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Review

Historical development of the treatment of skull base tumours

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ABSTRACT

Surgery has evolved greatly over the last decades thanks to the more sophisticated and conservative surgical approaches and also thanks to the progress of diagnostic imaging. An added value is represented by the increased experience of the professionals and the close multidisciplinarity of the procedures including neurosurgeons, otolaryngologists and maxillo-facial surgeons. One of the most recent developments is the endoscopic surgery allowing for more conservative and cosmetically satisfactory outcomes.

Radiation therapy has greatly changed over the last decades thanks to the technology advances related both to the availability of new imaging modalities and techniques of radiation delivery. Delivery of radiation evolved from three-dimensional conformal techniques to stereotactic and intensity-modulated radiation therapy. Particle therapy has the potential to further improve in the near future thanks to the progress of technology. Proton therapy allows for optimization of dose deposition in the target with lesser dose in the healthy tissues and ion therapy, currently using carbon ions, has been more recently introduced with the advantage of more effective treatments in case of less radio-sensitive tumours thanks to a higher biological effectiveness.

A relevant concept that can significantly improve the results is that of interaction and integration of different disciplines not only within the surgical field. The cooperation between surgeons of various disciplines, radiation oncologists and medical oncologists together with professionals from other disciplines, such as pathology and radiology is nowadays required in an effort to customize and optimize the treatment in each single patient.

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1. Background

The base of skull is an anatomical district characterized by various tissues that separate the intracranial content from the facial structures. A peculiar aspect of skull base tumours is the extreme heterogeneity of the lesions that may arise from or involve this specific anatomic site. Many are benign and may require a single treatment modality but others are malignant and can aggressively evolve with frequent recurrences and sometimes also distant metastases. Another particular aspect is the proximity of the skull base to many structures deputed to relevant physiologic functions that may not allow wide surgical resections in many cases. For this reason, malignant and also benign lesions cannot always be radically removed with a consequent high risk of local recurrence.

Surgery and radiotherapy have been the two main modalities employed in the treatment of these tumours and their clinical and technical progresses substantially have contributed to the improvement of the prognosis of patients affected by skull base malignancies.

The present article describes the main steps in the development of surgery and radiotherapy over the last decades.

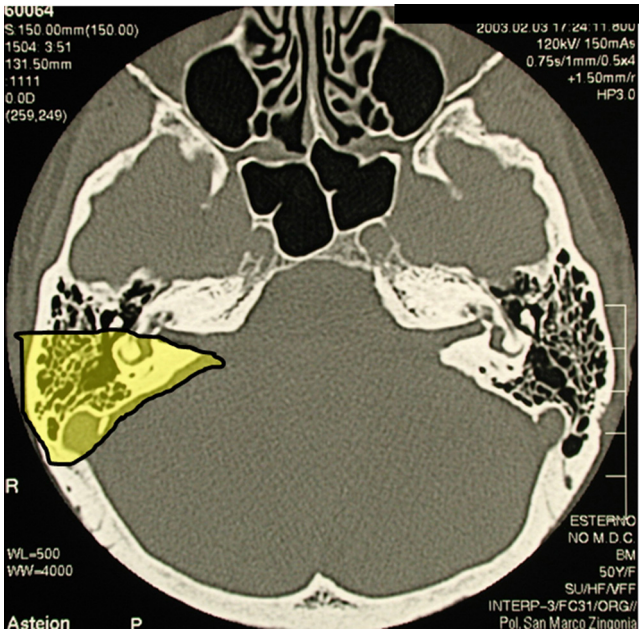

Fig. 1 – Axial CT bone window of the skull base showing extent of bone removal using the translabyrinthine approach to the cerebello-pontine angle (yellow area).

2. Surgery

The term "cranial base surgery" appeared in the surgical literature around the end of the 1960s and soon became familiar to practitioners and made them aware of a new principle of exposing some areas of the brain, neck and face.[1] As in every surgical procedure, there is an access route, a target area, and a surgical corridor obtained by removing, displacing, or bypassing anatomical structures; in cranial base surgery the approach route involves the bone of the skull base and the adjacent soft tissues.

The skeleton of the skull base is a bony diaphragm separating the brain on one side from the neck and face on the other. Skull base surgery is used to deal with lesions within the base and extending into the cranial cavity and/or neck or face as well as with lesions originating close to the base, but not necessarily extending into the base. The route used for the procedure thus involves an area of the bone of the base and contiguous soft tissues forming part of the neck, face and brain, but, conversely, it can involve a conventional mode of access – craniotomy, or upper neck or face approach that is enlarged to include the skull base as well.

The method was gradually developed, improving with experience and especially gaining from the imaging radiology that facilitated the diagnosis of the nature and extent of the disease to be treated, and enabled a more accurate preoperative planning of the procedure. The skull base ceased to be an unsurpassable barrier to the neurosurgeon on one hand, and to the otolaryngologist and maxillofacial surgeon on the other. It became a site approached by means of multidisciplinary combinations of techniques borrowed from all these specialties, mostly with the aid of a microscope, and involving the brain and dura, nerves and vessels, sensory organs, bone and face. At the same time, the procedure had to prepare grounds for the subsequent functional and aesthetic reconstructions.

In short, we are talking about primary lesions of the skull base that may or may not extend into the cranial cavity, face or neck, or about lesions of the brain, neck or face lying in the vicinity of the skull base but not necessarily extending within it. The route used for the surgical procedure involves the skull base and the contiguous cranium, brain, neck and face.

The translabyrinthine approach was the first typical example of such surgery.[2,3] Fig. 1 is an axial CT showing the bone removal needed to access to the cerebello-pontine angle. Initially intended as a procedure for removing an acoustic neuroma, the translabyrinthine approach helped to shape the principle that bone could be removed to expose lesions not only within the skull base (the internal auditory canal in the example shown), but also in the cranial cavity adjacent to the base, i.e. the cerebello-pontine angle.

A second historical contribution came from the system of infratemporal approaches which prompted the concept that a surgical corridor could be obtained by removing, displacing or bypassing anatomical structures to expose a lesion arising in the skull base and growing into the neck, face or cranium.[4] In the infratemporal approach A, bone removal extends from the petrous dura to the lower temporal bone and tympanum to expose a surgical field from the dura (and c.p.a.) to the neck. The facial nerve running through the middle of the field is displaced supero-anteriorly to clear the way to the jugular foramen. Similar principles apply to the infratemporal approaches B and C. The purpose of this system of approaches is to expose a wide area of the skull base, from the jugular foramen to the nasopharynx.

The idea of entering via the skull base and expanding the field into the adjacent cranium and neck, as well as the conventional craniotomy enlarged to involve the skull base, became well established. It was applied to a number of

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