Original Article

Complementary Fluoroscopic Guided Approach to Target the Foramen Ovale in Percutaneous Trigeminal Rhizotomy

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ABSTRACT

Background: Percutaneous cannulation of the foramen ovale to reach gasserian ganglion has been extensively discussed, starting with Hartel’s free hand approach to intraoperative imaging by CT or fluoroscopy, stereotaxy and neuronavigation techniques. Objective: We describe a technique to locate the foramen ovale by fluoroscopy and approach it in a real time fluoroscopic view using Hartel’s entry point and oblique submental view. Patients and Methods: A consecutive series of thirty patients treated in Suez Canal University Hospital between 2012 and 2015. The patient lies supine on fluoroscopic table, and moderate turn toward contralateral side of the target. We marked the Hartel’s entry point with a needle tip then obtain submental view of the skull. The foramen ovale was located and the foramen was cannulated in tunnel view. The impedance was measured (normal 200-350) and threshold painful stimulation (accuracy is <0.8V) was used as indicator for accuracy of the target.

Results: The immediate pain-relief was achieved in twenty nine patients who underwent radiofrequency trigeminal ablation. During the follow-up period two patients (6.6%) experienced recurrence of pain and reablation was done. The mean cannulation time was 11.9 min ±6.5, the mean threshold painful stimulation was 0.39 V ± 0.23 and the mean impedance was 288 Ohm ±47. Dysthesia occurred in 6 patients (20%), however, there was no permanent cranial nerve palsy or morbidity.

Conclusion: Real time fluoroscopy provides safe and accurate method to locate the trigeminal ganglion in relatively short time with feasible non expensive facilities.

INTRODUCTION

Trigeminal neuralgia is a common cause of facial pain. It is presented typically with paroxysmal, ultra-short, shock-like pain, affecting one or more divisions of the trigeminal nerve. Although it can occur at any age, it is more common in the elderly. Conservative treatment may help but a significant number of patients will need further treatment, including microvascular decompression.1-4

Less invasive techniques for treatment of trigeminal neuralgia are preferred and have shown significant and persistent pain relief. It is performed by a foramen ovale puncture up to the Gasserian ganglion, followed by destruction, either using radiofrequency, micro compression with a Fogarty catheter, or by neurotoxic substances (e.g. glycerol).5,6

Percutaneous cannulation of the foramen ovale to reach gasserian ganglion has been extensively discussed, starting with Hartel’s free hand approach to intraoperative imaging by CT or fluoroscopy, stereotaxy and neuronavigation techniques.7

Although the technical aspects of the fluoroscopic guided procedures are relatively straightforward using anteroposterior (AP) and lateral views, it can occasionally be difficult to cannulate the foramen ovale, especially in patients with multiple previous procedures.7,8 In addition, Significant morbidity has been reported due to the misplacement of the needle.9

We describe a technique to locate the foramen ovale by fluoroscopy and approach it in a real time oblique submental view using Hartel’s entry point.

PATIENTS AND METHODS

A total of thirty consecutive patients (thirteen males and seventeen females) with trigeminal neuralgia underwent a total of thirty two temperature controlled coagulations of the Gasserian ganglion with the new technique. Procedures were done in Suez Canal University Hospital in the Neurosurgery Department between June 2012 and December 2015.

Selection criteria

All patients who were diagnosed as trigeminal neuralgia. MRI was performed in all patients to exclude other etiology for trigeminal pain. All patients had drug treatment with carbamazepine and/or phenytoin. Trigeminal rhizotomy was recommended due to lack of efficacy or poor tolerance to drugs. The diagnostic criteria for primary, idiopathic trigeminal neuralgia were: 1) pain in the region of the trigeminal nerve 2)
paroxysmal with pain-free periods, abrupt onset; 3) sharp, shooting, electric shock-like pain; 4) provoked by light touch; 5) responded initially to anti-neuralgic therapy. Recurrence was defined as a return of persistent trigeminal pain, which had the same characteristics as pre-operatively, and required regular carbamazepine/phenytoin. 10

The outcome of radiofrequency trigeminal rhizotomy (RFT) was assessed in follow-up visits in every month after the procedure. Patients were asked to describe their post-RFT pain using Barrow Neurological Institute (BNI) Pain intensity scores as shown in table (1). Patients were also questioned about facial numbness, medication use, time to pain relief, and duration of relief. Outcome was assessed using BNI pain scale and grouped as good (BNI class I or II, no medication required) and bad (BNI class III, IV, V, medication required or failed).

Table 1: Barrow Neurological Institute pain intensity score

<table>
<thead>
<tr>
<th>No trigeminal pain, no medication</th>
<th>Occasional pain, not requiring medication</th>
<th>Some pain, adequately controlled with medication</th>
<th>Some pain, not adequately controlled with medication</th>
<th>Severe pain / No pain relief</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</table>

The intensity of pain was recorded using the visual analogue scale (VASs) before and after the procedure and during the follow up visits. The facial numbness before and after the procedure, corneal reflex, masticatory muscle power, medication used and duration of night sleep were recorded.

The patient lies supine on the fluoroscopic table with interscapular pad. Moderate turn of the head toward the contralateral side of the target minimizes the C-arm rotation in both caudocranial and lateral direction thus facilitating surgeon position near the head of the patient. The Hartel’s entry point is marked with a needle tip then obtain submental view of the skull. You can easily locate the foramen ovale by its location at the anterior border of petrous bone 12cm lateral to its apex. The foramen is adjusted to be medial to mandibular ramus and lateral to maxillary air sinus, and then align the foraminal metal pointer to be able to cannulate the foraminal in the tunnel view. Then we obtain lateral view by aligning the auditory meatus together to permit judgment of the depth of penetration of the needle (Figure 1 & 2).

After local infiltration of 2% lidocaine along the trajectory of cannulation over the skin and subcutaneous tissue, the cannula is introduced under fluoroscopic guidance. After verification of depth of penetration of foraminal ovale, the impedance is measured (normal 200-350 omme). Test stimulation was given at 50 Hz and 2 Hz to elicit paresthesia of painful division of trigeminal nerve and to check the threshold of masseter contraction. Paresthesia was elicited with average 0.15 volt in most cases (0.05-0.2 volt). After confirming the absence of side effect, the radiofrequency heat lesion was done at 70°C, 75°C, and 80°C for 60 seconds each. Careful sensory testing of the face was conducted during lesioning, and generating a lesion with mild to moderate, not dense, hypalgesia in the primarily affected division.

RESULTS

Between June 2012 and December 2015, thirty patients with trigeminal neuralgia underwent a total of thirty two temperature controlled coagulations of the Gasserian ganglion with this technique. The patients' age was between 24 and 76 years with a mean of 51 years. Thirteen patients were males and seventeen were females. All thirty patients were suffering from typical attacks triggered by brushing, touching, eating, or talking. Two younger patients had trigeminal neuralgia caused by multiple sclerosis, the others suffered from idiopathic trigeminal neuralgia. Five patients had in their history a previous coagulation of the Gasserian ganglion, and two patients had pain recurrence after vascular decompression.

The pain was right-sided in eighteen patients and left-sided in twelve patients. Three patients suffered from pain in the 2nd trigeminal branch only, five from pain in the 2nd and 3rd branches, nineteen from pain in the 3rd branch only, and two from pain in all trigeminal branches. Only one patient had pain in the 1st and 2nd branch. Table 2 summarizes the demographics in our series.

Table 2: Patient characteristics and demographics of patients in the study series

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients (n = 30)</th>
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<tbody>
<tr>
<td>Age</td>
<td>24- 76 (average 51) yrs</td>
</tr>
<tr>
<td>Sex (female : male)</td>
<td>17 / 13</td>
</tr>
<tr>
<td>Duration of symptoms</td>
<td>26 (range 8- 84)</td>
</tr>
<tr>
<td>Affected side</td>
<td>18 : 12</td>
</tr>
<tr>
<td>Affected division</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>3</td>
</tr>
<tr>
<td>V3</td>
<td>19</td>
</tr>
<tr>
<td>V1, V2</td>
<td>1</td>
</tr>
<tr>
<td>V2, V3</td>
<td>5</td>
</tr>
<tr>
<td>V1, V2, V3</td>
<td>2</td>
</tr>
<tr>
<td>Duration of follow-up</td>
<td>12 (range 6- 24)</td>
</tr>
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</table>

The number of reposition needed during cannulation of the foramen ovale was five. Therefore, total number of punctures needed for thirty patients with thirty two procedures was thirty seven. There were no complications, such as
hematoma and inadvertent puncture of other structures related to the cannulation of the foramen ovale. The mean time needed for cannulation of foramen was 11.9 min ± 6.5, the mean threshold painful stimulation was 0.39 V ±0.23 and the mean impedance was 288 Ohm ± 47.

All of the thirty patients experienced initial pain relief with radiofrequency trigeminal ablations, Barrow Neurological Institute score I in twenty seven, II in two, and III in one patient. (Table 3)

Table 3: Outcome and complications of percutaneous trigeminal radiofrequency ablation

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients (n = 30)</th>
<th></th>
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<tbody>
<tr>
<td>Recurrence</td>
<td>2 (6.6%)</td>
<td></td>
</tr>
<tr>
<td>Dysthesia / troublesome dysthesia</td>
<td>5 (16%) / 1 (3.3%)</td>
<td></td>
</tr>
<tr>
<td>Immediate pain relief</td>
<td></td>
<td>Barrow neurological institute pain intensity score</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I II III IV V</td>
</tr>
<tr>
<td></td>
<td>27 2 1</td>
<td></td>
</tr>
<tr>
<td>Long –term pain relief</td>
<td></td>
<td>Barrow neurological institute pain intensity score</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I II III IV V</td>
</tr>
<tr>
<td></td>
<td>25 3 1 1</td>
<td></td>
</tr>
</tbody>
</table>

In the long-term follow-up of the thirty patients, twenty five patients (84%) and three patients (10%) showed Barrow Neurological Institute score I and II responses, respectively. One (3.3%) patients was assessed as score III, another one (3.3%) showed score IV responses. (Table 3) The last two patient with score III and IV underwent radiofrequency ablation for the second time.

Five of thirty patients (16%) complained some degrees of dysthesia. This facial sensory deprivation was described as “not disturbing and not troublesome” in four patients, and as “an occasional and moderate disturbance in one patient. In addition, one patient of the whole series developed troublesome dysthesia (3%). Two patients (6.6%) developed weakness of the pterygoid or masseter muscles. Weakness resolved completely within three months. The corneal reflex was preserved in all patients. No bleeding and no infections were observed. We did not experience an occurrence of keratitis, paresis of extra ocular muscles, and other cranial nerve deficit. There was no mortality and no permanent cranial nerve deficit except dysthesia.

Fig 1 a&b : a: Patient head extension and lateral rotation to the contralateral side minimizing over rotation of the C-arm to locate the foramen facilitating the surgeon position at the right side of the patient to cannulate under real time fluoroscopy by right hand and fixing head (if needed) by left hand. b: Showing approach the superomedial wall of the foramen ovale using tunnel view making the cannula, Hartel’s entry point and the target (foramen ovale) as one point.
Fig 2 a&b: showing basic anatomical structures should be identified before locating the foramen ovale and adjusting the Hartel’s entry point by the needle marker to be aligned over the foramen ovale

DISCUSSION

Microvascular decompression of the trigeminal nerve is the standard technique in the treatment of idiopathic trigeminal neuralgia. Its main advantage is its causal therapy and the preservation of trigeminal nerve function. But there are still patients who are still candidates for a destructive intervention. These are patients with multiple sclerosis without vascular compression mimicking clinically typical attacks, patients with pain recurrence after vascular decompression or patients who are no candidates for an open surgery in the posterior fossa due to their general health condition. Finally, there are patients who prefer a destructive less invasive intervention by puncture of the Gasserian ganglion. For all these patients, a technically optimal destructive procedure at the level of the Gasserian ganglion should be offered. During the puncture of the foramen ovale, it is crucial to check the correct position of the needle tip.

The standard method to achieve this is fluoroscopic control in two planes: a lateral view to check the depth of the needle tip and an anterior sub mental projection to check the cranial-caudal position of the needle in relation to the foramen ovale. Although these standard projections give sufficient information of the needle position in most cases, frequently the mandible projects over the foramen ovale, and no good X-ray image quality can be obtained. This sometimes even result in the necessity to perform the puncture under CT guidance, and rarely access to the foramen ovale cannot be achieved at all.

To avoid the projection of the mandible over the foramen ovale during the standard sub mental X-ray projection, the head of the patient has to be sufficiently reclined, and the X-ray tube has to be tilted forward. Many elderly patients have however limitations reclining the head because of cervical spine stiffness. In other patients with huge chest volume, the X-ray tube may not be tilted sufficiently forward because of anatomical limitations. A solution to this problem consists in performing sub mental projection in a half sitting position as performed by Siegfried. However, this position is not felt comfortably by many patients. Additionally, there are also geometrical disadvantages by mimicking a correct needle position. This drawback can be partially overcome by comparing the needle position in sub mental projection with the position in the lateral projection. The importance of this procedural dilemma for all surgeons involved in percutaneous trigeminal neuralgia procedures is further supported by a recent publication by Tatli and Sindou. Those very experienced surgeons analyzed 100 cases to further define anatomical landmarks of the lateral projection to improve patients’ outcome.

An alternative to X-ray guidance represents direct visualization of the needle in CT images. The main drawback of the CT-based puncture is the fact that the standard CT slices are planes not perpendicular to the needle insertion. Therefore, this method is suitable to proof the position of the needle in the foramen ovale. Nevertheless, the orientation during puncture can be cumbersome. Gusmao et al. solved this problem by reformatting the CT planes becoming perpendicular to the inserting needle. Recently an even more sophisticated 3D computer-based method was proposed by Horiguchi. Yang et al. even evaluated the application of neuronavigation in the puncture of the foramen ovale.
However, all these techniques require a high computational expense in hardware and software.

In the current paper, a fluoroscopically controlled insertion of the needle into the foramen ovale using an oblique coaxial alignment of the X-ray tube is described which is very simple and overcomes all above described limitations with basically no additional expense and no time consumption. This projection has also the advantage that an incorrect needle position is immediately noticed, and an X-ray projection wrongly mimicking a correct needle tip position cannot occur. This projection also enables a very simple needle correction under fluoroscopic control during needle insertion. However, the oblique projection does not allow a comparison of the position of the foramen ovale on the other side as the submental projection does. We think that the oblique projection is superior to the standard anterior submental projection for controlling the position of the inserted needle in the foramen ovale.

Twenty five of the thirty patients selected for percutaneous radiofrequency trigeminal ablation are pain free up to their last follow-up. It is our strategy to be very cautious to avoid an anesthesia dolorosa. Therefore, we prefer to perform a second procedure rather than to produce a mostly not reparable anesthesia, which can lead to a permanent state of dysethesia or anesthesia dolorosa which is almost not curable because it is deafferentiation pain. Accordingly, two patients who did not show a long lasting benefit from the first procedure were selected for a second more rigorous percutaneous thermo coagulation which was performed successfully. Thus, preliminary data do rather support that the oblique projection could be more effective in entering the foramen ovale than the standard lateral and submental projections.

CONCLUSION

Oblique submental real time fluoroscopy provides safe and accurate method to locate the trigeminal ganglion in a relatively short time and is a non-expensive facility.

Declaration

The author(s) declare no conflict of interest or any financial support and confirm the approval of the submitted article by the concerned ethical committee.

REFERENCES


