Clinical Study

Minimizing Technical Failure of Percutaneous Balloon Compression for Trigeminal Neuralgia Using Neuronavigation

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Objective. Percutaneous balloon compression (PBC) is an effective and safe management for medically refractory trigeminal neuralgia; however, technical failure to cannulate the foramen ovale (FO) using only fluoroscopy is a significant problem in some cases. In this paper, we suggest the use of intraoperative navigation, in cases of reoperation due to prior technical failure to cannulate the FO under fluoroscopy.

Methods. A total of 174 patients underwent PBC for TN since 2003. In 9 cases the penetration of the FO was not accomplished. Five of those patients were reoperated on for PBC using navigation from March 2012 to September 2012. Surgical technique: preoperatively, a head Computed Tomography (CT) scan is performed and the acquired images are imported into the navigation system. Intraoperatively, a small reference frame is strapped firmly to the patient’s forehead, the CT images are registered, and cannulation is performed under the guidance of the navigation system.

Results. In all patients, the operation was completed successfully. Moreover, all patients reported complete pain relief immediately postoperatively, and no complications were recorded overall.

Conclusions. We suggest the use of neuronavigation in cases of technical failure of PBC. That technique involves technology with significant advantages helping the successful cannulation of the FO and seems more efficient and safer.

1. Introduction

Trigeminal neuralgia (TN), the most common craniofacial pain syndrome with an annual incidence of 3–5/100,000, can be a torturing condition devastating the patient’s quality of life [1, 2]. Half of the patients suffering from TN need an operation eventually, because of relapse or severe side effects of the drugs [2, 3].

Currently, the most popular therapeutic interventions for medically refractory TN include microvascular decompression, stereotactic radiosurgery, and percutaneous procedures, that is, percutaneous balloon compression (PBC), radiofrequency (RF) rhizotomy, and glycerol rhizotomy [2, 4–7]. Microvascular decompression provides the most long-lasting relief among the above techniques with the lowest recurrence rate [1, 4, 8, 9]. PBC is a reliable, effective, and safe technique [8–10]. Along with RF rhizotomy, it is one of the most effective ablative techniques, characterized also by a relatively low morbidity (16.1%) [8–10].

Typically, PBC is performed under the guidance of fluoroscopy (lateral, anteroposterior, and oblique submental views), but visualization of the FO can be inadequate sometimes and the exposure to radiation during fluoroscopy could be significant for the surgeon [11]. Also, the size of the foramen ovale (FO) is relatively small (6.5 × 3 mm) in contrast to the thick cannula used in PBC (14 gauges) [12, 13]. Moreover, the percutaneous approach of the FO is sometimes difficult, due to the presence of anatomical variations, such as ossified pterygospinous or pterygoalar ligaments or other intraforaminal bony ridges [4, 14, 15]. As a result, failure to cannulate the FO in PBC has been documented in up to 8% of the cases [16]. Also, multiple attempts to cannulate the FO might increase the risk of complications, such as vascular injuries or abducens nerve and other cranial nerve deficits [9, 10, 17].

For the above reasons, intraoperative navigation, which has been used successfully in various neurosurgical operations, could allow for an accurate targeting of the FO,
in cases of prior failure to cannulate it using fluoroscopy [12, 18–22]. The advantages of intraoperative navigation systems include three-dimensional planning (preoperative and intraoperative), real time instrument guidance, and accurate localization of intracranial targets [12].

In this paper, we suggest a treatment alternative: the use of intraoperative navigation for the guidance of PBC for TN, in cases of reoperation after prior technical failure to cannulate the FO under fluoroscopy.

2. Materials and Methods

2.1. Patients. A total of 174 patients underwent PBC for TN since 2003. In 9 cases the penetration of the FO was not accomplished and a narrow FO was suspected as a reason. Five of those patients, suffering from medically refractory primary TN, were reoperated on for PBC using navigation from March 2012 to September 2012. Four patients denied reoperation in spite of the persistence of pain.

Three patients were male and 2 female; their age ranged from 50 to 77 years and their disease duration from 2 to 11 years. Left trigeminal nerve was affected in 4 patients; the distribution of all branches was involved in 2, of the maxillary nerve in 2, and of V1–V2 in one. All procedures were performed by a single neurosurgeon. The research protocol has been approved by the Scientific and Ethics Committee of the University Hospital of Patras, Patras, Greece, and of the Faculty of Medicine of the University of Patras, Patras, Greece; and informed consent has been obtained from each patient.

2.2. Surgical Technique. A head CT scan (bone windows) is performed at 1.5 mm intervals, without contrast agent, one day before the operation. The acquired images are imported into the planning and navigation system (StealthStation S7, Medtronic Inc., Minneapolis, MN, USA); coronal, sagittal, probe’s eye, and 3D reconstructions are created, the FO is identified, and the ideal trajectory is designed (Figure 1). During the operation, the navigation system is combined with a small reference frame (Head Tracker Frame, Medtronic Inc., Minneapolis, MN, USA) and an adapter (SureTrak II, Medtronic Inc., Minneapolis, MN, USA) to make the cannula used in PBC identifiable by the navigation system.

3. Results and Discussion

3.1. Results. In all patients, the cannulation of the FO was accomplished with one attempt and the operation overall was completed successfully and conveniently. Furthermore, in 3 cases the FO of the target side was clearly narrower compared with the contralateral side of the skull base, as shown by the preoperative bone CT scan (Figure 2). The appropriate location of the inflated balloon was confirmed by fluoroscopy in the end. All patients reported complete pain relief immediately postoperatively. The patients were discharged on the first postoperative day, because it is routine practice in our center to observe their vital functions, consciousness level, and pain alleviation for one day.
Due to their cost. Besides, they may not provide an actual
visuospatially informative, especially in cases with anatomi-
cal variations [24].

Various methods have been described for the cannulation of
the FO using CT and navigation systems, in order to promote
successful insertion with the least possible attempts and avoid
complications, as well [12, 18, 19, 23–25]. However, we have
not encountered any other paper analyzing the application of
a navigation system, without impractical frames or intraop-
erative imaging systems, specifically for PBC and TN, after
technical failure to cannulate the FO under fluoroscopy.

The technique analyzed in this report does not involve
cumbersome frames for navigation's reference or stereotaxy,
head clamp fixation, or fiducials. Bale et al. have described
the use of an immobilization device with two mechanical
arms in combination with an individualized dental mold and
an aiming device, too [12]. Except for the patient’s comfort
and avoidance of postoperative pain because of head clamp
fixation or fiducials, a small practical reference frame, like the
Head Tracker Frame, can provide an ease in the maneuvers
during the operation.

The CT images used by the navigation systems offer a
superior resolution of the skull base osseous structures to the
classical fluoroscopic images, while the X-ray exposure from
fluoroscopy is reduced significantly. Fluoroscopy during the
protocol proposed in this paper was limited to one exposure,
making the procedure safer for the surgeon. The simulta-
neously display of different views (axial, coronal, sagittal,
and probe’s eye) or 3D reconstructed images is much more
visuospatially informative, especially in cases with anatomical
variations [24].

Intraoperative imaging systems have been used in some
studies [12, 18, 24]. Those systems are not widely available
due to their cost. Besides, they may not provide an actual
additional benefit. If cannulation is completed under naviga-
tion guidance using preoperative imaging as described above,
it can be confirmed by C-arm fluoroscopy using a common
device. If cannulation cannot be achieved even with naviga-
tion, sequential CT guidance could be used according to
Lin et al. [24].

RF rhizotomy has been applied in almost all studies
describing the use of navigation systems in percutaneous
procedures for TN [12, 19, 23–25]. According to reviews, PBC
is equally effective in the long term and has a lower complica-
tion rate (16.1%) than RF rhizotomy (29.2%), especially
concerning anesthesia dolorosa and keratitis [8–10]. PBC has
been used only in one study using navigation, in which an
intraoperative imaging system was used, as well [18].

5. Conclusions

Surgical management of unsuccessful PBC owing to technical
reasons remains controversial, since neurosurgeons may offer
another option, such as glycerol injections or RF rhizotomy.
In this report we suggest the use of navigation for the
guidance of the cannula during PBC, in cases of prior failure
to penetrate into the FO under fluoroscopy. That technique
involves technology with significant advantages helping the
successful cannulation of the FO and seems more convenient,
more efficient, and safer. Nonetheless, the latter has to be con-
firmed by clinical studies of sound methodology, for example,
prospective cohort studies or randomized controlled studies.

Conflict of Interests

The authors declare that there is no conflict of interests
regarding the publication of this paper.

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