Have we reached our limits in endoscopic skull base surgery?

BY PIERO NICOLAI

As being an anterior skull base surgeon becomes the aspiration of many ENT trainees, **Professor Nicolai** gives his personal insights into the future for this exciting subspeciality. Having been directly involved in the evolution of transnasal endscopic surgery (TES) since its inception, his observations are especially pertinent and clearly he foresees even further advances in 'extreme' skull base surgery supported by evermore sophisticated technology.

The last decades have seen a remarkable development of transnasal endoscopic surgery (TES) in the management of non-neoplastic and neoplastic diseases involving the skull base. This has been made possible by the continuous improvement of endoscopic and surgical instrumentation, the introduction and refinement of new tools (i.e. navigation systems, surgical Doppler, 3-D endoscopy), the growing confidence achieved by surgeons with the endoscopic perspective of complex skull base anatomy, together with the availability of many reconstructive techniques limiting the rate of cerebrospinal fluid (CSF) leak, and the concomitant progress in morphologic imaging and interventional radiology.

The question of "Have we reached our limits in endoscopic skull base surgery?" is therefore legitimate, and I will try to explain why in my opinion the evolution will go on. However, there are grey areas, for which we do not yet have a completely accurate definition of the real superiority of TES versus alternative techniques and of the indications for a 'specific' endoscopic technique for lesions of a 'specific' nature and extent.

One of the most recent developments in endoscopic skull base surgery is the concept of multiportal approaches, which consist of the combination of a standard transnasal avenue with other corridors to access and adequately expose diseases at a specific location. One example is the transnasal transorbital approach, which has been described as an alternative to craniotomy to treat selected cases of sphenoorbital meningioma with a predominant involvement of orbital walls and limited intracranial component [1, 2].

A second example is the combination of TES with a transoral transpharyngeal approach [3], which enhances the exposure of lesions involving the parapharyngeal or masticatory space inferior to the plane of the hard palate. Although the application of these multiportal approaches has been currently limited to a few cases, an expansion in their indications can be expected. In this respect, the introduction of specifically designed surgical instruments will be extremely helpful.

If a perfect understanding of skull base anatomy is a necessary requisite to safely perform TES and to develop new surgical strategies for enhancing lesion exposure, it is undeniable that the evolution of technologies supporting surgeons has a paramount impact as well. Navigation systems are routinely used in TES for skull base lesions. Although successful efforts have been made to make the available systems more user-friendly and accurate, there are still limits in the registration phase related to varying pressure and loss of contact.

In a recent clinical study comparing registration with automated facial recognition software with standard surface registration, the accuracy of the experimental system was superior without increasing registration time [4]. This is just one example demonstrating that technology undergoes a relentless evolution.

Great expectations have been created by the development of new robotic systems and 3D printers, which might be helpful to further minimise postoperative CSF leak, which in view of possible severe neurologic complications (i.e. meningitis, brain abscess) has always been a major concern for surgical teams performing TES of the skull base. In recent years, diffusion of the concept of multi-layered reconstruction and the introduction of a large variety of local pedicled flaps have contributed to a decrease in the occurrence of CSF leaks, especially in patients with high-flow defects, previous radiotherapy, and/or high BMI. Current robotic systems have major ergonomic limitations when applied in endoscopic skull base surgery. However, the evolution of a newly-designed flexible system towards a miniaturisation of instruments and the possibility of using powered instrumentation will allegedly allow one to suture grafts and flaps to the defect, with the advantage of improving dural sealing. Similarly, the application of 3D printers may provide preformed prostheses made with a biocompatible material suited for integration with adjacent tissues, based on a template of the skull base defect designed using a 3D CT study. This would be extremely helpful in large defects, with composite shapes.

Refinements in the indications for transnasal endoscopic techniques and a more accurate comparison with external/microscopic techniques for specific diseases and locations is another area that warrants dedicated studies. Help for the first goal can come from quantitative analyses made in the laboratory on anatomic specimens with dedicated software. Given a specific target area, it is possible to assess which approach enables the best exposure and more convenient freedom of movement for surgical instruments. This has been done for different types of endoscopic medial maxillectomies, in order to determine which window best fits a lesion with a given extension and volume [5].

If the superiority of TES for sinonasal

lesions involving the anterior skull base when compared with anterior craniofacial resection in terms of decreased morbidity is widely recognised, criteria for selecting the best approach for olfactory groove meningiomas are still controversial. The results of a recent systematic review on the topic indicate that, in spite of the increasing experience in TES and skull base reconstruction, the recent literature still favours a transcranial approach. TES may be an option in selected cases where visual improvement is the main goal of surgery and postoperative anosmia is acceptable to the patient or in medium-sized lesions with existing preoperative anosmia [6].

As a last consideration, it is worth understanding that surgery is just one avenue within the complex mosaic of management of skull base diseases, which includes diagnosis and treatment. Pathology, morphologic and metabolic imaging, radiation oncology, and medical oncology have all made continuous progress. The rapid development of next generation sequencing techniques provides insights into the biological profile of tumours, thus allowing us to move forward towards the direction of precision medicine and to take advantage of new drugs that target specific molecules or modify the immunologic response of the host to the tumour.

The years to come will show if my prediction will be confirmed by facts, or if my imagination, driven by a strong and enthusiastic belief in the potential of TES of the skull base, is too optimistic!

References

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