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ORIGINAL RESEARCH ARTICLE

The anatomy of pain relief: Lumbar oxygen-ozone epidural infiltrations for cervicobrachialgia

Luca Faccioli[1], Giulio Vara[2,3,*], Luca Spinardi[1], Marco Pastore Trossello[4], Gianfranco Vornetti[5], Mattia Gentilini[6], Stefano Ratti[3]

[1] *IRCCS Azienda Ospedaliero-Universitaria di Bologna, 40138 Bologna, Italy*

[2] *Diagnostic and Interventional Radiology, Ospedale Civile "Umberto I", 70033 Lugo, Italy*

[3] *Cellular Signalling Laboratory, Department of Biomedical and NeuroMotor Sciences (DIBINEM), University of Bologna, 40126 Bologna, Italy*

[4] *Department of Radiology, Villa Erbosa Hospital, 40129 Bologna, Italy*

[5] *IRCCS Istituto delle Scienze Neurologiche di Bologna, 40139 Bologna, Italy*

[6] *Centre Hospitalier des Escartons,05100 Briançon, France*

*** Corresponding author:** Giulio Vara, Giulio.vara@gmail.com

ABSTRACT

Objective: This study investigates the efficacy and safety of epidural infiltration with drugs and an oxygen-ozone mixture for treating cervicobrachialgia due to disc-radicular conflict or on a degenerative basis, utilizing both retrospective analysis and direct visualization techniques. **Methods:** A retrospective study involving 10 patients treated with epidural infiltrations of an oxygen-ozone mixture and cortisone was conducted. The procedures were performed under CT guidance to ensure precise delivery and to monitor the diffusion of the injected substances. Pain levels were assessed using the Numerical Rating Scale (NRS) and treatment efficacy was evaluated based on symptom relief and reduction in NSAID intake. **Results:** Significant pain reduction was observed post-treatment, with median NRS scores decreasing from 9 (baseline) to 2 (follow-up), and a significant decrease in on-demand NSAID intake. Only one minor complication of a headache was reported. The study also demonstrated the ability of ozone to diffuse through the epidural adipose tissue, potentially enhancing treatment efficacy. **Conclusion:** The combined use of an oxygen-ozone mixture and cortisone for epidural infiltration is an effective and safe treatment for cervicobrachialgia, offering significant pain relief and minimizing the risk associated with traditional epidural injections. This technique presents a viable non-surgical option for patients suffering from disc-radicular conflict or degenerative conditions.

Keywords: interventional radiology; peridural; ozone; cervicobrachialgy; radiculopathy

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1. Introduction

Cervicobrachialgia is a condition determined by the compression of the nerve roots, which manifests clinically with a broad spectrum of symptoms, including pain, sensory of motor deficits, and hyporeflexia. Incidence is esteemed to be 1.79/1000 per year, and affects the male population, with a ratio of 1.6:1[1,2].

One of the potential causes of radiculopathy is cervical hernia; asymptomatic cervical hernia has a prevalence in the general population of 18.6%, most of which is represented in the sixth decade, with a slight predominance in women with a ratio of 1.4:1. The most affected disc space is C6-C7. However, the incidence of symptomatic disc herniations is very low; a study by Young-Ki Kim et al. reports 1636.56/100,000 subjects in a 6-year time period

(0.27%/year)[3,4].

The most frequent cause of radiculopathy, on the other hand, is cervical spondylosis, a degenerative process that leads to hypertrophy of the ligaments and the formation of osteophytes, resulting in spinal cord compression and reduction in the width of the neural foramina. It has a reported prevalence of 13.76% in the general population[5].

It is a highly debilitating condition, with significant socio-economic and psychological consequences, therefore the clinical goal is that of a rapid treatment that allows to restore the patient's state of health.

In the absence of motor deficits or direct bone marrow involvement, the first line of treatment is medical conservative using NSAIDs, opioids or corticosteroids. Physical therapy, alone or in association with pharmacological treatment, is also part of the therapy, even if in the acute phase it can be difficult to implement.

The initial conservative therapy must however consider the possible side effects of the drugs, which are often used for quite extended periods, up to 2 months or more. In case of failure, therefore, or poor tolerance to the side effects of the drugs used, minimally invasive pre-surgical solutions can be adopted which are highly effective in controlling pain and often sufficient and valid alternative to the surgical procedure[6].

The most widely used treatment is infiltration of a drug cocktail administered into the epidural fat tissue, with or without imaging guidance.

Among the drugs used, in addition to cortisone, there is a growing interest in ozone which, through multiple mechanisms of action, can itself function as a powerful anti-inflammatory or emphasize the effectiveness of the associated cortisone.

Ozone is a powerful oxidant, toxic by inhalation, characterized by a complex multifactorial action mechanism consisting of high anti-inflammatory and disinfectant power, corrector of ischemia and venous stasis, increase of the pain threshold by stimulation of anti-nociceptors, activation of the descending antinociceptive system and oxidative degeneration of C-nociceptors.

If injected directly into the nucleus pulposus, the interaction with the proteoglycans determines its lysis with consequent release of water which, once reabsorbed, determines by dehydration a volumetric reduction of the disc and its hernia[7–9].

The proven efficacy of ozone and cortisone infiltrations for the control of herniated disc pain at the lumbo-sacral epidural level, its extraordinary ability to diffuse through the tissues and the observation that patients undergoing lumbar infiltrative procedures for lumbosciatica but also suffering of cervicobrachialgia from radicular compression also reported resolution or improvement of cervical symptoms, motivated us to further research in this regard.

The effectiveness of this approach was thus evaluated with a retrospective study conducted on 10 patients with cervicobrachialgia and indication for treatment.

2. Materials and methods

2.1. Population

Ten patients treated from 2018 to the current date were selected for the study. Information on the injection site, the drugs used, and the number of treatments performed via the electronic record, and the state of the cervical spine were retrospectively recorded through previous imaging studies on the company PACS.

An interview was then conducted by telephone with the patients in which data about pain and associated disc symptoms were collected before the procedure, two weeks after treatment, and as it stands today; the

Numerical Rating Scale (NRS) was used for the collection of pain data, for the evaluation of associated symptoms a McNab scale, the results of which were classified as excellent for complete resolution of symptoms, satisfactory with a significant reduction in symptoms , mediocre for a minor symptom reduction.

2.2. Technique

The procedure was performed by placing the patient prone on the CT bed, and a shaped thickness at the abdomen-pelvis passage to reduce lumbar lordosis and facilitate access to the epidural space via the interlaminar route. The optimal site for the injection was identified by means of a low-dose centering CT with the use of a cutaneous metal marker consisting of a network formed only by vertical filaments spaced 1cm apart, for a total width of 12 cm. Based on the CT data thus obtained, the distance and inclination of the needle from the skin surface to the injection target were calculated. The point of insertion of the needle was reported with the CT laser centering device on the patient's skin surface and marked with a dermographic pen.

We then proceeded in asepsis, to disinfect the skin, to the administration of 4–7 cc of 2% lidocaine and to the introduction of a needle 22 G × 9 cm whose distal end was positioned, with some CT scans, at the vertex of the adipose triangle epidural appreciable in the axial images thus obtained. The demonstration of the correct positioning of the needle within the epidural adipose tissue was confirmed by the injection of 0.5 cc of air which is distributed around the dural sac.

Subsequently, 3 cc of an oxygen-ozone mixture at a concentration ranging between 18 and 20 mcg/mL was injected, followed by the administration of the steroid cocktail (triamcinolone acetonide 60 mg) and ropivacaine 10% (1.5 mL). The injection was performed between D12 and L3 in most cases (50%) (**Figure 1**).

Figure 1. Axial **(A)** and parasagittal **(B)** acquisition during the procedure.

To verify and document the cranial migration of ozone along the epidural adipose tissue, a low-dose CT acquisition was performed and analyzed with HU (Hounsfield Unit) values specific for gas densities; a three-dimensional reconstruction for the representation of the gas was then obtained with the MeVis Lab software (**Figure 2**).

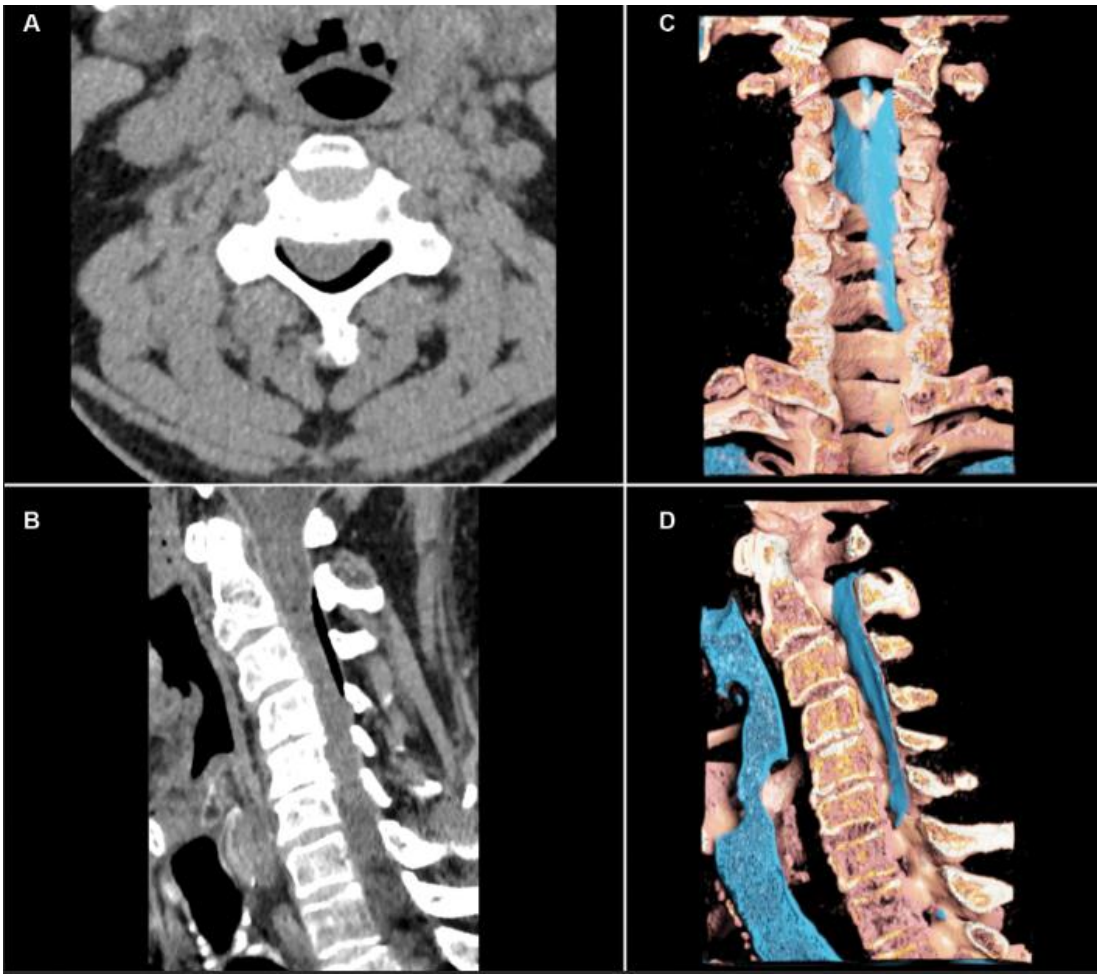

Figure 2. Axial **(A)** and sagittal **(B)** images obtained after the procedure, demonstrating air inside the spinal canal in the cervical region. Three-dimensional reconstruction obtained with the cinematic rendering technique on the coronal **(C)** and sagittal **(D)** plane, with selective highlighting of air HU value (in blue).

2.3. Statistical analysis

The Fisher test was used to assess the association between the nominal variables and the Wilcoxon test was used to evaluate the difference between medians in accordance with the sample size and the data distribution.

3. Results

Ten patients were selected, with a median age of 57.5 years (42–73), of which 5 were males (50%). All patients were affected by cervicobrachialgia, with pain radiating to the C6-C8 innervation territory with paresthesia in 7 patients. Patients with neck pain only, without root symptoms were excluded. The duration of symptoms before starting treatment ranges from 6 months to several years, with a median of 12 months. 7 patients had suffered from painful symptoms for more than 1 year. Regarding the extent of pain, the subjective evaluation by NRS showed a median of 9, with scores from 8 to 10. For symptom control, patients reported a median of 3 times per week NSAID intake. with a minimum of 2 and a maximum of 7.

Three patients underwent several sessions (never more than 3) of treatment if partial benefits were

reported at the first session or relapses after a few weeks.

All patients underwent the procedure only after clinical and radiological evaluation with MRI or CT if not possible; most patients were symptomatic of C6 (60%), C7 (30%), and C4 (10%) root pain. Disco-somatic degenerative phenomena were present in all patients, with particular evidence in 4 of these.

The characteristics of the population have been summarized in **Table 1**.

Table 1. Study population.

Age (y)	**57.5 (42–73)**
Sex	5M/5F
Paresthesias	7/10
NRS before treatment	9 (8–10)
Frequency of NSAID use before treatment (times/week)	3 (7-2)
Hernia location (C4/C5/C6/C7)	1/0/6/3

Following treatment, the median pain reported after 2 weeks was 6 (1-9) significantly reduced from baseline assessment (p = 0.009), and at follow-up status of 2 (1-9), significantly reduced from baseline (p = 0.006) but not from state at 2 weeks (p = 0.522) (**Figure 3**).

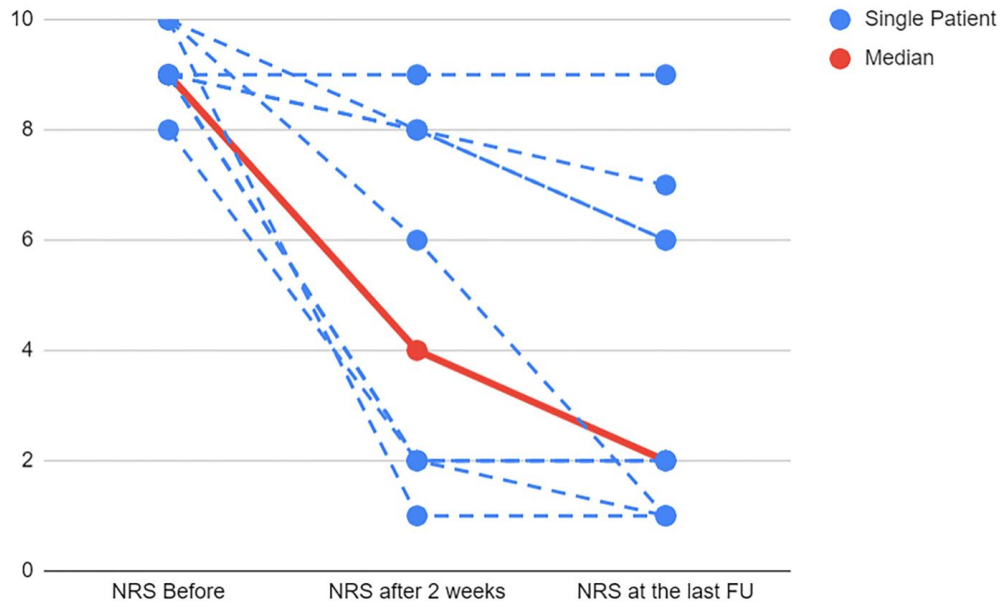

Figure 3. The line chart shows the NRS values of symptoms of cervicobrachialgia for every patient (blue) and the median value of the population (orange) at the baseline, at 2 weeks, and at the last follow up.

A significant difference was also observed in taking on-demand therapy, with a median of 0 and only one patient with sporadic NSAID intake with a frequency of less than 1/week. significant subjective improvement in paraesthesia was reported in 2 patients, moderate improvement in 4, no improvement in 1 patient.

Only one event was found as a complication: a slight headache immediately after the procedure, for which the patient was kept under observation until the spontaneous regression of symptoms.

The results obtained from the procedure are summarized in **Table 2**.

Table 2. Treatment outcomes.

	Before	After	Sign. (p)
NRS	9 (8–10)	2 (1–9)	0.006
NSAID/week	3 (2–7)	0 (0–1)	0.012

4. Discussion

Cervical hernia has a much lower frequency (about 5 times less) than lumbar hernia and is one of the most common causes of cervicobrachialgia[5,10]. In most cases the radicular impingement is due to the combination of disc-somatic degenerative phenomena ("disc-osteophytic bar"), while pure disc herniation (so-called "soft") is more infrequent and usually concerns post traumatic events in young subjects with good disc hydration[11].

Whatever the cause, the root conflict determines the onset of pain in the cervical region extended to the shoulder and upper limb often up to the hand, with painful paraesthesia with typical topography of the root territory involved, with particular frequency affecting the roots of C6 (space disc C5-C6) and C7 (disc space C6-C7)[12].

The most effective solution in pain control widely practiced, similarly to what happens for lumbar hernias, is the epidural injection of cortisone and anesthetic, possibly associated with the administration of oxygen-ozone, a procedure that can be performed in the hyperacute phase or after failure of medical therapy[6].

Cervical epidural injection, whether practiced with or without imaging guidance (fluoroscopy or CT), is burdened by a high intrinsic risk of accidental puncture of the dural lining or the medulla, with potentially catastrophic consequences. The risk is due to the fact that the epidural fat pad, (clearly visible in the MR images) progressively thins, proceeding caudo-cranial, until it becomes a virtual space at the C7-T1 passage. It follows that: cranially from C7-T1 the dural lining is closely adjacent to the yellow ligaments without interposition of visible adipose tissue; and it is not technically possible (or rather advisable) to infiltrate upstream of C7-T1, even if the radicular impingement concerns a more cranial root. The experience and the finding obtainable from the CT images suggested that the oxygen-ozone mixture injected at the lumbar level for the treatment of sciatica also positively influenced a possible concomitant cervicobrachialgia, with appreciable gas and therefore probably also associated drugs (cortisone and anesthetic) migrated to the cervical area.

The possibility of directly demonstrating the migration of gas with CT has allowed us to verify its diffusion capacity even within the epidural adipose tissue, which, although characterized by a dense network of vascular and connective structures, allows for "free" diffusion of the injection from the point of administration in the cranial and caudal direction.

5. Conclusions

The epidural infiltration technique of drugs and oxygen-ozone mixture, has proved effective and safe for the treatment of cervicobrachialgia due to disc-radicular conflict or on a degenerative basis in a broad sense, even when performed in the lumbar area or in the dorsal-lumbar passage, by natural diffusion of the injection along the entire rachis.

Direct visualization of the epidural adipose tissue when the procedure is performed under CT guidance allows you to identify the ideal injection point, even high dorsal, eliminating the risk of an accidental puncture of the cervical cord without compromising its effectiveness.

Author contributions

Conceptualization, LS and LF; methodology, GV (Giulio Vara); software, GV (Giulio Vara); validation, SR, GV (Gianfranco Vornetti) and MG; formal analysis, GV (Giulio Vara); investigation, LF and GV (Giulio Vara); resources, SR and MPT; data curation, LS and GV (Giulio Vara); writing—original draft preparation, GV (Giulio Vara); writing—review and editing, MG; visualization, GV (Giulio Vara); supervision, LF and SR; project administration, SR and MPT. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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