Update

SKULL BASE SURGERY - A NEW CONCEPT IN REGIONAL SURGERY

Lt Col A RAVIKUMAR*

ABSTRACT

Surgery of the skull base has evolved over the past 100 years. This anatomical area has been approached by neurosurgeons, otologists, maxillofacial surgeons and plastic surgeons from different angles. Presently, the combined skills of these surgeons are utilized in treating lesions of this area once considered a 'bony no man's land'. Modern microsurgical techniques are based on the principle that removal of adequate bone from the cranial base could provide sufficient access without the necessity to retract dura. Accurate preoperative assessment by imaging, the use of microsurgical techniques, preservation of vital structures such as nerves by intraoperative monitoring, and modern anaesthetic and postoperative management have all contributed to the reduction in mortality and morbidity to acceptable levels. In the future, with refinements in imaging, stereotactic radiosurgery and chemotherapy, the above management protocol would be tailored to suit each individual patient and decided by a team of experts.

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Surgery of the skull base was always considered to be difficult due to the complex anatomy of this region. The involvement of many vital structures in diseases affecting this area as well as the possibility of damage to these structures prevented surgeons from operating and it was labelled as a surgical 'no man's land'. Surgery of the skull base is an area where the combined skills of the neurosurgeon, otorhinolaryngologist and the reconstructive surgeon may be necessary to treat a patient adequately and safely [1]. Skull base surgery has undergone extraordinary development thanks to the pioneering effort of eminent specialists who had the foresight, single-mindedness and dedication to tackle the almost unsurmountable problems confronting them at the time. It is worth remembering pioneers such as Sir Charles Ballance who, in 1894, was the first to perform excision of an acoustic neuroma, and Cushing and Dandy who introduced silver haemostatic clips and electrocautery which helped in reducing the operative mortality to around 20 per cent [2,3]. Despite this, leading neurosurgeons like Pennybacker and Cairnes felt that it may be unwise to

operate on patients with skull base lesions because the patient may end up with more disability after surgery than before [4].

The contemporary era of skull base surgery began in the early 1960's when William House, considered the father of neuro-otology, decided to challenge the status quo. Thanks to refinements in audiological tests and radiological investigations he was able to diagnose these lesions early. He felt that a transtemporal approach to the posterior cranial fossa would be considerably safer and introduced 2 approaches -- middle fossa and translabyrinthine approaches -- to the cerebellopontine angle. He also introduced the microscope in neurosurgery which resulted in safe operations in areas previously considered to be hazardous. Thus, House succeeded in reducing the operative mortality for acoustic tumour surgery to less than 1 per cent [5].

The various approaches to the skull base can be considered under approaches to the anterior, middle and posterior cranial skull base.

Obwegeser and Tessier were responsible for ex-

*Reader, Dept of Otorhinolaryngology, Armed Forces Medical College, Pune 411040

panding the extent of anterior extracranial access. Modern cranio-maxillofacial surgical techniques were initially applied for the correction of major congenital skeletal deformities in 1957 by Dr Paul Tessier [6]. Later, he applied these techniques to correct late traumatic deformities. He demonstrated that performing selective osteotomies at specific points in the skull and repositioning the cranial bones was possible with excellent cosmetic and functional results. It was a decade later that these principles were applied in the resection of tumours of the orbit and paranasal sinuses extending into the anterior skull base. Transsphenoidal approach to the pituitary fossa for removal of pituitary tumours has evolved rapidly and is now the procedure of choice in microadenomas, its greatest advantage being the reduced morbidity when compared to the transfrontal approach [6-9]. Large tumours of the pituitary are resected using a combined transfrontal and transsphenoidal approach. At present anterior skull base approaches are used to treat fractures of the anterior cranial base, CSF rhinorrhoea, exophthalmos, inflammatory diseases of the frontal, ethmoidal and sphenoidal sinuses extending intracranially, and tumours of paranasal sinuses as in craniofacial resection.

The middle cranial fossa approach described by William House is used for removal of small intracranial acoustic neuromas less than 1 cm in size [5]. It is also used in performing vestibular neurectomy for Meniere's disease. The infratemporal fossa was explored by Ugo Fisch, another famous neuro-otologist. Using microsurgical techniques, he was guided by the principle that removal of adequate amounts of bone from the skull base could provide sufficient access without the necessity of retracting the dura. The facial nerve, which traversed the operative field, could be repositioned and adequate exposure of the infratemporal course of the carotid artery could be obtained. The infratemporal fossa approach of Fisch is of three types - Type A, B and C. These give access to the entire lateral skull base from the nasopharyngeal roof, clivus, the jugular bulb, internal carotid artery and the last 5 cranial nerves. Type A provides access along the infratemporal course of the internal carotid artery and to the jugular foramen. Type B and C approaches provide anterior exposure of the lateral skull base especially to the

clivus and nasopharyngeal roof. Type A and B approaches are useful in subtotal petrosectomy for extensive cholesteatoma of the petrous temporal bone, removal of glomus jugulare tumours, aneurysms of the carotid artery, high parapharyngeal tumours and malignant tumours of the middle ear cleft involving the petrous temporal bone. The type C approach provides access to the roof of the nasopharynx and the clivus for removal of tumours such as chordomas and recurrent nasopharyngeal carcinomas. These approaches, though time consuming, are safe as all the vital structures are identified and preserved while the morbidity is reduced due to minimal retraction of the brain [10-13].

The posterior cranial fossa was traditionally explored by the suboccipital route. This approach, though fast and relatively easy, was associated with increased morbidity due to cerebellar retraction and damage to the facial and other lower cranial nerves. To overcome this problem House had introduced the translabyrinthine approach where the morbidity was much less [5]. Modifications of this basic approach continue to evolve. Fisch described the transotic approach which gives a wider exposure when combined with the translabyrinthine approach [14]. Retrosigmoid and retromastoid approaches give wider exposure. As a result bigger tumours, up to 4 cm in size, can be resected in toto while preserving vital structures such as the facial nerve. Efforts to preserve cranial nerves was initiated by Krause in 1898 who was the first to identify the facial nerve by Faradic stimulation. Routine intraoperative nerve monitoring is now the standard practice during skull base procedures [15-17]. The contemporary monitoring systems are generally based on evoked electromyographic methods. This has resulted in better localization and preservation of function of the cranial nerves [18-20].

Advances in allied specialities have also contributed to the evolution of skull base surgery and resulted in improved treatment outcome besides reducing mortality and morbidity. Improvements in diagnostic imaging especially the invention of the computerized tomographic scan, high resolution computerized tomographic scan and magnetic resonance imaging have enabled clinicians to diagnose skull base lesions early and devise simpler and less destructive operations to excise them

[21,22]. The development of interventional radiology, especially digital subtraction angiography with superselective embolization of the tumour vasculature is invaluable while operating on highly vascular tumours such as juvenile nasopharyngeal angiofibromas. Anaesthetic techniques have also improved, notably the technique of hypotensive anaesthesia and monitoring of vital parameters during these long procedures. This has resulted in minimal intraoperative mortality and reduction in postoperative morbidity.

The development of stereotactic radiosurgery for the treatment of tumours of the skull base was viewed as a threat to skull base surgery. However the former is still in its infancy and the initial results, though encouraging, have not stood the test of time. The delayed complications are also many. Instead of replacing skull base surgery it may prove to be an alternative in poor-risk patients unable to withstand surgery and in patients with bilateral skull base lesions [23,24]. In future the management of skull base lesions will be tailored to suit the individual patient and the decision will be taken by a multidisciplinary team of skull base surgeons and their associates such as radiotherapists and chemotherapists. With this approach it would be possible to deliver the best treatment to the patient with minimal morbidity. Truly an exciting field for those who are dedicated!

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