

Retrospective Study



Ultrasound-Guided Intermediate Site Greater Occipital Nerve Infiltration: A Technical Feasibility Study

Jonathan Zipfel, MD¹, Adrian Kastler, MD, Msc^{2,3}, Laurent Tatu, MD, PhD^{4,5},
Julien Behr, MD⁶, Rachid Kechidi, MD⁷, and Bruno Kastler, MD, PhD^{8,9}

From: ¹Radiology Unit, CIMVES Vesoul, France; ²Neuroradiology and MRI unit, Grenoble University Hospital, France; ³University of Grenoble Alpes, Grenoble Institute des Neurosciences, Inserm, U1216, Grenoble, France; ⁴Department of Anatomy, Franche Comté University, Besançon, France; ⁵Department of Neuromuscular Diseases, University Hospital, Besançon, France; ⁶Radiology Department, University Hospital, Besançon, France; ⁷Radiology Department Guilloz, Central University Hospital, Nancy, France; ⁸René Descartes University, Paris, France; ⁹Department of Adult Radiology, Necker University Hospital, Paris, France

Address Correspondence:
Jonathan Zipfel, MD
Interventional Pain Management
Unit
University Hospital Jean Minjoz
Besançon, France
E-mail:
zipfel.jonathan@gmail.com

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Background: Two studies recently reported that computed tomography (CT) guided infiltration of the greater occipital nerve at its intermediate site allows a high efficacy rate with long-lasting pain relief following procedure in occipital neuralgia and in various craniofacial pain syndromes.

Objective: The purpose of our study was to evaluate the technical feasibility and safety of ultrasound-guided intermediate site greater occipital nerve infiltration.

Study Design: Retrospective study.

Setting: This study was conducted at the imaging department of a 1,409 bed university hospital.

Methods: Local institutional review board approval was obtained and written consent was waived. In this retrospective study, 12 patients suffering from refractory occipital neuralgia or craniofacial pain syndromes were included between April and October 2014. They underwent a total of 21 ultrasound-guided infiltrations. Infiltration of the greater occipital nerve was performed at the intermediate site of the greater occipital nerve, at its first bend between obliquus capitis inferior and semispinalis capitis muscles with local anesthetics and cortivazol. Technical success was defined as satisfactory diffusion of added iodinated contrast media in the fatty space between these muscles depicted on control CT scan. We also reported first data of immediate block test efficacy and initial clinical efficacy at 7 days, one month, and 3 months, defined by a decrease of at least 50% of visual analog scale (VAS) scores.

Results: Technical success rate was 95.24%. Patients suffered from right unilateral occipital neuralgia in 3 cases, left unilateral occipital neuralgia in 2 cases, bilateral occipital neuralgia in 2 cases, migraine in one case, cervicogenic headache in one case, tension-type headache in 2 cases, and cluster headache in one case. Block test efficacy was found in 93.3% (14/15) cases. Clinical efficacy was found in 80% of cases at 7 days, in 66.7% of cases at one month and in 60% of cases at 3 months. No major complications were noted.

Limitations: Some of the limitations of our study include that it represents a single institution. The low number of infiltrations included in this study, for this guidance procedure, is another bias.

Conclusions: This ultrasound-guided infiltration technique appears to be feasible, safe, non-ionizing, and fast when targeting the greater occipital nerve in its intermediate portion. This imaging guidance modality should be used in routine clinical practice.

Key words: Greater occipital nerve, infiltration, ultrasound guidance, corticosteroids, occipital neuralgia, craniofacial pain syndrome

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Greater occipital nerve (GON) infiltration has become a common procedure performed in various types of headache syndromes (1) such as occipital neuralgia (2), cluster headache (3,4), cervicogenic headache (5,6), trigeminal neuralgia (7), migraine (8-10), and tension type headache (11-13), with variable results. Three areas of GON vulnerabilities have been described: first, at its origin between the atlas (C1) and the axis (C2); second, the intermediate site, where the GON curves around the obliquus capitis inferior muscle (Fig. 1); and third, at its superficial emergence when perforating the aponeurosis of the upper trapezius muscle. This third infiltration site is the most used for GON infiltration in clinical practice (14-16). Infiltration, at either the C1-C2 origin of the GON or at both the C1-C2 origin and intermediate site (2), is less common but have been reported with satisfactory efficacy. A recent study (17) suggested that a computed tomography (CT)-guided approach at the intermediate site of the GON is safe and effective to manage occipital neuralgia. Another study showed satisfactorily results with this CT-guided procedure in craniofacial pain syndromes such as migraine, cluster headache, and trigeminal neuralgia (7). Therefore, the objective of

this study was to assess the technical feasibility and safety of ultrasound (US)-guided GON intermediate site infiltration. Initial data of clinical efficacy were also reported.

METHODS

Patients

Twelve patients aged over 18 years were included in this single center retrospective study. They underwent a total of 21 infiltrations between April and October 2014. All patients who underwent US-guided GON infiltration for craniofacial pain lasting for at least 3 months, referred by a local pain and evaluation treatment center, were included for analysis. Local Institutional Review Board approval was obtained and informed consent was waived. The exclusion criteria were as follows: refusal to participate in the study, history of GON neurolysis (including radiofrequency or surgical treatment), hypersensitivity to any of the constituents of the drugs injected, local or general infection, anticoagulation therapy, and diabetes mellitus. Clinical characteristics of the patients including age, gender, and clinical presentation were recorded. Patients were examined at one week and one month following injection by interventional radiologists. Clinical evaluation at 3 months was also performed.

Procedure

All of the procedures were accomplished by 3 radiologists (BK, JZ, RK) under US-guidance (Philips CX50 ultrasound system with 12 Mhz broadband linear probe L12-3, or Supersonic Imagine Aixplorer, with 10 or 15 Mhz frequency broadband). The patient was placed in prone position with the head slightly flexion facing the puncture site in case of unilateral infiltration and straight in case of bilateral infiltration. A probe with a frequency of 10 to 15 Mhz was used. The target site was defined as being the fatty space between obliquus capitis inferior and semispinalis capitis muscles at C1-C2 level (Fig. 2). After local skin sterilization and a sterile packaging of the probe, the optimal target site was spotted. The spinous process of C2 was located, and the probe shifted laterally towards the entry site, approximately 2 – 3 cm in axial slice, showing the fatty space between the inferior obliquus capitis and semi spinalis capitis muscle. Doppler was used to avoid inadvertent vascular structure puncture. A step-by-step progression of the 22 G needle was performed under US-guidance, tangentially to the probe, until the echographic rever-

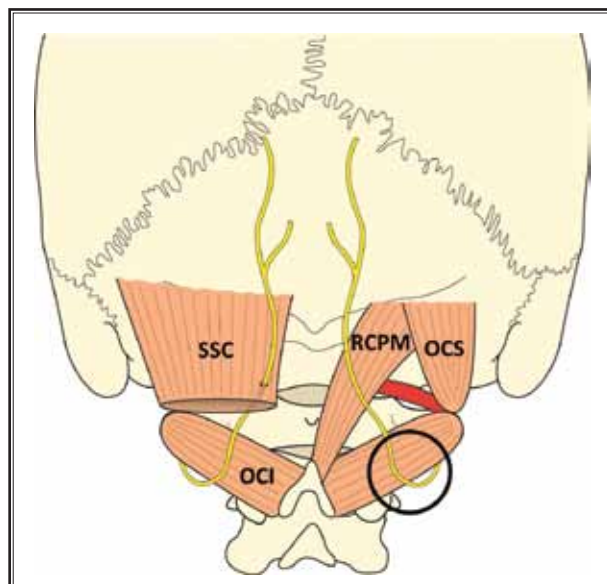


Fig. 1. *Anatomical schematic view of the GON.*
Notes: SSC: semi-spinalis muscle. OCI: obliquus capitis inferior muscle. OCS: obliquus capitis superior muscle. RCPM: rectus capitis posterior major muscle. Yellow structure: GON. Red structure: vertebral artery. Black circle: target site of the infiltration of the GON



Fig. 2. Axial ultrasound slice showing the target site of the infiltration of the GON. The fatty space appears as hyperechogenic structure between fibrillar hypoechogenic muscles structures.

Notes: C2: spinous process of C2. TPD: trapezius pars descendens muscle. SSC: semi-spinalis capitis muscle. SC: splenius capitis muscle. OCI: obliquus capitis inferior muscle. Red star: fatty space, defined as target site.

beration artifact at the needle tip was accurately situated at the target site (Fig. 2).

In order to control technical accuracy of this new guided infiltration technique, the procedures were performed on a CT table (Siemens Somatom Sensation CT 64-channel) in order to allow accurate needle and product diffusion control. Diluted iodinated contrast (0.5 mL material (Iomeron 300) was added to the mixture of fast and slow acting anesthetic (1.5 mL lidocaine hydrochloride monohydrate 1% and 3 mL ropivacaine hydrochloride monohydrate 2 mg/mL) injected in order to control accurate position and diffusion between the target muscles. A non-enhanced CT scan between C0 and C3 was performed for control. Then one and a half mL of cortivazol (3.75 mg) was injected before the needle was removed. The patient was supervised for 30 minutes at the CT-unit to monitor any early complication.

The duration of the procedure was also noted.

Technical success was defined as the ability to inject anesthetics and contrast media in the fatty space between obliquus capitis inferior and semispinalis capitis muscles, confirmed by CT slices, and therefore to inject corticosteroids in the accurate anatomical space (Fig. 3).

Target to skin distance was reported for each site of infiltration (Table 1).

Visualization and aspect in US of the first mix of the products injected was also noted.

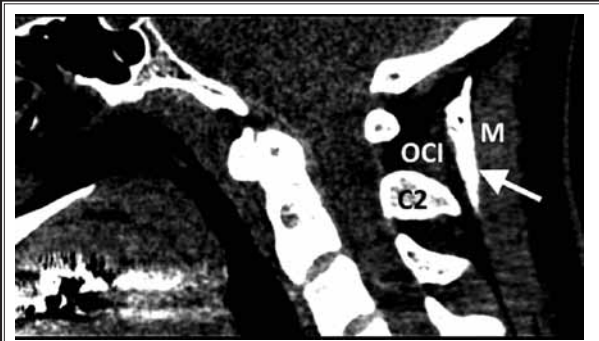


Fig. 3. Sagittal CT view showing post procedure accurate iodinated contrast media diffusion.

Notes: C2: spinous process of C2. OCI: obliquus capitis inferior muscle. M: muscles including semi-spinalis capitis muscle, splenius capitis muscle, and trapezius pars descendens muscle (from deep to superficial plan). White arrow: accurate iodinated contrast media diffusion level.

Pain Evaluation

The following criteria were noted prior to the procedure: maximum pain level using visual analog scale (VAS) scores (0 – 10). Immediately post procedure, maximum pain of the infiltration was assessed using VAS scores. In case of bilateral infiltration, the maximum VAS score was noted for each side. Pain follow-up was at 24 hours, 7 days, and one month using VAS scores for each side in case of typical occipital neuralgia, and overall in case of cervicogenic headache, migraine, cluster headache, and tension-type headache. Block test efficacy was defined by a decrease of at least 50% of VAS scores at 24 hours following procedure. Clinical efficacy at 7 days and one month was defined by a decrease of at least 50% of VAS scores. The occurrence of complications was evaluated and reported, with severity based on the Clavien-Dindo Classification of Surgical Complications (18).

Statistical Analysis

Results of continuous variables were expressed as mean ± standard deviation.

Block test efficacy and clinical efficacy variable at 7 days and one month were studied. Due to the small sample size with matched results, a nonparametric test was chosen. Wilcoxon signed rank test with continuity correction was performed on the data using the BiostaTGV website (19). A *P* value of < 0.05 was considered significant for the statistical analysis.

Table 1. Patient and procedure characteristics.

Patient	Gender	Age	Pathology	Infiltration Side	Target depth (mm)	Procedure duration	Technical success
1	M	27	Right ON	Right	44	7'2"	Yes
2	M	53	Bilateral ON	Right	28	17'	Yes
				Left	27		Yes
3	F	36	Right ON	Right	30	10'6"	Yes
4	F	66	Migraine	Right	31	13'05"	Yes
				Left	29		Yes
				Right	31	14'13"	Yes
				Left	29		Yes
5	F	49	Tension type headache	Right	49	13'10"	Yes
				Left	48		Yes
6	M	42	Cluster Headache	Right	27	7'51"	Yes
				Left	26		Yes
7	M	47	Tension type headache	Right	32	24'24"	Yes
				Left	34		Yes
8	F	50	Left ON	Left	51	8'30"	Yes
9	M	46	Right ON	Right	53	10'10"	Yes
10	M	45	Bilateral ON	Right	31	27'01"	Yes
				Left	30		Yes
11	M	49	Cervicogenic headache	Right	42	25'05"	Yes
				Left	40		Yes
12	F	48	Left ON	Left	36	7'44"	No

RESULTS

Patients

Patients' characteristics are given in Table 1.

A total of 12 consecutive patients were included. Seven men and 5 women, with a mean age of 46.5 ± 8.5 (27 – 66) years old. Seven patients underwent bilateral infiltrations and one 2 bilateral infiltrations. Patients suffered from right unilateral ON in 3 cases, left unilateral ON in 2 cases, bilateral ON in 2 cases, migraine without aura in one case, cervicogenic headache in one case, tension-type headache in 2 cases, and cluster headache in one case. In 83.4% (10/12) of cases, a history of cervical trauma or cervical surgery was noted.

Procedure

Procedure characteristics are given in Table 1.

Predefined target was identified by US in 100% of cases. Technical success, as defined, was 95.24% (20/21), with only one case of technical failure. Average duration of unilateral infiltration was 8 minutes, 42 seconds

(\pm 1 minute, 15 seconds), and average duration of bilateral infiltrations was 17 minutes, 46 seconds (\pm 6 minutes, 29 seconds).

Mean skin-target site distance was measured at 36 mm (\pm 8.7 mm).

Visualization of the first mixture of products injected under US was assessed in 100% of cases and appeared as a biconvex anechogenous lens (Fig. 4).

Pain Evaluation

Detailed VAS scores are given in Table 2.

Mean VAS score prior to the procedure was 8.4 ± 1.3 (6 – 10). Mean post-procedural VAS score was 3.6 ± 1.9 (1 – 6). Mean VAS score at 24 hours was 2.6 ± 2.2 (0 – 10). Mean VAS score at 7 days following the procedure was 3.3 ± 2.8 (0 – 10). Mean VAS score at one month following the procedure was 4.2 ± 2.8 (0 – 9). Mean VAS score at 3 months following the procedure was 4.74 ± 2.46 (1 – 9).

Block test efficacy, as defined, was obtained in 93.4% cases ($P < 0.0009$). Efficacy at 7 days, as defined,

was obtained in 80% cases ($P < 0.001$). Efficacy at one month, as defined, was obtained in 66.7% cases ($P < 0.0006$). Efficacy at 3 months, as defined, was obtained in 60% cases ($P < 0.0007$).

In the 6 cases of clinical failure at 3 months after GON infiltration, 4 patients benefited from pain relief lasting for one week or less (one patient with tension headache and one patient with cluster headache benefited from infiltration with a major pain relief [70%] for 24 hours). One patient with cervicogenic headache benefited from major pain relief (58%) for at least 7 days. One patient with left ON benefited from 50% pain decrease lasting for 7 days. One patient with right ON benefited from clinical efficacy as defined at one month and a 37.5% pain decrease at 3 months.

Only one patient with left ON did not benefit from pain relief but a decrease in medical treatment was noted (decrease of 70% of LAROXYL® posology).

No major complications occurred. In 3 procedures, minor Grade I side effects occurred as follows: One case of transient cervicalgia (lasting for 6 days) and 2 cases

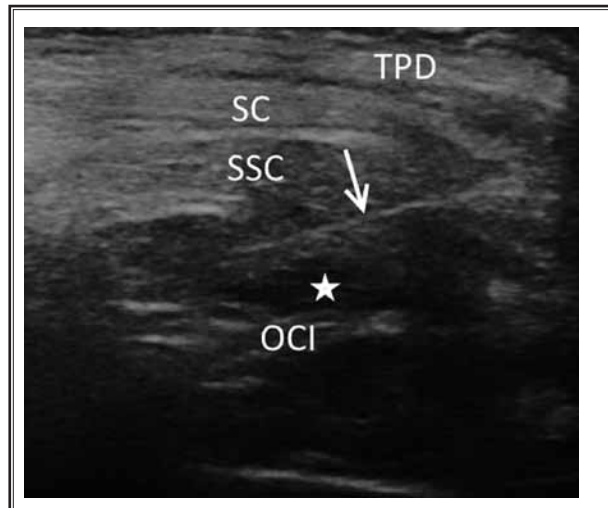


Fig. 4. Axial ultrasound slice showing needle reverberation artifact and anechoic biconvex lens.

Notes: TPD: trapezius pars descendens. SC: splenius capitis muscle. SSC: semi-spinalis capitis muscle. OCI: obliquus capitis muscle. White arrow: needle in position at the infiltration site. White star: biconvex anechoic lens.

Table 2. Detailed VAS scores.

Patient	Infiltration Side	Procedure VASS	Base VASS	24 hours VASS	7 days VASS	One month VASS	3 months VASS
1	Right	2	8	2	2	4	4
2	Right	2	8	2	0	0	1
	Left	2	8	1	0	0	3
3	Right	3	9	2	2	2	2
4	Right	5	6	2	2	3	3
	Left	6					
	Right	6	6	0	1	1	2
	Left	3					
5	Right	6	10	2	9	9	9
	Left	6					
6	Right	1	10	3	6	6	7
	Left	1					
7	Right	6	8	2	2	4	4
	Left	4					
8	Left	8	10	10	10	9	9
9	Right	7	8	3	4	4	5
10	Right	2	9	2	3	4	4
	Left	4	9	2	2	4	4
11	Right	3	7	2	3	5	6
	Left	4					
12	Left	3	10	5	4	8	8

of transient neck torticollis (lasting for respectively 5 and 10 days).

Discussion

Peripheral nerve blocks have been performed in headache treatment for a long time (2,4-6,17,20) and many physicians continue to perform GON infiltration based on external anatomical landmarks (21), despite the variability of the position of the emergence of the GON (22,23). Others have suggested the use of US-guidance for subcutaneous GON infiltration (24,25). Recently, a study suggested that the intermediate infiltration site of the GON might be used as target with US-guidance (26) and 2 studies demonstrated that the intermediate infiltration site of the GON had a high efficacy rate and long-lasting result in various craniofacial pain syndromes (7,17). Ultrasound-guided infiltrations are commonly performed in various other indications (27) allowing high technical success rates. However, the present study is the first to assess GON infiltration with US-guidance performed at the intermediate site. Results show a high technical success rate of 95% (20/21)

with a high block test efficacy rate of 93.4%, and with a good efficacy rate of 80% at 7 days, 66% at one month, and 60% at 3 months. Indeed, the predefined target site (fatty space between the obliquus capitis inferior and semispinalis capitis muscles) was accurately visualized in all cases and puncture of obliquus capitis inferior muscle was avoided in all cases. In the only case of technical failure, diffusion of contrast dye in the fatty space was not satisfactory, and the needle had to be replaced. The route of the needle was too superficial and inferiorly situated at level of C3 and the contrast media diffusion was on the external and inferior part of the fatty space with inadequate partial semi spinalis capitis myography (Fig. 5). Technical success was achieved after needle repositioning.

This procedure appears to be safe, as no major complication occurred and only 3 minor side effects were noted, which does not appear to be higher than with other imaging techniques (17). Classically described side effects such as vaso-vagal syncopal attack, transient dizziness following the injection, alopecia around the injection site, exaggerated headache (20), and Cushing's syndrome (14) were not observed in our study. Theoretical risk of injury to the vertebral artery is known when targeting the deep C1-C2 GON site. However, this intermediate infiltration site is situated at a safe distance from surrounding vital vascular structures (17). Occurrence of local hematoma is possible but may be avoided by the use of color Doppler, allowing to detect surrounding vascular structures present in the fatty space between the obliquus capitis inferior and semi spinalis muscles.

Furthermore, US-guided intermediate GON infiltration appears to be fast, as mean duration time of unilateral procedures and bilateral procedures remains under 18 minutes (8 and 18 minutes, respectively).

Advantages of US-guidance compared with CT-guidance are obvious: US is a non-ionizing procedure, it is more available, and bed side injection may be performed. Disadvantages of US guidance are also well described (28), especially in cases of obese patients or patients with a thick neck. However, these cases were not encountered in our study.

In order to enhance technical success of the procedure, a number of operational steps must be followed in a rigorous way. First, the right probe must be chosen, with a frequency between 10 and 15 Mhz, as the target site is situated at a mean distance of 3 cm to the entry point. Second, a muscle preset program should be selected in order to optimally differentiate fat and muscle



Fig. 5. Axial control CT slice with inadequate position of iodinated contrast media diffusion at C3 level. Partial myography of the semi-spinalis capitis muscle (white arrow).

Notes: OCI: inferior part of obliquus capitis muscle. SSC: semi-spinalis capitis muscle. SC: splenius capitis muscle. Red star: lower aspect of the fatty space at C3 level, under the first bend of the GON.

echogenicity and to improve target site and needle visualization. Third, the spinous process of C2 must be located, and the probe must be shifted laterally towards the entry site, approximately 2 – 3 cm, in axial slice.

Entry point of the needle must be correctly chosen in order to have the shortest route to the target located rather close to the obliquus capitis inferior muscle.

Limitations of the study are those inherent to retrospective and small study samples. Moreover, clinical efficacy rate at one month (66.7%) appears to be slightly lower than that reported in other studies (2,17). However, the few number of patients included in this study and the wider range of indications may partially explain these results. The main objective of this study was to focus on feasibility. The clinical efficacy of this technique in the mid and long term should be studied in a dedicated and prospective study. Moreover, because the initial course of the lesser occipital nerve is close to that of the GON, partial block of the lesser

occipital nerve may not entirely be excluded, and may cause a bias in some cases.

The use of CT guidance to confirm injectant diffusion is debatable, as it results in patient ionization. However, the objective of this study was to assess the feasibility of this technique, currently performed under CT guidance in our institution. Therefore, the use of adjunct of CT to confirm accurate diffusion of contrast seemed necessary to validate technical success. However, results of the study show that US alone is sufficient to assess accurate diffusion of injectant, as it is well depicted on real time US imaging as a biconvex anechogenous lens appearing in the fatty target space.

Despite these limitations, this study showed that intermediate GON infiltration under US guidance is technically feasible. Preliminary results show a safe and fast procedure, required in routine clinical practice, with satisfactorily clinical results.

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