Metastatic tumors of the optic nerve are extremely rare. The review of literature revealed only 12 cases of breast carcinoma metastasis to the optic nerve. All patients survived less than 6 months after surgical treatment. We describe a case of breast carcinoma metastasis to the optic nerve that occurred 8 years after radical mastectomy followed by chemotherapy. The metastasis manifested with a progressive decrease in visual acuity in the right eye during 3 months. CT and MRI demonstrated enhancing lesion in the muscle cone apex of the right orbit with an extension to the optic canal. The presumable diagnosis was optic nerve sheath meningioma, and surgical resection was performed. The tumor involved the optic nerve and has been resected together with the nerve. Histology report confirmed metastatic tumor. Postoperatively, the patient received additional stereotactic radiotherapy. Patient died of tumor dissemination 2.5 years after surgery. Breast carcinoma metastases to the optic nerve usually have unfavorable prognosis both for survival and for visual acuity. Isolated metastatic tumors of the optic nerve remain a diagnostic challenge because of their clinical and radiological similarities to more common primary tumors of the optic nerve.

Keywords: metastatic skull base tumor, cerebral metastases, metastases to the optic nerve.
vention. Resection of the right-sided cranio-orbital tumor was performed on July 13, 2006.

Soft tissues were incised in the right frontotemporal area, the temporal muscle was detached, and the underlying bone was skeletonized. The supraorbital flap including the supralateral regions of the orbital ring with the adjacent regions of the orbital roof and squama of the frontal and temporal bones was formed and removed. The outer parts of the sphenoid wings were resected; the superior orbital fissure was opened. The thickened anterior clinoid process was resected; the optic tract was opened. The appearance of the optic nerve sheath in the canal was not altered. After the dissection of the orbital periosteum, a grey-yellow neoplasm with stringy structure infiltrating the adjacent orbital tissues was detected in the muscle cone apex.

The affected superior oblique muscle was excised and the nasociliary nerve originating from the tumor was cut when isolating the neoplasm. When the front pole of the tumor was isolated, the optic nerve originating from the tumor was detected (Fig. 2). An attempt to detach the tumor from the optic nerve showed that the tumor intergrew into its sheath. The optic nerve was cut at the spot where it came out from the front pole of the tumor. The tumor node linked to the nerve was isolated before its entry to the optic tract during coagulation and excision of the infiltrated orbital tissues. In the projection of the first one-third of the optic canal, the infiltrated portion of the optic nerve became normal. Coagulation and transsection of the intercanal portion of the optic nerve at this level was performed; the tumor was removed together with the affected optic nerve. The infiltrated portions of the superior and lateral rectus muscles were then excised. Examination of the optic canal revealed no further intracanal spreading of the tumor. The emergency biopsy showed tumor malignancy. Plastic surgery of the skull base was performed using orbital adipose tissue and a pedicled periosteal flap harvested from the frontotemporal region. After the bone flap was placed and fixed, layer-wise suturing of the soft tissues of the wound was performed.

During the postoperative period, the right-sided oculomotor disorders aggravated to total ophthalmoplegia; complete ptosis and blindness were observed.

Histological examination of the surgical samples showed that morphological presentation corresponded to metastatic BC (Fig. 3).

Immunohistochemical examination was performed to verify the diagnosis. Tumor cells were found to express cytokeratin 7 and 5/6, estrogen and progesterone recep-

Fig. 1. CT (a) and MRI (b) of the orbits.
An oval-shaped tumor (indicated with an arrow) tightly enveloping the optic nerve and spreading into the optic nerve canal is imaged in the posterior portions of the right orbit.
Fig. 2. Intraoperative image.
A xanthochromic metastasis and the optic nerve stretched above it (arrows) are detected.

Fig. 3. BC metastasis to the optic nerve.
Hematoxylin and eosin staining. ×200

Fig. 4. BC metastasis to the optic nerve.
a – immunohistochemical reaction with estrogen receptors. ×200; b – immunohistochemical reaction with Her-2-neu (Cerb-B2) gene receptor. ×400.

According to the histological presentation and the immunophenotype of the tumor it should be regarded as metastatic carcinoma with primary localization of the tumor in the mammary gland (Fig. 4).

CT scanning of the brain and orbits in the early postoperative period detected no residual tumor tissue (Fig. 5).

During the period from May 3, 2007 to June 16, 2007, the patient underwent one cycle of stereotactic radiotherapy for the area of the resected metastasis. Patient’s head was immobilized using a BrainLab reinforced thermoplastic mask. 3D planning was performed using the topometric CT and contrast-enhanced MRI data on a specialized BrainScan computer-assisted system. The target volume included in the 80% isodose curve was 33.40 cm³. The total radiation dose at the isocenter after 30 sessions was 60 Gy. Radiation was generated by a Novalis multileaf collimator-based linear accelerator (radiation intensity 6 MeV; seven conformal static fields). Patient’s condition after the surgery was satisfactory.

The patient died 2.5 years after neurosurgical intervention (11 years after being diagnosed with BC and the mastectomy) of disseminated cancer.

Discussion

According to the data provided by different authors [1, 29], the incidence rate of metastases of malignant tumors to the eye and optic nerve ranges from 2 to 12%. Breast cancer metastases occur most frequently (25–48%) [21, 29].

Despite the fact that metastases to the eye occur relatively often, the cases of isolated lesions of the optic nerve are extremely rare. In 1974, A. Ferry and R. Font reported on 3 (1.3%) cases of carcinomas metastasizing to the optic nerve in a series of 227 patients with metastatic le-
sions of the orbit and eye. Metastatic breast cancer was observed in only one patient (0.4%) [15].

A total of 12 cases of metastatic lesions of the optic nerve were found in literature.

Table summarizes the data on patients, including our own observation.

Breast carcinoma metastases to the eye and optic nerve occur in relatively young population of working age. The mean age of the known 13 patients with metastatic BC to the optic nerve was 48 (31–70) years. Most of them (8 patients) were younger than 50 years.

11 of 13 patients had unilateral lesion of the optic nerve: left- and right-sided in 7 and 4 patients, respectively. Bilateral lesion of the optic nerves was observed in a single case. In one patient, the metastasis affected the optic chiasm region [3]. In the overwhelming majority of cases (10 of 13), vision loss was the main symptom of the lesion of the optic nerve. Bitemporal hemianopsia in a female patient with metastasis to the optic chiasm region was reported. No clinical presentation was provided by R. Font and A. Ferry in their case report [15]. In one patient, the ophthalmological symptoms included only the exophthalmos on the affected side. Optic disorders combined with the exophthalmos, with orbital pain, and with occlusion of the central retinal vein were reported (each case was reported once) [4, 9].

The ophthalmic examination revealed the normal eye ground, optic disc edema, and retinal detachment [19, 20, 28]. Thus, fundoscopy showed no regular patterns [6].

By the time when the metastasis to the optic nerve was revealed, 6 patients had other symptoms of cancer: locoregional metastases in 2 patients and distal metastases in 4 patients.

Positive oncological anamnesis was known in 12 cases. Metastases to the optic nerve emerged on average after 4.7 years (6 months – 13 years) after the primary tumor had been resected.

It is very difficult to make accurate preoperative diagnosis of breast carcinoma metastases to the optic nerve. Despite the fact that positive oncological anamnesis had been known in 12 of 13 patients by the time of manifestation of the metastasis to the optic nerve, preoperative diagnosis was made properly in only 2 (15.4%) patients. Diagnosis was unclear in five patients; retrobulbar neuritis and optic nerve sheath meningioma were suspected in 1 and 5 cases, respectively.

Similar to metastatic brain carcinoma, optic nerve sheath meningiomas mostly occur in middle-aged women and are likely to cause unilateral lesions [8, 27]. The incidence rate of bilateral lesions of the optic nerves is comparable: bilateral lesions are detected in 5% of patients with meningiomas and 7.7% of patients with metastases [9, 20].

The major clinical manifestations in patients with metastases to the optic nerve are similar to those in patients with optic nerve sheath meningiomas: progressive loss of vision acuity and exophthalmos [12, 25]. However, the progression of clinical presentation is slower in meningioma patients, as opposed to patients with metastases (eyelid edema, ptosis, oculomotor disorders caused by lesion of structures of the superior orbital fissure develop by the time of emergence of optic disorders) [12]. The fundoscopic results also differ for these two groups of patients: metastases progress relatively rapidly so that the changes in the eye ground either have not been developed yet or have a more acute nature in the form of hemorrhages, retinal vein thrombosis, or bulky neoplasms; whereas signs of congestion and atrophy prevail in meningioma patients because of slow tumor growth [13, 19, 25].

It is a well-known fact that the risk of developing meningioma in patients with breast adenocarcinoma is
<table>
<thead>
<tr>
<th>Author and year</th>
<th>Patient's age, years</th>
<th>Affected side</th>
<th>Main symptoms</th>
<th>Ophthalmic examination</th>
<th>Other metastases</th>
<th>Period between the mastectomy and the emergence of metastases</th>
<th>Survival period</th>
<th>Preoperative diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. Holden, 1902 [18]</td>
<td>41</td>
<td>Left</td>
<td>Vision loss and pain</td>
<td>Normal</td>
<td>Distal metastases</td>
<td>2 years</td>
<td>3 months</td>
<td>Not determined</td>
</tr>
<tr>
<td>H. Norton, 1959 [23]</td>
<td>31</td>
<td>Left</td>
<td>Vision loss</td>
<td>Enlarged optic nerve disc</td>
<td>Loco-regional recurrence</td>
<td>5 years</td>
<td>6 months</td>
<td>Not determined</td>
</tr>
<tr>
<td>R. Font, A. Ferry, 1974 [15]</td>
<td>No data available</td>
<td>Bilaterally affected</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
</tr>
<tr>
<td>A. Arnold et al., 1981 [4]</td>
<td>70</td>
<td>Left</td>
<td>Vision loss</td>
<td>A structure in the eye ground was detected</td>
<td>Loco-regional recurrence</td>
<td>3 years</td>
<td>3 years</td>
<td>No data available</td>
</tr>
<tr>
<td>A. Mansour et al., 1993 [22]</td>
<td>41</td>
<td>Left</td>
<td>Vision loss</td>
<td>Slight pailness of the disc</td>
<td>Distal metastases (frontal lobe tumor)</td>
<td>7 years</td>
<td>No data available</td>
<td>Metastasis</td>
</tr>
<tr>
<td>M. Hashimoto et al., 1995 [17]</td>
<td>45</td>
<td>Right</td>
<td>Exophthalmos</td>
<td>Not determined</td>
<td>No data available</td>
<td>2 years</td>
<td>No data available</td>
<td>Optic nerve sheath meningioma</td>
</tr>
<tr>
<td>G. Aliaire et al., 1995 [2]</td>
<td>39</td>
<td>Right</td>
<td>Exophthalmos</td>
<td>A structure near the optic disc nerve was detected</td>
<td>Distal metastases to the lungs</td>
<td>21 months</td>
<td>6 months</td>
<td>Metastasis</td>
</tr>
<tr>
<td>N. Newman et al., 1996 [24]</td>
<td>61</td>
<td>Left</td>
<td>Vision loss</td>
<td>Moderate disc swelling</td>
<td>No data available</td>
<td>2 years</td>
<td>Not determined</td>
<td>Optic nerve sheath meningioma</td>
</tr>
<tr>
<td>O. Backhouse et al., 1998 [5]</td>
<td>60</td>
<td>Left</td>
<td>Central retinal vein occlusion, vision loss</td>
<td>Hemorrhage to the vitrous humor</td>
<td>Not determined</td>
<td>3 years</td>
<td>4.5 months</td>
<td>The same</td>
</tr>
<tr>
<td>S. Baessa, B. Benoit, 1999 [6]</td>
<td>45</td>
<td>Optic chiasm</td>
<td>Bitemporal hemianopsia</td>
<td>Normal</td>
<td>No reliable data</td>
<td>6 months</td>
<td>6 months</td>
<td>Not determined</td>
</tr>
<tr>
<td>B. Fox et al., 2005 [16]</td>
<td>47</td>
<td>Right</td>
<td>Vision loss</td>
<td>Painless of the optic nerve disc</td>
<td>Distal metastases to the kidney, gallbladder, and lungs</td>
<td>13 years</td>
<td>4 months</td>
<td>Optic nerve sheath meningioma</td>
</tr>
<tr>
<td>H. Cho et al., 2010 [10]</td>
<td>51</td>
<td>Left</td>
<td>Vision impairment</td>
<td>Enlarged optic nerve disc</td>
<td>No data available</td>
<td>10 years</td>
<td>No data available</td>
<td>Retro-bulbar neuritis</td>
</tr>
<tr>
<td>Our own observation</td>
<td>48</td>
<td>Right</td>
<td>Vision loss</td>
<td>Retinal detachment</td>
<td>No data available</td>
<td>8 years</td>
<td>11 months</td>
<td>Optic nerve sheath meningioma</td>
</tr>
</tbody>
</table>
1.5—1.9-fold higher than that in the total population [9]. On the other hand, meningiomas and optic nerve gliomas are the most common tumors of the optic nerve. According to [25, 26], the incidence rate of metastases to the optic nerve is 0.4%, while meningiomas and gliomas account for 14% of tumors of this localization. However, while gliomas and metastases can be easily differentiated by radiological examination, meningiomas and metastases are radiologically similar [15, 19].

CT and MRI are characterized by high sensitivity but low specificity in diagnosing metastases and meningiomas of the optic nerve [11, 12].

These methods allow one to accurately reveal the localization of the process; however, the histological diagnosis cannot be made, since the MRI and CT signs of breast carcinoma and optic nerve sheath meningiomas are similar both for the native mode and intravenous contrast. T1-weighted images show isointense (60—90%) and hypointense (10—30%) meningiomas. T2-weighted images show 30—45% hypointense and 50% isointense meningiomas. Metastatic carcinomas are isointense or moderately hyperintense on T1-weighted images and hypointense on T2-weighted images. Homogeneous accumulation of the contrast agent in both tumors is observed when using intravenous contrasting imaging [10—12].

Accurate diagnosis can be made only after tumor biopsy, based on the morphological and immunohistochemical examination data. Only after that, the tumor type can be determined correctly and the optimal treatment strategy can be selected.

Taking into account these similarities between the two pathologies, it is no coincidence that the metastasis to the optic nerve in the reported case, which had been detected 8 years after the primary tumor had been resected, in the absence of any other signs of oncological processes was originally diagnosed as optic nerve sheath meningioma.

In meningioma patients, radical resection allows one to cure a patient [29]. Metastasis to the eye bulb or optic nerve is a prognostically unfavorable factor attesting to the progression of the oncological process. Resection of a metastatic tumor makes it possible to ensure local control over the tumor but has virtually no effect on the survival period [4, 16, 28].

Prognosis in patients with metastases to the eye and/or optic nerve is unfavorable. The mean survival period after a metastasis to the eye was revealed is 13 months; in case of metastases to the retina and optic nerve, it is ~9 months [5]. The maximum survival period is observed in patients with metastatic breast carcinoma (15—16 months after the resection of metastasis) [14, 20].

**Conclusion**

Breast carcinoma metastasis to the optic nerve is a rare pathology that is prognostically unfavorable both in terms of survival period and vision. Metastases to the optic nerve are clinically and radiologically similar to optic nerve sheath meningiomas. There are no pathognomonic signs allowing one to differentiate between BC metastases and primary tumors of the optic nerve, which makes preoperative diagnosing very challenging. Such factors as positive oncological anamnesis, presence of other metastases, presentation of acute changes in the eye ground detected by fundoscopy, or slowly progressing symptoms of the lesion of the superior orbital fissure that manifest earlier than the vision disorders in patients with optic nerve sheath meningiomas may contribute to correct preoperative diagnosis. Nevertheless, the diagnosis both in patients with and without positive oncological anamnesis can be reliably made only based on pathomorphological and immunohistochemical examination.

**REFERENCES**

The authors reported a rare case of isolated breast carcinoma metastasis to the optic nerve in a 48-year-old female patient 8 years after radical mastectomy. This report is of significance for neurosurgeons and pathomorphologists, since preoperative diagnosis in this situation is usually extremely challenging. However, accurate diagnosis is required already at the preoperative stage due to the fact that these patients need a different surgical strategy and postoperative management.

Breast carcinoma metastasis to the optic nerve usually needs to be distinguished from optic nerve meningiomas. Diagnostics is challenging, since none of the existing methods is absolutely sensitive in terms of differential diagnosis.

We certainly believe that when a tumor is detected in a patient with positive oncological anamnesis, one should rely on the metastatic genesis of a neoplasm and conduct preoperative studies aimed at either confirming or refuting this assumption. First of all, the authors should have assessed the oncomarker level. It can be regarded as a drawback of this study. However, it should be mentioned that neither positive nor negative result of this examination would have a significant effect on the strategy of subsequent treatment, since histological verification (which was actually performed by the authors) is the only reliable diagnostic method in patients with an isolated metastatic focus in the long-term period after the primary tumor had been resected. The malignant tumor was detected intraoperatively. Based on this fact, the most adequate surgical strategy (total tumor resection) was selected.

Along with other similar observations, the aforementioned case emphasizes the significance of comprehensive diagnostics of neoplasms in patients with positive oncological anamnesis.

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