Carotid-cavernous fistula following percutaneous retrogasserian procedures

Report of two cases

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Carotid arterial puncture during percutaneous retrogasserian procedures is a common but usually harmless complication. Strokes, resulting presumably from carotid artery thrombosis, have been reported previously following percutaneous retrogasserian coagulation. The authors report two cases of carotid-cavernous fistula, one following percutaneous radiofrequency rhizotomy and the other after percutaneous retrogasserian block. The latter patient had an anomalous primitive foramen lacerum. Both fistulas were obliterated successfully by intracavernous injection of isobutyl-2 cyanoacrylate, using intra-arterial balloon flotation catheters. Carotid-cavernous fistula is a potentially serious complication of such procedures, and may be more common than realized since small fistulas may close spontaneously.

KEY WORDS □ percutaneous rhizotomy □ carotid artery □ carotid-cavernous fistula □ balloon flotation catheter □ trigeminal neuralgia □ therapeutic embolization □ cyanoacrylate

ALCOHOL injection of the Gasserian ganglion and the retrogasserian trigeminal nerve for the relief of facial pain was first performed by Taptas in 1909. Kirschner introduced electrocoagulation of the Gasserian ganglion in Germany in 1931. This technique was made safer by the introduction of radiofrequency current and controlled thermocoagulation by White and Sweet in 1965. Since then, percutaneous rhizotomy has become a popular method of treating the patient with facial pain, and several large series of patients treated this way have been reported. Complications due to percutaneous radiofrequency rhizotomy have been mainly related to injury to the trigeminal nerve (corneal anesthesia and ulceration, facial dysesthesias, anesthesia dolorosa). Injury of the second, third, fourth, and sixth cranial nerves, seizures, intratemporal hematoma, subarachnoid hemorrhage, intratemporal abscess, and stroke have also been occasionally reported.

Percutaneous retrogasserian block with lidocaine or other anesthetic agents is a useful diagnostic and sometimes therapeutic procedure in patients with facial pain not due to typical trigeminal neuralgia. Transient paralysis of the muscles of the eye, inadvertent abducens block, and subarachnoid injection resulting in high-spinal anesthesia, cranial nerve palsies, and respiratory arrest have resulted occasionally from this procedure.

There have been relatively few reports of complications related to injury to the internal carotid artery (ICA) following percutaneous retrogasserian procedures, despite the proximity of the needle to certain portions of the ICA. In our institution, we have encountered two cases of carotid-cavernous fistula following percutaneous retrogasserian procedures. One of these occurred after a local anesthetic injection into Meckel's cave, and the other after percutaneous radiofrequency rhizotomy. To our knowledge, these are the first such cases ever reported in the literature.

Embolization Technique for Fistula Repair

Occlusion of the fistulas in both cases was performed using the technique of Kerber, et al. Two
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catheters are placed in the ICA by percutaneous
techniques. The femoral route is preferred, although
one catheter may be placed directly into the common
carotid artery. One catheter is used to inject localizing
portions of contrast agents; the other delivers a flow-
guided balloon microcatheter made entirely of
silicone.*

By varying the size and position of the balloon, it is
frequently possible to enter carotid-cavernous fistulas.
The balloon does not become large enough to occlude
the IBCA to harden in the blood. The balloon is then
deflated and removed immediately. Follow-up
angiography can then be performed.

Postoperative Course. On the second postoperative
day, the patient started hearing a roaring noise in the
right ear. On the third postoperative day, she noticed
some weakness of the left hand. Neurological ex-
amination revealed minimal weakness of the left hand,
fingers, and triceps, with the other muscle groups
quite intact. A continuous bruit was present over the
right eye. Visual acuity, fields, and funduscopy were
normal. Transfemoral selective angiography was per-
formed on the next day, demonstrating a right carotid-
cavernous fistula (Fig. 1 upper left).

The patient was followed for a period of 3 months in
the hope that the fistula would close spontaneously.
However, the facial pain recurred and the patient
returned with increasing noise in the right ear and
swelling of both periorbital areas, worse on the right.
Examination showed mild, nonpulsatile proptosis of
the right eye with chemosis and periorbital edema.
The bruit could now be heard over both eyes and the
right carotid bifurcation. The visual acuity on the
right had worsened to 20/70. The left upper limb
weakness, however, was mostly resolved. The facial
sensation was similar to that described prior to the
block.

Fistula Embolization. A cerebral angiogram was
repeated. This demonstrated the carotid-cavernous
fistula, but the draining veins were significantly larger
compared to the previous angiogram. A flow-guided
intra-arterial microcatheter was introduced into the
cavernous sinus through the fistula, and 0.3 cc of
tantalum-impregnated IBCA was injected (Fig. 1 up-
ner right). The patient had some immediate headache
but no other neurological problems. Subsequent films
demonstrated complete occlusion of the fistula with
the glue filling the majority of the right cavernous
sinus and the superior ophthalmic vein. A small
amount of glue was noted in the distribution of the
callosal artery. There was complete disappearance
of symptoms relating to her carotid-cavernous fistula.

A cerebral angiogram performed 2 months later
demonstrated complete occlusion of the fistula (Fig. 1

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*Calibrated leak balloon microcatheter manufactured by
Cook, Inc., P.O. Box 489, Bloomington, Indiana.
†Dow Corning Silicone Fluid 360, 350 Centistoke
Viscosity, manufactured by Dow Corning, Midland,
Michigan.
FIG. 1. Case 1. **Upper Left:** Cerebral angiogram, right internal carotid (ICA) injection, demonstrating the carotid-cavernous fistula. The site of the fistula in the cavernous sinus could not be localized. **Upper Right:** A calibrated-leak balloon microcatheter was introduced into the right ICA. The inflated balloon at the tip is marked by the large arrow. The site of exit of the catheter from the ICA inside the cavernous sinus is indicated by the small arrow. This point is fairly anterior to the location of the normal foramen ovale and the Gasserian ganglion. **Lower:** Angiogram performed 2 months after occlusion of the fistula. The anterior bend of the ICA appears slightly thickened because of overlying radiopaque adhesive in the cavernous sinus.

lower). A retromastoid craniectomy and section of the portio major of the trigeminal nerve was performed for relief of recurrent facial pain. The patient was free of pain for about 2 months, at which time pain recurred.

**Case 2**

This 64-year-old woman presented with left-sided facial pain of 2 years' duration. The pain would occur in the left eye in severe, sharp excruciating spasms that lasted 15 to 60 minutes on each occasion. She had obtained no relief with Tegretol, Dilantin, or alcohol injection of the infraorbital nerve.

A retromastoid craniectomy was performed, and a loop of superior cerebellar artery on the superior aspect of the trigeminal nerve at the root entry zone was moved away and held in place with an Ivalon sponge. The patient had complete remission of her pain postoperatively, but it recurred 3 months later with a different quality. There was a dull pain in the left eye that occurred every 4 to 6 hours, lasting about 45 minutes each time, aggravated by bending down or
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by pressure on the back of the neck. There were no neurological deficits on examination.

**Operation.** A percutaneous radiofrequency retrogasserian rhizotomy was then performed. The patient was premedicated intramuscularly with morphine, 6 mg; droperidol, 6 mg; and glycopyrrolate, 0.3 mg. During the procedure, local anesthetic infiltration of the face with Xylocaine (lidocaine) was supplemented in periodic amounts with intravenous fentanyl, 0.3 mg; droperidol, 2.5 mg; and diazepam, 2.5 mg. The technique of percutaneous rhizotomy was similar to that described by Nugent and Berry. A No. 18 thin-walled lumbar puncture needle was passed into the foramen ovale without any difficulty. The stylet of the needle was removed and cerebrospinal fluid escaped. For stimulation and production of lesions, a Teflon-insulated electrode measuring 0.0016 in. in diameter, with its tip exposed 3 mm and slightly curved, was used. After stimulation produced pain over the forehead and orbit, several lesions were made at 100 to 150 mA, lasting 30 to 60 seconds each. There was no subjective or objective change during a series of 30 such stimulations and lesions. However, after the final lesion, which was similar in every way to the others, the patient developed analgesia over the left forehead, cornea, and upper cheek.

**Postoperative Course.** Her ocular pain was completely abolished. However, on the first postoperative day, she developed a mild headache associated with diplopia and a roaring noise in the left ear. Examination showed a left abducens paralysis. There was no proptosis or chemosis. A bruit was present over the left eye and the supraorbital area and disappeared on left common carotid compression. The patient was discharged since it was felt that the fistula might seal spontaneously.

She was readmitted 2 months later with the complaint of increasing noise in the left ear. The left orbital pain was still present but was considerably reduced and quite tolerable. Analgesia and anesthesia of V1, decreased sensation over V2 and V3, weakness of motor fifth nerve, and abducens palsy were observed. No proptosis or chemosis was noted. A bruit was now heard over both eyes and carotid bifurcations; it could be obliterated by left common carotid compression. The patient was discharged since it was felt that the fistula might seal spontaneously.

By the right transfemoral route a balloon microcatheter was flow-directed into the cavernous sinus and 0.3 cc of tantalum-impregnated IBCA was injected to occlude the posterior draining channels to the straight sinus. Anterior flow through the ophthalmic vein remained (Fig. 3 upper). The patient's lid elevation improved, and the noise in the ear decreased. Since it was thought that the sinus might occlude further, she was discharged.

The patient returned to Presbyterian Hospital with recurrence of the noise in the left ear and marked proptosis. An attempt at catheterization of the sinus was unsuccessful due to rupture of the balloon. A third treatment 1 week later was successful, and an additional 0.3 cc of IBCA was injected with complete occlusion of the fistula (Fig. 3 lower). Three hours after the occlusion, the patient developed a nominal and Wernicke's aphasia, right upper limb paresis, and a partial abducens nerve palsy. These cleared completely over the next 48 hours. The bruit was not heard any more, and at the time of discharge the proptosis and chemosis were subsiding and the patient was free of pain.

**Discussion**

The patient in Case 2 had a fistula of the ascending part of the ICA as it enters the cavernous sinus (Fig. 3 upper). The injury to the arterial wall was probably due to extension of the thermal lesion rather than to direct puncture. It is conceivable that the use of a protruding curved electrode and multiple lesions were contributing factors; however, the safety of this particular technique has been amply proven by others. 

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FIG. 2. Case 2. Cerebral angiogram, left internal carotid injection, showing a large carotid-cavernous fistula with drainage into the superior ophthalmic vein and into the straight sinus. The site of the fistulous opening could not be located.

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The patient in Case 1 had a fistula in the anterior part of the cavernous sinus at the junction of the horizontal and the ascending portions of the carotid artery (Fig. 1). Simulations on normal human skulls suggest to us that it is impossible to puncture the artery at that point by Härtel's approach. The base views of the skull were then reviewed carefully and it was seen that the medial aspect of the margin of the foramen ovale was ill defined. The foramen ovale was fused with the foramen lacerum, forming a primitive foramen lacerum medius. It is quite likely that on initial positioning, the needle had passed through the medial aspect of this foramen. The venous blood aspirated then may have been from the cavernous sinus and through-and-through puncture of the carotid artery may have occurred at this point.
Sondheimer noted that primitive foramen lacerum medius was much more common than realized, occurring in 4% of routine skull radiographs that were reviewed. He emphasized that the presence of such a finding on the stereoscopic base views of the skull should be followed by tomography in order to differentiate this from erosion caused by tumors and other lesions in this area. The neurosurgeon should be especially watchful for the possibility of arterial injury when such a bone abnormality exists.

The anatomy of the intracranial ICA in relation to the trigeminal ganglion has been well described by Parkinson, and Harris and Rhoton. In the latter study the terminal part of the petrous carotid artery was separated from the trigeminal nerve (in Meckel's cave) by dura only in 84% of the cases studied. After study the terminal part of the petrous carotid artery the trigeminal ganglion has been well described by jury when such a bone abnormality exists.

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Before the introduction of controlled thermocoagulation using radiofrequency current, there had been several reports of deaths related to carotid artery injury. One of Kubanyi's patients died about 1 week after the procedure from rupture of the coagulated wall of the ICA. The other deaths followed hemiplegia, apparently related to carotid thrombosis. Hensell and Zenker have each had one patient who was rendered stuporous, hemiparetic, and/or aphasic, but recovered completely in some weeks. Since the introduction of radiofrequency current and controlled thermocoagulation, however, there has been only one report of stroke due to puncture of the ICA. Rish reported puncture of the ICA twice in the foramen lacerum during separate attempts to enter the foramen ovale. After the second attempt, the patient was rendered dysphasic, hemiplegic, and eventually permanently disabled. A carotid angiogram only demonstrated a minute mural irregularity of the petrous portion of the ICA.

Puncture of the ICA during percutaneous procedures of the trigeminal ganglion has been noted by several surgeons previously, apparently without any complications. White and Sweet warned that this may occur "if the needle is too low, too medial or too far posterior" and recommended the use of a hollow No. 20 needle. If puncture occurs, they advised termination of the procedure, "to try again another day." Wepsic encountered arterial bleeding from the cannula in eight of 816 cases, and particularly cautioned against placement of the needle too posteriorly and against entry into the foramen lacerum. He also recorded a case where a tortuous ICA passed directly over the foramen ovale, thus making percutaneous rhizotomy impossible on three separate occasions. The patient eventually was treated by open rhizotomy. Nugent and Berry recorded carotid puncture in four instances of a total of 65 cases. In three of these cases the needle was placed too medially, but in one case the needle was in the foramen ovale. Tew and his coworkers also encountered this problem in some of their cases, without apparent sequelae. It is interesting that some of their patients reported difficulty in hearing due to roaring sounds in the ear. This symptom was ascribed to paralysis of the tensor tympani; however, it may have been due to a small carotid-cavernous fistula that subsequently closed spontaneously. It is well known that small carotid-cavernous fistulas may seal spontaneously, and this complication may be more common than realized. In our institution we have seen one other patient who developed an intermittent roaring noise in the ear associated with a recurring bruit over the eye. This patient was not studied angiographically. The symptoms and bruit disappeared on follow-up review, ostensibly due to closure of a presumed fistula.

Carotid-cavernous fistula must be considered an infrequent but definitely possible complication of percutaneous procedures in the retrogasserian area. Caution should be exercised to avoid placing the needle too medially into the foramen lacerum, and, as mentioned before, special care should be exercised in patients with a primitive foramen lacerum medius. The use of smaller gauge needles, as recommended by White and Sweet, may reduce the chances of developing a significant fistula. If arterial puncture occurs, we would agree with them that the procedure must be terminated, to return later.

It would be wise to question all patients specifically about "noises in the head" after these procedures. This may identify the patients with small fistulas, and these patients may then be watched closely.

Finally, intracavernous injection of isobutyl-2 cyanacrylate is a useful but still experimental technique of treating carotid-cavernous fistulas. Further clinical experience is necessary to fully evaluate the risk versus benefit ratio and to maximize the safety of the procedure.

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References


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