

Binocular Double Vision – A Review

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Abstract

A 62-year-old male with history of hypertension presented to our emergency department with new onset diplopia. He denied recent trauma. The patient had binocular double vision with abducens nerve palsy. There were no other complaints.

We review the relevant anatomy, multiple etiologies, necessary diagnostic testing, and treatment of diplopia. Careful physical examination and detail to the patient's past history is essential for making an accurate diagnosis. Since sudden onset of this entity may represent a serious condition requiring urgent attention, emergency physicians should be familiar with this dysfunction. Most importantly, visual disturbances may be the initial manifestation of occult disease - tumors, multiple sclerosis, vascular disease, myasthenia gravis, or Miller-Fisher syndrome.

Discussion

Anatomy

The abducens nerve innervates the lateral rectus muscle. After the nerve exits the brainstem, it enters the cavernous sinus where it is lateral to the internal carotid artery. It then proceeds to the orbit. The sixth cranial nerve also traverses the pons.¹

Dysfunction

Injury to the nerve results in deviation inward of the affected eye from unopposed pull from the medial rectus muscle. Compression or stretching of the nerve may result in injury.¹ Dysfunction of the nerve may lead to double vision with ocular misalignment.²⁻⁴ Ruling out cranial nerve palsies, including III, IV, V, in addition to VI, should be kept in mind. Patients with sudden onset of monocular diplopia require complete ophthalmological examinations as well as detailed review of current

and past medical histories. The ocular exam should include visual acuity, extraocular motility, pupillary response, and ophthalmoscopy to rule out papilledema of the optic disc.

Etiology, Differential Diagnoses, and Treatment of Diplopia

Etiologies include vasculopathic, trauma, tumors, multiple sclerosis, diabetes, stroke, meningeal inflammation/infection, and giant cell arteritis. Differential diagnoses include thyroid eye disease, myasthenia gravis, orbital inflammatory disease, orbital trauma (medial wall fracture resulting in entrapment of the ipsilateral medial rectus muscle), post-procedural complications (after strabismus surgery), migraine, and Duane Syndrome (congenital innervation disorder causing limited ability to move the eye inward). Medications may also be associated with diplopia. These causes will be discussed, in addition to the appropriate treatments and prognoses.

Trauma

Cranial nerve VI palsy may be the result of trauma causing avulsion and brainstem displacement.¹

Vascular Pathology

Cases of diplopia have been reported secondary to vascular pathology.⁵⁻⁷ Palsies of the ocular muscles secondary to ischemia from carotid artery occlusion has been reported.⁵ Dissection of the internal carotid artery with pseudoaneurysm and cavernous sinus fistula has led to binocular diplopia; this was diagnosed with computer tomographic angiogram.⁶ Orbital varices, which was treated with gamma knife radiosurgery, has caused diplopia.⁷ Abducens nerve palsy secondary to infarct of the lateral

and paramedian areas at the base of the pons has been reported. This was diagnosed with magnetic resonance imaging.⁸

Tumors

Multiple cases of diplopia have been described as a result of tumor growth.⁹⁻¹² Orbit metastasis is an uncommon cause.⁹ Soft tissue neoplasm, such as primitive neuroectodermal tumor involving the parasellar area and optic chiasm, has also been reported; this was diagnosed with magnetic resonance imaging and treated with gamma knife surgery, chemotherapy, and radiotherapy.¹⁰ Schwannomas of the abducent nerve, although rare, have led to diplopia. These were treated with gamma knife surgery.¹¹ Double vision has been reported as a result of sphenoidal meningioma.¹²

Endocrinopathies

Endocrinopathies may lead to visual disturbances including diplopia.¹³⁻¹⁵ Diabetic patients may have ophthalmological emergencies and need close monitoring.¹³ They may develop neuropathy leading to dysfunction of the abducens nerve.¹ Diabetics develop ocular motor neuropathy secondary to ischemia.¹⁴ Pituitary disorders and thyroid disease may lead to ophthalmological problems.¹⁵ Graves eye disease may result in severe diplopia.¹⁵ The patients may develop massively enlarged extraocular muscles, congestion of the orbit, and strabismus.¹⁵ Patients with Graves eye disease require medical care for this autoimmune disorder as well as surgical care.¹⁵ Orbital decompression and strabismus surgery may be required.¹⁵

Metabolic and Nutritional Etiologies

Metabolic and nutritional disease may also lead to visual problems.^{16,17} Nutritional disorders and vitamin deficiencies, which result from gastrointestinal surgery and malabsorption, can lead to eye manifestations.¹⁶ Alcohol abuse and Wernicke-Korsakoff's Syndrome with severe thiamine deficiency lead to peripheral neuropathies with abnormal oculomotor function.¹⁷

Inflammatory Disorders

Inflammatory diseases may also cause ophthalmological manifestations.^{18,19} Temporal arteritis may result in diplopia and headache.¹⁹ Any patient over 50 suspected of having giant cell arteritis needs immediate sedimentation rate, C-reactive protein, and platelet count performed. Biopsy of the temporal artery is needed for definitive diagnosis.¹⁹ If positive, treatment with steroids is required.¹⁹

Infectious Etiologies

Cranial nerve palsies with abducens involvement resulting in diplopia may be a complication of herpes zoster ophthalmicus.²⁰ Treatment includes oral acyclovir, acyclovir ointment, and oral steroids.²⁰ Oculomotor palsies may occur with other infectious disorders.²¹ Miller-Fisher Syndrome, a variant of Guillain-Barre Syndrome, may result in ophthalmoplegia.²¹ It is an immune-mediated post-infectious disease, which is diagnosed with lumbar puncture. Immunotherapy with intravenous immunoglobulin and plasma exchange may be required in severe cases.²¹ Multiple infections, e.g., campylobacter jejuni,

cytomegalovirus, and Epstein-Barr virus, may cause antibodies to ganglioside with resultant demyelinating polyradiculoneuropathy and ophthalmoplegias.²²

Neuromuscular Junction Transmission Failure

Myasthenia gravis is an auto-immune disorder leading to muscle weakness, which is painless.²³ Chemical transmission at the neuromuscular junction fails because of antibody formation.²³ The patient may exhibit diplopia and ptosis, which waxes and wanes.²³ There may be precipitating factors such as emotional stress and intercurrent illness.²³ Diagnostic testing includes edrophonium chloride test, electromyography, and the presence of antiacetylcholine antibodies.^{23,24} Treatment is with acetylcholinesterase-blocking agents, such as pyridostigmine.²³ Immunomodulatory therapy and steroids may be needed for substantial improvement, but respiratory support during a myasthenia crisis can occur at some point.^{23,24} Patients may present with ocular manifestations initially, but 80% of them go on to have generalized weakness.²³ Respiratory weakness may be fatal.²² Two-thirds of patients with ocular myasthenia gravis develop generalized weakness within two years.²⁵ These patients require the care of ophthalmologists and neurologists and recognition by physicians that the disease is life-threatening.²⁵

Central Nervous System Demyelination

Multiple sclerosis, a disorder of the spinal cord, optic nerve, and brain, frequently presents initially with eye complaints.²⁶ It is reported as high as 70%.²⁶ The disorder is inflammatory and degenerative. Diagnosis is based on lumbar puncture, revealing oligoclonal bands in the spinal fluid, and magnetic resonance imaging, demonstrating white matter lesions.²⁶ Visual dysfunction may present with eye abduction paresis.²⁷

Neuro-ophthalmic abnormalities in patients with multiple sclerosis result from central nervous system demyelination.²⁷ If the diagnosis is made early, immunomodulatory treatment will optimize the patient's care.²⁸

Post-Procedural Complications

There have been reports of patients developing intracranial subdural hematoma after spinal anesthesia resulting in prolonged headache and sixth cranial nerve paresis.²⁹

Patients have also developed double vision as a complication of strabismus surgery.³⁰ Diplopia rarely occurs following cataract extraction.³¹

Medication-Related

Associations between diplopia and medication have been reported.^{32,33} Patients taking lacosamide, a new antiepileptic medication, have developed diplopia with neurotoxicity.³² A relationship between diplopia and use of fluoroquinolones is possible.³³

Fracture as an Etiology

Diplopia has also been described in association with malarzygomatic fractures.³⁴

Migraine-Related

In addition, migraines have been reported as a cause of diplopia.³⁵

Prognosis

Isolated abducens nerve palsy is a common cause of binocular diplopia.³⁵ If caused by microvascular disease as a result of diabetes and/or hypertension, the prognosis is good. One study reported 87% spontaneous recovery at five months and 95% at twelve months. Patients with cranial nerve palsies resulting from non-microvascular disease, the etiologies of which included multiple sclerosis, myasthenia gravis, trauma, and space-occupying lesions, had a reported complete recovery at one year of 62%. Patients with abducens nerve palsy not caused by microvascular disease had a 44% rate of no recovery at the end of one year.³⁵

Conclusion

Patients may present to emergency departments with binocular diplopia. This eye misalignment may be the result of cranial nerve palsies, a problem with neuromuscular transmission, or mechanical dysfunction of the ocular muscles. It may be related to vascular disease, procedures performed, trauma, medication, nutritional deficits, endocrinopathies, infection, or occult disease.¹⁻³⁴ The possible etiologies are diverse and range significantly in seriousness, some of which are life-threatening. Fortunately, many patients have spontaneous recovery at twelve months.³⁵ Magnetic resonance imaging and angiography identify vascular problems, tumors, and infarcts leading to diplopia.⁵⁻¹² Emergency physicians should be aware of the etiologies of this entity as well the appropriate diagnostic tests and management. Most importantly, diplopia may be the initial presentation of occult illness. Particular focus should be on investigating the possibility of previously undiagnosed tumors, vascular disease, multiple sclerosis, Miller-Fisher syndrome, or myasthenia gravis.^{5-12,22-28}

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