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Unilateral mydriasis in a child with a ventriculoperitoneal shunt for obstructive hydrocephalus: a diagnostic dilemma

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SUMMARY

There are several causes for sudden onset unilateral mydriasis, however impending transtentorial uncal herniation needs to be ruled out. This unique case highlights an uncommon adverse response to a common mode of treatment that leads to a diagnostic dilemma. A 3-year-old boy with a ventriculoperitoneal (VP) shunt for an obstructive hydrocephalus presented with an acute respiratory distress. He developed unilateral mydriasis with absent light reflex during treatment with nebulisers. An urgent CT scan of the brain did not show any new intracranial abnormality. A case of pharmacological anisocoria was diagnosed that resolved completely within 24 hours of discontinuation of ipratropium bromide. Although ipratropium-induced anisocoria has been reported in children, but to our knowledge none in a child with VP shunt for hydrocephalus. This emphasises the urgency in evaluating unilateral mydriasis to rule out life-threatening conditions. Clinicians should remember that ipratropium administered through ill-fitting face masks could cause this completely reversible adverse effect.

BACKGROUND

Children with ventriculoperitoneal (VP) shunt for obstructive hydrocephalus can present acutely with symptoms of shunt blockage and any delay in diagnosis results in serious complications including death. A new onset neurological sign should be investigated urgently, but being aware of potential non-serious causes could avoid unnecessary neurological interventions from a diagnostic dilemma.

CASE PRESENTATION

A 3-year-old boy was admitted to the paediatric ward with acute respiratory distress. He had a complex background of extreme prematurity, quadriplegic cerebral palsy, global developmental delay and a VP shunt on left side for an obstructive hydrocephalus from grade 4 intraventricular haemorrhage. He had also developed severe (grade 3+) retinopathy of prematurity bilaterally and required laser coagulation during early infancy. He had chronic lung disease and was treated for lower respiratory tract infection (LRTI) associated wheeze on several occasions in the past.

INVESTIGATIONS

Blood investigations showed neutrophilic leukocytosis and a maximum C reactive protein (CRP) of 78 mg/L; urea and electrolytes including blood glucose remained stable throughout the stay. Blood gases were also stable with a peak lactate of 2.6 mmol/L during salbutamol infusion. The theophylline levels were within the therapeutic range during aminophylline infusion. A nasopharyngeal aspirate was positive for respiratory syncytial virus. Chest X-ray showed minimal opacity at left middle zone with hyperinflated lung fields.

DIFFERENTIAL DIAGNOSIS

Although he was treated for worsening acute viral-induced wheeze, blocked VP shunt with increasing intracranial pressure and risk of uncal herniation needed ruling out.

TREATMENT

He was treated for LRTI and acute viral-induced wheeze. He initially required high-flow nasal cannula oxygen and later continuous positive airway pressure to maintain oxygen saturation and to support his work of breathing. He was treated with regular salbutamol and ipratropium bromide nebulisation, but later required intravenous salbutamol (up to 2 µg/kg/min) and aminophylline (1 mg/kg/hour) infusions along with intravenous hydrocortisone. He fought vigorously with administration of nebulisations when awake.

On the fourth day of admission, he was noted to have unequal pupils. He opened both his eyes spontaneously with no ptosis. The pupillary examination revealed right pupil diameter of 3 mm with sluggish reaction to light. The left pupil was dilated as shown in figure 1, and measured 6 mm in diameter with no reaction to light. There was no nystagmus, and it was challenging to assess his ocular movements accurately. He communicated with his parents, was generally irritable but did not seem to be in any pain and settled intermittently when undisturbed. He had generalised hypertonia and bilateral ankle clonus, which was secondary to pre-existing quadriplegic cerebral palsy. Apart from bilateral wheeze in his chest, rest of the examination remained unremarkable. In view of new onset unilateral mydriasis, the case was urgently discussed with neurosurgical team and a CT scan of the brain was performed, which did not show any new intracranial abnormality.

OUTCOME AND FOLLOW-UP

Based on detailed clinical review and reassuring CT scan of the brain, a diagnosis of pharmacologic mydriasis was made. As the child struggled

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Figure 1 Left pupillary mydriasis.

with nebulisers, ipratropium bromide had probably trickled on to the affected eye resulting in a fixed dilated pupil. The ipratropium bromide nebulisers were stopped, and the pupils were completely normal within 24 hours. The child was gradually weaned off salbutamol and discharged home on day 7.

DISCUSSION

Anisocoria (unequal pupils) may be physiological (simple or essential) or secondary to conditions related to the eye, such as post ocular trauma/eye surgery or oculomotor nerve paralysis.[1] More importantly, it may be a sign of a potentially life-threatening condition from raised intracranial pressure, secondary to intracranial space occupying lesion, intracranial haemorrhage, traumatic brain injury, meningoencephalitis or blocked VP shunt.[2] Physiological (simple) anisocoria with pupillary inequality of >0.4 mm is present in around 20% of normal people.[3] Pharmacological mydriasis is well known, and is caused by topical application of drugs like atropine, tropicamide and cyclopentolate. Cases of ipratropium bromide-induced pharmacological anisocoria have been reported in the literature, but only few in children, with the youngest being in a 6-month-old child.[4] Even transdermal hyoscine patch has been reported to cause anisocoria in an adolescent, probably due to contaminated hands.[5] Interestingly, environmental exposure to the sap of *Angel's trumpet* (*Datura suaveolens*) containing parasympatholytic alkaloids has been reported to result in anisocoria.[6] Rarely episodic unilateral mydriasis has been noted in patients with migraine.[7 8]

Either dilatation or constriction of only one pupil results in anisocoria. Normally pupils dilate in the dark and constrict in bright light. When anisocoria becomes prominent in the dark, it indicates that the small pupil is abnormal and hence the problem is with the sympathetic pathway. Conversely, if anisocoria becomes prominent in light, it indicates that the dilated pupil is abnormal and hence the problem is with the parasympathetic pathway.[9] Our index child had a fixed dilated pupil in the left eye, which was more prominent in bright light, indicating parasympathetic involvement.

Ipratropium bromide inhalers or nebulisers are crucial for the management of viral-induced wheeze/asthma and are delivered using spacer device or face mask. Ipratropium bromide has antimuscarinic properties and leakage from ill-fitting face masks can be absorbed by the cornea and conjunctiva. Older preparations containing benzalkonium chloride preservative increased the permeability of the cornea.[10] Once the drug reaches cornea, it acts like atropine and produces a parasympatholytic effect. It blocks muscarinic acetylcholine receptors, resulting in paralysis of sphincter pupillae and inhibits the ciliary muscles. This leads to mydriasis, a fixed dilated pupil, and when affected on one side leads to anisocoria. Rarely delays in diagnosis of this cause have resulted in angle-closure glaucoma.[2] Pilocarpine test using 0.1% and 1% drops on the eye produces pupillary constriction in Adie's pupil and oculomotor palsy, respectively, through muscarinic action.[11] However, pilocarpine fails to reverse pupillary dilatation in case of pharmacological mydriasis where muscarinic receptors are already saturated with antimuscarinic agent.

Ipratropium-induced pharmacological anisocoria resolves within 24 hours of discontinuation of the drug, including our index child.[2] To our knowledge, no case of pharmacological anisocoria has been reported in a child with underlying hydrocephalus and VP shunt. The dilemma here was to rule out a shunt blockage and avoid neurological sequelae. Rarely death from blocked VP shunt resulting in uncal and tonsillar herniation has been noted at autopsy.[12] However, autopsy examinations are not carried out often in those with chronic disabilities and VP shunt, resulting in under-reporting of mortality associated with shunt block. A unilateral dilated pupil can be the first sign of impending uncal herniation which tend to occur often in intracranial conditions exerting excessive unilateral forces.[13] Timely interventions done rapidly could potentially reverse an evolving uncal herniation.[14]

A quick and correct diagnosis of pharmacological anisocoria can ensure complete recovery within 24 hours. It may also be worth considering eye patches or protective goggles in children who struggle with the use of face masks.[2 15]

Patient's perspective

When I first noticed that one of our son's pupils was dilated, my immediate thought was that it was a problem with his shunt. A worry following his admission with severe respiratory problem and that he had to have laser surgery on his eyes previously. A problem with the shunt was the last thing he needed. After speaking with AG and having our son examined, I was relieved to be told that it was not a shunt malfunction and that it was the medication in his nebuliser that had caused his pupil to dilate. The medical staff were very thorough in their approach and quick to resolve this worrying matter.

Learning points

- Clinicians should bear in mind that ipratropium bromide administered via nebulisers through face mask could result in this adverse effect.
- Timely ophthalmology input and appropriate use of pilocarpine test would be helpful in differentiating oculomotor palsy from drug-induced anisocoria.
- A quick and correct diagnosis will ensure complete recovery within 24 hours, often avoids complications and unnecessary neurological intervention in a child.
- To consider eye patches or protective goggles in children who struggle with the use of face masks for nebulisation.

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