



RESEARCH ARTICLE

Preoperative Computed-Tomography for Endoscopic Sinus Surgery: A Simplified Checklist

Saad M Alshammari, MD^{1*} and Nada A Alshaikh, MD²

¹Department of Otolaryngology, Head and Neck Surgery, College of Medicine, King Fahad Hospital of University, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

²Department of Otolaryngology, Head and Neck Surgery, Dammam Medical Complex-Ministry of Health, Dammam, Saudi Arabia

*Corresponding author: Saad M Alshammari, MD, Department of Otolaryngology, Head and Neck Surgery, College of Medicine, King Fahad Hospital of University, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia



Abstract

Introduction: Endoscopic sinus surgery (ESS) gained growing popularity with indications expanding beyond rhinosinusitis. Preoperative high-resolution computed tomography (CT) scan is essential in providing the surgical map for surgeons. In addition of being a diagnostic imaging technique, it gives valuable information about origin, nature and extension of the pathology to adjacent structures. Therefore, preoperative review of para-nasal sinuses (PNS) CT scan is crucial in order to perform successful and complete surgery with avoidance of complications. Variable preoperative CT checklists were published in literature in order to standardize radiological reporting and assess surgical planning. However, those lists have rarely been utilized which is very likely due to complexity, deficiencies and low clinical applicability. The main objective of this research is to propose a new comprehensive, simplified, practical, and applicable pre-endoscopic sinus surgery CT scan checklist.

Method and materials: Extensive literature review in database engines was conducted. Published checklists were identified and reviewed carefully with in-depth analysis. The strength as well as the deficiencies in the previous lists were identified. Accordingly, a new checklist was constructed. It incorporates significant pathological data in addition to the previously included items in the published checklists. It also considered surgeon's most common pattern in looking and analyzing the CT scans. The new checklist was applied and tested for competency, by two otolaryngology surgeons, on 50 previously preformed and randomly selected CT scans. After application of the constructed checklist, we compared the results with the radiological report of the same CT scans to ensure validity and completeness of the information.

Results: Database search revealed nine English-written relevant articles, in which four proposed checklists were published. For our new systematic pre-endoscopic sinus surgery CT scan checklist, we follow a simple principle to interpret images by involving three major components: Disease (epicenter, nature, extension, and behavior), Anatomy and anatomical variations and Boundaries. Two otolaryngology surgeons tested the checklist and applied it on samples of preoperative CT images. Surgeons found the new checklist comprehensive, simple and competent in comparison to radiologist's reports. In fact, some pathological findings and majority of normal variations had not been mentioned in the original radiology reports.

Discussion: Literature review showed four relevant published checklists. Surgery planning, radiology reporting template and resident education were within objectives. Martinez Del Pero, et al., S Vaid, et al. and Samuel S Becker proposed preoperative CT checklists to evaluate paranasal sinuses. Previous checklists focused on anatomical structures, anatomical variations and bony defects in a detailed and organized manner. However, pathology description was deficient. There was no mention of disease origin, nature or extent. In our opinion, attention to complex anatomy, anatomical variations, bony defects, disease, boundaries of the sinuses and surrounding structures is an essential step to be considered before surgery.

Conclusion: Preoperative CT checklist for endoscopic sinus surgery improves surgeon understanding of the anatomy, nature of the disease and helps planning the surgery. Utilizing the checklist aid to organize the process of interpretation the CT scans and avoids missing significant findings. Careful reviewing of preoperative images with radiologist can help to address critical anatomical areas and to avoid complications.

Keywords

Endoscopic sinus surgery (ESS), Functional endoscopic sinus surgery (FESS), Computed tomography (CT), Checklist, Preoperative (Pre-op), Para-nasal sinuses (PNS)

Introduction

The late 21st century witnessed advancement in endoscopic sinus surgery (ESS), from technological evolutions in fiber-optic endoscopy to medical imaging and computer aided surgery. ESS has gained growing popularity with indications expanding beyond rhinosinusitis to include tumors, developmental malformations, skull base pathologies, orbital pathologies and management of facial fractures [1]. Preoperative high-resolution computed tomography (HRCT) scan is essential in providing the surgical map for surgeon [2]. In addition of being a diagnostic imaging technique, it gives valuable information about origin, nature and extension of the pathology to adjacent structures. Furthermore, areas with bone dehiscence that required attention can be identified preoperatively [1,2]. Moreover, preoperative review of CT scan is crucial in order to understand nature and epicenter of the pathology along with the contributing factors in order to perform successful and complete surgery with low risk for complications.

Variable preoperative CT checklists were published in literature in order to standardize radiological reporting and assess surgical planning. However, those lists have rarely been utilized which is very likely due to complexity, deficiencies and low clinical applicability [3,4].

The main objective of this research is to introduce a new comprehensive, simplified, practical, and applicable pre-endoscopic sinus surgery CT scan checklist that takes into consideration all the previously mentioned aspects. In addition, we are looking forward to standardize the reporting of CT scan sinuses in order to avoid missing any significant information for the surgeons and to unify the way both radiologist and surgeons to read CT scan sinuses.

Method and Materials

Extensive literature review and search in database engines including Pubmed, EBSCO, Medline, and Elsevier for keywords such as endoscopic sinus surgery (ESS), functional endoscopic sinus surgery (FESS), computed tomography (CT), checklist, preoperative (Pre-op) was conducted. Published checklists were identified and reviewed carefully with in-depth analysis. The strength as well as the deficiencies in the previous lists were identified. Accordingly, a new checklist was constructed. It incorporates significant pathological data in addition to the previously included items in the published checklists. It also considered the surgeon's most common pattern in looking and analyzing the CT scans. The new checklist was applied and tested for competency, by two otolar-

ngology surgeons, on 50 previously preformed and randomly selected sinus CT scans. The selection was through the radiology department to include variable diagnosis such as chronic rhinosinusitis, allergic fungal rhinosinusitis and sinonasal tumors. After application of the constructed checklist, we compared the results with the radiological report of the same CT scan to ensure validity and completeness of the information.

This research did not require patient samples, intervention procedures or questionnaires. The steps of the research were part of the routine patients care process.

Results

Database search revealed nine English-written relevant articles, in which four proposed checklists were published [3,5-7]. Further details will be included in discussion section.

For our new systematic pre-endoscopic sinus surgery CT scan checklist ([Supplementary Table 1](#)), we start with patient demographic data and CT scan details. We then follow a simple principle to interpret CT images by involving three major components:

- Disease (epicenter, nature, extension, behavior)
- Anatomy and anatomical variations
- Boundaries

CT images were obtained by 46-slice Toshiba CT scanner, contrasted or non-contrasted according to the request, 0.5-1.0 mm thickness. Three cuts were prepared; direct axial and reconstructed coronal & sagittal images.

Disease

Attention to origin and epicenter of the disease along with involvement of other sinuses and ostiomeatal complex (OMC) are included in the checklist. Frontal, maxillary, ethmoids, sphenoid sinuses and OMC are evaluated for patency and presence of opacification which must be specified whether it is complete or partial and whether heterogeneous or homogenous. Unilateral or bilateral involvement must be documented and the predominant side, if noticed in bilateral cases, must be highlighted. Such details will add up to give the Lund-Mackay score that reflects disease extent.

Further details of the opacity; whether mucosal thickening, air fluid levels or soft tissue masses should be specified. Bone remodeling, hyperostosis or dehiscence must be reported and documented if present. Bone changes can be seen with longstanding diseases, benign but locally aggressive diseases, and in malignancies. If a contrast is given, comparison of tissue enhancement before and after contrast must be documented.

Anatomy and anatomical variations

All anatomy and anatomic variations must be studied including the presence of septal variations (deviation, spur, pneumatization), concha bullosa of any of the turbinates, paradoxical and duplicated bifid middle turbinate, unciniate process variations (attachment, pneumatization, bifid), presence of uncommon ethmoid cells (frontal cells, inter-frontal sinus septal cell, supra-orbital ethmoid cell, supra bullar cell, frontal bulla cell, haller cell, onodi cell), skull base classification, anterior ethmoid artery anatomy, crista galli and/or anterior clinoid process pneumatization, and anatomical variations of the paranasal sinuses such as hypoplasia, aplasia, or multiple septations of the sinus.

Boundaries

In cases of bone remodeling, erosion, and dehiscence, the extent of disease must be followed and detected beyond the boundaries of the sinuses. In addition, evaluation of the neighboring structures i.e. orbit, brain, cavernous sinus, pterygopalatine fossa, infratemporal fossa and palate must be done. In case there is any extension within these structures, it must be documented. Involvement of surrounding structures is an indication for further investigation by magnetic resonance imaging (MRI) and possible ophthalmology, neurosurgery, or maxillofacial consultations.

The proposed CT scan checklist gives some space for free writing for any further findings that need to be reported. After completing the checklist, there is a part for writing the differential diagnosis, report date/time and reporter name and signature.

Two otolaryngology surgeons tested the checklist form and applied it on a sample of 50 randomly selected preoperative paranasal sinuses CT scans. Surgeon's feedback about the checklist was that it is comprehensive and constructed in easy way to use. They experienced and noticed improvement in time taken to review the images and to fill the items in the list.

In addition, when we compared the results of the surgeon's checklist findings and the original radiology reports for the same CT scans, we found that some pathological findings and normal anatomic variations had not been mentioned in the original reports and critical areas were reviewed in more depth by using the checklist.

Discussion

Literature review showed four relevant published checklists; three in constructed forms and one within a text [7]. Surgery planning, radiology reporting template and resident education were within objectives [3,8,9]. Martinez Del Pero and Philpott proposed a preoperative CT checklist to evaluate paranasal sinuses.

Anatomical structures were reviewed in coronal, axial and sagittal cuts to include: Frontal sinus, nasal septum, anterior ethmoid artery, unciniate process attachment, concha bullosa, Haller cells, hypoplastic maxillary sinus, ethmoid bulla, Keros classification [10], dehiscence of lamina papyracea, frontal recess, Onodi cells, superior turbinate attachment to sphenoid face, dehiscence of carotid artery and height of ethmoidal cells [6]. The checklist did not consider description of the pathology or the complete boundaries of the sinuses.

S Vaid, et al. published a radiological-reporting form for preoperative CT in consideration of sinonasal surgical approach. Anatomical structures and surgical relevance were explained and illustrated with figures. These included septum, middle turbinate, unciniate process, ostiomeatal complex, maxillary sinus, frontal sinus drainage pathway, frontal peak, Agger nasi cell, frontoethmoidal cells, frontal sinus, anterior ethmoid cells, bulla ethmoidalis, supraorbital cells, basal lamella, posterior ethmoid sinus, sphenoid sinus, anterior skull base, anterior ethmoidal artery, lamina papyracea, bony margins of sinuses, orbit, brain and nasopharynx [3]. However, the description of the pathology was not included in the report.

Samuel S Becker published an illustrated preoperative checklist. Elements contains frontal sinus outflow tract, unciniate process superior attachment, frontal cells, frontal table dehiscence, orbital roof dehiscence, ethmoid frontal angle, unciniate process atelectasis, nasolacrimal duct, Haller cells, infraorbital nerve, maxillary sinus roof dehiscence, anterior ethmoid artery, Keros skull base level, skull base asymmetry, ethmoid cell character, skull base thickness, lamina papyracea, sphenoid ostium location, Onodi cells, bone over carotid, location of optic nerve and skull base defects [5].

The previously mentioned preoperative checklists focused on anatomical structures, anatomical variations and bony defects in a detailed and organized manner [3,5-7]. However, pathology description was deficient. There was no mention of disease origin, nature or extent.

Lund and Mackay, on the other hand, published the widely utilized CT scan scoring method for radiologic staging of chronic rhinosinusitis. The objective was to measure the extent of disease, guide extent of surgery and predict recurrence rate. However, their scoring system is specific for rhinosinusitis and does not take into consideration anatomy or nature of the disease [11].

In our opinion, attention to complex anatomy, anatomical variations, bony defects, disease, boundaries of the sinuses and surrounding structures is an essential step to be considered before surgery.

In the future, further updates, adjustments and illustrations can be added on the currently proposed checklist. It can serve as a template for radiological

reporting of CT sinuses. In addition, further advances may lead to incorporation of the checklist into the hospital radiology information system (RIS) and enabling RIS to generate a structured readable reports from the completed checklists.

Conclusion

Preoperative CT checklist for endoscopic sinus surgery improves surgeon understanding of the anatomy, nature of the disease and helps planning the surgery. The checklist aids to organize the process of interpretation of CT scans and avoids missing significant findings. In addition, it improves young residents knowledge and helps to build up their surgical concept [9,12]. However, careful reviewing of preoperative images with radiologist is crucial and can help to address critical anatomical areas in order to avoid complications.

Conflicts of Interest

The authors have no conflicts of interest to declare.

References

1. Wigand ME (2008) Endoscopic surgery of the paranasal sinuses and anterior skull base. Thieme.
2. Vaid S, Vaid N (2015) Normal anatomy and anatomic variants of the paranasal sinuses on computed tomography. *Neuroimaging Clin N Am* 25: 527-548.
3. Vaid S, Vaid N, Rawat S, Ahuja AT (2011) An imaging checklist for pre-FESS CT: Framing a surgically relevant report. *Clin Radiol* 66: 459-470.
4. Elahi M, Frenkiel S, Remy H, Just N, Haddad M (1996) Development of a standardized proforma for reporting computerized tomographic images of the paranasal sinuses. *J Otolaryngol* 25: 113-120.
5. Becker SS (2010) Preoperative computed tomography evaluation in sinus surgery: A template-driven approach. *Otolaryngol Clin North Am* 43: 731-751.
6. Martinez Del Pero M, Philpott C (2012) A useful tool-systematic checklist for evaluating sinus scans. *Clin Otolaryngol* 37: 82-84.
7. Mason JDT, Jones NS, Hughes RJ, Holland IM (1998) A systematic approach to the interpretation of computed tomography scans prior to endoscopic sinus surgery. *J Laryngol Otol* 112: 986-990.
8. Deutschmann MW, Yeung J, Bosch M, Lysack JT, Kingstone M, et al. (2013) Radiologic reporting for paranasal sinus computed tomography: A multi-institutional review of content and consistency. *Laryngoscope* 123: 1100-1105.
9. Yao CM, Fernandes VT, Palmer JN, Lee JM (2013) Educational value of a preoperative CT sinus checklist: A resident's perspective. *J Surg Educ* 70: 585-587.
10. Keros P (1962) On the practical value of differences in the level of the lamina cribrosa of the ethmoid. *Z Laryngol Rhinol Otol* 41: 809-813.
11. Lund VJ, Mackay IS (1993) Staging in rhinosinusitis. *Rhinology* 31: 183-184.
12. Casiano RR, Numa WA (2000) Efficacy of computed tomographic image--guided endoscopic sinus surgery in residency training programs. *Laryngoscope* 110: 1277-1282.