Navigation in Endoscopic Sinus Surgery: The First Indian Experience

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Received: 14 September 2011 / Accepted: 1 December 2012 / Published online: 9 February 2013
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Abstract Although the use of image guidance surgery (IGS) is standard practice in developed countries, it has not been in use in Indian Otolaryngology ever since its clinical inception in 1994. Some clinically interesting applications, relevant indications, practical tips and results in the Indian context are presented. Usage technique and data presentation. Indications based on AAO-HNS 2002 guidelines seem valid, and though the accuracy parameters remain still guarded, in line with the best technology available, based on the evidences of scattered reports and expert opinions, the use of navigation can be recommended as state of the art. IGS provides reliable information to a sinus surgeon in difficult circumstances. Its adaptation fortunately does not require a significant learning curve as it does not change the methodology of the surgical procedure. It can be an excellent teaching tool, but its use does not replace proper surgical training.

Keywords Image guided · IGS · NIGS · Endoscopic · Computer assisted · Sinus surgery · Navigation

Introduction

The need of minimally invasive surgery of the head and neck to be precise and safe has prompted the development of image-guidance systems to assist the surgeon with

intraoperative anatomical localization. These systems use computerized tracking devices to monitor the position of endoscopic instruments relative to the patient's anatomical landmarks. The location of these instruments is depicted on a 3-dimensional video display of the preoperative computed tomographic (CT) or magnetic resonance imaging (MRI) scan in axial, coronal and sagittal frames simultaneously.

Initially developed for neurosurgical procedures that required head fixation in a stereotaxic frame, image-guidance systems have recently been introduced that allow for free head movement during surgery. Owing to the better resolution of CT scans in a bony anatomy, and little possibility of tissue shift intraoperatively, these systems have been used for procedures involving the paranasal sinuses, skull base, and temporal bone. Also surgery in these regions is particularly well suited for image-guidance applications because of the proximity to the orbit and cranial cavities, which demands a high degree of anatomical precision [1].

The usefulness of this technology, first developed in Germany in 1994 can also be ascertained from the fact that more than 400 units in the United States alone at the turn of the century are functional and actively using Image guided surgery (IGS) [2]. The American academy of Otolaryngology-Head and neck Surgery has adopted by consensus the following set of classical indications for IGS that include [3]:

- Revision sinus surgery
- Distorted sinus anatomy of development, postoperative, or traumatic origin, which includes surgery in the absence of normal landmarks or in the presence of anatomical pitfalls (e.g. dehiscent lamina papyracea)
- Extensive nasal polypsis
- Pathology involving the frontal, posterior ethmoid or sphenoid sinuses

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Fig. 1 The Operative Setting

- Disease abutting the cranial base, orbit, optic nerve or carotid artery
- Cerebrospinal fluid rhinorrhea or conditions where there is a skull base defect and
- Benign and malignant neoplasms.

Technical Considerations

Preoperative Requirements

Image-guided surgery begins with obtaining a CT scan. The CT scan acquisition protocol used for the authors' needs consists of a helical, 1-mm-thickness axial CT scan. The scans need to be done with a 0 degree gantry tilt and contiguous scans are to be done with or without metallic fiducial land marking. This allows registration of the imaging to the patient's anatomy in the operating room.

The imaging data set is transferred via optical disk, CD-ROM, or computer network to the operating room, where it is loaded into the workstation. The images are brought up on the IGS system prior to the procedure and checked for image quality and accuracy.

The preferable type of anaesthesia for IGS is general, as a tight headband or stickpad is required for the localization and registration. In the optical system, currently being used at the set up, light reflectors or glians are placed on the headset and also on the active probe, and both the instruments are brought in vicinity line of the infrared cameras mounted on the workstation (Fig. 1).

Once verification of the entered data, head probe and active instruments is done, the process of registration is completed by means of cross checking of fiducial markers, surface or laser registration of probes (Fig. 2). Once

Fig. 2 Calibration settings being done

registration is complete and the instruments are calibrated by the system, accuracy is verified by testing various known landmarks on the patients face and in the nares. The coordinates are stored and used throughout the procedure to monitor any changes in the accuracy of the device. Done correctly the system becomes ready for navigation (Fig. 3).

Methods

The experience of the first time use of IGS in an Indian setup required the implementation of the system in a manner that could we could use it in coordination with the existing infrastructure and resources as well as keep the economic implications in mind. We found the existing

Fig. 3 System ready for navigation

DICOM enabled software at the CT scan center extremely efficient for data acquisition.

After using fiducial markers in the initial period, the use of surface registration for probes was started and found to be a cost effective and faster option.

The cost of passive probes (glions) cannot be avoided at times but they can be used for up to four times with ethylene oxide sterilization before they wear off. The probes are also available in active form i.e. LED fitted with wire which upon usage further reduce costs without compromising accuracy.

Cases

See Fig. 4, 5, 6, 7.

Results

See Table 1.

Conclusions

- Image-guided surgery assists the experienced surgeon in reassessing position when faced with distorted landmarks.
- It is not a replacement for thorough anatomical training.
- Accuracy within 2 mm is acceptable.
- Based on experience with the currently used systems, registration can be accomplished with minimal additional operating room time of 2–3 min.
- Image-guided surgery allows the surgeon to routinely perform a more complete exploration of the paranasal sinuses, particularly when it comes to smaller cells occupying the crevices of the sinus cavities
- Difficult sphenoid sinus and ethmoid sinus anatomy can be approached with more surgical confidence using computer-guided dissection
- Frontal sinus anatomy can be approached with greater confidence, particularly in the presence of frontal cells.

Fig. 4 Extensive fungal sinusitis **Fig. 5** Choanal atresia

Fig. 6 Meningocele **Fig. 7** CSF Rhinorrhoea

Table 1 Total cases operated with IGS ($n = 183$)

FESS	27
Sphenoid sinus lesion	18
Revision FESS	51
Extensive fungal sinusitis	37
Invasive fungal sinusitis	11
Meningioma	01
Inverted papilloma	05
Fibrous osseous dysplasia	01
CSF leak	22
Angiofibroma	06
Choanal atresia	04

2. Anon JB, Lipman SP, Oppenheim D, Halt RA (1994) Computer assisted endoscopic sinus surgery. *Laryngoscope* 104:901–905
3. Citardi MJ, Batra PS (2005) Image-guided sinus surgery: current concepts & technology. *Otolaryngologic Clinics of North America* 38(3):439–452

References

1. Metson R, Cosenza M, Gliklich RE, Montgomery WW (1999) The role of image-guidance systems for head and neck surgery. *Arch Otolaryngol Head Neck Surg* 125:1100–1104