Transient facial nerve palsy after topical papaverine application during vestibular schwannoma surgery

Case report

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✓ Some evidence in the literature supports the topical application of papaverine to the cochlear nerve to prevent internal auditory artery vasospasm and cochlear ischemia as a method of enhancing the ability to preserve hearing during acoustic neuroma surgery. The authors report a case of transient facial nerve palsy that occurred after papaverine was topically applied during a hearing preservation acoustic neuroma removal. A 58-year-old woman presented with tinnitus and serviceable sensorineural hearing loss in her right ear (speech reception threshold 15 dB, speech discrimination score 100%). Magnetic resonance imaging demonstrated a 1.5-cm acoustic neuroma in the right cerebellopontine angle (CPA). A retrosigmoid approach was performed to achieve gross-total resection of the tumor. During tumor removal, a solution of 3% papaverine soaked in a Gelfoam pledget was placed over the cochlear nerve. Shortly thereafter, the quality of the facial nerve stimulation deteriorated markedly. Electrical stimulation of the facial nerve did not elicit a response at the level of the brainstem but was observed to elicit a robust response more peripherally. There were no changes in auditory brainstem responses. Immediately after surgery, the patient had a House–Brackmann Grade V facial palsy on the right side. After several hours, this improved to a Grade I. At the 1-month follow-up examination, the patient exhibited normal facial nerve function and stable hearing.

Intracisternal papaverine may cause a transient facial nerve palsy by producing a temporary conduction block of the facial nerve. This adverse effect should be recognized when topical papaverine is used during CPA surgery.

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KEY WORDS • acoustic neuroma • facial nerve palsy • hearing preservation • intracisternal papaverine • vestibular schwannoma

ACOUSTIC neuromas comprise 8 to 10% of all intracranial tumors. Hearing preservation can be an achievable goal in the surgical treatment of these lesions when the patient has serviceable hearing preoperatively; however, postoperative sensorineural hearing loss can occur after tumor resection even when the cochlear nerve is anatomically intact. Such loss is thought to result from cochlear ischemia secondary to IAA vasospasm. Physical manipulation during IAC dissection or metabolic changes in the vicinity of the IAA are thought to be possible inducers of vasospasm.

Papaverine hydrochloride is a benzylisoquinoline alkaloid derived from opium and is known to be a potent vasodilator. Papaverine has been used to treat arterial vasospasm after aneurysmal subarachnoid hemorrhage. Intracisternal papaverine has been used to prevent IAA vasospasm to improve hearing preservation after vestibular schwannoma surgery. Papaverine acts directly on smooth muscle, causing it to relax. Its mechanism of action is thought to be inhibition of cyclic adenosine monophosphate and cyclic guanosine monophosphate phosphodiesterases in smooth muscle, leading to increased intracellular levels of cyclic adenosine monophosphate and cyclic guanosine monophosphate and nonspecific smooth muscle relaxation. In addition, papaverine may inhibit the release of calcium from the intracellular space by blocking calcium ion channels in the cell membrane. The most common reported side effect of using intracisternal papaverine is benign transient pupillary mydriasis, which usually resolves within 2 to 4 hours.

Abbreviations used in this paper: CPA = cerebellopontine angle; CSF = cerebrospinal fluid; IAA = internal auditory artery; IAC = internal auditory canal.
after intraoperative administration. Transient facial nerve palsy after intracisternal papaverine application is extremely rare. We report a case of transient facial nerve palsy and markedly diminished response to electrical stimulation after topical application of papaverine during removal of a vestibular schwannoma.

Case Report

Presentation. This 58-year-old woman presented with tinnitus and progressive hearing loss in her right ear. She had noted no definite balance disturbances or dizziness.

Examination. On physical examination, the patient was found to have diminished hearing on the right side. Neurological examination demonstrated her neurological function as otherwise intact. An audiogram revealed sensorineural serviceable hearing loss on the right side (speech reception threshold 15 dB, speech discrimination score 100%).

Magnetic resonance images obtained after the administration of gadolinium demonstrated an enhancing 1.5-cm mass in the right CPA with extension into the IAC, consistent with a vestibular schwannoma (Fig. 1).

Operation. The patient was counseled regarding the various treatment options, including conservative therapy, stereotactic radiosurgery, and microsurgical resection, and elected to undergo microsurgical resection. A suboccipital craniectomy was performed, and the tumor was removed via a retrosigmoid approach with the intention of preserving hearing. Facial nerve and brainstem auditory evoked response monitoring were used. During surgery, the tumor was seen emanating from the porus acusticus, which was distorting the eighth cranial nerve. The posterior meatus of the IAC was drilled to expose the intracanalicular portion of the tumor. The superior and inferior vestibular nerves were identified and divided to dissect the tumor off the facial and cochlear nerves. Gross-total removal of the tumor was achieved.

During tumor removal, a Gelfoam pledget soaked in a solution of 3% papaverine (30 mg/mL) was placed over the cochlear nerve. A few minutes later, the quality of the facial nerve’s response to stimulation deteriorated markedly. After tumor removal, electrical stimulation of the facial nerve did not elicit a response at the level of the brainstem but was observed to elicit a robust response more peripherally. Near the end of the procedure, tracings could be obtained proximally on the nerve at the lowest settings of the recording device but were not nearly as robust as earlier in the procedure. Final auditory brainstem response testing showed no significant decrease in Wave V amplitude and normal I through V interpeak latencies with absolute latencies slightly delayed compared with baseline.

Postoperative Course. Immediately after surgery, the patient had a House–Brackmann Grade V facial palsy on the right side. After several hours, this improved to a Grade I. The remainder of the patient’s hospital stay was uneventful, and she was discharged on postoperative Day 4 with normal facial nerve function. At 1-month follow-up, the patient exhibited normal facial nerve function and improved balance function. An audiogram revealed retained hearing with a cochlear threshold of approximately 40 dB, with 86% speech discrimination.

Discussion

Attempts at preserving hearing during acoustic neuroma removal procedures can be unsuccessful despite anatomical preservation of the cochlear nerve. These outcomes are thought to result from compromise of the blood supply to the cochlea via the IAA. Cochlear ischemia can result from vasospasm of the IAA caused by surgical manipulation during tumor dissection. This ischemia is thought to be the primary cause of postoperative hearing loss after removal of acoustic neuromas with attempted hearing preservation. Deliberate interruptions of the cochlear blood supply have been shown in animal studies to affect the physiological activity of the cochlea adversely, which may result in irreversible functional damage. Vasospasm of the IAA has been reproduced in animal models by applying surgical maneuvers to the cochlea’s blood supply in the region of the CPA.

The use of topical papaverine, a nonspecific vasodilator, to prevent vasospasm and cochlear ischemia has been suggested to improve outcomes in hearing preservation after acoustic neuroma removal. Brackmann et al. reported an increase in hearing preservation rates after using topical papaverine for middle fossa removal of acoustic neuromas. They used a pledget of Gelfoam soaked in papaverine solution and placed on the cochlear nerve in the IAC at the modiolus. A decrease in the latency of Wave V as well as improvement of the waveforms on intraoperative auditory brain responses was observed upon topical application of papaverine to the cochlear nerve and at the modiolus. This observation has also been documented in animal models. Morawski et al. showed that mechanically induced vasospasm of the IAA was prevented by topical application of papaverine in a rabbit animal model. Recovery of cochlear blood flow and distortion product otoacoustic emissions was demonstrated in the papaverine-treated group and not in the untreated group.

Despite the effectiveness of topical papaverine in preventing IAA vasospasm and enhancing the ability to preserve hearing during vestibular schwannoma surgery, its use is not without complications. Transient mydriasis and...
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areflexia, profound hypotension, hyperthermia, and metabolic acidosis have all been reported after the use of topical papaverine, although these side effects occur rarely and have only been noted in case reports. Transient effects on the oculomotor nerve (resulting in a fixed and dilated pupil) represent the most common cranial neuropathy after intracisternal papaverine use. In this report, we describe a rare case of transient facial nerve paralysis after topical use of papaverine in the CPA.

Two other cases of facial nerve paralysis after the use of intracisternal papaverine have been described. In one case, 3% papaverine solution (30 mg/mL) was applied to an anteroinferior cerebellar artery in which vasospasm had developed during a translabyrinthine removal of an acoustic neuroma. The indication for papaverine application was to prevent an ischemic anteroinferior cerebellar artery stroke. Within seconds of papaverine application, all spontaneous and stimulated activity from the facial nerve was lost. The facial nerve could not be stimulated at 1.0 mA at the brain stem but could be stimulated at 0.7 mA distally at the porus acusticus, suggesting a conduction block. The patient awoke with facial paralysis (House–Brackmann grade was not stated in the report), which resolved completely after approximately 12 hours.

In another case, 240 mg of papaverine in 20 mL of normal saline was instilled in the CSF cistern around the aneurysm clip after it was placed in an unruptured middle cerebral artery aneurysm. After 3 to 4 minutes, the cisterns were irrigated with normal saline. Postoperatively, the patient had transient mydriasis and pupillary areflexia that lasted for 90 minutes and a House–Brackmann Grade IV facial nerve palsy that improved partially after a few hours. The facial nerve palsy had improved to House–Brackmann Grade II at 5 weeks after surgery. Subsequent electromyographic testing was consistent with a recovery of lower motor neuron facial nerve palsy. At the 2-month follow-up examination, the patient’s facial nerve palsy had fully resolved. Although papaverine was not applied directly to the facial nerve, the authors suggested that prolonged irrigation of the cisterns may have washed the papaverine into contact with the facial nerve. The timing of facial nerve recovery in this case suggests a dose-related response to papaverine, which may influence both the extent of facial nerve palsy and the time course of recovery.

Our present case is similar in that immediately after the topical application of papaverine, the quality of the facial nerve’s response to stimulation deteriorated markedly. Electrical stimulation of the facial nerve did not elicit a response at the level of the brainstem but was observed to elicit a robust response more peripherally. Our patient experienced a House–Brackmann Grade V facial nerve palsy postoperatively, which resolved within several hours of surgery. The location of the neurapraxia as well as the time course of facial nerve recovery was consistent with the location of papaverine application and the half-life of papaverine. In all three cases, including the present case, papaverine was not directly applied to the facial nerve but may have circulated in the CSF to interact with the facial nerve.

The exact mechanism of transient facial nerve palsy in these cases has not yet been elucidated. We hypothesize that the papaverine applied to the cochlear nerve interacted with the juxtaposed facial nerve, resulting in a local temporary conduction block of the cisternal segment of the facial nerve. This result may be related to a direct interaction of papaverine with opioid receptors that decreased neurotransmission. Papaverine may bind to a membrane ion channel (like a local anesthetic), thereby decreasing facial nerve conduction and causing transient facial nerve palsy. In our case, the timing of the onset and resolution of facial nerve palsy appeared consistent with the application and half-life of papaverine, suggesting a direct effect of the drug on the nerve. The ability to elicit a response via electrical stimulation was only blocked in the local region of papaverine administration in the CPA. Although we did not observe any crystalline precipitate intraoperatively, this finding was reported by Eisenman et al., who proposed it as a probable cause of transient facial nerve palsy. They suggested that there was a biochemical reaction of papaverine with the CSF, evidenced by a crystalline precipitate in the CPA during surgery, which adversely affected the facial nerve. The precipitate around the nerve may have caused a decrease in nerve conduction. Papaverine in high doses has been shown to crystallize in the presence of human serum components. Whatever the mechanism, the facial nerve palsy appeared to resolve in temporal relation to the decreasing concentration of papaverine within the surrounding area of application.

Conclusions

The use of intracisternal or topical papaverine in the CPA may result in transient facial nerve palsy. At higher doses, the palsy may be more prolonged. This palsy should be recognized as a potential side effect when papaverine is used for hearing preservation acoustic neuroma surgery or any CPA surgery.

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References


