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Reconstruction of Skull Base Defects

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Management of skull base neoplasms poses a difficult problem for the reconstructive surgeon. Tumor extirpation in this region usually requires extensive resection, which often creates a large defect that requires soft tissue or bony reconstruction. These defects are significant because of the anatomic dimensions and location and because of the potentially life-threatening complications that may occur if the reconstruction fails. Because of the close proximity of the dura to the paranasal sinuses and nasopharynx following tumor resection, there is increased risk for an ascending intracranial infection; hence, in the past, many considered these tumors inoperable. Advances in surgical techniques and diagnostic and interventional radiology and the development of the multidisciplinary surgical team have made possible the successful surgical treatment of most cranial base tumors.

History

Before the introduction of the radical neck dissection by Crile [1] in 1906, less than half of the patients with cancer of the head and neck were successfully treated by surgery [2]. In the early twentieth century, methods of reconstruction were virtually nonexistent, so skin grafts were commonly used for coverage. Because of the extensive defects in this region, skin grafts were often applied directly to the bone or dura [3–5]. For orbital reconstruction, tubed pedicles were used, but these required at least a two-stage procedure [6]. The use of the temporalis muscle flap for soft tissue replacement of the orbit was first described by Golovine [7] in 1898 and later reported by Gillies [8]. With good local soft tissue coverage, the temporalis flap remains a viable choice for the reconstruction of the various defects in this region [6,9–12]. In 1963, McGregor [13] described the use of the forehead flap for intraoral lining, and Thomson [14] popularized the use of the ipsilateral forehead flap for orbital reconstruction. For oropharyngeal reconstruction, Bakamjian [15] in 1965 reported the use of the deltopectoral flap. Subsequently, McGregor and Jackson [16] described a technique to lengthen the flap so that it would reach the ear. This flap can be tunnelled internally to reconstruct the nasopharynx [17]; if

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transferred externally, the flap will extend to both the orbital and zygomatic regions. Both the temporalis and deltopectoral flaps were once the workhorses of all head and neck reconstructions [2]. Despite the adequate soft tissue coverage when these flaps are used, donor-site morbidity is significant. In defects superior to the palate, a 40% to 50% [18,19] complication rate is reported when using the deltopectoral flap. This high complication rate is likely a result of the incapacity of these flaps to provide a watertight seal of the oral cavity in a one-stage surgical procedure.

The introduction of the pedicled myocutaneous flap provided a new reconstructive option in the field of head and neck surgery. The pectoralis major and the latissimus dorsi flaps were the most commonly used pedicled flaps in skull base surgery. In 1979, Ariyan [20] described the use of the pectoralis major myocutaneous flap for head and neck reconstruction, then demonstrated that when the flap is transferred externally it can be used to repair defects even at the level of the orbital region [21].

In 1978 [22], the latissimus dorsi myocutaneous flap was described to reconstruct head and neck defects. This flap had many advantages, including a large arc of rotation, which permitted its transfer as high as the floor of the middle fossa. However, one of its disadvantages is the need for patient repositioning for flap elevation. At present, the latissimus dorsi pedicled muscle flap is rarely used for primary skull base reconstruction.

The trapezius myocutaneous flap was first introduced in 1842 by Mutter [23] for treatment of a burn contracture of the neck. The multiple variations of this pedicled flap have been well described in the literature, including the cervico-humeral pedicle flap [24] and the lateral trapezius flap [25–27].

The introduction and refinement of free-tissue transfer over the past 20 years has provided a source of well-vascularized tissue for repair of large complex cranial base defects [28]. Because flap placement is not restricted by the pedicle and the arc of rotation, there are increased options for multiple flap designs. A two–surgical team approach may be used, allowing one team to proceed with flap harvest while the other team completes the tumor ablation. Successful outcome depends on microvascular expertise; however, most centers now report flap success of greater than 95%, so flap failure is no longer a concern.

The introduction of the multidisciplinary surgical team approach, using expertise from the head and neck surgeon, the plastic reconstructive surgeon, and the neurosurgeon, has further expanded the surgical options available to patients with tumors in the skull base region.

Anatomy

The floor of the anterior, middle, and posterior cranial fossae forms the intracranial surface of the skull base. The extracranial component of the skull base forms the roof of the orbits, sphenoid sinus, nasopharynx, and infratemporal fossa. This area has numerous vital anatomic structures that enter and exit the cranium by means of foramina and canals. The strategic location and function of this region makes the skull base susceptible to many pathologic processes.

Because of the complexity and diversity of the skull base region, this area has been classified into different regions by several authors [17,29,30]. Jackson and Hide [17] divided the skull base into the anterior and posterior areas to describe the surgical reconstruction requirements. The anterior area corresponds to the anterior cranial fossa, and the posterior area is divided into three segments: posterior-anterior, posterior-central, and posterior-posterior. Jones et al [30], in their description of cranial base surgical reconstruction, divided the skull base into the anterior, middle, and posterior regions, corresponding to the anterior, middle, and posterior cranial fossae. Irish et al [29], in their review of 77 skull base neoplasms, divided the skull base into three regions [Fig. 1] based on anatomic boundaries and tumor growth patterns within the different zones. Tumors in Region I arise from the sinuses, orbit, and other local structures anteriorly and extend to involve the anterior cranial fossae. In addition, tumors that arise from the clivus and extend posteriorly to the foramen magnum are included in Region I, because they behave similarly to other

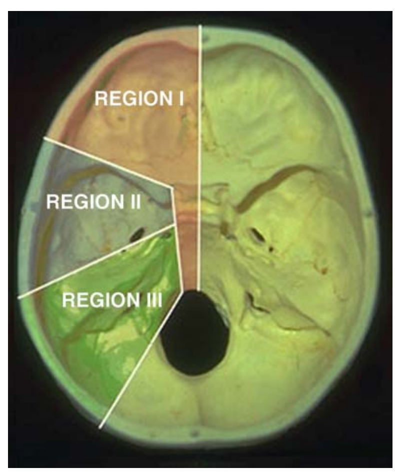

Fig. 1. The skull base is divided into three regions based on the anatomic location and growth pattern of the tumors. (*From* Neligan PC, Boyd JB. Reconstruction of the cranial base defect. Clin Plast Surg 1995; 22(1):72; with permission.)