Entrapment neuropathy of the optic nerve due to hyperostosis associated with congenital anemia

Case report

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The authors report on the case of a 14-year-old boy who presented with bilateral visual impairment due to optic canal stenosis caused by hyperplasia of the bone marrow arising from anemia. The patient had hereditary hemolytic anemia with unstable hemoglobin of the Christchurch type. This congenital form of anemia caused hyperplasia of the bone marrow as well as hyperostosis of the entire calvarial bone, which in turn led to optic canal stenosis. The patient underwent surgical decompression of the optic canal, resulting in significant improvement in visual acuity. Pathological findings in the calvarial bone indicated hypertrophic bone marrow with no other specific features such as neoplastic pattern or fibrous dysplasia. With the exception of objective hearing impairment, no other significant cranial neuropathy has been detected thus far.

On reviewing the published literature, this case was found to be the first in which hyperostosis due to congenital anemia resulted in symptomatic entrapment neuropathy of the optic nerve. The authors concluded that surgical decompression effectively improves visual acuity.

KEY WORDS • optic canal • cribra orbitalia • hemolytic anemia • hyperostosis • visual defect

Cranial neuropathy due to entrapment at the neuronal foramen is occasionally associated with osteoplastic diseases such as fibrous dysplasia and Paget disease. On the other hand, it is a well-recognized fact that severe anemia during childhood can lead to hyperostosis of the skull and other bones. Nevertheless, hyperostosis caused by congenital anemia has never been reported to induce symptomatic entrapment of the cranial nerve, such as visual disturbance or hearing loss.

In this report we describe an extremely unusual case of entrapment neuropathy of the optic nerve caused by hyperostosis. According to the published literature reviewed thus far, this is the first reported case of entrapment neuropathy of the cranial nerve caused by congenital anemia.

Case Report

History. This 14-year-old boy with congenital hemolytic anemia accompanied by unstable hemoglobin presented to a local community hospital, exhibiting impaired visual acuity in the right eye. He had congenital Christchurch-type hemoglobin anemia, which was caused by the alternation of the amino acid residue 71 from phenylalanine to serine in the hemoglobin β-chain. Results of an ophthalmological examination revealed that his right-sided visual acuity had decreased to 0.02 and could not be corrected; visual acuity in his left eye was 1.0. A fundus examination conducted by an ophthalmologist revealed bilateral, multiple soft patches, which were caused by hemolytic anemia; the examination also revealed right optic atrophy in the right macula lutea.

Examination. One year later, the patient was admitted to our hospital because visual acuity in his left eye had progressively worsened, decreasing to 0.1. Results of CT scanning studies revealed an abnormally thickened calvaria, a skull base including sphenoidal bone, and an extremely narrowed optic canal (arrows). A 3D CT scan demonstrated...
cribra orbitalia, which is a sieve-like appearance of the orbital roof (Fig. 2). Magnetic resonance images were nondiagnostic, exhibiting no thickened cranial bone. Other x-ray films of the spine, pelvis, and extremities demonstrated hyperostosis.

On hematological examination, slightly normocytic normochromic anemia (red blood cells, 3.5 × 10^{12}/L; hemoglobin, 10 g/dl; hematocrit, 32.2%; mean corpuscular volume, 92 fl; mean corpuscular hemoglobin, 28.6 pg; and mean corpuscular hemoglobin concentration, 31.1 g/dl) was observed, and the reticulocyte count (13.1%) was significantly increased. Total bilirubin (5.7 mg/dl), indirect bilirubin (5.1 mg/dl), lactic dehydrogenase (263 IU/L), and alkaline phosphatase (684 IU/L) were elevated. These laboratory data strongly indicated the prominent acceleration of hematoipoiesis. Fibrous dysplasia, Paget disease, and certain other osteoplastic neoplastic diseases were considered as the differential diagnoses.

Treatment. The patient underwent left optic canal decompression through an extradural frontotemporal craniotomy. Macroscopically, the patient’s skull and orbital roof appeared to be extremely thick but very fragile. The cortical bone was very thin and transparent, and the hypertrophic bone marrow could be seen through it (Fig. 3 upper). Note, however, that the degree of bleeding from the bone medulla was not excessive and was easily controlled by bone wax application. It was confirmed that the narrowed optic canal entrapped the optic nerve (Fig. 3 lower). The roof and lateral wall of the optic canal were removed, and the optic nerve was successfully decompressed.

Histopathological findings demonstrated that the osseous change was simple hypertrophic bone marrow with hypercellularity due to increased erythroblasts. No abnormality of bone structure and no abnormal cells were observed (Fig. 4).

Postoperative Course. Two months after the operation, visual acuity in the patient improved to 0.5. Six months after surgery on the left side, the same surgical decompression was performed on the right side, and visual acuity improved.

![Fig. 2. Three-dimensional reconstructed CT image (upper) and two-dimensional reconstructed coronal sectional image (lower) revealing cribra orbitalia, which is a sievelike lesion of the orbital roof.](image)

![Fig. 3. Upper: Photographs obtained pre- (left) and post-craniotomy (right), demonstrating that the surface of the frontal bone is gray and transparent, revealing the thickened bone marrow. Lower: Photograph obtained during opening of the optic canal, indicating that the hypertrophic bone severely tightened the optic nerve.](image)
Symptomatic hyperostosis due to anemia

Fig. 4. Photomicrographs showing a section of the excised calvarial bone. The bone marrow demonstrates marked high cellularity (upper). The majority of the cells are normal erythroblasts, and pathologically abnormal cells are not shown (lower). H & E, original magnification × 10 (upper) and × 40 (lower).

Discussion

Entrapment neuropathy due to an osseous structure is a very common occurrence in spinal diseases, including spinal canal stenosis and foraminal stenosis caused by osteophytic spur formation. Note, however, that it is very unusual for such entrapment neuropathy to occur in association with calvarial hyperostosis. Osteoplastic disorders, such as Paget disease and fibrous dysplasia, may cause cranial nerve entrapment neuropathy. It is well known that fibrous dysplasia occasionally causes visual disturbance due to optic nerve entrapment. Indeed, in our case, fibrous dysplasia was the most probable differential diagnosis. Nevertheless, the radiological findings in this case were not always compatible with those of typical fibrous dysplasia in which the unilateral sphenoid bone is involved and its osseous hypertrophic lesion is usually regional. Moreover, results of the pathological examination of the surgical specimen revealed that the hyperostotic reactive change was not the fibrous dysplasia but the reactive hyperplasia of the bone marrow and the thinning of the cortex.

It is a well-recognized fact that anemia during childhood is related to the cause of hyperostosis of the skull. Thus far, however, no author has reported that entrapment neuropathy of the cranial nerve due to reactive hyperostosis is associated with congenital anemia. In the patient in our case, the bilateral auditory canals were also stenotic, and so far only a mild hearing disturbance has been detected. Other cranial foramina were generally observed to be stenotic without any sign of entrapment neuropathy.

Severe thinning of the cortex of the calvaria was also observed during surgery. In addition, we noted extreme thinning of the cortex of the orbital roof. In anthropological studies, it has occasionally been reported that the porotic hyperostotic change of the calvaria is caused by chronic anemias, such as sickle cell disease. In particular, the sieve-like appearance of the orbital roof observed in the present case is referred to as “cribra orbitalia.” The secondary hyperplasia of the bone marrow and the reciprocal thinning of the cortex are believed to induce this unique change in the orbital roof. These bone changes are estimated to be an important indicator of health and nutritional conditions, especially anemia, and many authors have investigated the social health status associated with these changes in various eras and locations. The 3D CT scanning studies obtained in the patient in our study indicated cribra orbitalia, results similar to the 3D CT findings in the historic skull reported on by Exner, et al.

Conclusions

In summary, this study is the first report of a case of symptomatic optic canal stenosis which exhibited hereditary hemolytic anemia with cribra orbitalia. So far, the patient in this case has shown no obvious neurological symptoms caused by the other cranial nerves, despite the fact that the other cranial nerve canals demonstrated severe narrowing (for example, internal auditory meatus) on CT scans. It is conceivable that in the near future, we will have to consider the necessity of decompressing the other cranial nerves.

References


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