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CT-guided percutaneous radiofrequency thermocoagulation for glossopharyngeal neuralgia: A retrospective clinical study of 117 cases

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ABSTRACT

Objective: Glossopharyngeal neuralgia (GPN) is a rare disorder of the ninth cranial nerve. Percutaneous radiofrequency thermocoagulation (PRT) is an established treatment for neuropathic pain. Since PRT was first applied with GPN, only a few studies have provided detailed reports on its clinical outcomes and complications, and the number of cases was small. The aim of this study was to investigate the effects, incidence rates, and severity of adverse events of computed tomography (CT)-guided PRT in 117 patients with GPN.

Patients and methods: A total of 117 patients with idiopathic GPN underwent CT-guided PRT from July 2004 to December 2016. A retrospective review of medical records was performed to investigate baseline characteristics and immediate outcomes after operation. Long-term outcomes were obtained via telephone interviews. Patients were followed up at 3 months, 6 months, and thereafter, every year after operation. According to Barrow Neurological Institute (BNI) pain scale, the effects of this treatment were categorized into 5 levels. Adverse events, frequencies, severity, and recovery times of complications were recorded.

Results: Patients who were classified into BNI class I and BNI class II experienced excellent pain relief. Ninety-six patients (82.1%) achieved "excellent" pain relief immediately after treatment. The mean follow-up period was 73.6 months (range, 13–150). With regard to long-term outcomes, the percentage of patients who experienced "excellent" pain relief was 75.9% at 1 year, 63.0% at 3 years, 54.0% at 5 years, 44.2% at 10 years, and 39.3% at 12.5 years. Complications, which included dysphagia, lingual numbness, pharynx and larynx numbness, hoarseness, and abnormal sense of taste, were graded 1 as defined by the Landriel Ibanez classification, and all complications disappeared within 12.9 ± 5.1 weeks.

Conclusion: This study indicates that PRT is a minimally invasive procedure that leads to minor complications and is proven to have immediate and long-term effectiveness for managing GPN. It is especially suitable for patients with contraindication to surgery and patients who require recurrent treatment. We provide a detailed report of the adverse events experienced by GPN patients who underwent PRT.

1. Introduction

Glossopharyngeal neuralgia (GPN) is a rare disorder of the ninth cranial nerve. It is characterized by severe paroxysmal episodes of electric shock-like pain typically localized to the oropharyngeal area. This intense pain is triggered by swallowing, talking, and coughing, making patients reluctant to eat, drink, and talk. Diagnosis of GPN is extremely challenging because of its atypical symptoms and its combination with other cranial nerve diseases. The prevalence of GPN is estimated to be approximately 0.8 per 100,000 population [1].

The treatments for refractory GPN are mainly limited to microvascular decompression (MVD) and percutaneous surgery [2]. MVD has become a widely used surgical treatment option for GPN [3,4]. There are many retrospective studies of MVD with large samples and detailed reports on clinical outcomes. Given the high risks associated with surgery and the potential for reoperation, safer and more effective percutaneous surgeries are in demand. Percutaneous radiofrequency thermocoagulation (PRT) is one established treatment for neuropathic pain [5–7]. The first PRT for GPN was reported in 1979 by Lazorthes and Verdie [8]. Since PRT was first applied with GPN, only a few studies have provided detailed reports on the clinical outcomes and complications of this approach, and sample sizes were small. In this

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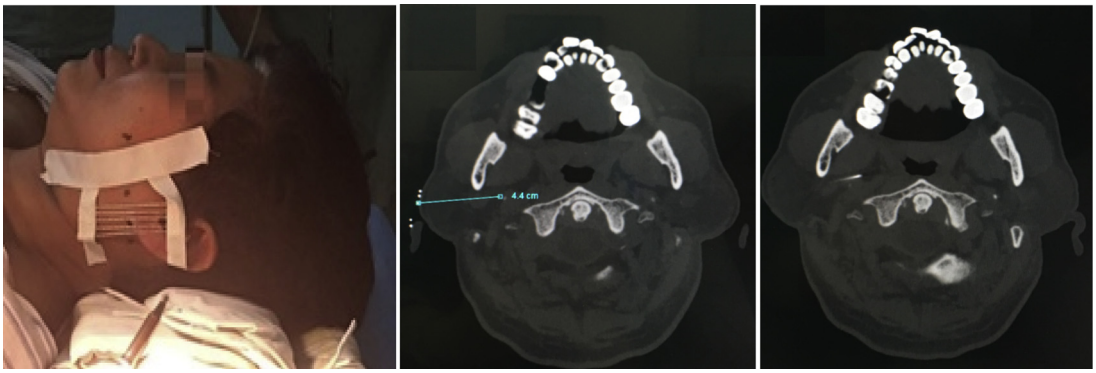

Fig. 1. PRT procedures.
A: A location bar placed on the skin of the mandibular angle.
B: CT scan confiremed the best puncture approach to the tip of the styloid process.
C: Repeated CT scan confirmed the needle in medial edge of styloid process.

retrospective study, we intended to provide the first detailed description of the outcomes, incidence rates, and severity of adverse events of PRT in a large number of patients with GPN. At the same time, clinical features of 117 patients were evaluated.

2. Patients and methods

From July 2004 to December 2016, records of 117 cases of idiopathic GPN were collected from our department. This study was approved by the local ethics committee. GPN was diagnosed according to the International Headache Society criteria [9].

2.1. PRT procedures

Each patient was taken to our disinfected CT examination room and placed in a supine position with the patient's head overhanging the CT scanner bed. ECG was continued for each patient, and the location bar was placed at the mandibular angle. (Fig. 1A shows location bar placed on the skin of the mandibular angle). CT scanning was used to determine the appropriate puncture approach and the corresponding skin insertion point to reach the tip of the styloid process. (Fig. 1B shows CT scan having confirmed the appropriate puncture approach to reach the tip of the styloid process). After sterilization, the insertion point was anesthetized with 1% lidocaine. Next, a 22-gauge radiofrequency-insulated needle with a 5-mm active tip was inserted. As soon as the needle reaches the styloid process, causing bone sensation, depth of needle insertion is marked, and the needle is then moved forward to a depth of 0.5 cm. Repeated CT scans were used to confirm that the needle tip was localized to the medial edge of the styloid process (Fig. 1C shows that repetition of CT scans confirmed position of the needle at the medial edge of the styloid process). Sensory stimulation of up to 0.5 V at 50 Hz was performed to reproduce concordant pain at the posterior part of the tongue, tonsils, and pharynx. Motor stimulation of up to 1.0 V at 2 Hz was negative, meaning no muscle contraction was caused. After confirming the proper location, the patient was given intravenous anesthesia (propofol, 1–2 mg/kg) and supplemented with oxygen through a facemask. Tracheal intubation was not performed. The glossopharyngeal nerve was then thermally coagulated with radiofrequency at 70 °C–85 °C for 120–180 seconds, depending on the patient's reaction to stimulation and the physician's experience. Vital signs were carefully monitored throughout the procedure.

2.2. Study variables

Baseline characteristics and immediate outcomes during hospitalization were obtained from the patients' medical records, and long-term results were obtained by an independent interviewer via telephone. The patients were followed up at 3 months, 6 months, and thereafter, every year after surgery.

Pain intensity: a numeric rating scale (NRS) score was used (0 = no pain, 10 = intolerable pain). The CT-guided PRT were categorized into 5 levels according to the Barrow Neurological Institute (BNI) pain scale: BNI class I (no pain, no medication), BNI class II (mostly pain-free and mostly without medication), BNI class III (tolerable pain with medication), BNI class IV (not adequately managed with medication), and BNI class V (severe pain or treatment failure) [10].

Complications: adverse events, frequencies, severity, and recovery times were recorded. The presence of adverse events was determined by hospital chart reports, as well as by direct statement from patients during follow-up. We classified the complications into three categories base on whether or not the complication affected quality of life: I, ild abnormalities and no influences on quality of life; II, moderate abnormalities and mild influences on quality of life; and III, severe abnormalities and serious impact on quality of life.

2.3. Statistical analysis

Statistical analysis was performed using SPSS software (ver. 20; IBM SPSS Statistics, Armonk, NY, USA). Descriptive statistics were used for patient data. Kaplan–Meier curves were calculated to determine the percentage of patients in the "BNI class I" and "BNI class II" outcome categories after CT-guided PRT. P values < 0.05 were considered to indicate statistical significance.

3. Results

3.1. Patient characteristics

Baseline characteristics of all patients are presented in Table 1. Patients' age, gender, and duration of symptoms are listed in Table 1. The mean follow-up period was 73.6 months (range, 13–150), and 21 patients were not available for follow up. The pain sites in 63 patients were the tongue, pharynx, and larynx. Pain usually begins in the region of the throat or at the base of the tongue and then radiates to the ipsilateral ear region or vice versa. In 9 cases, patients experienced auricular pain, in 29 cases mastoid pain and pain in the angle of the jaw, and in 16 cases neck pain radiating to the face. Procedures prior to PRT were recorded and are accounted for as follows: MVD procedure (n = 9, 7.7%), PRT (n = 5, 4.3%), stereotactic radiosurgery (n = 1, 0.8%), and nerve blocks (n = 12, 10.3%).

3.2. Post-operative outcomes

(1) Excellent pain relief (n = 96, 82.1%): patients who were

Table 1
Patient characteristics.

Feature	
No. of patients	117
Age (years; mean ± SD)	60.38 ± 11.16
Gender (female/male)	60/57
Duration of symptoms (months; mean ± SD)	38.32 ± 37.21
Follow-up time (months; mean ± SD)	73.6 ± 41.4
Symptomatic site (n)	
Tongue, pharynx, and larynx	63
Only auricular pain	9
Mastoid and angle of the jaw	29
Neck with radiation to head and face	16
Prior procedures	
MVD	9
PRT	5
Stereotactic radiosurgery	1
Nerve block	12

classified into BNI class I and BNI class II experienced excellent pain relief. Of 96 patients, 37 patients had an NRS score of 0, while the remaining 59 had scores ranging from 1 to 3. (2) Inadequate analgesia or relapse occurred (n = 21, 17.9%): patients were classified into BNI class III, IV, or V when inadequate levels of analgesia were achieved or when relapse occurred. Of these 21 patients, 6 patients had satisfactory pain control with medical treatment, and 10 patients underwent additional surgery, including repeat radiofrequency thermocoagulation (n = 4) and MVD (n = 6). Records of the remaining 5 cases were lost.

3.3. Long-term outcomes

Among 117 patients, 96 could be contacted to obtain follow-up data. Kaplan–Meier curves showed that the percentage of patients in the BNI class I and BNI class II outcome categories was 75.9% at 1 year, 63.0% at 3 years, 54.0% at 5 years, 44.2% at 10 years, and 39.3% at 12.5 years (Fig. 2). At 12.5 years of follow-up, symptoms had recurred in 58 patients. Of these patients, 20 were treated with medication to control their symptoms. Nine of these 20 patients were treated with gabapentin or oxcarbazepine, three with antidepressants, and the remaining eight with a combination of anticonvulsants and antidepressants. Thirteen patients underwent PRT again, and seven underwent MVD. Nine patients achieved pain relief through multiple nerve blockades. Three patients were treated with transcranial magnetic stimulation, but they did not experience positive outcomes. No

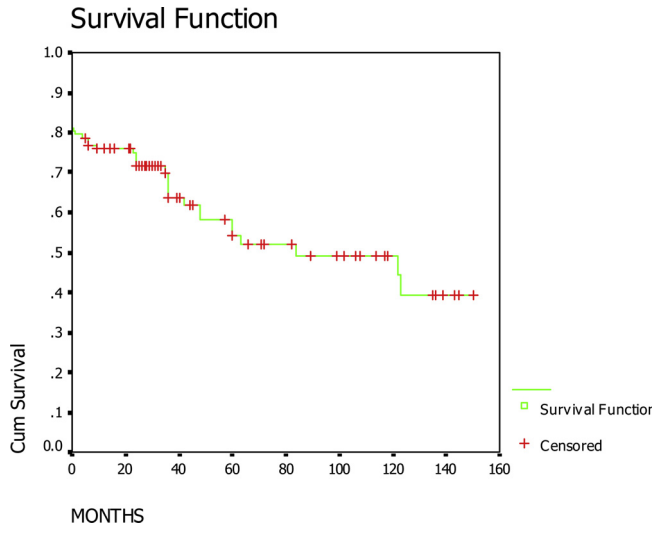

Fig. 2. Kaplan-Meier curve showing the long-term outcomes of PRT. X-axis is Months after PRT, and y-axis is probability of BNI class I and BNI class II.

Table 2
Complications of PRT for 117 cases.

Adverse event	Grade	Number	Ratio	Recovery time (weeks)
Dysphagia	I	7	6.00%	5.8 ± 2.3
	II	13	11.10%	
	III	6	5.10%	
Lingual numbness and abnormal sensation	I	21	17.90%	11.3 ± 5.6
	II	9	7.70%	
	III	0	0%	
Pharynx and larynx numbness	I	17	14.50%	12.9 ± 5.1
	II	5	4.30%	
	III	0	0%	
Hoarseness	I	3	2.60%	7.6 ± 3.4
	II	0	0%	
	III	0	0%	
Abnormal sense of taste	I	2	1.70%	5.0 ± 2.4
	II	0	0%	
	III	0	0%	

treatment was administered for six patients.

3.4. Complications

Table 2 lists postoperative adverse events, complication frequencies, and severity. No mortality or serious morbidity was observed in the patients. Twenty-six (22.2%) patients experienced dysphagia; of these, 13 patients' daily diets were mildly affected as they could only nibble on food. 6 were more seriously affected as they could only be fed with fluids. The dysphagia disappeared gradually, with a mean duration of 5.8 ± 2.3 weeks. The shortest and longest recovery times were 2 and 12 weeks, respectively. Thirty (25.6%) patients experienced lingual numbness and abnormal sensations; of these, 9 patients' lives were mildly affected as they were forced to eat using the contralateral side. These symptoms disappeared gradually with a mean duration of 11.3 ± 5.6 weeks, except for in 4 patients whose lives had not been affected. Twenty-two (18.8%) patients had mild-to-moderate pharynx and larynx numbness, and the mean recovery time was 12.9 ± 5.1 weeks, except for in 4 patients whose lives had been mildly affected, as they occasionally experienced choking coughs. Additional post-procedure complications included hoarseness (n = 3, 2.6%) and an abnormal sense of taste (n = 2, 1.7%), which slightly impact one's life. These symptoms improved within 12 weeks.

4. Discussion

The clinical characteristics, efficacy, and safety of PRT in 117 patients with GPN were examined in this study. The rate of immediate pain relief in patients treated with PRT was 82.1%, and long-term pain relief was 75.9% at 1 year, 63.0% at 3 years, 54.0% at 5 years, 44.2% at 10 years, and 39.3% at 12.5 years. Kaplan-Meier analysis shows that the duration of excellent pain relief tapers off with time. The decline in pain relief rates means that more patients have a relapse. Recurrence may occur with any treatment, including drug therapy, MVD, and PRT. The etiology of such instances of recurrence is uncertain but may be related to vascular compression or nerve demyelination. The cause for recurrence of GPN after PRT may be that most damaged nerve fibers destroyed by thermocoagulation can be gradually repaired physiologically, and some patients experience pain recurrence after repair. The overall immediate success rate of MVD exceeded 90% [11,12], and the rate of long-term (2.73–5 years) pain relief was 76%–92.3% [13,14]. Although the possibility of pain relief after PRT was lower than with MVD, PRT does not require craniotomy, tracheal intubation and shorter operation time [15]. The pain relief rate of Gamma knife radiosurgery is 71% in short term and 57% in long term (mean 16 months follow-up) [16]. When compared with the effects of radiosurgery, the efficiency of PRT is higher. Thus, PRT, which is minimally invasive, has a shorter

operative duration, and is associated with minor complications, is especially suitable for patients with a contraindication to surgery and patients who require recurrent treatment.

A few large samples have been used in previous studies of GPN, most of which were case reports or were limited in sample size. To our knowledge, only two published articles contained large sample sizes (217 and 228 patients), and although these groups of patients underwent MVD [11,13], there were no reports on clinical features. The diagnosis of GPN is mainly determined by clinical symptoms [12] and can sometimes be challenging. In this study, 54 (46.2%) cases of pain were not observed in the tongue, pharynx and larynx, which are the classic sites, but rather in the mastoid and angle of the jaw, ear, neck, and face. When pain occurs in these areas of multiple cranial nerve innervation, the possibility that it may arise from GPN should be considered. A thorough pre-operative assessment of pain distribution should always be carried out.

Radiofrequency thermocoagulation is widely used in the treatment of neuralgia [17,18]. In early PRT for GPN, the jugular foramen approach was used [8,19]. In this study, the target was the tip of the styloid process via a lateral cervical approach, rather than the classical jugular foramen. Cranial nerves IX, X, and XI pass through together at the level of the jugular foramen, which makes it easy for the nearby vagus nerve, spinal accessory nerve, and internal carotid artery to be injured. This leads to hemodynamic fluctuations during operation and a higher incidence of complications [20]. At the styloid process level, however, cranial nerves IX, X, and XI have sufficiently separated from each other, with the glossopharyngeal nerve being most adjacent to the distal part of the styloid process. This approach avoids neurovascular complications. Fluorography-guided puncture is more common than the CT-guided approach in the treatment of neuralgia but is difficult to perform on the glossopharyngeal nerve due to its location and adjacent neurovascular [21]. CT imaging can clearly visualize bones and soft tissue as well as determine the appropriate puncture path. In this study, all patients were successfully punctured using CT at the styloid process level.

Complications of PRT for GPN were described in detail in this study. All complications were of grade I as defined by the Landriel Ibanez classification [22]. Compared to MVD, there were no grade II or III complications [23], and the severity was of a lesser degree. We also provided three detailed classifications of adverse events based on whether or not quality of life was affected. Compared with MVD, complications are mainly due to nerve thermocoagulation, including dysphagia and numbness of the tongue and throat. There were no complications associated with craniotomy and mortality. These syndromes disappeared within an average of 12.9 weeks. This study is the first to describe the classification, frequency, severity, and recovery time of PRT-related complications, and it enhanced the feasibility of comparing the various surgical alternatives in existence. To reduce adverse effects in patients' lives, we propose the following measures: 1. provide oral care, eliminate residual food, and keep the mouth clean to prevent oral infection; 2. for patients with abnormal throat sensitivity provide an inhalation treatment using atomization, and encourage patients to use a normal tone of voice and avoid shouting; and 3. compensate by using the healthy side: instruct patients to eat and chew on the normal sensation side.

5. Conclusions

In our study, PRT was demonstrated to be safe and minimally invasive and showed immediate and long-term effectiveness for managing GPN. It is especially suitable for patients with contraindication to surgery and patients who require recurrent treatment. We provided a detailed report of adverse events in GPN patients who underwent PRT. For patients with oral, head, and neck pain, a comprehensive assessment of clinical symptoms is necessary.

Conflicts of interest

We declare that there are no conflicts of interest regarding the publication of this paper.

Author contributions

Jiaxiang Ni performed all of the minimally invasive surgeries in this study. Liping Song, Qian Pei, Kejun Peng, Nan Wang, and Zhaoxuan Guo collected the data. Liping Song and Liangliang He interpreted the results. Liping Song wrote the manuscript.

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