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CT-guided trigeminal ganglion neurolysis combined with sphenopalatine ganglion neurolysis for persistent idiopathic facial pain: A retrospective comparative analysis with propensity score matching

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Abstract

Background: Persistent idiopathic facial pain (PIFP) is one of the most challenging diseases to management. This retrospective comparative analysis is to compare the outcome of trigeminal ganglion (TG) neurolysis combined with sphenopalatine ganglion (SPG) neurolysis versus SPG neurolysis. The neurolysis was performed under CT guidance with oxygen-ozone gas. *Methods:* A retrospective clinical study was performed of retrospectively acquired data between January 2008 and January 2020 at our Pain Management Center. Patients were allocated into two groups; Group A: SPG neurolysis; Group B: TG neurolysis combined with SPG neurolysis. The baseline prognostic factors were equalized between the two groups using propensity score matching (PSM). Results: A total of 84 patients were enrolled in the two groups. Based on pain assessment by visual analogue scale (VAS), there was significant reduction for Group B versus Group A by one week that persisted till 1 year. The treatment success rate in Group A was 85.2% (29 of 34), 64.7% (22 of 34), 52.9% (18 of 34), 58.8% (20 of 34) and 47.1% (16 of 34) at 1 day, 1 week, 3 months, 6 months and 1 year after surgery, respectively. And in Group B was 94.1% (32 of 34), 82.4% (28 of 34), 70.6% (24 of 34), 76.5% (26 of 34), and 70.6% (24 of 34) respectively. No serious complications or side effects were observed.
Conclusions: CT-guided TG neurolysis combined with SPG neurolysis has a relatively better reduction of pain score than SPG neurolysis only.

Keywords: CT-guided; trigeminal ganglion neurolysis; sphenopalatine ganglion neurolysis; persistent idiopathic facial pain

INTRODUCTION

Persistent idiopathic facial pain (PIFP) is also known as atypical facial pain (AFP) or chronic AFP (CAFP). According to the International Classification of Headache Disorders, third edition (ICHD-3), it is defined as a persistent facial and/or oral pain, variable features, and recurring daily for more than 2 hours per day for more than 3 months, and in the absence of clinical neurological deficit.[1] PIFP can be diagnosed only when other known etiologies of facial pain are excluded and there are no distinguishable laboratory markers or abnormalities.[2] The etiology of PIFP is not clear, and may be related to infection, autonomic dysfunction and psychological factors. Some investigators believe that there was a neuropathic component to PIFP.[3] Evidence for the effectiveness of treatment for PIFP, whether it be opiate, anti-epileptic drugs, low-level laser, or sphenopalatine ganglion (SPG) block, is all inconclusive to make a definite recommendation. Thus, multimodality approaches are often used[3] and can be challenging.

The trigeminal ganglion (TG) and SPG have been proven to be related with PIFP.[4] Some interventional minimally invasive techniques targeting the TG and SPG, such as SPG block,

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alcohol and radiofrequency neurolysis[5], have been used to treat PIFP. However, alcohol and radiofrequency technique are plagued with an irreversible adverse effect, such as deafferentation pain along the ablated nerve post intervention, as well as irreversible sensory and motor loss.[5] SPG block has fewer complications, but it has a relatively lower efficacy rate.[6,7]

In the early stage of our clinical practice, we used SPG neurolysis (nerve block combined with ozone) to treat PIFP, but the efficacy of some patients was not satisfactory. Later we used TG neurolysis combined with SPG neurolysis under CT guidance. The CT guidance with the use of ozone allowed precise localization of the neurolysis target. In the review of literature, these two treatment techniques have not been compared. The objective of the current study was thus to compare the combined TG and SPG block, versus SPG block only. To reduce the bias of retrospective studies and the heterogeneity between two groups, we used propensity score matching (PSM) analysis.

METHODS

Participants

A retrospective comparative analysis was performed on the data acquired from participants who underwent TG neurolysis combined with SPG neurolysis or SPG neurolysis only under CT-guided at our pain management center between January 2008 and January 2020. All the patients failed to respond or had contraindications to gabapentin, pregabalin, and one of either carbamazepine or oxcarbazepine. This study was approved by our hospital research ethics committee.

The study subjects fulfilled the following inclusion criteria: The diagnosis of PIEP meet the PIFP diagnostic criteria according to ICHD-3, assessed by two experienced pain clinicians (HF Yang and XX Xu); the preoperative pain score should be visual analogue scale (VAS) > 6 (range 0–10); the pain did not respond to oral medications; and the subjects were age 18 years or older. Participants who had any of the followings were excluded: Brain MRI showed multiple sclerosis, arteriovenous malformation, brain tumor and other organic diseases; history of mental disorders and drug abuse; previous TG and SPG radiofrequency treatment, glycerol injection, balloon compression procedure; microvascular decompression (MVD) surgery; and gamma knife treatment. Demographic information of the study subjects, pain at baseline, detail of oral treatments, pain duration along with the surgical information, such as surgery site and technique, complications, and outcomes of the surgical interventions, were also recorded by two pain clinicians (B Li and C Zhang).

Procedure

Previous treatment agents were discontinued 12 h before the procedure. Participants were divided into the following two groups: Group A: SPG neurolysis; only Group B: TG neurolysis combined with SPG neurolysis. All patients were placed supine on the CT scanner (Philips MX-16). The heart rate, blood pressure, oxygen saturation (SpO2), and electrocardiogram (ECG) were continuously monitored. All operations are performed by the same experienced pain clinician (HF Yang). A 1-mm planning initial CT scan was performed, from the upper edge of the orbit to the hard palate. Enhanced contrast CT was needed to locate the maxillary artery and ensure an accurate needle path. Puncture location was determined on the CT scan, and the corresponding percutaneous point was marked. In group A, the puncture location was set at the pterygopalatine fossa (PPF). In group B, the puncture location was set at the PPF and foramen ovale (FO). Because the puncture length of the infrazygomatic approach is relatively short, and there is no important structure, then an infrazygomatic approach was preferably used. The puncture angle and depth of the needle were measured. Following sterilization and local anesthesia with 1% lidocaine, one or two 20 g needles (Straight; Tuoren, Henan Province, China) were inserted through the marked skin point to the target under CT guidance. For SPG neurolysis, the target was set as the PPF; and for TG neurolysis, the target was set just below the FO (Figures 1–4).

Once in place, the needle was maintained in aspiration for 3 s to prevent intra-vascular injection; 5 ml oxygen–ozone gas (25 μg/ml) was injected first and then 5 ml of lidocaine–contrast mixture was injected after. CT scans were performed to monitor the contrast and gas spread (Figure 1). In the meantime, patient's reaction was observed. If the pain disappeared, the needle was pulled out. After completion of the procedure, control scans were performed. Participants were then shifted to the ward, in a supine posture without a pillow on the hospital bed and monitored for 4 h. The mean duration of the procedure was about 30-40 mins.

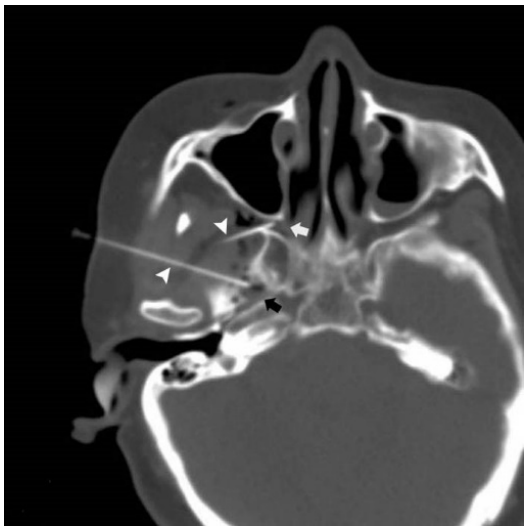

Figure 1. Axial computed tomography (CT) image showing the needle (White arrowhead) tip at the pterygopalatine fossa (PPF) (White arrow) and foramen ovale (FO) (Black arrow). Distribution of ozone gas can be seen.

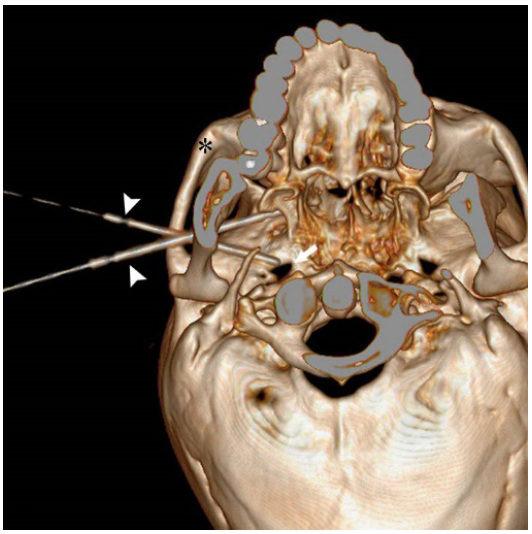

Figure 2. The 3D reconstruction CT showing the position of needle (White arrowhead). White arrow: foramen ovale (FO). * zygomatic.

Statistical methods

Statistical analysis was performed using the Statistical Package for the Social Sciences version 23.0 (IBM, USA). For comparison of the two groups, this study equalized the baseline prognostic factors of the two groups using PSM. The propensity score was based on the following baseline covariates: age, gender, pain duration, pain location, preoperative VAS. During matching, this study used a caliper width of 0.2 standard deviation (SD) of the propensity score to limit the allowed distance between two matched patients. Kolmogorov-Smirnov test was used to verify standard normal distributional assumptions. Student's t-test was used to compare continuous variables before PSM. Continuous variables after PSM were performed using a paired t-test. Data are presented as mean ± standard deviation.

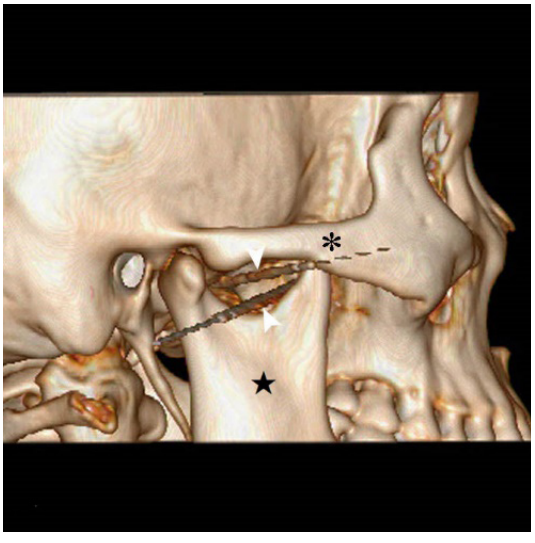

Figure 3. The 3D reconstruction CT showing the needle (White arrowhead) which with an infrazygomatic approach. * zygomatic; ★ Mandible.

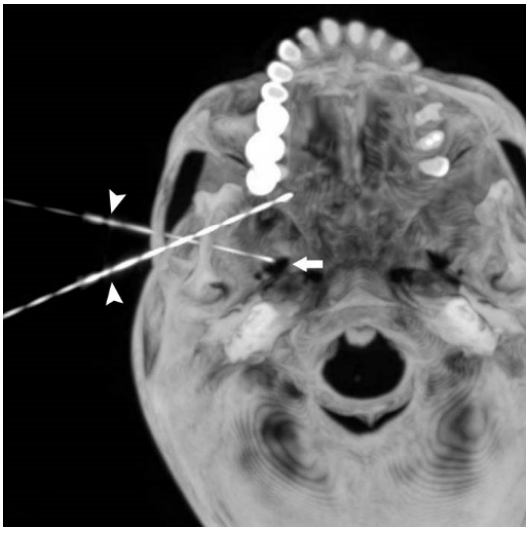

Figure 4. The maximal intensity projection (MIP) CT showing the needle (White arrowhead) tip just nearby the foramen ovale (FO) (White arrow).

Table 1: Patient characteristics by group

Characteristics	Before matching				After matching			
	Group A (n=46)	Group B (n=38)	P-value	SMD	Group A (n=34)	Group B (n=34)	P-value	SMD
Age	53.50±10.28	61.04±11.70	0.010	2.789	57.94±12.34	57.06±11.84	0.658	1.953
Gender	M/F=26/20	M/F=24/14	0.668	0.122	M/F=20/14	M/F=26/8	0.269	0.154
Pain duration	7.67±6.63	15.44±17.04	0.037	3.547	6.47±3.59	7.12±2.62	0.574	1.128
Pain Location	R/L=18/26	R/L=14/11	0.246	0.125	R/L=9/8	R/L=9/8	1.000	0.171
Preoperative VAS	7.00±1.11	7.3±1.05	0.269	0.272	7.00±1.22	7.29±1.10	0.400	0.340

SMD, standardized mean difference; VAS, visual analogue scale;

Comparisons of categorical variables were performed using χ^2 test. We defined a 50% or more reduction in pain intensity from baseline after treatment as successful pain reduction. A *P* value < 0.05 was considered statistically significant.

RESULTS

A total of 84 patients were included in the two groups. The 34 paired patients were selected by PSM. The patient characteristics before and after PSM are shown in Table 1. The mean ages of patients in the two groups were 57.94 years (age range 34 to 78 years) and 57.06 years (age range 35to 76 years), respectively. Patients in group A and group B reported severe local pain at baseline, and the scores were 7.00 and 7.29, respectively. Mean pain durations in the two corresponding groups were 6.47 and 7.12 months, respectively. There was no significant difference in mean age, gender, VAS pain scores, or pain duration between the two groups (Table 1).

The treatment success rate in group A was 85.2% (29 of 34), 64.7% (22 of 34), 52.9% (18 of 34), 58.8% (20 of 34) and 47.1% (16 of 34) at 1 day, 1 week, 3 months, 6 months and 1 year after procedure, respectively. The treatment success rate in group B was 94.1% (32 of 34), 82.4% (28 of 34), 70.6% (24 of 34), 76.5% (26 of 34), and 70.6% (24 of 34) at 1 day, 1 week, 3 months, 6 months and 1 year after procedure respectively. There was statistically significant difference in outcome between two groups at 1 year, but there were no statistically significant difference in outcome between two groups at 1 day, 1 week, 3 months, and 6 months (Table 2). VAS scores were significantly decreased in both group A and group B when compared with the baseline values in the same group at all points of follow-up. There were statistically significant difference when compare the VAS scores between two groups at 1 week, 3 months, 6 months and 1 year after procedure (Table 3 and Figure 5).

Patients in group A who had unfavorable outcomes at 1 year after surgery, eleven patients received TG and SPG neurolysis, seven patients

Table 2: Success rate of two groups after the treatment

Period	Group	Successful Patients	Unsuccessful Patients	Success Rate	*P* value
1-day follow-up	A	29	5	85.2%	0.231
	B	32	2	94.1%	
1-week follow-up	A	22	12	64.7%	0.099
	B	28	6	82.4%	
3-month follow-up	A	18	16	52.9%	0.134
	B	24	10	70.6%	
6-month follow-up	A	20	14	58.8%	0.120
	B	26	8	76.5%	
1-year follow-up	A	16	18	47.1%	0.049
	B	24	10	70.6%	

"Successful" is defined as a relative pain reduction of 50% or more; "unsuccessful" is defined as a relative pain reduction less than 50%.

Table 3: VAS Scores of two groups after the treatment

Period of follow-up	Group A	Group B	*P* value
Baseline	7.00±1.22*	7.29±1.10*	0.400
1 day	2.41±0.87*	2.06±0.90*	0.231
1 week	3.29±1.16*	2.47±0.80*	0.014
3 month	3.29±0.92*	2.53±0.80*	0.023
6 month	3.41±1.06*	2.41±0.79*	0.010
1 year	3.18±1.18*	2.12±0.78*	0.004

*$P < 0.05$ during comparison of different values with baseline in the same group.

received TG radiofrequency. In group B, six patients received TG and SPG neurolysis again, four patients received TG radiofrequency. Six patients had facial hematoma after surgery, two patients from group A and four patients from group B, there were no statistically significant difference in complications rate between two groups. No other complications or side effects were observed (Table 4).

DISCUSSION

Chronic or persistent pain, which occurs in PIFP, is associated with severe emotional, physical, or social consequences.[8] It affects not only the patient but also the patient's family. The financial burden can also be significant. The PIFP presentation may be atypical resulting in delay of diagnosis and treatment. The diversity in the causes of PIFP and differences in the treatment technique have made the clinical management of PIFP challenging.[9,10]

In our study, PSM was used to balance the baseline variables of the two groups. Our study showed that CT-guided TG neurolysis combined with SPG neurolysis is a feasible and effective procedure. Furthermore, this technique being a minimally percutaneous treatment (as opposed to surgical management) does not require other expensive devices (such as stimulation or radiofrequency), and due to the precise step-by-step guidance by CT, it is a cost-effective treatment with low complication rates.

TG and SPG have been shown to be associated with various types of PIFP.[9,11,12] The primary sensory innervation of the face is provided by the trigeminal system. A percutaneous transovale approach to the TG for ethanol neurolysis was first published by Hartel in 1912.[13] An alternative percutaneous procedure targeting the TG is balloon compression, first described by Mullan and Lichton in 1978 and first published in 1983.[14] Radiofrequency ablation (RFA) of the Gasserian ganglion was first described as a successful treatment for TN by Dr. Sweet and published in 1974.[2] Numerous studies have shown similar results. Treatment efficacy of RFA in treating trigeminal neuralgia was 80%–98% (i.e., high-grade or complete relief) in these studies. A

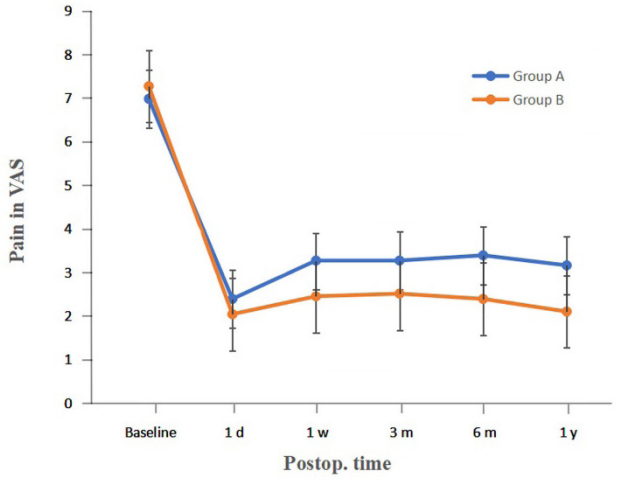

Figure 5. Visual analogue scale (VAS) between group A and group B at 1 day, 1week, 3 months, 6 months and 1 year after surgery.

Table 4: Complications of two groups after treatment

Group	Complications number	Complications type	Percentage (%)	*P* value
A	2	facial hematoma	0.059	0.400
B	4	facial hematoma	0.118	

15%–20% symptom recurrence rate within the first year and 4%–65% rate within 13 years were also reported. RFA showed a better initial success rate and less likelihood of symptom recurrence at 1 year compared with other percutaneous techniques.[4] But there were some anticipated side effects following RFA of the TG, including sensory loss in the distribution of the treated nerve(s), corneal anesthesia, and masseter weakness. There have been reports of intracranial hemorrhage, stroke, and death following TG RFA.[15,16]

The SPG is the largest and most superior ganglion of sensory and sympathetic system, and has been postulated to be involved in facial pain and headaches for over a century. Because the sympathetic trunk is connected to the deep petrosal nerve then to the SPG, SPG blockade is thought to be able to relieve pain from the head and face. Since Sluder first described transnasal SPG block in 1908 with satisfactory short-term results, and several interventional treatment methods have emerged thereafter.[17] As the first report on the use of radiofrequency on the SPG for treating Sluder's neuralgia by Salar[18], multiple studies using SPG radiofrequency ablation for treating head and facial pain have been reported.[17] Compared to the SPG block, SPG radiofrequency ablation often tends to have a more sustained effect. The side effects include paresthesia in the cheek and upper gums, cheek hematomas, and temporary postoperative epistaxis. Some studies have also reported occasional partial radiofrequency lesion of the maxillary nerve.[12,16,17]

In our study, we combined TG neurolysis with SPG neurolysis for the treatment of PIFP, and the results showed that this method is more effective than SPG neurolysis only. In general, the common puncture site for trigeminal nerve treatment is located on the side of the mouth and the needle tip is advanced inside the FO.[15] This approach may lead to complications, such as cerebral spinal fluid (CSF) leak, hematoma, and nerve injury.[15] Thus, we used a lateral approach posterior to the coronoid process of the mandible through the mandibular notch and placed the needle tip under the FO. In our study, no significant complications occurred. In addition, use of TG neurolysis combined with SPG neurolysis has expanded the therapeutic range. In the procedure of neurolysis, we injected oxygen–ozone before drug solution injection. The use of oxygen-ozone gas could improve microcirculation and resolution of the venous stasis, increase the local oxygen supply, reduce nerve root edema and ischemia, and separate the adhesions around the nerve, and if combined with drug solution, it can expand drug solution distribution, thus have a synergistic effect.[19]

The differential diagnosis between PIFP and TN is important but can be difficult. In our study, the differential diagnosis was performed by two experienced pain physicians. All patients included in the study fulfil the diagnostic criteria of PIFP according to ICHD-3, thus enhancing the quality of the study data.

The limitation of our study is the inherent defect of retrospective studies. Thus, future randomized controlled studies with a large sample size are needed.

In conclusion, in this series of 34 paired patients with PIFP, we have shown that CT-guided TG neurolysis combined with SPG neurolysis has a relatively higher treatment success rate than SPG neurolysis only within 1 year follow-up, and it is a feasible, safe, and effective therapy. Further large patient cohorts are needed to confirm the results.

DISCLOSURE

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Conflict of interest: None

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