit the appropriateness criteria for ESS prior dental implant surgery, this is not a necessity and cases must undergo the standard patient-centred informed decision-making processes to ascertain absolute appropriateness.

Challenges, limitations and future studies

This study was based on the most commonly encountered clinical scenarios and presentations. Invariably, there will be clinical situations which fall outside those looked at in this study. It is important that ESS is still offered in such clinical scenarios and not under-utilised if it was felt appropriate after specialist review, even if not falling within the appropriateness criteria described. Similarly, patient expectation and personal preference should always be involved in any decision-making process surrounding appropriateness for any surgical intervention.

As a result of there being a lack of high-quality evidence currently available on this topic, the expert panel based the appropriateness criteria on the current available evidence together with their own personal experience and expertise. Individual and geographical bias was minimised through having an international faculty and thirteen members on the expert

panel. With time, further high-quality evidence may be published which could potentially alter the criteria for appropriateness of ESS in patients planned for dental implant surgery. The panel would recommend that further high-quality evidence is created through research and that where appropriate further studies are undertaken to maintain an updated appropriateness criteria. We would encourage comparative studies looking at outcomes of those defined within the appropriate and inappropriate criteria. Future studies should ensure that patient reported outcomes measures are integral to reported outcomes.

An important challenge to overcome is the dissemination of the above criteria to dental implant surgeons and provide clear understanding of what OMC obstruction is and how to interpret it on CBCT.

In the majority of cases, CBCT provides an adequate quality of images to allow for initial radiological diagnosis of the maxillary sinus pathology and assessment of the other paranasal sinuses. Dental implant surgeons should, however, be made aware of the importance of widening the radiological image windows of the CBCT to include the ipsilateral OMC and ethmoid sinuses.

The decision making process surrounding whether a 'functional' or 'full' ESS approach is required in such cases is beyond the remit of this study, however, it is likely this is a decision to be made by the operating otolaryngologist taking into consideration patient symptoms and radiological findings together with the planned dental implant work.

CONCLUSION

This study has developed and reported a list of appropriateness criteria to offer ESS in adult dental implant patients with incidental maxillary sinus findings on CBCT. These criteria were based on the best currently available evidence together with the experience and expertise from an expert panel of clinicians with specialist knowledge on ESS.

The criteria described are to be used as a guide for clinicians in when it is appropriate to offer ESS prior to dental implant surgery. Absolute decisions regarding proceeding to surgery should follow standard patient-centred processes. However, through identification of appropriateness criteria we hope to reduce unnecessary hospital visits and delay in patients' care pathways.

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FIGURE LEGENDS

Figure 1: Flowchart demonstrating RAND/UCLA appropriateness methodology.

Figure 2: An example of a clinical scenario with relevant information provided to the expert panel for rating appropriateness for ESS prior to dental implant surgery.