The role of simulation in endoscopic transsphenoidal surgical training

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Introduction

In recent years, surgical simulators have become increasingly prevalent in medical training. New realistic 3D models have been introduced, aiming to simulate anatomical structures and tissue characteristics, including haptic feedback, to enhance surgical skills. Various virtual and physical models of simulators specifically designed for transnasal and transsphenoidal endoscopic surgery training have already been reported. This study was designed to assess three main objectives: the effectiveness of UpSurgeOn's transnasal transsphenoidal surgery simulator, its impact on improving surgical skills when compared to cadaveric dissection, either separately or in sequence, and the validity of a training model that includes simulation as a preparatory step before cadaveric dissection.

Methods and Materials

A total of 34 participants, comprising neurosurgeons and head and neck surgeons at various stages of their careers (residents and junior consultants), were included in the study. These participants were divided into two distinct groups to assess the impact of simulation on surgical training.

- **Group 1** underwent a comprehensive training program that involved performing a dissection on a 3D surgical simulator, followed by a subsequent dissection on a cadaver.
- **Group 2**, on the other hand, performed only the cadaveric dissection without prior simulation-based training.

The training program was structured to cover a range of key surgical steps involved in transnasal and transsphenoidal procedures. Throughout the training, participant performance was recorded for later evaluation.

At the conclusion of the course, all participants were asked to complete a structured questionnaire designed to gather feedback on their experience and the perceived effectiveness of the training. Performance evaluations were conducted by six independent experts who were blinded to the group assignments. The experts utilized the validated Global Rating Scale (G.R.S.) for Endoscopic Surgery, a tool specifically designed to assess surgical skill and proficiency.

The performance scores for both groups were statistically analyzed using Student's t-tests to determine whether simulation training had a measurable impact on skill development and overall surgical performance. This methodology allowed for a robust comparison of the effectiveness of simulation as a preparatory step in surgical training.

Figure 1. **The external appearance of TNSBox**
Using 3D printing technology, this model is crafted from silicone and resin to replicate the medial portion of the ethmoid and sphenoid sinuses. It facilitates the simulation of the endoscopic transsphenoidal approach to the pituitary gland.

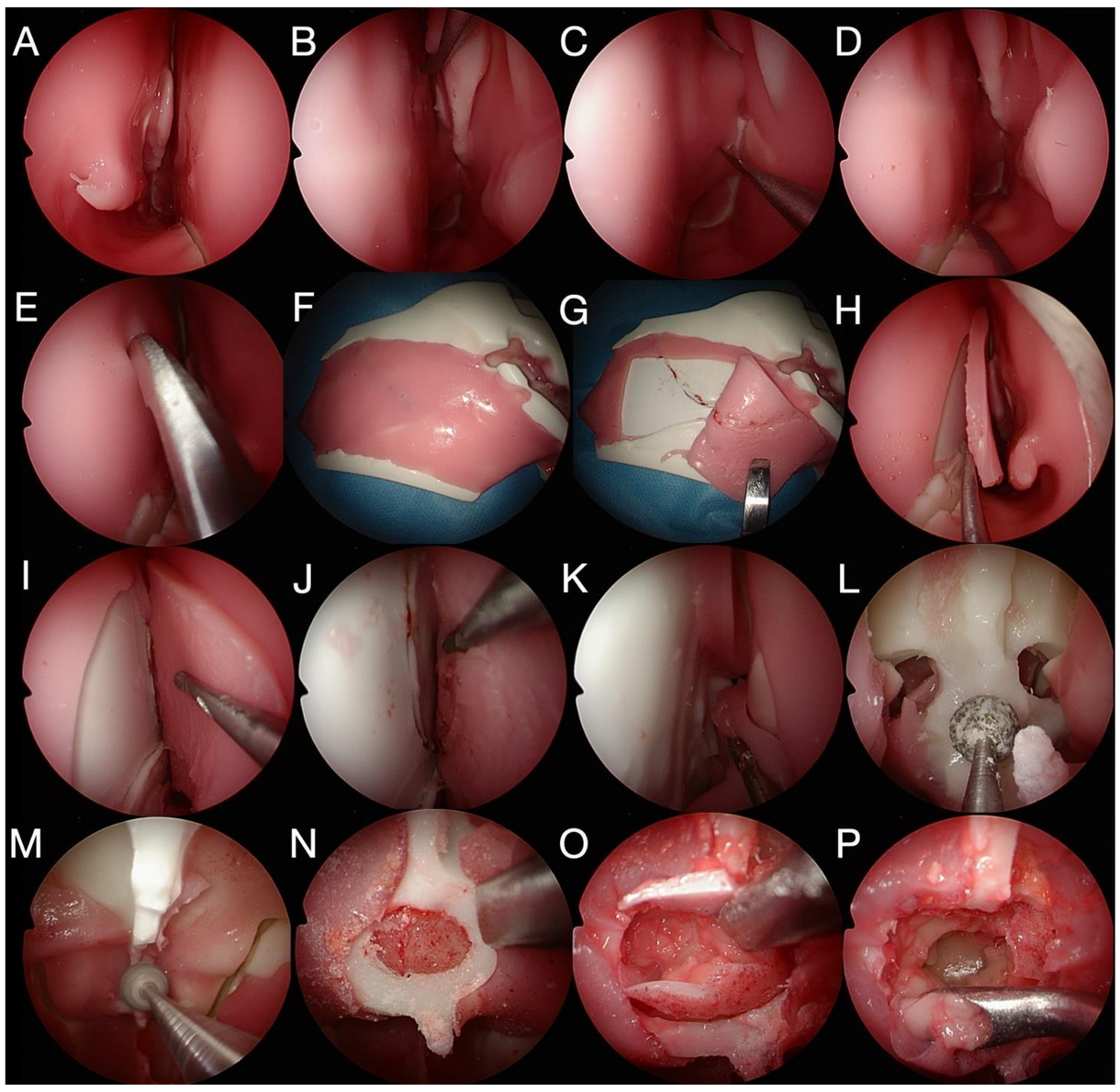

Figure 2
A-B. Endoscopic views of the right (A) and left (B) nasal cavities.
C-K. Harvesting the nasoseptal flap in the left nasal cavity involves making incisions along anatomical landmarks, such as the choana, axilla of the superior and middle turbinates, anterior edge of the inferior turbinate, and nasal vestibule (C-E). If needed, the model can be disassembled to isolate the nasal septum and verify the accuracy of the cuts (F-G). The flap is then mobilized to expose the septum, allowing for a posterior septectomy (H-K).
L-M. A drill is used to open the anterior wall of the sphenoid sinus after identifying the ostium on both sides (L), and the sellar floor is visualized (M).
N-P. The sella is accessed (N) following standard anatomical landmarks, the sellar periosteum is incised (O), and a simulated tumor, mimicking a macroadenoma, is removed (P).

Results

The study revealed that both experienced specialists and residents at the early stages of their training in endoscopic transsphenoidal surgery showed significant improvement in their surgical skills after participating in a simulation-based initial training program. This finding underscores the effectiveness of incorporating simulation as a foundational step in surgical education, providing a structured and practical environment for skill enhancement before transitioning to real-life surgical scenarios.

Discussion and Conclusions

The innovative UpSurgeOn TNSBox offers a valuable addition to a hybrid training approach, combining simulation with cadaveric dissection to enhance the development of foundational endoscopic surgical skills. This study demonstrated that both specialists and residents new to endoscopic transsphenoidal surgery experienced significant skill improvement when beginning their training with simulation-based techniques. The use of 3D dissection models holds great promise in facilitating the acquisition of fundamental technical skills, potentially accelerating the overall progression of surgical expertise.

Conflict of interest
FN and GS are the founders of UpSurgeOn and the neurosurgeons who invented the simulation model used in this study. F.N. is the company's CEO.
The remaining authors declare that the research was conducted without commercial or financial relationships that could be construed as a potential conflict of interest.

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