Pain Medicine, 0(0), 2018, 1–8
doi: 10.1093/pm/pny227
Preliminary Research Article

The Feasibility and Efficacy of Ultrasound-Guided C2 Nerve Root Coblation for Cervicogenic Headache

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Funding sources: This work was supported by the Scientific Research Incubation Project of Beijing Municipal Administration of Hospitals (No. PX2016015), High-level Health and Technical Personnel Training Plan for Beijing Healthy System, Beijing Municipal Commission of Health and Family Planning (No. 2015-3-067), and Fundamental-Clinical Cooperative Research Cooperation Fund of Capital Medical University (No. 16JL50).

Conflicts of interest: The authors have no conflicts of interest to disclose.

Abstract

Objective. The cervicogenic headache is a syndrome caused by dysfunction of the upper cervical spine and its component bony, disc, and/or soft tissue elements. The C2 nerve root may play a pivotal role in cervicogenic headache. In this retrospective study, we evaluated the feasibility and efficacy of ultrasound-guided C2 nerve root coblation in managing 26 patients with cervicogenic headache. **Design and Setting.** The data were collected retrospectively by reviewing the patient's medical records and pain questionnaires. **Subjects and Methods.** A total of 109 patients with cervicogenic headache sustained for at least six months were identified. Of those patients, 26 had a visual analog scale score $\geq$6 and subsequently underwent an ultrasound-guided C2 nerve root coblation. **Results.** All 26 patients had >50% pain relief one day after coblation. Twenty-three of the 26 patients (92.31%) had a decrease in their pain score of 50% or more at 24-week follow-up. The mean pain score was 7.38 ± 1.13 before coblation and 1.85 ± 0.83 one day after coblation (Bonferroni-adjusted $P < 0.001$). At 12 and 24 weeks after coblation, the mean pain scores were 2.96 ± 0.96 ($P < 0.001$) and 3.08 ± 1.38 ($P < 0.008$), respectively. **Conclusions.** C2 nerve coblation may provide the majority of patients with a pain relief period as long as 24 weeks. And ultrasound guidance is an efficient method with which to perform coblation.

Key Words: Cervicogenic Headache; Ultrasound-Guided; Coblation; C2 Spinal Nerve; Oblique Capitis Inferior

Introduction

Cervicogenic headache (CEH) is a term first used by Sjaastad as a hypothesis to differentiate migraine, cluster headache, etc. [1]. It has been depicted as a unilateral headache (bilateral also admitted) caused by a syndrome of the cervical spine and its component bony, disc, and/or soft tissue elements, usually but not invariably accompanied by neck pain [1–3]. The prevalence of CEH has been estimated at 0.17%∼4.1% according to different reports [4–6]. Although there have been no reports about the prevalence of CEH in China until now, CEH is exhibiting an increasing prevalence with a lowering onset age based on the authors' hospital clinical data. And this inclination in phubbings, persons who are frequent users

of electronic devices, may be higher. Traditionally, noninvasive therapeutic strategies (e.g., medication [7], physical activity [8], manual manipulation [8]) and invasive therapeutic strategies (e.g., radiofrequency [9,10], acupuncture, anesthetic block [9,11]) have been the treatments most preferred by patients and/or pain physicians. Coblation, the controlled ablation technique, has been applied in different clinical situations, including otolaryngology, urology, and gynecology [12–14]. Coblation utilizes bipolar radiofrequency current to create a thin plasma field that breaks the target tissue into tiny pieces at relatively low temperatures (40°C~70°C) [15]. Recently, coblation has been successfully applied to alleviate discogenic pain [16] and phantom limb pain [17] in our hospital. In our previous report, we found that cervical coblation nucleoplasty could alleviate CEH [18]. However, further investigation and more evidence are needed to develop a more effective therapeutic strategy of coblation to treat CEH.

The primary causes of CEH are external compression or aseptic inflammation on the greater occipital nerve and the lesser occipital nerve, which originate from the C2 nerve [10]. More importantly, several anatomical investigations have indicated that C2 nerve may be more susceptible than other structures, for example, the Atlanto-Axial and C2-C3 zygapophysial joint [19,20]. Therefore, fluoroscopy and ultrasound guidance treatment such as radiofrequency [21], occipital nerve blocks [11], and cervical facet joint blocks [22] were applied to treat CEH. However, the effect of C2 nerve root coblation on CEH is still unknown (Figure 1). There are also no reports depicting how to perform C2 nerve root coblation through ultrasound guidance. Thus, the purpose of this retrospective study was to assess the feasibility and efficacy of ultrasound-guided C2 nerve root coblation for patients with cervicogenic headache.

Methods

Patients

Twenty-six adult patients (≥18 years old) were included in this single-center retrospective clinical study. This retrospective study was approved by the institution's Ethics Examination Committee of Human Research (Xuanwu Hospital, Capital Medical University, Beijing, China), and informed consent was obtained from all participants before coblation treatment. They received one ultrasound-guided C2 cervical nerve root coblation treatment between January and June 2017. The inclusion criteria were as follows: diagnosis of unilateral CEH fulfilling both the criteria of the Cervicogenic Headache International Study Group [2] and the International Classification of Headache Disorders, 3rd edition, beta version [3,23]; a CEH history lasting six months or longer; body mass index (BMI) between 18 and 25. The exclusion criteria were refusal to participate, visual analog scale (VAS) score of <6, radiofrequency or surgical treatment history of any cervical nerves or their ramus, local or systemic infection, receipt of anticoagulation therapy, and diabetes mellitus.

Demographic data of the patients, including age, gender, weight, height, BMI, CEH duration, and affected side, were recorded in Table 1. Patients' VAS score was evaluated at one day before treatment (baseline [BL]), one day, three days, one week, two weeks, four weeks, and every four weeks following coblation by a pain physician who was blinded to the procedure. Patients returned for reexamination, and evaluations at four, 12, and 24 weeks were also performed.

Ultrasound-Guided Coblation Procedure

All procedures were accomplished under ultrasound-guided (the Sonimage HS-1 ultrasound system Konica Minolta with 5 MHz curve probe L5–3) in an operating room equipped with a fluoroscope (GE OEC 9900 Elite C-Arm). The patients' main physiological parameters, blood pressure (BP), heart rate (HR), electrocardiography (ECG), and saturation of pulse oxygen (SpO_2), were monitored, and the baseline data were recorded in a supine position. All patients received continuing low-flow nonhumidified nasal cannula oxygen (2 L/min) and continued intravenous infusion of Ringer's solution while respiratory signs were closely monitored during the procedure. Then patients were placed in a lateral position with their affected side upwards. Several gel cushions were placed under their head, neck, and arm to put the neck in a stable and slightly anterior flexion position (Figure 3A). A 3–5 MHz probe was used to perform a prescan. The probe was placed in an oblique/axial plane across the oblique capitis inferior (OCI) from C1 transverse process (TP) to the C2 spinous process (SP) (Figure 2A) to show the C1 TP, C2 SP, vertebral artery (VA), and OCI (Figure 2B, C). After that, the skin was sterilized, and the probe was sheathed in a sterile plastic package (Figure 3A). Ultrasound images of C1 TP, C2 SP, VA, and OCI were procured again to determine the puncture routine, and then the puncture routine was locally anesthetized using 1% lidocaine. After local anesthesia onset, a step-by-step progression of the 18G introduce needle was gently inserted under ultrasound guided by doppler to avoid inadvertent vascular puncture, especially of the VA. Once the introduce needle tip had almost arrived at the target site, the coblation wand (UNITEC, China America United Technology Co. Ltd, Beijing, China) was inserted through the introduce needle and extended 5 mm to reach the target site under ultrasound guidance. Then, coagulation mode was used to confirm if the wand tip reached the target, as we depict below. Once the tip's position was determined, the position of the coblation wand tip was reconfirmed by fluoroscopy using open mouth anterior/posterior and lateral positions (Figure 3C, D).

The coblation procedure was performed as our previous report [17,24]. Briefly, the coagulation mode was set

Table 1. Demographic data of patients

Patient ID	Gender	Age, y	Weight, kg	Height, m	BMI, kg/m^2	CEH Duration, mo	Affected Side
1	Male	48	52	1.62	19.81	8	Right
2	Male	28	57	1.68	20.20	8	Right
3	Male	18	56	1.69	19.61	11	Right
4	Female	63	55	1.58	22.03	7	Left
5	Female	62	46	1.52	19.91	9	Right
6	Female	74	46	1.51	20.17	11	Right
7	Female	45	56	1.59	22.15	8	Right
8	Male	62	68	1.72	22.99	8	Right
9	Female	42	57	1.61	21.99	7	Left
10	Female	26	56	1.63	21.08	8	Left
11	Female	51	56	1.60	21.88	7	Right
12	Male	62	50	1.64	18.59	12	Right
13	Female	48	67	1.64	24.91	12	Left
14	Male	22	52	1.63	19.57	7	Right
15	Male	67	55	1.67	19.72	9	Right
16	Female	52	46	1.55	19.15	10	Left
17	Female	46	48	1.58	19.23	9	Right
18	Male	37	64	1.75	20.90	10	Left
19	Male	52	62	1.73	20.72	9	Right
20	Male	58	61	1.68	21.61	8	Left
21	Female	42	58	1.52	25.10	11	Right
22	Male	48	52	1.62	19.81	9	Right
23	Male	59	67	1.68	23.74	9	Left
24	Female	25	56	1.51	24.56	10	Right
25	Female	57	58	1.54	24.46	6	Right
26	Female	41	66	1.63	24.84	7	Left

BMI = body mass index; CEH = cervicogenic headache.

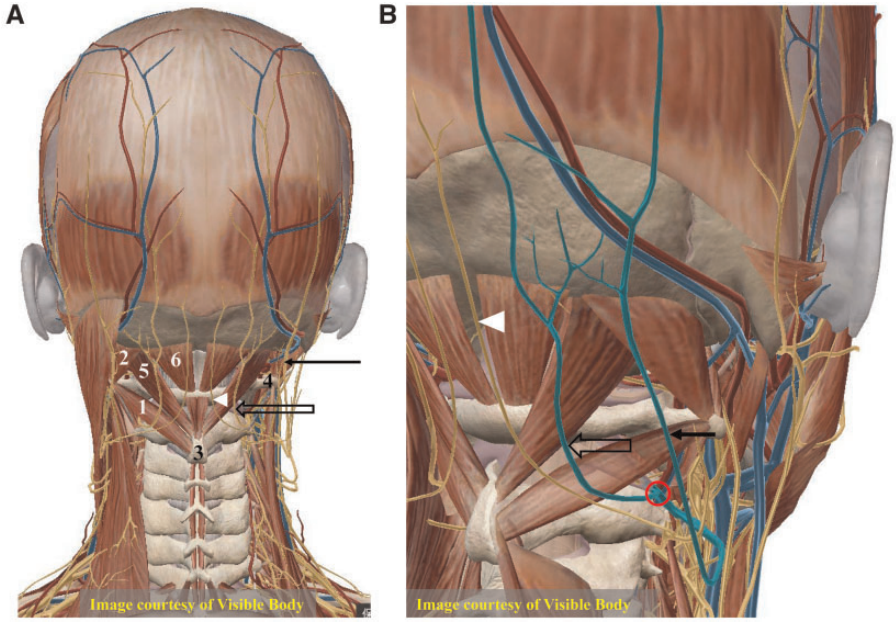

Figure 1. Virtual anatomical structure of the oblique capitis inferior (OCI) and C2 cervical nerve. A) Coronal view of the OCI and ventral ramus of the C2 cervical nerve. B) Virtual anatomical structure of coblation target. 1) OCI. 2) Oblique capitis superior [OCS]. 3) C2 spinous process. 4) C1 transverse process. 5) Musculi rectus capitis posterior major. 6) Musculi rectus capitis posterior minor. Arrow: lesser occipital nerve (LON; minor occipital nerve). Hollow arrow: greater occipital nerve (GON; major occipital nerve). Arrow head: tertiary occipital nerve. Red circle: C2 cervical root (coblation target).

with a radiofrequency controller to 1' (33 Watts) for 0.5 seconds to induce the presence of paresthesia and muscle movement in the distribution of the target nerve and ensure that the active portion of the wand had reached the target. Then the target nerve was ablated using a previously used ablated program [24]: 100 kHz, 2'

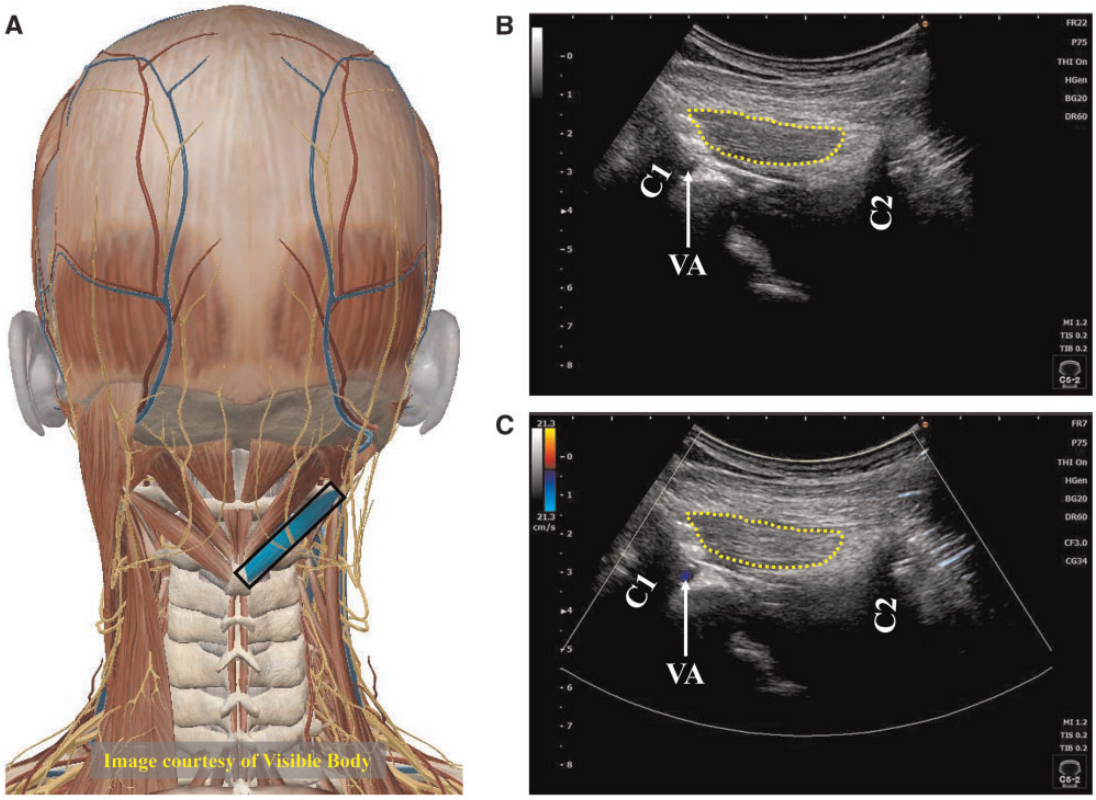

Figure 2. Ultrasound scanning plane and image of oblique capitis inferior. A) Virtual ultrasound scanning plane and ultrasound probe position. B, C) Ultrasound image of oblique capitis inferior. Black rectangle: ultrasound scanning plane. Yellow dotted contour: oblique capitis inferior. C1 = C1 transverse process; C2 = C2 spinous process; VA = vertebral artery.

(52 Watts), 6∼10 sec/cycle, six ablations. The duration of coblation was approximately one minute. During the coblation, the operator communicated with the patient continuously to ensure consciousness. Following the procedure, patients were mandated to stay in bed for 24 hours. All procedures were conducted by BSW and TT, who are experienced in ultrasound-guided procedures.

Pain Intensity Evaluation

Pain intensity was evaluated via visual analog scale (VAS) scores (0∼10). Pain intensity evaluation follow-up was at one day, three days, one week, two weeks, four weeks, eight weeks, 12 weeks, 16 weeks, 20 weeks, and 24 weeks using the VAS for affected side of cervicogenic headache. Clinical efficacy was defined by a decrease of at least 50% of the baseline VAS score following coblation. Clinical efficacy at 12 weeks and 24 weeks was defined by a decrease of at least 50% of the baseline VAS score, depicted through a Kaplan-Meier survival curve. The occurrence of complications was evaluated and reported, with severity based on the Clavien-Dindo Classification of Surgical Complications [25].

Statistical Analysis

Continuous variables were expressed as mean ± SD. Clinical efficacy was studied. Due to the small sample size of the current study, a nonparametric test was chosen. P values < 0.05 were considered statistically significant. Statistical analysis was performed using SPSS 20.0 Statistics (IBM SPSS Statistics, version 20.0, IBM Corp, North Castle, NY, USA).

Results

Patients' Demography

Patients' demographic data are shown in Table 1. Twenty-six patients met inclusion criteria and were included in the present study. There are 12 males and 14 females, with a mean age of 47.50 ± 14.74 (18∼74) years and mean weight of 56.42 ± 6.53 (46∼68) kg, included in present retrospective study. Seventeen patients suffered right unilateral CEH, and nine patients suffered left unilateral CEH. The mean duration of pain in these patients was 8.85 ± 1.64 (6∼12) months.

Procedure

The coblation procedures were tolerable for all patients during treatment. Two patients complained of neck and shoulder discomfort during treatment. None of the patients in this study had any treatment-related severe complications.

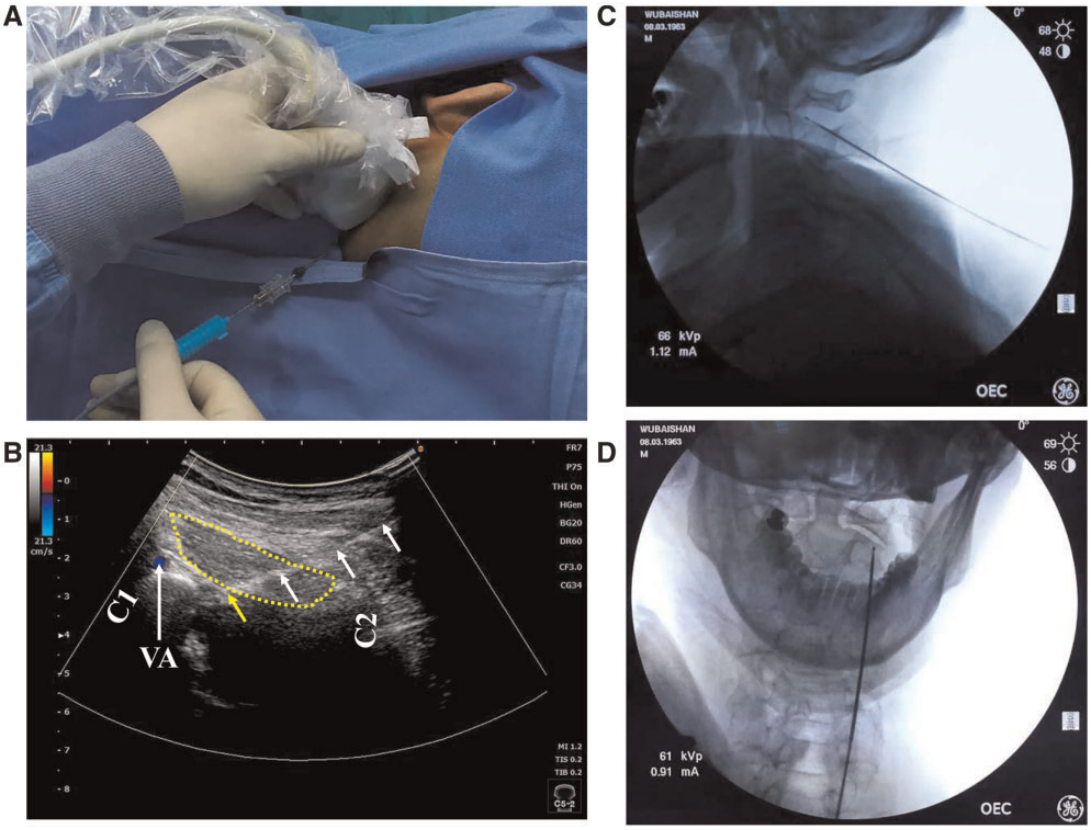

Figure 3. Ultrasound-guided coblation through oblique capitis inferior. A) Patient's position and coblation needle insertion. B) Ultrasound image of the oblique capitis inferior (OCI) and coblation needle. C, D) Needle tip position confirmed by fluoroscopy (anterior/posterior [open mouth] and lateral position). White arrow: needle. Yellow arrow: needle tip. Yellow dotted contour: OCI. C1 = C1 transverse process; C2 = C2 spinous process; VA = vertebral artery.

Pain Assessment

The VAS score during treatment is shown in Figure 4. The mean BL VAS score was 7.38 ± 1.13 (6∼10). The mean VAS score one day after coblation was 1.85 ± 0.83 (1∼4). The mean VAS score three days, one week, two weeks, four weeks, eight weeks, 12 weeks, 16 weeks, 20 weeks, and 24 weeks after coblation was 2.00 ± 0.75 (1∼4), 2.62 ± 1.13 (1∼7), 2.77 ± 1.07 (1∼7), 2.85 ± 1.08 (1∼7), 2.85 ± 1.08 (1∼7), 2.96 ± 0.96 (2∼7), 3.04 ± 0.96 (2∼7), 3.12 ± 1.07 (2∼7), and 3.08 ± 1.38 (1∼8), respectively.

Clinical efficacy, defined as a decrease of at least 50% in VAS scores, was achieved at 100% ($P = 0.000$ and $P = 0.000$) at one day and three days after coblation. Clinical efficacy at 12 weeks and 24 weeks was achieved at 92.31% ($P = 0.000$) and 88.46% ($P = 0.000$), respectively. The Kaplan-Meier survival of clinical efficacy is shown in Figure 5. The mild percentage, defined as VAS score ≤ 3, at different time points in 26 patients was 96.15%, 96.15%, 96.15%, 96.15%, 92.31%, 92.31%, 92.31%, 88.46%, 88.46%, 88.46% (Figure 6).

Of three patients with clinical failure at 12 or 24 weeks after coblation (Figure 4), patients No. 19 and No. 20 acquired two weeks and 12 weeks of relief or mild pain (VAS ≤ 3), respectively. Patient No. 22 only acquired three days of 50% pain relief and was back to severe pain (VAS ≥ 7) at one week after coblation.

No major complications occurred in all 26 patients. In this retrospective study, one patient developed transient neck torticollis (lasting three days) and two patients developed ecchymotic lesion at the needle puncture site (resolved within 10 and 15 days, respectively), which are defined as minor grade I side effects according to the Clavien-Dindo Classification of Surgical Complications [25].

Discussion

In this retrospective study, we evaluated the feasibility and efficacy of ultrasound-guided C2 nerve root coblation for cervicogeneric headache treatment. Our results suggest that C2 nerve root coblation is an effective therapeutic strategy for cervicogeneric headache. In the present study, 23 of 26 patients achieved sustained pain relief for as long as 24 weeks. Furthermore, ultrasound guidance is an efficient method with which to perform the coblation procedure.

Cervicogeneric headache is a secondary headache that originates from any structure in the neck, including the upper cervical spine, muscle, and other softer tissues [3].

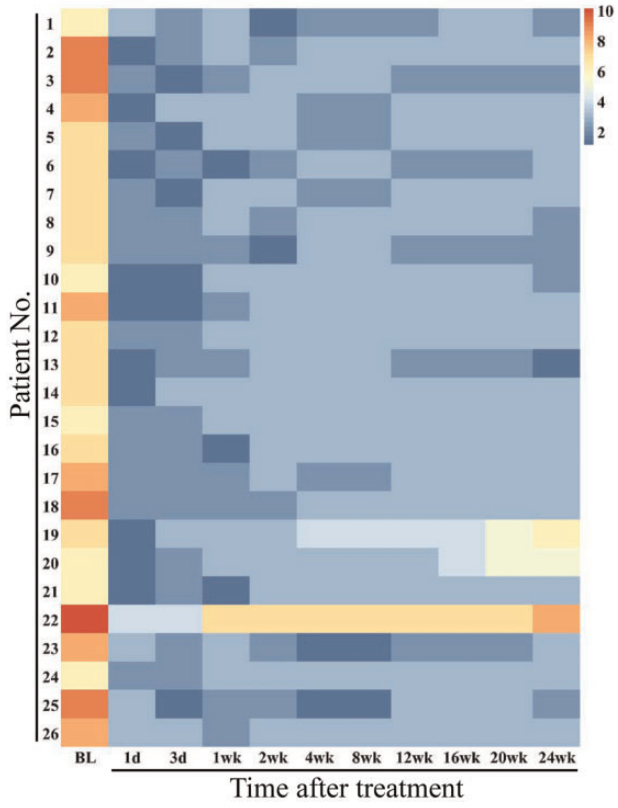

Figure 4. Heatmap of pain intensity (visual analog score [VAS]). The heatmap indicates the raw VAS of each patient during 24 weeks of follow-up after coblation treatment.

Current CEH treatments can be divided into noninvasive methods (e.g., medication, physical therapy, manual manipulation) and invasive methods (e.g., acupuncture, injections, interventional procedures) [9]. Injection using local anesthetics and glucocorticoid is the most used treatment among invasive methods. Wan et al. [26] reported that ultrasound-guided single injection using 2∼4 mL of 1% lidocaine and 7 mg of betamethasone along the C2 and/or C3 transverse process could produce two weeks to six months of pain relief. Other studies using the C2-C3 z-joint, A-A joint, and the dorsal ramus of C2 and C3 have also reported that >80% of patients had 50% pain relief instantly after injection. Unfortunately, patients did not show obvious benefit six months after injection [27,28]. Radiofrequency is another popular interventional therapy in CEH. Halim et al. [21] reported that half of 86 patients had >50% pain relief at two and six months, and 38 of 86 patients achieved >50% pain relief at one year after experiencing pulsed radiofrequency to the lateral A-A joint. In a case report series, Zhang et al. [10] reported that pulsed radiofrequency ablation of the C2 ganglion in two CEH patients produced six months of 100% pain relief. Hamer et al. also found that radiofrequency coblation of the C2 dorsal root ganglion and/or third occipital nerve could produce a mean pain relief duration of 22.35 weeks in patients who had refractory cervicogenic headache or occipital neuralgia. Twenty-eight of 40 patients reported at least 80% pain relief after treatment in their retrospective study [29]. However, there are no reports depicting the feasibility and efficacy

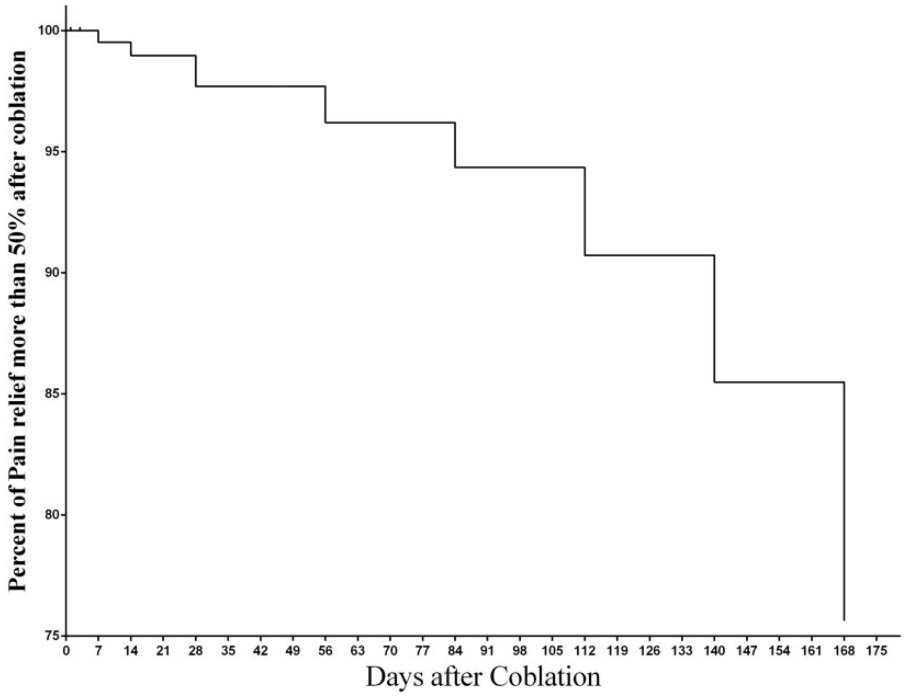

Figure 5. Kaplan-Meier survival curve of pain relief ≥50% during the 24 weeks of follow-up.

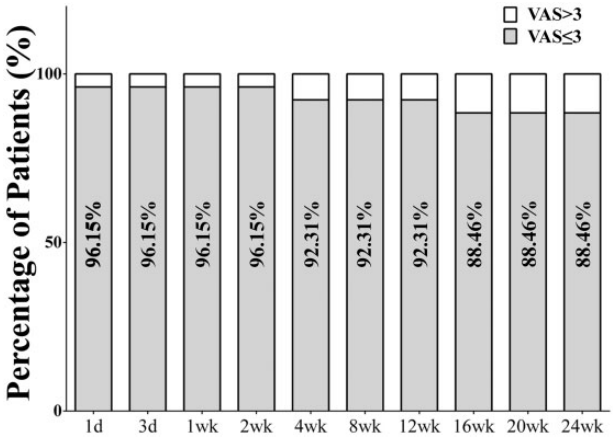

Figure 6. Mild pain percentage at different follow-up time points. The grey part represents the mild pain percentage of patients (visual analog scale $\leq$3) at different follow-up time points, and the white part represents the moderate or more intense pain percentage of patients at different follow-up time points.

of C2 nerve root coblation in CEH treatment. Coblation utilizes radiofrequency energy to destruct pathologic tissues via conductive solutions at a relatively lower temperature than radiofrequency ablation, which can reduce the surrounding intact tissue's impairment. In the present study, our results found that C2 nerve root coblation alleviated headache in 23 of 26 patients during the 24-week follow-up period and suggest that C2 nerve root coblation is a viable and effective therapeutic strategy to treat CEH. Moreover, only three patients had minor grade I complications, which indicated that coblation may produce less damage to surrounding tissues than radiofrequency ablation.

From an anatomic perspective (Figure 1), the recurrent meningeal branch of the C1 ventral ramus joins with the C2 and C3 nerves to innervate the medial Atlanto-Axial joint (A-A joint). The sinuvertebral branch of the C1, C2, and C3 nerves innervates the dura mater over the clivus in the posterior cranial fossa. More importantly, the ventral ramus of the C2 nerve innervates the sternocleidomastoid, trapezius, and the lateral A-A joint; the dorsal ramus of the C2 nerve innervates the splenius capitis and semispinalis capitis; and the medial branch of the C2 nerve innervates the occipital area through the greater occipital nerve [9,30]. These anatomical structures suggest a central role of the C2 nerve in CEH. Therefore, in the present study, we chose C2 nerve root coblation to treat CEH. Our results found that all the patients achieved instant pain relief after C2 nerve root coblation, 92.31% and 88.46 of our patients had clinical efficacy (a decrease of at least 50% in VAS scores) for 12 weeks and 24 weeks of pain relief, respectively. For three patients who failed to reach the clinical efficacy standard, there may have been other anatomic structures, for example, the ventral ramus and the superficial medial branch of the C3 nerve, involved in their headache [31].

Although fluoroscope and computed tomography are the most used guide methods in pain treatment to confirm needle position, ultrasound guidance has been considered a feasible and accurate alternative method to monitor these procedures [32,33]. The primary advantage is that ultrasound guidance can provide a real-time image during the needle insertion procedure under an ionizing-free condition. Moreover, the ultrasound doppler can easily identify vertebral artery and other blood vessels, which can significantly reduce unintentionally vascular injury. Ultrasound may fail to obtain a clear image in obese patients, especially those patients with a thick or short neck, but this limitation can be overcome by several fluoroscope examinations to confirm the needle position.

There several limitations of the present investigation: 1) 26 patients is a relatively small sample size; therefore, more clinical evidence is still needed to confirm our clinical research; 2) although our results showed that ultrasound guidance may be sufficient to perform the procedure, it is a challenge to design a double-blinded study for comparing the advantages and disadvantages of fluoroscopy and ultrasound guidance. More clinical investigations, especially multicenter clinical trial and those with large samples, may contribute to improving these limitations.

Conclusions

Our results suggest that C2 nerve coblation is an effective therapeutic strategy to treat CEH patients, which can produce significant and long-lasting pain relief. Ultrasound guidance is a convenient and effective method that could provide patients and pain physicians with a nonionized or less ionized exposure environment.

Acknowledgments

We would like to thank Visible Body for the generous permission they gave us to freely use the screenshots from their software 2018 Human Anatomy Atlas (Chinese Version).

Reference

1. Sjaastad O, Saunte C, Hovdahl H, Breivik H, Grønbaek E. "Cervicogenic" headache. An hypothesis. Cephalalgia 1983;3(4):249–56.
2. Sjaastad O, Fredriksen TA, Pfaffenrath V. Cervicogenic headache: Diagnostic criteria. The Cervicogenic Headache International Study Group. Headache 1998;38(6):442–5.
3. Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia 2013;33 (9):629–808.

4. Nilsson N. The prevalence of cervicogenic headache in a random population sample of 20–59 year olds. Spine 1995;20(17):1884–8.
5. Sjaastad O, Bakketeig LS. Prevalence of cervicogenic headache: Vaga study of headache epidemiology. Acta Neurol Scand 2008;117(3):173–80.
6. Knackstedt H, Bansevicius D, Aaseth K, et al. Cervicogenic headache in the general population: The Akershus Study of Chronic Headache. Cephalalgia 2010;30(12):1468–76.
7. Vincent MB. Headache and neck. Curr Pain Headache Rep 2011;15(4):324–31.
8. Jull G, Trott P, Potter H, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine 2002;27(17):1835–43; discussion 1843.
9. Mehnert MJ, Freedman MK. Update on the role of z-joint injection and radiofrequency neurotomy for cervicogenic headache. PM R 2013;5(3):221–7.
10. Zhang J, Shi DS, Wang R. Pulsed radiofrequency of the second cervical ganglion (C2) for the treatment of cervicogenic headache. J Headache Pain 2011;12 (5):569–71.
11. Zipfel J, Kastler A, Tatu L, et al. Ultrasound-guided intermediate site greater occipital nerve infiltration: A technical feasibility study. Pain Physician 2016;19 (7):E1027–34.
12. Geavlete B, Stanescu F, Iacoboaie C, Geavlete P. Bipolar plasma enucleation of the prostate vs open prostatectomy in large benign prostatic hyperplasia cases—a medium term, prospective, randomized comparison. BJU Int 2013;111(5):793–803.
13. Joshi H, Carney AS. Use of coblation in otolaryngology, head and neck surgery. Br J Hosp Med (Lond) 2011;72(10):565–9.
14. Roman H, Bubenheim M, Auber M, Marpeau L, Puscasiu L. Antimullerian hormone level and endometrioma ablation using plasma energy. JSLS 2014; 18(3):e2014.00002.
15. Woloszko J, Stalder KR, Brown IG. Plasma characteristics of repetitively-pulsed electrical discharges in saline solutions used for surgical procedures. IEEE Trans Plasma Sci 2002;30(3):1376–83.
16. He L, Tang Y, Li X, Li N, Ni J. Efficacy of coblation technology in treating cervical discogenic upper back pain. Medicine 2015;94(20):e858.
17. Zeng Y, Wang X, Guo Y, He L, Ni J. Coblation of femoral and sciatic nerve for stump pain and phantom limb pain: A case report. Pain Pract 2016;16 (2):E35–41.
18. He L, Yue J, Yang L, et al. Cervicogenic headache alleviation after cervical coblation nucleoplasty: A prospective cohort study. Medicine 2016;95(39):e4786.
19. Stechison MT, Mullin BB. Surgical treatment of greater occipital neuralgia: An appraisal of strategies. Acta Neurochir 1994;131(3–4):236–40.
20. Bogduk N. C2 ganglion can be injured by compression between the posterior arch of the atlas and the lamina of C2. Spine 1999;24(3):308–9.
21. Halim W, Chua NH, Vissers KC. 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 2010;10(4):267–71.
22. Zhou L, Hud-Shakoor Z, Hennessey C, Ashkenazi A. Upper cervical facet joint and spinal rami blocks for the treatment of cervicogenic headache. Headache 2010;50(4):657–63.
23. Olesen J. Problem areas in the International Classification of Headache Disorders, 3rd edition (beta). Cephalalgia 2014;34(14):1193–9.
24. Yang LQ, Gong WY, Wang XP, et al. Computed tomography-guided percutaneously controlled ablation of the thoracic paravertebral nerve due to thoracic neuropathic pain. Pain Pract 2017;17(6):792–9.
25. Rassweiler JJ, Rassweiler MC, Michel MS. Classification of complications: Is the Clavien-Dindo classification the gold standard? Eur Urol 2012;62 (2):256–8; discussion 259–60.
26. Wan Q, Yang H, Li X, et al. Ultrasound-guided versus fluoroscopy-guided deep cervical plexus block for the treatment of cervicogenic headache. Biomed Res Int 2017;2017:4654803.
27. Slipman CW, Lipetz JS, Plastaras CT, et al. Therapeutic zygapophyseal joint injections for headaches emanating from the C2–3 joint. Am J Phys Med Rehabil 2001;80(3):182–8.
28. Narouze SN, Casanova J, Mekhail N. The longitudinal effectiveness of lateral atlantoaxial intra-articular steroid injection in the treatment of cervicogenic headache. Pain Med 2007;8(2):184–8.
29. Hamer JF, Purath TA. Response of cervicogenic headaches and occipital neuralgia to radiofrequency ablation of the C2 dorsal root ganglion and/or third occipital nerve. Headache 2014;54 (3):500–10.
30. Cooper G, Bailey B, Bogduk N. Cervical zygapophysial joint pain maps. Pain Med 2007;8(4):344–53.
31. Bogduk N. Cervicogenic headache: Anatomic basis and pathophysiologic mechanisms. Curr Pain Headache Rep 2001;5(4):382–6.
32. Amber KT, Landy DC, Amber I, Knopf D, Guerra J. Comparing the accuracy of ultrasound versus fluoroscopy in glenohumeral injections: A systematic review and meta-analysis. J Clin Ultrasound 2014;42 (7):411–6.
33. Wu T, Zhao WH, Dong Y, Song HX, Li JH. Effectiveness of ultrasound-guided versus fluoroscopy or computed tomography scanning guidance in lumbar facet joint injections in adults with facet joint syndrome: A meta-analysis of controlled trials. Arch Phys Med Rehabil 2016;97(9):1558–63.