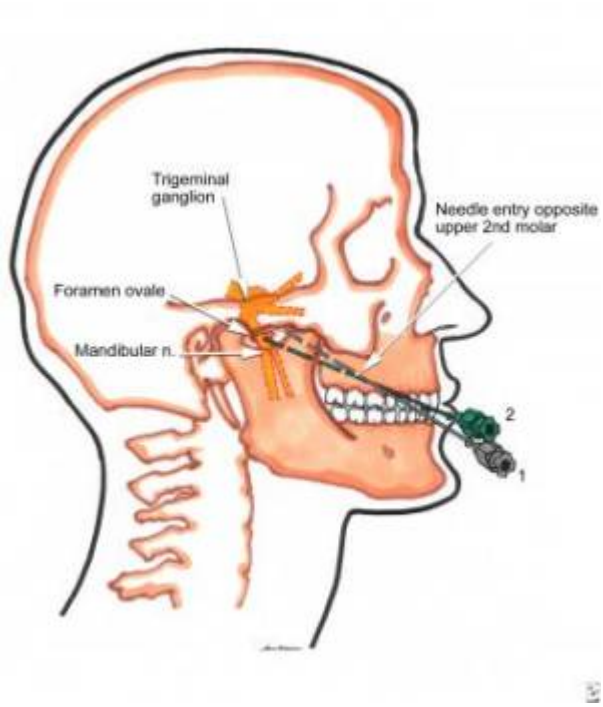
Percutaneous Foramen Ovale Puncture



Foramen ovale (FO) puncture allows percutaneous trigeminal rhizotomy, Foramen ovale electrode placement, and selected biopsy studies.

Balloon compression of the gasserian ganglion has been a well-established percutaneous treatment of trigeminal neuralgia since the 1980s.

Technique and nuances

For this procedure, different potential operative and technical nuances exist.

Puncture of the foramen ovale by conventional single-plane fluoroscopy can be difficult in cases of local anatomic abnormalities.

Mendes et al. presented the case of a 49-year-old woman diagnosed with idiopathic trigeminal neuralgia refractory to pharmacological treatment. After failure of puncture by conventional fluoroscopy for percutaneous gasserian ganglion balloon compression due to a narrow foramen ovale, the patient was submitted to puncture guided by computed tomography.

Alternative imaging methods, such as computed tomography, should be considered when Percutaneous Foramen Ovale Puncture by conventional single-plane fluoroscopy fails, to minimize the risk of potential complications triggered by frustrated puncture attempts [1)].

Between March 2018 and February 2021, 20 peroral balloon compression rhizotomy procedures with a 3D-PSGT were performed in 18 consecutive trigeminal pain patients (13 female, mean age 58 yr). We registered the procedure duration, side effects, complications, and trigeminal function. The

therapeutic effect was gauged from reduction of TP and use of analgesics.

Results: All catheter insertions and rhizotomy procedures were successful at the first attempt. Apart from fluoroscopy, no auxiliary material was necessary. The average length of surgery was 19 min (range, 11-27 min). In total, 8 patients indicated complete analgesia and 6 patients pain relief; in 4 patients, persistence of TP was observed during follow-up examinations of up to 20 mo. In total, 6 patients reported of new mild to moderate facial hypesthesia affecting the trigeminal branches V2, V3, or V1-3. No masticatory musculature or corneal affections and device-related complications occurred.

The peroral 3D-PSGT trigeminal rhizotomy is straightforward for the neurosurgeon. This operative approach allows for rapid, safe, and simple foramen ovale puncture cannulation in TP patients and reduces the use of additional equipment, radiation exposure, and procedure time [2].

Complications

Although Gasserian ganglion block is an established treatment for trigeminal neuralgia, the foramen ovale cannot always be clearly visualized by classical X-ray radiography.

Cannulation procedures, including those utilizing neuronavigational technology, are occasionally complicated by anatomical variation of the FO, sometimes resulting in miscannulation and subsequent adverse events. The FO, while commonly thought of as oval-shaped, has also been described as “almond,” “banana,” “D shape,” “pear,” and “triangular.” [3].

Advancement of the catheter more than 10 mm from the foramen ovale is likely to damage the internal carotid artery and the abducens nerve at the medial side of the petrolingual ligament. Thermocoagulation of the lateral wall of the cavernous sinus may damage the cranial nerves by heat, giving rise to pareses [4].

Case series

Forty-five patients were included in the study. All patients underwent a computed tomography examination. Among them, the simulated preoperative puncture pathway was reconstructed on the basis of computed tomography scan examination for 22 patients. Procedures were performed by 2 surgeons: one experienced surgeon and another young surgeon with surgical qualification. The puncturing time and cumulative radiation exposure dose, from start of the puncturing until reaching the foramen ovale, were recorded. Postoperative pain relief, facial hypoesthesia, masticatory muscle weakness, and other complications were recorded.

Results: In all cases, the procedure of cannulation was completed successfully. The puncturing time for both the experienced and young surgeon with the use of preoperative image simulation seemed to be time-saving. The young surgeon had less cumulative radiation exposure with the use of preoperative image simulation. Moreover, the intraoperative puncture pathways were almost consistent with the preoperative simulated images. The rest of the process went smoothly. Short-term outcomes of all the 45 patients were satisfactory.

Based on our preliminary experience, the preoperative image simulation-guided technique is useful

during these cases [5].

Guo et al., described a technique that includes a stereotactic approach in the preoperative plan in cases where the foramen ovale is difficult to access for radiofrequency thermocoagulation of the Gasserian ganglion.

The study included 395 patients for whom three-dimensional computed tomographic reconstruction of the skull base, maxilla, and mandible was conducted before surgery. Accessibility of the foramen ovale was defined using numerical data from the three-dimensional computed tomographic reconstruction images. In those patients for whom accessibility of the foramen ovale was considered difficult, the authors used a stereotactic frame to design an individual operative plan. Adjustments of a single point of data,-that is, a change in X axis, Y axis, or an arc angle-were guided by radiographic fluoroscopy images. After verifying successful cannulation and electroneurophysiology, thermocoagulation targets-especially multiple targets recorded as data on the Z axis of the stereotactic approach-were identified and treated.

There were 24 patients who met the predetermined criteria for having a difficult-to-access foramen ovales-that is, they had at least two contributing factors and/or involvement of division V1 . Twenty-one of the 24 patients required a single satisfactory puncture; three patients required two to three punctures to successfully access the foramen ovale. There were no permanent complications from the procedure.

The authors conclude that this stereotactic approach combined with three-dimensional computed tomographic reconstruction model can improve the accuracy, safety, and efficiency of percutaneous radiofrequency thermocoagulation in patients with trigeminal neuralgia for whom the foramen ovale is difficult to access [6].

Ding et al., assessed the feasibility of accessing the Gasserian ganglion through the FO from a mandibular angle under computed tomography (CT) and neuronavigation guidance.A total of 108 patients with TN were randomly divided into 2 groups (Group G and Group H) using a random number table. In Group H, anterior Hartel approach was used to puncture the FO; whereas in Group G, a percutaneous puncture through a mandibular angle was used to reach the FO. In both groups, procedures were guided by CT imaging and neuronavigation. The success rates, therapeutic effects, complications, and recurrence rates of the 2 groups were compared.The puncture success rates in Group H and Group G were 52/54 (96.30%) and 49/54 (90.74%), respectively ($P=0.24$). The 2 procedural failures in Group H were rescued by using submandibular trajectory, and the 5 failures in Group G were successfully reapproached by Hartel method. Therapeutic effects as measured by Barrow Neurological Institute Pain Scale ($P=0.03$) and quality of life (QOL) scores ($P=0.04$) were significantly better in Group G than those in Group H at 36 months posttreatment. Hematoma developed in 1/54 (1.85%) cases in Group H, and no cases of hematoma were observed in Group G ($P=0.33$). In Group H, RFT resulted in injury to the unintended trigeminal nerve branches and motor fibers in 27/52 (51.92%) cases; in Group G, it resulted in the same type of injury in 7/49 cases (14.29%) ($P<0.01$). In Group H, the 24- and 36-month recurrence rates were 12/51 (23.53%) and 20/51 (39.22%), respectively; in Group G, these recurrence rates were 7/49 (12.24%) and 9/49 (16.33%, $P=0.03$), respectively.CT- and neuronavigation-guided puncture from a mandibular angle through the FO into the Gasserian ganglion can be safely and effectively used to deliver RFT for the treatment of pTN. This method may represent a viable option to treat TN in addition to Hartel

approach [7].

The goals of a study of Peris-Celda et al., were to demonstrate the anatomical basis of complications related to FO puncture, and provide anatomical landmarks for improvement of safety, selective lesioning of the trigeminal nerve (TN), and optimal placement of electrodes.

Both sides of 50 dry skulls were studied to obtain the distances from the FO to relevant cranial base references. A total of 36 sides from 18 formalin-fixed specimens were dissected for Meckel cave and TN measurements. The best radiographic projection for FO visualization was assessed in 40 skulls, and the optimal trajectory angles, insertion depths, and topographies of the lesions were evaluated in 17 specimens. In addition, the differences in postoperative pain relief after the radiofrequency procedure among different branches of the TN were statistically assessed in 49 patients to determine if there was any TN branch less efficiently targeted.

Most severe complications during FO puncture are related to incorrect needle placement intracranially or extracranially. The needle should be inserted 25 mm lateral to the oral commissure, forming an approximately 45° angle with the hard palate in the lateral radiographic view, directed 20° medially in the anteroposterior view. Once the needle reaches the FO, it can be advanced by 20 mm, on average, up to the petrous ridge. If the needle/radiofrequency electrode tip remains more than 18 mm away from the midline, injury to the cavernous carotid artery is minimized. Anatomically there is less potential for complications when the needle/radiofrequency electrode is advanced no more than 2 mm away from the clival line in the lateral view, when the needle pierces the medial part of the FO toward the medial part of the trigeminal impression in the petrous ridge, and no more than 4 mm in the lateral part. The 40°/45° inferior transfacial-20° oblique radiographic projection visualized 96.2% of the FOs in dry skulls, and the remainder were not visualized in any other projection of the radiograph. Patients with V1 involvement experienced postoperative pain more frequently than did patients with V2 or V3 involvement. Anatomical targeting of V1 in specimens was more efficiently achieved by inserting the needle in the medial third of the FO; for V2 targeting, in the middle of the FO; and for V3 targeting, in the lateral third of the FO.

Knowledge of the extracranial and intracranial anatomical relationships of the FO is essential to understanding and avoiding complications during FO puncture. These data suggest that better radiographic visualization of the FO can improve lesioning accuracy depending on the part of the FO to be punctured. The angles and safety distances obtained may help the neurosurgeon minimize complications during FO puncture and TN lesioning [8].

Koizuka et al., presented a new method for percutaneous radio-frequency thermocoagulation of the Gasserian ganglion, in which computed tomography (CT) fluoroscopy is used to guide needle placement.

In the present study, 15 patients with trigeminal neuralgia underwent percutaneous radio-frequency thermocoagulation of the Gasserian ganglion guided by high-speed real-time CT fluoroscopy.

RESULTS: Trigeminal neuralgia was improved in all patients after treatment without any severe complications. Moderate dysesthesia occurred in only one case.

CT fluoroscopy-guided percutaneous radio-frequency thermocoagulation of the Gasserian ganglion

was safe, quick, and effective for patients with intractable idiopathic trigeminal neuralgia [9].

Videos

<html><iframe width="560" height="315" src="https://www.youtube.com/embed/DB1GD9i3l5k" frameborder="0" allow="accelerometer; autoplay; encrypted-media; gyroscope; picture-in-picture" allowfullscreen></iframe></html>

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