Navigation-assisted Resection of a Primary Extraocular Melanoma of the Orbit

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Abstract. A 22-year-old male presented with proptosis of the right eye and diplopia. On magnetic resonance images (MRI), a well-delineated orbital tumor medio-distal to the eye was detected, respecting the eye-ball and the orbital walls. The aim of navigation-assisted surgery was to excise the progressive tumor while maintaining vision. A modified latero-cranial orbitotomy was used to approach the tumor. Microscopic analysis of the resection specimen revealed a melanoma. The patient’s postoperative course was uneventful. The diplopia improved rapidly. Two further eye-saving second-look revisions of the tumor site excluded further melanoma infiltrates and revealed melanophages in scar tissue. Intraoperative navigation was used during all procedures. The tumor showed some interesting features concerning its histopathological appearance and magnetic resonance imaging. Detailed histopathological investigations supported the decision for organ-saving surgery. Follow-up MRI and positron emission tomograms up to 14 months later showed neither local tumor recurrence nor distant spread. Conclusion: In the presented case with the incidental finding of orbital melanoma without invasion of the globe or orbital walls, navigation-assisted surgery supported the eye-saving operating procedures.

Case Report

A 22-year-old Caucasian male with proptosis of the right eye was referred for surgical treatment to the maxillofacial surgery department. Over the previous weeks the patient had developed a slight proptosis of the right eye followed by diplopia. The patient reported a change of the orbital volume over the previous 6 months. Ophthalmological investigation documented the proptosis and diplopia and excluded intraocular tumors or dysplasia of both eyes (10).

MRI. Magnetic resonance imaging revealed a displacing round mass, medial and distal to the right globe. The tumor appeared well delineated, isointense on fat-suppressed images, and showed no arrosion of the adjacent bones. The optic nerve was displaced in the caudal direction. Furthermore, the globe was displaced by the tumor mass but a thin delineating line could be seen. On T1-weighted images a moderate and homogenous hyperintensity of the tumor was recorded. On T2-weighted images the tumor induced weaker signals that were moderately enhanced following injection of contrast medium. The lesion’s dimensions were 2x2x2.5 cm³ and showed no invasive pattern. The tentative radiological diagnosis was a dermoid tumor or pseudotumor of the orbit (Figure 1).
Treatment. Surgery was planned based on the assumption that the tumor might be benign. Applying navigation assistance, the aim of surgery was to excise the progressive tumor while maintaining vision. Therefore, the tumor resection via a latero-cranial orbitotomy and intraoperative navigation (VectorVision, BrainLAB, Heimstetten, Germany) was planned. For intraoperative referencing a cortical fixed reference system was used (Latero Reference Star, z-touch, BrainLAB). The accuracy of this referencing method was checked by anatomical landmarks (9). A modified lateral orbitotomy was used (11). The solid tumor was extirpated. The patient’s postoperative course was uneventful and the diplopia improved rapidly. Two further eye-saving navigation-assisted second-look revisions of the tumor site were performed 2 and 5 months later (Figure 2). The excised soft tissue was macroscopically focally pigmented. However, histological investigation excluded melanoma and revealed melanophages in scar tissue in all sections. Intraoperative navigation was used during all procedures.

Macroscopy. 2.2x1.7x1 cm³ dark soft tissue tumor (Figure 3).

Histology. The tumor cells were organized in alveolar or solid clusters separated by thin stromal bands. They were of quite large size and polygonal, containing round to oval, polymorphic and hyperchromatic nuclei with prominent nucleoli and a slightly increased number of mitoses. The cytoplasm was loosely arranged with some PAS-positive glycogen and different amounts of granular melanin pigments in about 40% of the tumor cells.

The proliferation index in terms of Ki-67 positive tumor cells was low, not exceeding 10% (MIB1). The proliferation seemed to be higher in non-pigmented tumor cells. The tumor failed to stain for tyrosine hydrolase, chromogranin, neurofilament, pan-cytokeratin (AE1/AE3), EGFR or GFAP. The tumor cells stained intensely for c-kit and HMB 45, and weakly for NSE, melan A and synaptophysin. MIC2 antigen (CD99) and vimentin were identified in some tumor cells. Some tumor cells were positive for S-100 and CD 68. MIC2 antigen (CD 99) was identified in tumor cells. The tentative differential diagnoses in addition to malignant melanoma were pigmented paragranuloma, melanotic schwannoma and malignant melanocytoma. Electron microscopy excluded the presence of secretory granula (not shown). The tumor cells were not surrounded by a basal membrane. Therefore, the tumor did not possess the characteristics for a paragranuloma. Melanotic schwannoma was excluded due to the lack of spindle-cells in the resection specimen. Melanotic melanocytoma would be expected to show a
higher mitotic index than in the present case. The diagnosis of an atypical melanoma was consistent with the morphological findings. No associated orbital blue nevus was found.

Follow-up. Repeated magnetic resonance images and positron emission tomograms failed to identify any local relapse or distant spread over a follow-up period of 14 months. Ophthalmological investigation excluded any pathological retinal findings prior to surgery or in the follow-up.

Family history. A thorough medical report after the first surgical intervention revealed that the mother had developed a malignant melanoma of her upper limb at the age of 36 years (13-year follow-up; Clark level 3 to 4; Breslow 0.75-0.8 mm) and that the mother’s brother had developed a superficial spreading melanoma of the left lower limb at the age of 47 years (7-year follow-up; Clark level 4; Breslow: 0.8 mm) In both relatives the tumors were completely resected and no local recurrence nor further tumors had yet occurred.

Discussion

This report describes the successful application of navigation-assisted surgery in the treatment of an orbital tumor that was initially erroneously considered to represent a benign entity on MRI. It was therefore decided to use this advanced technique for further procedures in the surgically altered region, optimizing the surgical approach and the eye-saving surgical intention. Furthermore, this report shows that the diagnosis of a primary malignant melanoma still needs to be stated with caution and differential diagnosis requires expertise in the field of orbital pathology.

By definition, orbital melanoma infiltrates, originating from primary sites such as the eyelid, eyebrow, eye surface or other regions, including the globe, should be considered as secondary malignant melanomas (1). Melanoma of the uvea (choroidea, ciliary body, iris) constitute the majority of melanomas arising in orbital organs (2). A thorough ophthalmological investigation is mandatory in order to exclude a primary tumor located in the globe, e.g. the orbital extension of a choroidal melanoma (12) or the metastasis to the orbit from the contralateral choroidea (10).

Characteristics of melanoma on magnetic resonance images are differentiated for melanotic and amelanotic patterns. The signal pattern of the tumor is often compared to the cortex (13) or globe (14). In melanotic melanomas, the image consists of a high signal intensity on T1-weighted and low signal intensity on T2-weighted images, compared to the cortex. In amelanotic melanoma, the tumor is hypointense or isointense to the cortex on T1-weighted images and hyperintense or isointense to the cortex on T2-
weighted images. However, deviations from this imaging pattern appear to be frequent, including melanoma in the head and neck region (13). Growth characteristics are proposed for uveal melanoma. Melanin-containing melanoma reduces the relaxing time in T1- and T2-weighted images (15), while melanin-containing melanoma is hyperintense in T1-weighted and hypointense on T2-weighted images, compared to the globe (14, 16, 17).

The pathogenesis of primary orbital melanoma is not clear. The putative cell of origin seems to be the orbital melanocyte, a neural crest derivative that may be found in the leptomeninges of the optic nerve, in scleral emissarial vessels or along ciliary nerves (1, 18, 19). Primary melanoma was found in the exenterated orbit following radiotherapy for a retinoblastoma in early childhood (1).

Malignant melanoma arising in the orbital portion of the optic nerve is extremely rare (20). In this case, the ophthalmological investigation of the optic disk had revealed a black lesion and feathery margins years before. Neurological deficits were the first clinical findings that led to the establishment of diagnosis. Proptosis seems to be the most consistent clinical finding associated with primary orbital melanoma (1, 4).

About 50% of orbital melanomas were found to be associated with pigmented disorders, e.g. blue nevi, oculodermal melanocytosis (nevus of Ota) or ocular melanocytosis. Most frequently associated were cellular blue nevi (1). A review on this topic was presented from the Armed Forces Institute of Pathology based on the analyses of the 21 files collected over a period of 40 years. In this series, 90% of primary orbital melanomas were associated with blue nevi and 10% had some form of congenital melanosis (2). This condition might be present in the histological section, where a biphasic growth pattern in primary orbital melanoma is frequently seen, reflecting the presence of a blue nevus and the malignancy (1).

It is difficult to predict the clinical course of primary orbital melanoma due to the rarity of the entity and the limited reports on long-term follow-up (1, 7). According to Tellado et al. (2) it seems prudent to apply the diagnostic criteria that are proposed for uveal melanomas to primary orbital melanoma. From their evaluation of orbital primaries, the most predictive parameters concerning poor prognosis were a mixed cell type of the tumour according to a modified Callender’s classification (21), a high mitotic count, age and congenital melanosis.

In the present case, the mitotic count was low and the tumor showed a mixed cell type. There was no congenital melanosis and the patient was young. There is some support from the literature to elect for a conservative approach in tumors with an encapsulated aspect and exclusion of metastases (1, 4, 7). However, time to relapse can be extended (1, 2, 22).

The latero-superior orbitotomy provided excellent access to the orbit and allowed the complete excision of the primary (23). This approach is more commonly used to gain access to lateral orbital lesions. However, the lateral approach is also advocated to release tumors in the orbital apex that are located more medially, combined with a medial route (11). Navigation-assisted surgery allowed the excision of the pseudo-encapsulated tumor and to prove the superimposition of the pointer in situ with the estimated borders of the tumor on preoperative images. However, after excision of the tumor, the superimposition of the true pointer position with the image position was impaired in the orbital soft-tissues due to the repositioning of the globe, muscles and fat. On the other hand, the position was reproducible when checked against orbital landmarks. During the second-look revision of the site the navigation enabled us to precisely take the orbital biopsies from regions where grade could not precisely be determined on MRI. Replacement of the bone, resulted in uneventful healing on all three occasions, illustrating the excellent wound healing in this region.

Conclusion

Navigation-assisted imaging provides an effective tool for orbital surgery. Long-term follow-up is necessary in patients with a history of orbital melanoma (22).

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References


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