Improved visualization of the foramen ovale for percutaneous approaches to the gasserian ganglion

Technical note

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Percutaneous procedures for treating trigeminal neuralgia involve the penetration of foramen ovale using cutaneous landmarks and radiological guidance. The placement of radiopaque markers over the commonly used "zygomatic points" in front of the ears provides landmarks on intraoperative radiological studies that facilitate localization of the foramen ovale. Speed and safety of percutaneous trigeminal procedures should be enhanced. There is no increase in radiation exposure over that in other commonly used approaches.

KEY WORDS · foramen ovale · trigeminal neuralgia · tic douloureux · fluoroscopy

Since the description of the anterior approach through the cheek to the foramen ovale by Hartel in 1914, this approach has been used for injection, radiofrequency coagulation, and balloon microcompression of the gasserian ganglion. Numerous approaches have been suggested for the radiographic monitoring of needle position during penetration of the foramen ovale. Perl and Ecker, using x-ray studies, positioned the patient's head so that a vertical line passing through the cheek would penetrate the foramen. The patient's head was rotated 15° away from the painful side of the face and the neck extended to permit the central x-ray beam to pass through a plane 35° caudal to the canthomeatal (orbitomeatal) line. After confirming the position on repeated skull x-ray films, they would then blindly direct the needle vertically downward to penetrate the foramen ovale. In 1972, Whisler and Hill described the use of an image intensifier with the same beam direction.

Tator and Rowed started the procedure with the beam 45° caudal to the orbitomeatal line and the head rotated 35° to 50° away from the painful side. Under fluoroscopy, the head position was then adjusted to obtain clear visualization of the foramen ovale. They also devised a canvas head-sling to simplify positioning.

Some neurosurgeons employ the submental vertex view of the skull in combination with a lateral view. However, this position may be uncomfortable for the patient. Nugent and Berry described the use of an anteroposterior projection of the skull in combination with a lateral image. With the intersection of the clivus and petrous ridge on the lateral image and the dip in the petrous ridge on the anteroposterior image as targets, they readily penetrated the foramen ovale.

Skin guidelines and needle trajectories for penetrating the foramen ovale have been described by Nugent and Berry, Tew and Keller, and Rovit. Common to their techniques is a skin marker over the ipsilateral zygoma that approximates the lateral projection of the foramen ovale onto the skin. Tew and Keller place this "zygomatic point" 3 cm anterior to the external auditory meatus, Nugent and Berry at a point 2.5 cm anterior to the auditory canal, and Rovit at two-thirds of the distance between the lateral canthus and the external auditory meatus. Rovit stated that this point is usually 2.5 cm medial (anterior) to the external meatus. According to Penman, the zygomatic point is located 2.5 cm from the middle of the external auditory meatus and "may be defined as the point at which a straight line joining the centers of the two foramina ovale, when reproduced, will pass through the skin of the side of the face." Large series of percutaneous procedures making use of these landmarks to penetrate the foramen ovale have been performed. Another skin guideline is located on the medial aspect of the ipsilateral pupil. When used in conjunction with the puncture point adjacent to the second upper molar described by Hartel, these skin guidelines have permitted surgeons to place needles in close enough proximity to the foramen ovale to be able to penetrate it with minimal adjustment. The success of skin targets both 2.5 and 3.0 cm anterior to the meatus can be explained by the
Improved fluoroscopic identification of foramen ovale

Fig. 1. Photograph (left) and x-ray film (right) of a skull showing the metal rings (5 mm in diameter) on the "zygomatic point" used as landmarks when performing percutaneous procedures involving the penetration of the foramen ovale.

size of the foramen ovale, which was not less than 0.5 cm long in the lateral projection when measured in a series of dry skulls.

My own experience in performing percutaneous procedures for trigeminal neuralgia and teaching the balloon microcompression technique made me aware of limitations inherent in all of these approaches. Even with ideal positioning of the patient's head, it can be difficult to clearly visualize the foramen ovale. This may be because of osteoporosis involving a target structure or increased calcification of the skull or dura. Technical differences in imaging equipment could also influence clarity. Missing the foramen ovale and going further posteromedially could result in puncture or laceration of the internal carotid artery.

To facilitate radiological visualization of the foramen ovale, the basilar aspects of numerous dried skulls were studied. When looking at the foramen ovale along the anticipated needle track, the foramen lies between the anterior border of the mandibular ramus and the lateral edge of the maxilla. A line connecting points on the zygoma 2.5 cm anterior to each external meatus passes through both foramina ovale. This observation led to a new localization technique in which the established skin targets were made visible on the radiological studies.

Technique

A metal ring (5 mm in diameter) is taped over each zygomatic point 2.5 cm anterior to the external meatus (Fig. 1). The skull is positioned on the x-ray table rotated 20° away from the ipsilateral side, with the central x-ray beam directed at the foramen ovale at an angle 55° caudal to the orbitomeatal line. Films are taken that include both metal rings (Fig. 2 left), revealing that a
straight line joining the centers of the two rings passes through the foramen ovale (Fig. 2 right). A second observation is that, with a 55° caudocephalic x-ray beam and 20° skull rotation, the foramen ovale was just lateral to a line through the lateral wall of the orbit. This technique was repeated with lead shot taped to the skin of a volunteer, and the findings were reproduced (Fig. 3).

It is important to keep the central beam angled at least 40° caudal to the orbitomeatal line. With less angulation, the foramen ovale may be superimposed on the petrous bones, thus obscuring the image. In some patients, depending upon how widely the mouth is opened, the foramen may be superimposed on the mandibular ramus (Fig. 4). If the foramen ovale is indistinct in this position, decreasing the angle of rotation of the head will place the foramen medial to the anterior edge of the ramus.

As a general precaution, it is recommended that the needle be directed at the anterolateral aspect of the foramen ovale and “walked” into the foramen. This decreases the possibility of going too far posterosmedially in the proximity of the carotid artery. The image intensifier can then be rotated for a lateral image to permit judgment of the depth of penetration of needles or Fogarty balloon catheters into the skull.

When I perform procedures requiring radiological views of the foramen ovale, the patient’s head is placed on a cerebellar head rest such as the cerebellar attachment to the Mayfield head rest. This head support can be positioned out of the line of view of the image intensifier.

In the oblique position, it is not unusual for the x-ray beam to overpenetrate the metallic marker on the side of the face contralateral to the pain. Image quality of the marker will be greatly improved if a 0.5-mm thick lead sheet is placed on the image intensifier centered behind the marker. A piece cut from a discarded x-ray apron will serve this purpose.

Conclusions

A technique is described for improving identification of the foramen ovale during percutaneous procedures for trigeminal neuralgia. This localization technique does not eliminate the need for identifying the foramen ovale. It provides landmarks on the radiological studies that facilitate recognition of indistinctly imaged foramen. Placement of a 0.5-mm lead sheet behind the contralateral marker is recommended to improve image quality.

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