Meningiomas of the cranial base

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Summary

Treatment objectives for meningiomas of the cranial base include relief of neurologic disability and prevention of clinical progression or recurrence with the least morbidity. Recent advances in skull base surgical techniques, through an appreciation of skull base anatomy and institutional specialization, have contributed major improvements to the outlook for patients with these tumors, and previously inoperable cases may now often be removed completely with acceptable risk. Since significant morbidity may be incurred during surgical resection of these difficult lesions, especially in terms of cranial nerve dysfunction, the value of aggressive surgical resection must be weighed against the often indolent natural history of these lesions, and must be individualized in each patient. Completeness of resection is the major prognostic factor determining the outcome of patients with typical benign meningiomas in terms of length of survival, risk of recurrence, and neurological disability. Various means of prognosticating the growth potential of a given tumor are being investigated, though none have yet been confirmed for their predictive value in typical, histologically benign meningiomas. The role of external beam radiotherapy has not been subjected to adequately controlled, prospective studies, and there is currently insufficient followup to assess the risks and benefits of stereotactic radiosurgery.

Advances in the clinical management of tumors of the skull base have had perhaps the greatest impact for patients with meningiomas who constitute a large portion of tumors seen in these locations. Although the majority have benign histological features, skull base meningiomas can present a formidable challenge due to their proximity to vital structures, surgical inaccessibility, and occasional aggressive features. The combination in recent years of advances in skull base surgical techniques, adjuvant therapy, and rehabilitation methods have dramatically improved the outcome for these tumors.

Historical perspective

The tumors of the meninges were described by a diverse nomenclature prior to the use of the term meningioma by Cushing in 1922 [1]. Historically, the first reported successful removal of a meningioma was that of a basal tumor of the sinciput by Zanobi Pecchiolo in 1835, with the patient being followed for two years [2]. Durante subsequently removed an olfactory groove tumor ‘the size of an apple’ in an operation lasting one hour [3]. The patient survived over 20 years, requiring one reoperation for recurrence at 11 years, and was presented in the United States at the International Medical Congress in 1887. Perhaps the most important early contribution to the field came with the publication of Cushing and Eisenhardt’s widely cited monograph on meningiomas in 1938 [3, 4], containing many ob-
servations that still remain of interest and controversy today.

Meningiomas constitute about 15 to 20% of all primary brain tumors when large neurosurgical series are combined [5-7], with 33% to 50% of them occurring in skull base locations [9-13]. Nakasu [8] found meningiomas as an incidental finding in 2.3% of 10,033 autopsies, a reflection of their often benign evolution. The relevant sites of induction are related to the presence of arachnoidal cap cells in granulations where CSF resorption occurs, particularly along the major venous sinuses and their tributary veins, as well as around bony foramina for exiting vascular and nervous structures. Arachnoidal cap cells are felt to be a neural crest derivative, a feature relevant to the finding of other types of associated tumors in the syndrome of central or Type II neurofibromatosis (NF2) [14-17]. A candidate gene for this disease has been isolated recently, and may be relevant as tumor suppressor specific to meningiomas and related neoplasms [18].

Biological and pathological features

Pathology

The most widely used pathological description of these tumors is a modification of the terminology used by Cushing and Eisenhardt. The fibrous, syncytial (or meningotheliomatous), transitional, and angioblastic varieties make up the vast majority of cases. Other subvariants include tumors demonstrating psammomatous, microcystic, myxoid, xanthomatous, lipomatous, granulomatous, or secretory differentiation [5, 6]. The papillary variety has been associated with a higher incidence of malignant behavior and metastases [19, 20]. The hemangiopericytoma of the meninges (sometimes included under the term angioblastic meningioma) has also been found to have a more malignant natural history, and hemangiopericytic and papillary features may be found together in the same tumor [19, 21-23]. These more aggressive tumors are responsive to radiotherapy, which can lengthen disease free survival [24, 25].

Growth characteristics

Even when histologically indistinguishable, individual skull base meningiomas can have highly variable natural histories ranging from rapidly growing and invasive to slow-growing and indolent. The ability to predict a given tumor's clinical behavior would be of obvious value for the clinician making patient management decisions. For histologically benign meningiomas, the only clear risk factor for recurrence is extent of resection, though researchers have looked for markers of aggressive growth potential. Atypical, papillary, or angioblastic tumors have histological features which distinguish their more aggressive behavior [5, 6]. de la Monte [26] has identified several features of meningiomas with benign histology that were correlated to recurrence or decreased progression-free survival.

Additional predictive information may come from studies of markers for proliferative potential such as flow cytometry and bromodeoxyuridine labelling index. Flow cytometry of archival tissue was analyzed by May [27] in 40 patients undergoing complete resection of their tumors. Twenty patients were recurrence-free at an average follow up of 11.4 years, and 20 had recurrence documented radiographically at a mean interval to recurrence of 7.5 years. Tumors which recur had a statistically significant difference in proliferative index compared to those which did not. The proliferative index was never above 19.2% in nonrecurrent tumors, but was greater than this value in 2/3 of the recurrent tumors. There appears to be little sampling error with this technique [28].

Bromodeoxyuridine labelling has also been used to examine biological behavior, with labelling indices correlated to radiographic doubling time, cell kinetics in culture, and histological features of atypia [29-31]. This vital procedure precludes examination of archival tissue and therefore the initial labelling index is not known for many recurrent tumors, but was greater than this value in 2/3 of the recurrent tumors. There appears to be little sampling error with this technique [28].

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