Conventional learning and pre-surgical planning have traditionally involved review of two-dimensional (2D) computed tomography images in a tri-planar format. For the novice trainee, this can create a challenge in thoroughly comprehending the three-dimensional (3D) spatial orientation of the frontal recess and frontal sinus drainage pathway during endoscopic sinus surgery. In this study, we sought to evaluate the effectiveness of using a novel virtual 3D imaging viewing software to assist otorhinolaryngology trainees in better understanding the anatomy and spatial orientation of the frontal recess and frontal sinus outflow tract.

Methods and Materials

A multi-institutional trial was conducted consisting of 20 otorhinolaryngology trainees from two academic Institutions. Each subject underwent learning of frontal recess anatomy with both traditional 2D learning methods using a standard DICOM viewing software (RadiAnt Dicom Viewer Version 1.9.16) and 3D learning utilizing a novel preoperative virtual planning software (Scopis Building Blocks, GmbH, Berlin, Germany). The RadiAnt Dicom Viewer presents the learner with conventional sagittal and coronal images that have been constructed from thin-cut axial data; the learner can scroll through images in each plane and adjust other parameters, including magnification and windows level/width settings (Figure 1). Scopis Building Blocks (SBB) has a similar tool set, but also adds features that permit the learner to draw 3D boxes on relevant anatomical structures and to highlight the frontal sinus outflow tract (Figure 2). Two questionnaires that included a total of twenty items were scored to record subject self-assessment on knowledge of frontal recess and frontal sinus drainage pathway anatomy prior to and following each learned modality. A two-sample Wilcoxon rank-sum test was used to find statistical analysis. Approval to conduct this study was obtained from the University of Texas Health and Science Center institutional review board.

Results

All trainees successfully completed all educational and learning tasks. With the exception of one respondent, all completed each questionnaire in its entirety. When compared to traditional 2D learning, 3D SBB was perceived by the trainees to be a more effective learning technique in understanding the spatial orientation of the frontal sinus frontal sinus outflow tract. When asked which learning modality helped most in understanding the spatial orientation of the frontal sinus pathway 95% (19/20) respondents chose the 3D SBB as their preferred technique. When asked which learning modality helped most in understanding the spatial orientation of the frontal sinus 90% (18/20) of respondents choose 3D SBB, 1/20 choose 2D traditional learning, and the remaining respondent reported no difference between the two modalities.

When independently assessing SBB software, all participants with the exception of one either agreed (N = 6) or strongly agreed (N = 13) that they would recommend this software as an educational tool to others. If available, seventeen (85%) of trainees either strongly agreed (N = 13) or agreed (N = 4) that they would go on to utilize the software in their clinical practice.

Discussion

Due to its complicated anatomical configuration, surgically addressing the frontal sinus can often times be disorienting and frustrating, even for the experienced endoscopic sinus surgeon. P.J Wormald first introduced the concept of transforming cells of the frontal recess into three dimensional blocks to help simplify the complex surgical dissection of the frontal sinus; in this approach, the surgeon develops a pre-operative step by step surgical plan to address the various cell types of the frontal recess thereby defining the natural drainage pathway. The SBB software represents the implementation of Wormald’s “building blocks” concept for both surgical planning and education. SBB software allows the user to construct three dimensional building blocks in the context of a traditional triplanar format. One can then rotate and view the constructed 3D building blocks in multiple planes and accurately outline the natural drainage pathway of the frontal sinus. This added dimension allows the user to visualize the anatomy in a more understandable 3D anatomical picture. We believe introducing this novel technique into residency training has the potential to augment trainee proficiency and comprehension of frontal sinus anatomy. This theoretically could translate to the operating room setting leading to improved surgical skill, reduced surgical time, and improvement in patient outcomes.

Conclusions

The ability to reconstruct CT imaging into a three dimensional plane appears to have benefit for the novice trainee in understanding the complex anatomy and spatial orientation of the frontal recess and frontal sinus drainage pathway. The potential increase in trainee proficiency and comprehension theoretically may translate to the operating room theatre leading to improved surgical skill, reduced surgical time, and improvement in patient outcomes. Future randomized controlled studies are required to confirm these hypotheses.

References


