Neurological Sciences (2019) 40:1173–1181
https://doi.org/10.1007/s10072-019-03782-x

ORIGINAL ARTICLE

Pulsed radiofrequency of the C2 dorsal root ganglion and epidural steroid injections for cervicogenic headache

Shao-jun Li[1] · Dan Feng[1]

Received: 9 October 2018 / Accepted: 19 February 2019 / Published online: 7 March 2019

Abstract

Background Cervicogenic headache (CEH) is characterized by unilateral headache symptoms referred to the head from the cervical spine. Few methods have addressed long-term pain relief for CEH. This study was undertaken to evaluate pain control and quality of life after pulsed radiofrequency (PRF) for the C2 dorsal root ganglion and epidural steroid injections (ESI) for CEH.

Methods This was a case-control study. One hundred thirty-nine patients suffering from CEH were enrolled in this study. Of these patients, 87 CEH patients underwent PRF for the C2 dorsal root ganglion and ESI therapy, and 52 CEH patients only underwent ESI therapy. Quality of life and pain control were measured with the European Organization for Research and Treatment of Cancer (EORTC) Quality-of-Life Questionnaire (QLQ-C30) and Izbicki pain scores. Kaplan-Meier curve was used to evaluate the efficacy of the treatment in the groups.

Results Before therapy, the median of Izbicki pain score in PRF+ESI group and ESI group was 78.5 and 72.5, respectively ($p = 0.574$). After 2 year follow-up, significant reduction was found in the two groups (11.25 versus 40.00, $p < 0.001$). The two groups demonstrated an equal distribution of age and gender ($p > 0.05$). SF (68.52 ± 21.50 versus 50.63 ± 15.42), PF (70.61 ± 29.47 versus 47.87 ± 21.53), RF (52.04 ± 17.92 versus 38.13 ± 24.07), EF (61.17 ± 28.41 versus 43.52 ± 25.48), CF (55.36 ± 19.82 versus 46.82 ± 23.54), and QL (59.31 ± 27.44 versus 50.73 ± 21.90) were significantly higher in PRF+ESI group than in ESI group. Kaplan-Meier curve showed that the probability of treatment success in PRF+ESI group was higher than that in ESI group (median pain relief: ESI group, 4 months; PRF+ESI group, 8 months) (Log-Rank test, $p < 0.001$). There was no serious side effect in this study.

Conclusion The combination of PRF for the C2 dorsal root ganglion and ESI is a relatively safe therapy for CEH. This technique not only provides the sustained relief of pain symptom but improves the quality of life in patients with CEH.

Keywords Cervicogenic headache · Pulsed radiofrequency · Cervical epidural steroid injection · Therapy

Abbreviations

CEH	Cervicogenic headache
PRF	Pulsed radiofrequency
ESI	Epidural steroid injections
NDI	Neck disability index
EORTC	European Organization for Research and Treatment of Cancer
SF	Social function
CF	Cognitive function
EF	Emotional function
RF	Role function
PF	Physical function
QL	Global health score
IQR	Interquartile range

Introduction

Cervicogenic headache (CEH) is characterized by unilateral headache symptoms referred to the head from the cervical spine [1, 2]. The headache symptoms can present with neck pain, muscle stiffness, and neck activity limits, even associating with unilateral shoulder and arm pain [3]. CEH is one of the common headaches. The prevalence of CEH varies from 1 to 13.8% [4, 5]. Clinically, the diagnosis of CEH is difficult.

✉ Dan Feng
13995621216@163.com

[1] Department of pain management, Wuhan No.1 Hospital, Wuhan 430022, Hubei Province, China

Most patients with CEH have a unilateral headache, whereas some present with bilateral symptoms. The headache usually starts posteriorly, sometimes can move to the front. The pain can occur in neck, radiating outward to the fronto-temporal area. Moreover, pain severity and character are different during the course of the disease. Pain symptoms have many forms range from those CEH patients with little pain to those with continuous and severe pain. In addition, the CEH patients share many features in common with other forms of headache, such as migraine and tension-type headache [6]. Headache symptoms are an important feature of these diseases. CEH is referred pain from the cervical spine and usually a unilateral headache. The pattern of pain episodes can change into a chronic fluctuating continuous pain. Well, patients with chronic migraine have headaches on at least 15 days a month, with at least 8 days a month on which their headaches [7]. Unilateral location is also one of the characteristic in migraine, tension-type headache. Symptoms such as nausea and/or vomiting, dizziness, photophobia, and phonophobia, moderate or severe pain intensity can also occur in CEH patients [8]. In addition, pain in CEH clinically starts in the neck and develops to oculo-fronto-temporal areas. Similarly, some migraine patients report neck discomfort and stiffness during an attack, likely related to pain referral from the head to the neck. It is noteworthy that patients with a history of migraine or a genetic tendency for migraine may be especially prone to developing CEH [9, 10].

Pain treatment in CEH patients remains the most difficult challenge. In the past, pain treatment begins with conservative treatments, such as drugs, manual therapy, and exercises. However, there is no specific therapy to relieve the pain in the long-term follow-up. Until recently, various interventional procedures were reported. Anthony et al. [11] reported that over 90% (169/180) CEH patients with occipital nerve blockade had pain relief. Bovim et al. [12] have described the benefit of cervical nerve (C2) injections and cervical facet injections (C2/3 facet level). He et al. [13] reported 37 CEH patients treated by a continuous epidural block. A significant reduction was found in headache frequency and intensity for cervical epidural steroid injections in 6 months. Although injections of the nervus occipitalis or cervical facet injections could be a beneficial treatment for CEH in short-term relief, no improvement was seen in long-term follow-up.

Hopefully, radiofrequency (RF) treatment was a satisfactory treatment option for CEH. Bovaira et al. present three CEH patients with RF treatment. Two patients reported 70% improvement after 1 month, 60% improvement after 6 months, and 30–50% after 1 year [14]. Similarly, Hamer et al. [15] conducted a prospective study of 40 patients with radiofrequency ablation of the C2 dorsal root ganglion and/or third occipital nerve. Thirty-five percent cases had pain totally disappeared. But, 15% patients had complications or side effects. Recently, pulsed radiofrequency (PRF) could provide the most sustained relief of CEH. Zhang et al. [16] reported two CEH patients who were treated with PRF on the position of the second cervical ganglion (C2) and the patients had satisfied pain control. Moreover, epidural steroid injection (ESI) was a safety technology in previous studies for CEH. Therefore, we compared PRF for the C2 dorsal root ganglion and ESI, and cervical ESI only for CEH.

Methods

Patient selection

This was a single-center retrospective study. Between 1 December 2015 and 1 December 2017, 156 patients diagnosed with CEH were referred in the Department of Pain Management, Wuhan No.1 Hospital, Wuhan, China. The study was conducted in accordance with the principles of the Declaration of Helsinki and the guidelines of Wuhan No.1 Hospital. All the selected patients agreed to the treatment and were asked to sign informed consent before therapy. CEH was diagnosed according to the CHIG classification system, which included clinical history and physical examination [17, 18] (Table 1).

On admission, all CEH patients from the study cohort were evaluated by CT and MRI images. The CT and MRI images were usually used to exclude tumors, fractures, infections, and cervical disc herniation. Instability of the cervical spine and abnormal physiological curvature (usually occurring in C2-C3, and C3-C4) can be found in most CEH patients on CT images. The most common abnormal finding in MRI images was cervical degeneration. Cervical disc herniation or bulging was also found in MRI examination. In our study, pain treatment began with medical therapy (Celebrex, 200 mg, 2 times a day). PRF for the C2 dorsal root ganglion and ESI therapy or

Table 1 Diagnostic criteria of cervicogenic headache (CEH)

1. Unilateral headache without side-shift
2. Symptoms and signs of neck involvement: pain triggered by neck movement or sustained awkward posture and/or external pressure of the posterior neck or occipital region; ipsilateral neck, shoulder, and arm pain; reduced range of motion
3. Pain episodes of varying duration or fluctuating continuous pain
4. Moderate, non-excruciating pain, usually of a non-throbbing nature
5. Pain starting in the neck, spreading to oculo-fronto-temporal areas
6. Anesthetic blockades abolish the pain transiently provided complete anesthesia is obtained, or occurrence of sustained neck trauma shortly before onset
7. Various attack-related events: autonomic symptoms and signs, nausea, vomiting, ipsilateral edema and flushing in the peri-ocular area, dizziness, photophobia, phonophobia, or blurred vision in the ipsilateral eye

only ESI therapy is considered for patients who have refused or not responded to medical therapy. Exclusion criteria were as follows: (1) patients diagnosed with CEH < 1 month; (2) patients with spinal cord compression and/or myelopathy; (3) migraine, tension-type headache, and occipital neuralgia; (4) pain-related cranial neuralgias (the pain caused by 12 pairs of cranial nerves such as trigeminal neuralgia, facial neuralgia, glossal-pharynx neuralgic); and (5) tumors, fractures, infections, and rheumatoid arthritis of the upper cervical spine.

Measurements

Health-related quality of life was assessed using the European Organization for Research and Treatment of Cancer (EORTC) quality of life questionnaire. The EORTC questionnaire contains 30 items. It contains eight dimensions: functional scale; working ability scale; general symptom scale; scales on cognitive, emotional, and social functioning; financial strain scale; and global quality of life scale [19]. A pain scoring system including a visual pain analogue scale, frequency of pain attacks, analgesic medication as morphine equivalents, and time of disease-related inability to work was used to assess pain intensity [20]. Neck disability index (NDI) is a self-administrated questionnaire to measure neck-related disability. It incorporated ten items scored 0 (no activity limitation) to 5 (major activity limitations) [21].

Follow-up examination was conducted before therapy and 2 years after therapy in all the eligible patients. The deadline for the follow-up time was 1 July 2018. Preoperative variables included age, gender, duration, symptoms, limited normal activity, pain character, and pain severities were recorded. Follow-up data were performed in all the selected patients in the form of mailed questionnaires or additional telephone contact to the patient or home physician or outpatient visits. They always included standardized questionnaires asking the presence of pain, pain intensity (including visual analogue scales), pain frequency (none/daily/weekly/monthly/yearly), the EORTC QLQ-C30 questionnaires, and Neck Disability Index (NDI) questionnaires. The pain recurrence event was the key point in the study. In addition, physical and mental health, length of hospital stay, and number of procedures performed were also evaluated. In our study, all treatments were performed by the same doctor (Dan Feng). All the questionnaires and follow-up data were recorded by a doctor (Shao-jun Li).

Technique

A preoperative plasma glucose level test routinely screens for CEH patients. The patient was placed in a supine position. Under the guidance of X-rays. Epidural catheter was selected at the C6-7 vertebral bodies to reach the level of C2 vertebral body, then injecting the contrast agent to confirm the catheter position at C2 level. Five milliliters of liquid local anesthetic mixture (2% lidocaine + 1.5 mg/ml betamethasone + 0.9% normal saline) was injected into C2 nerve root. Meanwhile, sensory stimulation test was conducted when the puncture needle arrive at bone of the C2 level at 50 Hz. The puncture was directed toward the epidural space and over the same atlantoaxial joint. Then, motor stimulation was tested at 2 Hz. PRF was performed at 42 °C, frequency 60 Hz for 5 min.

Statistical analysis

SPSS software, version 22.0 (SPSS Inc.) was used for statistical analysis. Quantitative data were expressed as means ± standard deviations. To identify statistical differences, two-sided Fisher's exact tests, Mann-Whitney *U* test, and chi-square tests were used as appropriate. Kaplan-Meier curve was used to assess the probability of treatment success with time. The data was analyzed using the log-rank test. A value of $p < 0.05$ was considered significant.

Results

General characteristics of patients

Thirteen patients were excluded from this study and 4 patients lost to follow-up. Of the 156 patients, 139 patients were eligible for criteria for study after 2-year follow-up (Fig. 1). There were 91 men (65.5%) and 48 women (34.5%), with a mean age of 47.5 ± 12.4 years (range 39 to 76 years). The median interval from onset of symptoms of pain to referral for therapy was 50.4 (SD, 37.6) months (range 2–180 months). Over 40% (62/139) patients had a history of headache for more than 2 years (Fig. 2). Neck soreness occurred in 126 (90.6%) patients, stiffness in 53 (38.1%) patients, limited normal activity in 37 (26.6%), and decreased appetite in 85 (61.1%). Symptoms and signs of neck involvement occurred in 124 (89.2%) patients, shoulder involvement in 42 (30.2%) patients, and arm involvement in 37 (26.6%) patients. Other pain symptoms are shown in Table 2.

Pain assessment and quality of life

Of the 139 patients, 87 CEH patients underwent PRF for the C2 dorsal root ganglion and ESI, and 52 CEH patients only underwent cervical ESI. Before therapy, the median of Izbicki pain score in PRF+ESI group and ESI group were 78.5 and 72.5, respectively ($p = 0.574$). After 2-year follow-up, significant reduction of total pain score was found in the PRF+ESI group and ESI group (11.25 versus 40.00, $p < 0.001$). Additionally, the PRF+ESI group had lower score in pain

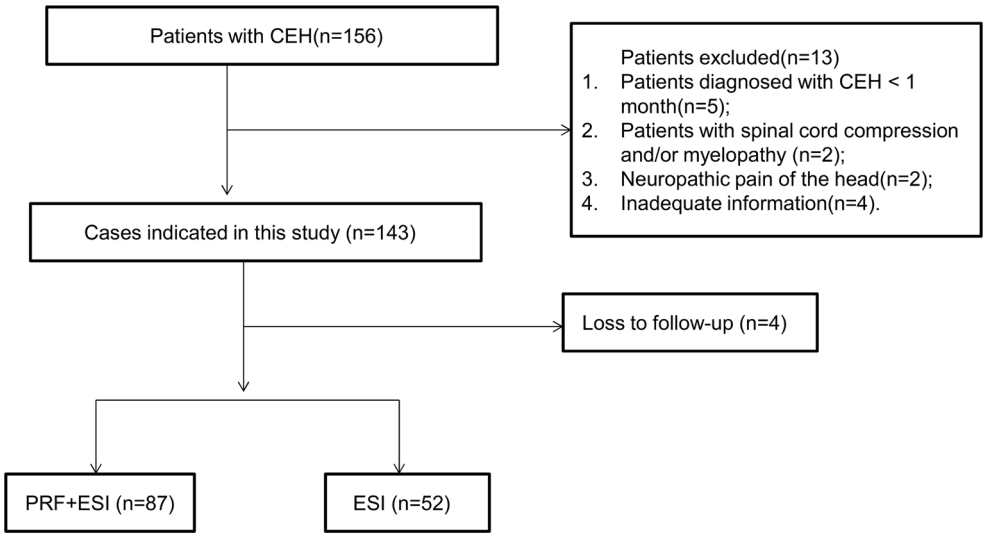

Fig. 1 Study enrollment

VAS, frequency of pain attacks, pain medication, and inability to work than ESI group ($p < 0.001$) (Table 3).

Quality of life evaluation according to the EORTC QLQ-30 during follow-up after therapy is shown in Table 4. The two groups demonstrated an equal distribution of age and gender ($p > 0.05$). Social function (SF, 68.52 ± 21.50 versus 50.63 ± 15.42), physical function (PF, 70.61 ± 29.47 versus 47.87 ± 21.53), role function (RF, 52.04 ± 17.92 versus 38.13 ± 24.07), emotional function (EF, 61.17 ± 28.41 versus 43.52 ± 25.48), cognitive function (CF, 55.36 ± 19.82 versus 46.82 ± 23.54), and global health score (QL, 59.31 ± 27.44 versus 50.73 ± 21.90) were significantly higher in PRF+ESI group than in ESI group. Regarding the symptom scales, fatigue, pain, appetite loss, and sleep disturbance were lower in PRF+ESI group ($p < 0.05$). There was no difference in two groups in financial difficulties ($p = 0.731$), treatment strain ($p = 0.063$), and hope and confidence ($p = 0.418$).

Neck Disability Index scores and Kaplan-Meier curve for the pain relief

The total score of NDI was lower in PRF+ESI group than in ESI group (median, IQR—16, 18 versus 28, 24) ($p < 0.001$). Also, there was significant difference between the two groups with regard to pain intensity (median, IQR—2, 3 versus 2, 4), personal care (median, IQR—1, 2 versus 1, 4), lifting (median, IQR—1, 2 versus 3, 4), sleeping (median, IQR 2, 3 versus 3, 2), driving (median, IQR—1, 2 versus 2, 2), recreation (median, IQR—1, 2 versus 4, 3), headaches (median, IQR—1, 2 versus 2, 3), concentration (median, IQR—1, 1 versus 3, 2), reading (median, IQR—3, 3 versus 3, 4), and work (median, IQR—2, 2 versus 4, 3) ($p < 0.05$) (Table 5).

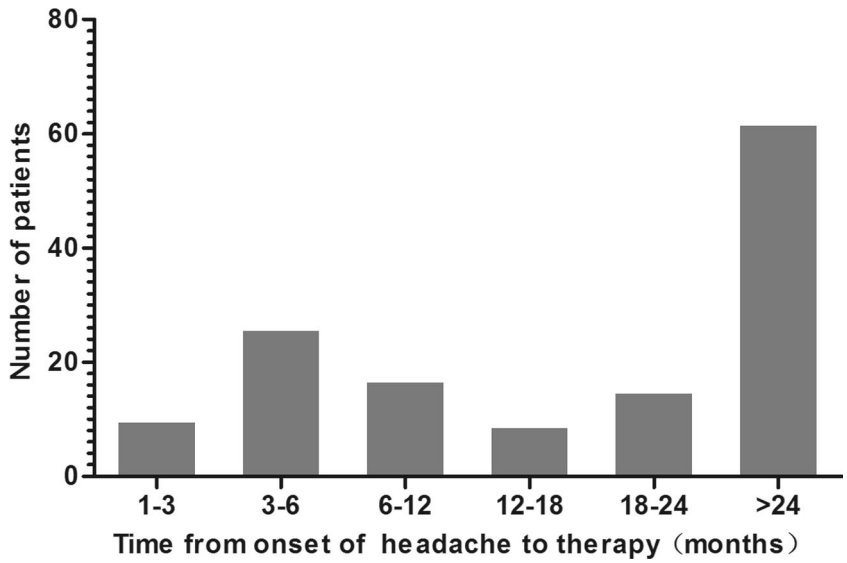

Fig. 2 Duration of time between onset of headache and the treatment for cervicogenic headache (CEH); over 40% (62/139) patients had a history of headache for more than 2 years

Table 2 The demographic and clinical characteristics in CEH patients ($n = 139$)

Variable	Patients with CEH
Age (years), mean (SD) (range)	47.5 ± 12.4 (39–76)
Sex, *n* (%)	
Female	91 (65.5)
Male	48 (34.5)
Duration, (months), mean (SD) (range)	50.4 ± 37.6 (3–180)
Symptoms, *n* (%)	
Soreness	126 (90.6)
Stiffness	53 (38.1)
Limited normal activity	37 (26.6)
Decreased appetite	85 (61.1)
Affected part, *n* (%)	
Neck	124 (89.2)
Shoulder	42 (30.2)
Arm	37 (26.6)
Side of symptoms, *n* (%)	
Right	78 (56.1)
Left	61 (43.9)
Onset pain, *n* (%)	
Suddenly	46 (33.1)
Gradually	93 (66.9)
Pain frequency, *n* (%)	
Never pain-free	86 (61.9)
Pain-free some hours	38 (27.3)
Pain-free some days	15 (10.8)

Kaplan-Meier curve showed that the probability of treatment success in PRF+ESI group was higher than in ESI group (median pain relief: ESI group, 4 months; PRF+ESI group 8 months) (Log-Rank test, $p < 0.001$) (Fig. 3). In ESI group, 8 patients were retreated with PRF after the failure of ESI, and postoperative pain relieved satisfactorily. In PRF+ESI group, 5 patients had recurrent pain after therapy. Of the 5 patients, 3 patients had reoperation and had pain relief. These two types of patients were not included in the statistical analysis.

Table 4 Quality of life evaluation according to the EORTC QLQ-30 during follow-up after therapy

	PRF+ESI ($n = 87$)	ESI ($n = 52$)	*p*
Age	49.2 ± 13.21	51.4 ± 10.63	0.752
Men	28 (32.2%)	20 (38.5%)	0.451
Functional scales			
SF	68.52 ± 21.50	50.63 ± 15.42	< 0.001
CF	55.36 ± 19.82	46.82 ± 23.54	0.026
EF	61.17 ± 28.41	43.52 ± 25.48	< 0.001
RF	52.04 ± 17.92	38.13 ± 24.07	< 0.001
PF	70.61 ± 29.47	47.87 ± 21.53	< 0.001
QL	59.31 ± 27.44	50.73 ± 21.90	0.032
Symptom scales			
Fatigue	36.83 ± 16.24	57.44 ± 20.37	< 0.001
Pain	32.06 ± 29.63	51.91 ± 26.17	< 0.001
Appetite loss	50.80 ± 11.31	67.63 ± 25.21	0.042
Sleep disturbance	41.13 ± 14.36	78.22 ± 20.48	< 0.001
Financial difficulties	63.72 ± 21.05	73.63 ± 25.12	0.731
Treatment strain	69.63 ± 25.03	62.39 ± 27.28	0.063
Hope and confidence	51.43 ± 28.19	57.10 ± 20.83	0.418

Scores range from 0 to 100; a higher score for functional scale or health status represents a higher level of functioning or health status, and a higher score in the symptom scale represents more severe symptoms; values are expressed as means ± SDs

SF social function, *CF* cognitive function, *EF* emotional function, *RF* role function, *PF* physical function, *QL* global health score

*Mann-Whitney *U* test

Discussion

CEH is a relatively common headache syndrome relating to pain generators in the upper cervical region. The typical clinical symptom of CEH is unilateral headache. And this chronic hemicranial pain can radiate to the neck, fronto-temporal, and possibly to the supraorbital region[22]. All structures in neck such as facet joints, intervertebral discs, muscles, and ligaments can produce pain. Studies have founded that C1–C3 joints are the common joints implicated in CEH, and noxious

Table 3 Follow-up results of the pain score according to the Izbicki pain score system for the 139 patients at 2-year follow-up

Pain score	PRF+ESI ($n = 87$)		ESI ($n = 52$)		*p**
	Median	Range (IQR)	Median	Range (IQR)	
Pain VAS	20	0–80 (40)	60	0–90 (50)	< 0.001
Frequency of pain attacks	25	0–75 (50)	50	0–100 (50)	< 0.001
Pain medication	0	0–15 (0)	0	0–15 (0)	< 0.001
Inability to work	0	0–75 (25)	50	0–100 (25)	< 0.001
Total pain score	11.25		40.00		< 0.001

IQR interquartile range

*Mann-Whitney *U* test

Table 5 Neck disability index (NDI) scores in patients

NDI score	PRF+ESI Median, range, (IQR)	ESI Median, range, (IQR)	*p*
Pain intensity	2, 0–4(3)	2, 0–5(4)	< 0.001
Personal care	1, 0–5(2)	1, 1–5(4)	< 0.001
Lifting	1, 0–3(2)	3, 1–5(4)	0.003
Reading	3, 0–5(3)	3, 0–5(4)	< 0.001
Headache	1, 0–3(2)	2, 0–5(3)	< 0.001
Concentration	1, 0–3(1)	3, 0–5(2)	< 0.001
Work	2, 0–5(2)	4, 0–5(3)	< 0.001
Driving	1, 0–3(2)	2, 0–5(2)	0.002
Sleep	2, 0–4(3)	3, 0–5(2)	< 0.001
Recreation	1, 0–3(2)	4, 0–5(3)	< 0.001
Total score	16, 5–38(18)	28, 12–45(24)	< 0.001

IQR interquartile range

stimulation is more susceptible to the C2 nerve [23, 24]. The C2 dorsal root ganglion is anatomically located in the middle part of the medial part of the lateral atlantoaxial joint and is very short, about 5–11 mm. The medial branch of the C2 dorsal root ganglion and the nerve fibers from the three spinal nerves constitute the greater occipital nerve. In a case series report, PRF was performed on the position of the C2 dorsal root ganglion and had pain totally disappeared for 6 months [16]. In addition, Ferrante et al. [25] has indicated that ESI was the efficiency to treat CEH. Although PRF or ESI was reported as effective treatment for CEH, these therapies provided only temporary pain relief. There was little information about the changes of pain relief and the quality of life in CEH patients in long-term follow-up. Thus, our study carried out a longitudinal study to assess PRF for C2 dorsal root ganglion and ESI in patients with CEH.

The mechanism of PRF and ESI for treatment of CEH is unclear. It is common knowledge that PRF is a neuromodulatory technique. The energy of PRF is applied in a pulsatile fashion. PRF can provide high intensity currents in pulses. It is noteworthy that temperature control is maintained less than 42 °C to avoid neurodestructive. If a higher temperature of 42 °C, allodynia, hyperalgesia, or dysesthesias could occur because of coagulation of neuroprotein [16, 26]. ESI is also an effective treatment for CEH. Cervical/thoracic/lumbar interlaminar epidural steroid injection is regarded as an

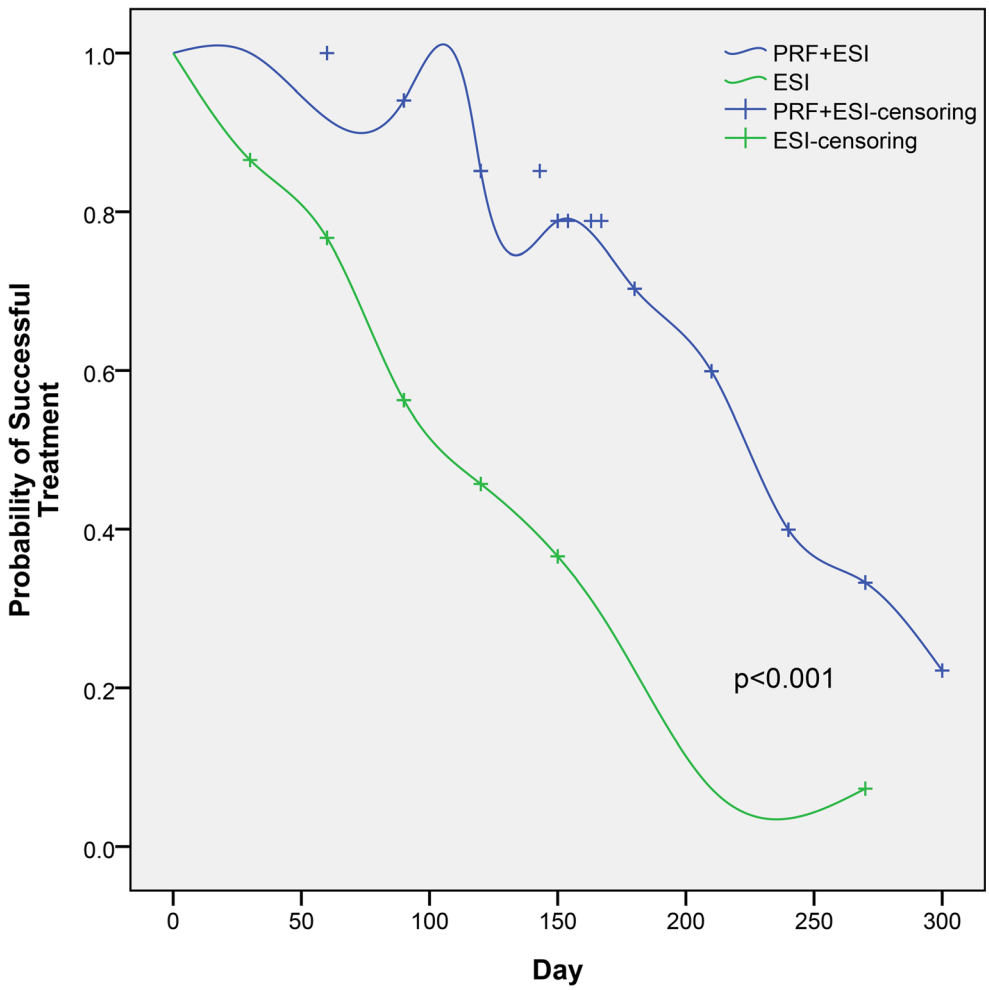

Fig. 3 Kaplan-Meier curve of the probability of treatment success with time. (Median pain relief: ESI group, 4 months; PRF+ESI group, 8 months) (Log-Rank test, $p < 0.001$)

effective anesthetic treatment in patients with radicular pain or radiculopathy [27]. Glucocorticoid has been the first choice to treat aseptic inflammation-related pain. It has a strong anti-inflammatory effect and can effectively inhibit the synthesis of prostaglandin and other pain factors.

PRF or ESI can lead to significant pain relief for treating CEH. Halim et al. [28] reported that PRF application of the lateral C1–2 facet joint was a feasible and safe technique for treating CEH. They concluded that the percentage of patients who had 50% pain relief at 2 months, 6 months, and 1 year were 50% (43/86), 50% (43/86), and 44.2% (38/86), respectively. In contrast, Stovner et al. [29] conducted a randomized, double-blind, sham-controlled study. The results revealed that PRF treatment of facet joints C2–C6 was not a promising procedure for CEH patients. Notably, in the Stovner study, only 12 patients were included in the study. Kurain et al. [30] have described the benefit of cervical epidural steroid injections. Martelletti et al. [31] reported that 9 patients suffering from CEH treated with epidural steroid (methylprednisolone 40 mg) injection into the epidural cervical space (C6–C7 or C7–T1) level. The patients achieved short-term (12 h) and medium-term (4 weeks) marked clinical improvement. Disappointingly, ESI provided temporary pain relief.

In this study, PRF combined with ESI can provide sustained pain relief and improve the quality of life for CEH patients. Traditionally, studies used visual analogue scales (VAS) or numeric rating scale (NRS) for pain evaluation in CEH [32], [33]. This common approach to evaluating pain has used measurements of pain intensity. In this trial, Izbicki pain scores system was used to determine the efficacy of therapies. This pain score included two subjective items (pain analogue scale and frequency of pain attacks) and two objective items (analgesic medication and the time periods of inability to work) [19]. This system is composite scales and has been tested to be a reliable and valid measure of pain. In our study, we found that significant difference was found in the two groups (11.25 versus 40.00, $p < 0.001$) after 2-year follow-up. Additionally, the PRF+ESI group had lower score in pain VAS, frequency of pain attacks, pain medication, and inability to work than ESI group ($p < 0.001$).

Quality of life should be considered as the main outcome measure in evaluating therapeutic options. Patients with chronic pain in CEH have a substantially impaired quality of life. Initially, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-C30 has been published to evaluate the quality in cancer [34]. Recently, EORCT-QLQ-C30 has been demonstrated to be a valid and reliable tool to measure the quality of life in benign disease, such as chronic pancreatitis [35]. In our study, statistically significant changes in functional and symptom levels were observed in PRF+ESI group. Moreover, our study also found that patients with CEH had lower NDI in the PRF+ESI group.

With respect to pain recurrence in CEH, there was little information. This study using Kaplan-Meier curve has shown that the probability time of recurrence in PRF+ESI group was lower than in ESI group. It was not surprising because previous study has been reported that ESI was not proven to be of benefit in the long-term (6 months) pain relief [31]. In our study, the median pain relief in ESI group was 4 months. Therefore, we suggest that cervical ESI should be not only performed in CEH patient. The PRF should be conducted at the same time.

As for the complications, there was no serious side effect. One study reported that three patients undergone ESI had a flushing sensation in the face, but this symptom had disappeared in the follow-up [31]. Other potential complications, such as infection, stroke, paralysis, cerebrospinal fluid leak, hypothalamic-pituitary axis suppression, or immunosuppression may be associated with PRF or ESI [16]. In fact, we found 23 patients had elevated blood glucose. Of the 23 patients, 19 patients were diagnosed with diabetes previously; 4 patients had no diabetes before therapy. All these patients required insulin to recover blood sugar. There was no other complication in our study.

It is generally known that CEH is referred pain from the cervical spine. Pain symptoms in a long term of years impact on patients' lives. Pain control should be considered as the main outcome measure in evaluating therapeutic options. It is very difficult to accurately assess pain symptoms. In previous literatures, visual pain analogue scale (VAS) was usually used to assess pain control. But, this method is a subjective measurement, which is lack of accuracy. The Izbicki pain score is widely used to assess pain control. The Izbicki pain score system included not only two subjective items (the patient's self-estimation of intensity of pain using VAS and the frequency of pain attacks), but also two objective items (analgesic medication and the time periods of inability to work). The EORTC QLQ-C30 health-related quality of life (HRQoL) questionnaire was designed to be adopted not only in clinical cancer trials, but also in chronic pain. The EORTC QLQ-C30 is widely used in chronic nonmalignant pain. Unfortunately, few studies used the Izbicki pain score system and EORTC QLQ-C30 questionnaire to pain control and assess quality of life in CEH. Therefore, we used the two questionnaires to evaluate pain control and quality of life after PRF for the C2 dorsal root ganglion and ESI for CEH.

Our study has several limitations. First, this was a retrospective study and the patient numbers are relatively low. Second, EORTC QLQ-C30 Questionnaire, Izbicki pain scores, and NDI are subjective measurements. We did not show the validity and reliability of the three tools in CEH. Hence, further studies concerning the validity and reliability of the measures are urgently needed. Finally, we did not assess the effectiveness in CEH patients with only PRF therapy. Although PRF was reported to be effective for CEH in

previous studies [14, 28], the follow-up time seems to be relatively short. And these studies were not RCT studies. Moreover, Nagar et al. [26] believed that there was poor evidence to support PRF for CEH. Also, in a recently systematic review study, PRF provided very limited benefit in the management of CEH [36]. Importantly, in our early treatment, five patients with CEH performed PRF alone, and these patients were converted from PRF to the combination of PRF and ESI finally. Thus, whether only PRF therapy does just as good effect as the combination of PRF and ESI is not clear.

Conclusion

In conclusion, the combination of PRF for the C2 dorsal root ganglion and ESI is a relatively safe therapy for CEH. This technique not only provides the sustained relief of pain symptom, but improves the quality of life in patients with CEH.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethics approval The study was conducted in accordance with the principles of the Declaration of Helsinki and the guidelines of Wuhan No.1 Hospital.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. Bogduk N, Govind J (2009) Cervicogenic headache: an assessment of the evidence on clinical diagnosis, invasive tests, and treatment. Lancet Neurol 8:959–968
2. Antonaci F, Sjaastad O (2011) Cervicogenic headache: a real headache. Curr Neurol Neurosci Rep 11:149–155
3. Biondi DM (2005) Cervicogenic headache: a review of diagnostic and treatment strategies. J Am Osteopath Assoc 105:16S
4. Vincent M (1998) Validation of the criteria for cervicogenic headache. Funct Neurol 13:74–75
5. Sjaastad O, Bakketeig LS (2008) Prevalence of cervicogenic headache: vaga study of headache epidemiology. Acta Neurol Scand 117:173–180
6. Vincent M (2010) Cervicogenic headache: a review comparison with migraine, tension-type headache, and whiplash. Curr Pain Headache Rep 14:238–243
7. Schwedt TJ (2014) Chronic migraine. BMJ 24:g348–g1416
8. Manzoni GC, Torelli P (2009) Chronic migraine and chronic tension-type headache: are they the same or different? Neurol Sci 30:81–84
9. Becker WJ (2010) Cervicogenic headache: evidence that the neck is a pain generator. Headache 50:699–705
10. Avramidis T, Bougea A, Hadjigeorgiou G, Thomaides T, Papadimitriou A (2017) Blink reflex habituation in migraine and chronic tension-type headache. Neurol Sci 38:1–6
11. Anthony M (2000) Cervicogenic headache: prevalence and response to local steroid therapy. Clin Exp Rheumatol 18:S59–S64
12. Bovim G, Berg R, Dale LG (1992) Cervicogenic headache: anesthetic blockades of cervical nerves (C2-C5) and facet joint (C2/C3). Pain 49:315–320
13. He MW, Ni JX, Guo YN, Wang Q, Yang LQ, Liu JJ (2009) Continuous epidural block of the cervical vertebrae for cervicogenic headache. Chin Med J 122:427–430
14. Bovaira M, Peñarrocha M, Peñarrocha M, Calvo A, Jiménez A, March R (2013) Radiofrequency treatment of cervicogenic headache. Med Oral Patol Oral Cir Bucal 18:e293–e297
15. Hamer JF, Purath TA (2014) Response of cervicogenic headaches and occipital neuralgia to radiofrequency ablation of the C2 dorsal root ganglion and/or third occipital nerve. Headache 54:500–510
16. Zhang J, Shi DS, Wang R (2011) Pulsed radiofrequency of the second cervical ganglion (C2) for the treatment of cervicogenic headache. J Headache Pain 12:569–571
17. Sjaastad O, Saunte C, Hovdahl H, Breivik H, Grønbaek E (1983) "Cervicogenic" headache. A hypothesis. Cephalalgia 3:249–256
18. Sjaastad O, Fredriksen TA, Pfaffenrath V (1998) Cervicogenic headache: diagnostic criteria. The Cervicogenic Headache International Study Group. Headache 38:442–445
19. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, Filiberti A, Flechtner H, Fleishman SB, de Haes JC (1993) The European organization for research and treatment of cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer lnst 85:365–376
20. Bloechle C, Izbicki JR, Knoefel WT, Kuechler T, Broelsch CE (1995) Quality of life in chronic pancreatitis: results after duodenum-preserving resection of the head of the pancreas. Pancreas 11:77–85
21. Hoving JL, O'Leary EF, Niere KR, Green S, Buchbinder R (2003) Validity of the neck disability index, Northwick Park neck pain questionnaire, and problem elicitation technique for measuring disability associated with whiplash-associated disorders. Pain 102:273–281
22. van Suijlekom H, Van Zundert J, Narouze S, van Kleef M, Mekhail N (2010) Cervicogenic headache. Pain Pract 10:124–130
23. Dreyfuss P, Michaelsen M, Fletcher D (1994) Atlanto-occipital and lateral atlanto-axial joint pain patterns. Spine (Phila Pa 1976) 19:1125–1131
24. Poletti CE, Sweet WH (1990) Entrapment of the C2 root and ganglion by the atlanto-epistrophic ligament: clinical syndrome and surgical anatomy. Neurosurgery 27:288–291
25. Ferrante FM, Wilson SP, Iacobo C, Orav EJ, Rocco AG, Lipson S (1993) Clinical classification as a predictor of therapeutic outcome after cervical epidural steroid injection. Spine 18:730–736
26. Nagar VR, Birthi P, Grider JS, Asopa A (2015) Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headache. Pain Physician 18:109–130
27. Wang E, Wang D (2014) Treatment of cervicogenic headache with cervical epidural steroid injection. Curr Pain Headache Rep 18:442
28. Halim W, Chua NH, Vissers KC (2010) Long-term pain relief in patients with cervicogenic headaches after pulsed radiofrequency application into the lateral atlantoaxial (C1-2) joint using an anterolateral approach. Pain Pract 10:267–271
29. Stovner LJ, Kolstad F, Helde G (2004) Radiofrequency denervation of facet joints C2-C6 in cervicogenic headache: a randomized, double-blind, sham-controlled study. Cephalalgia 24:821–830
30. Kurain J, Raghavan V, Raobaikady R (2002) Minimizing the risk of dural puncture during cervical epidural steroid injection. Anesth Analg 94:1366
31. Martelletti P, Di Sabato F, Granata M, Alampi D, Apponi F, Borgonuovo P, Reale C, Giacovazzo M (1998) Epidural corticosteroid blockade in cervicogenic headache. Eur Rev Med Pharmacol Sci 2:31–36

32. Pingree MJ, Sole JS, O Brien TG, Eldrige JS, Moeschler SM (2017) Clinical efficacy of an ultrasound-guided greater occipital nerve block at the level of C2. Reg Anesth Pain Med 42:99–104
33. [33]Lauretti GR, Corrêa SW, Mattos AL (2015) Efficacy of the greater occipital nerve block for cervicogenic headache: comparing classical and subcompartmental techniques. Pain Pract 15:654–661
34. Fitzsimmons D, Kahl S, Butturini G, van Wyk M, Bornman P, Bassi C, Malfertheiner P, George SL, Johnson CD (2005) Symptoms and quality of life in chronic pancreatitis assessed by structured interview and the EORTC QLQ-C30 and QLQ-PAN26. Am J Gastroenterol 100:918–926
35. Olesen SS, Juel J, Nielsen AK, Frøkjær JB, Wilder-Smith OH, Drewes AM (2014) Pain severity reduces life quality in chronic pancreatitis: implications for design of future outcome trials. Pancreatology 14:497–502
36. Grandhi RK, Kaye AD, Abd-Elsayed A (2018) Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. Curr Pain Headache Rep 22:18