

# Technical efficacy and safety of CT-guided transforaminal periradicular infiltration using CT foot switches and MPR images

Luca Saba<sup>1,2,3</sup>, Francesco Saba<sup>4</sup>, Robert Dagan<sup>1,2</sup>, Massimo De Filippo<sup>5</sup>, Pierre Yves Marcy<sup>1,2</sup>

<sup>1</sup>Department of Radiology, Clinique Les Fleurs (Groupe ELSAN), Ollioules (France); <sup>2</sup>Department of Radiology, Clinique du Cap-d'Or (Groupe ELSAN), La Seyne-sur-Mer (France); <sup>3</sup>Departement of Radiology, Humanitas Mater Domini, Castellanza VA (Italy); <sup>4</sup>Departement of Gastroenterology, University of Sassari, Sassari (Italy); <sup>5</sup>Departement of Radiology, University of Parma, Parma Hospital, Parma (Italy)

**Abstract. Purpose:** To demonstrate the technical efficacy and safety of CT-guided transforaminal periradicular infiltration in the treatment of the radicular pain without surgical intervention, using CT foot switches and MPR images. **Materials and Methods:** Four hundred and eighty two patients (286 males and 196 females, age range 27-71 years, mean age 56 years) with a unilateral or bilateral radiculopathy who underwent CT-guided transforaminal periradicular infiltration without surgical intervention, were retrospectively selected in the period from January 2019 to February 2020. Patients who had received surgery for herniated disc or laminectomy, patients with a previous vertebral fractures, and patients with inflammatory syndrome or risk of bleeding were excluded. **Results:** There were no major or minor clinically relevant complications. Many patients a marked reduction or resolution of pain after the CT-guided infiltration ( $P < 0.05$ ). No patient required hospitalization. One patient reported an episode of intense headache, which resolved after twenty minutes. In eleven cases, a slight increase in pain related to spinal compression caused by the administration of the drug was reported, even if administrated extremely slowly. Sixteen patients reported pain in the upper limbs during and after the procedure, however this was not related to infiltration but to the forced and prolonged arm position. **Conclusion:** CT-guided transforaminal periradicular infiltration is a semi-invasive and well tolerated procedure, moreover it has a reduced comorbidity and no observed major or minor complications. The CT foot switches and MPR evaluation may help to make the procedure more efficient. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** CT guided transforaminal periradicular infiltration; efficacy and safety; CT foot switches; MPR images.

## Introduction

The Lumbar infiltrations, also known epidural infiltrations, are frequently used at the end of relieving back pain, sciatica and persistent cruralgia. Although increasingly accurate thanks to the guidance of medical imaging, their effectiveness is however inconsistent (1-2).

The lumbar infiltration consists in injecting locally low dose of an anti-inflammatory treatment,

most often based on cortisone, in order to decrease the local inflammation, and consequently the pain. The infiltration makes possible to deliver even a powerful anti-inflammatory directly on the painful site, with an remarkably weak general diffusion that allows a better effectiveness, while avoiding the side effects of the anti-inflammatory treatments (1, 3, 4).

The injection is performed in the backbone, precisely in the epidural space concerning the root of the

nerve, therefore where the nerve comes out of the spine. The product can be injected at the interlaminar level, caudal or transforaminal, depending on the desired diffusion of the drug (3-4).

Infiltration is offered as a second option for patients who are suffering for several weeks, that were not relieved by rest and medication, patients who suffer of acute low back pain, or sciatica or cruralgia related to a herniated disc or related to narrow lumbar canal (1-2).

Those kinds of infiltrations have been traditionally performed under fluoroscopy, but the use of Computed Tomographic (CT) guidance has steadily increased. Compared to fluoroscopy CT guidance offers a superior anatomic orientation and the needle tip can be placed directly near the visible affected nerve root (1, 3-4).

The aim of the study was demonstrating the technical efficacy and safety of CT guided transforaminal periradicular infiltration in the treatment of the radicular pain using CT foot switches and Multiplanar Reformation (MPR) images without surgical intervention.

## Materials and Methods

Forty hundred and eighty two patients (286 males and 196 females, age ranging from 27 to 71, means an average of 56 years old patients) who underwent CT-guided transforaminal periradicular infiltration were retrospectively selected in the period from January 2019 to February 2020; 428 suffered from an unilateral radiculopathy and 54 of a bilateral pain, all of them have not surgical intervention. Lumbar MRI was performed two months prior the procedure on all the patients.

Ethical approval statement is not required for this study.

Exclusion criteria: were excluded patients operated on for herniated disc or laminectomy, patients with previous vertebral fractures, patients with inflammatory syndrome or risk of bleeding.

The weeks before the procedure was carried out a radiological consultation to identify and confirm the presence of the lumbar pain, to explain the procedure

of CT-guided infiltration to the patient, to obtain informed consent and exclude some risk factors, especially the hemorrhagic one.

Coagulation balance is necessary before performing the procedure. The platelets must be at least 100.000.

The epidural infiltration will be carried out 10 days after the interruption of the platelet antiagregant. Antivitamines K (AVK) treatment is a contraindication to spinal infiltration of corticosteroids.

If spinal infiltration is required, the AVK will be interrupted and relayed by a low molecular weight heparin (LMWH); infiltration will be performed when the International Normalized Ratio (INR) is less than 1.5 and 24 hours after the LMWH injection.

The procedure was performed by three radiologists with at least 5 years of experience.

The patients were placed prone on the CT table with their arms over their head and was performed a CT scan (GE Healthcare Discovery 16 slice, Chicago, Illinois, USA) to identify the needle path.

Then a laser landmark was established.

The patients were disinfected profusely; then, a sterile material was prepared for the procedure (Fig. 1).

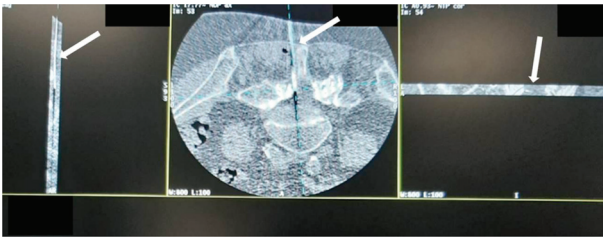
After percutaneous anesthesia on the painful side, a 22 Gauge (G) x 9 cm Chiba needle (up to 15 cm in the case of a major pathway) was used to achieve the epidural space, passing over the yellow ligament. Each image acquisition was performed by using the CT foot switches, allow a rapid execution without leaving the



**Figure 1.** Summary of the material used for the CT guided transforaminal periradicular infiltration.

CT room; as a consequence three axial images were displayed directly on the screen into the CT room, to help to follow the needle path during the procedure; the MPR images of the needle path were used for a better accuracy and a faster execution (Fig. 2).

Contrast medium (0,2-0,3 cc, Visipaque 270 mgI/mL, GE healthcare - Boston, Massachusetts, U.S.A.) was administered to evaluate the correct position of the needle tip (Fig. 3 a-c and 4).



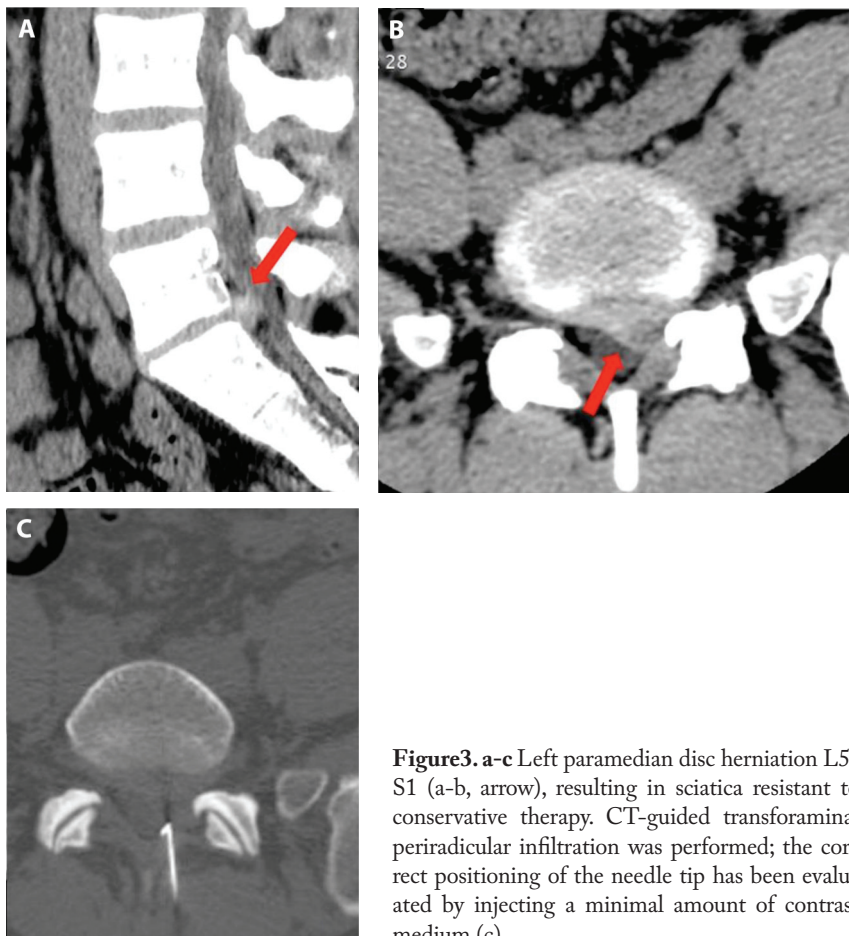
**Figure 2.** The image shows the needle path control (arrows) into the CT room screen by using foot switches, using MPR images.

Then Prednisolone 2,5 gr (Hydrocortansyl 2,5% prednisolone, Sanofi-Aventis Groupe, Paris, France) was administered (about 5 cc) extremely slowly to allow a gradual diffusion and avoid spinal compression given by the administration of the drug.

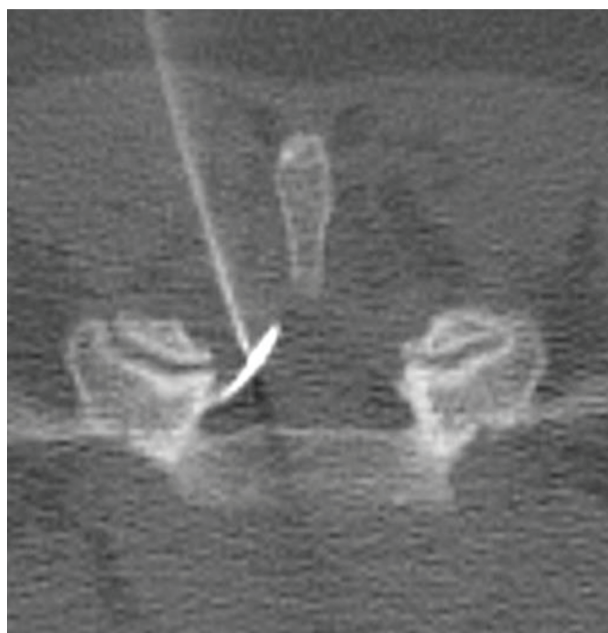
After the CT-guided infiltration the patient were held for about twenty minutes in a lying position before leaving the radiology service; normally, all patients were called by our service to assess the technique effectiveness and the appearance of complications; the results were transcribed in the patient's medical record

## Results

Forty hundred and eightytwo CT-guided transforaminal periradicular infiltration were carried out, of which 246 at L4-L5 level, 162 at L5-S1 level and 74 at L3-L4 level.



**Figure3. a-c** Left paramedian disc herniation L5-S1 (a-b, arrow), resulting in sciatica resistant to conservative therapy. CT-guided transforaminal periradicular infiltration was performed; the correct positioning of the needle tip has been evaluated by injecting a minimal amount of contrast medium (c).



**Figure 4.** Introduction of the needle into the epidural space; the correct positioning has been evaluated by injecting a minimal amount of contrast medium.

Among those, 86 were bilateral, of which 54 at L4-L5 level, 24 at L5-S1 level and 8 at L3-L4 level.

The results of the technique effectiveness were retrieved from our database and correspond to thirty days after the treatment. Normally it was asked to the patients to quantify the pain reduction after infiltration on a scale of 1 to 5, where 1 represents the absence of benefit and 5 the disappearance of the symptoms; 2, 3 and 4 represented three different levels of pain reduction. The pain value has been a subjective quantification dependent on the patient's perception.

The differences between the first (detection pain from 1 to 3) and the second group (detection pain from 4 to 5) were statistically significant according to the Chi-Square Test ( $P < 0.01$ ).

The results are summarized in the table 1.

There were no major or minor clinically relevant complications neither immediately nor after two days.

No patient needed hospitalization.

There was one episode of intense headache, resolved after twenty minutes.

In 11 cases was reported a slight increase in pain, related to spinal compression given by the

**Table 1.** The table summarizes the number of cases (N) and their percentage with respect to all cases (%) in relation to the pain scale, thirty days after the guided CT infiltration ( $P < 0.01$ ).

PAIN SCALE	N (%)
1	12 (2,5%)
2	14 (2,9%)
3	42 (8,7%)
4	196 (40,7%)
5	218 (45,2%)

administration of the drug, even if it was administrated extremely slowly.

Sixteen patients suffered by pain in the upper limbs during and after the procedure, however not related to infiltration but to the forced and prolonged arms position.

## Discussion

Our study confirms the data in the literature: this procedure has been rapid, in most cases, without any complication, the pain during the procedure is, practically, never revealed, given also to the exceptional activity of lidocaine as a local anesthetic.

According to the literature, that defined extremely limited risks, in our study there were no major complications.

The current literature reports success rates up to 100% for transforaminal periradicular infiltration, depending probably on methodology and technique (1, 3).

Many patients have a marked pain reduction after the CT-guided infiltration. To achieve full effect for those who have only mild pain relief another supplementary injection may be performed, usually from one to four weeks intervals (2, 3).

After the procedure, the patient was held under observation for about twenty minutes, which is usually appreciated from the patient.

We believe that a consultancy before the infiltration is necessary, it clearly increases the patient's compliance which arrives the day of the infiltration calm and aware of the procedure.

Most of our patients have been a benefit after the procedure, with pain reduction or disappearance, especially in the short term.

The treatment is therefore semi-invasive but well tolerated, with a very low comorbidity.

A review by Depriester et al. reported on 1156 CT-guided lumbar transforaminal epidural infiltrations performed in the year before publication without major complications (4). There are some reports that describe something catastrophic complications (5-8); in particular Atluri et al have been reported 18 cases of a severe complication as spinal ischemia (9).

The technique of passing posteriorly with respect to the nerve, like our technique, reduces the development of a spinal ischemia, because the spinal artery is usually located in anterior and superior position respect to the nerve, except for congenitally alterations.

In our study we also emphasize the use of CT foot switches which allow a rapid procedure execution making sure that the radiologist can stay in the CT rooms: the advantages of using the CT foot switches cannot be quantified not only numerically (reduction of the radiant dose) but in practice: reduces the time of the procedure, allows the use of the remote control by the radiologist to be able to adjust the acquisition windows directly, without the help of the radiographer. Furthermore, for better performance, the MPR reconstruction software was used directly on the screen in the CT room, to evaluate the 3D needle path (Fig. 2). We have not found relevant studies that talk about this topic.

All cases of serious neurological complications have been reported after the immediate injection of a particulate corticosteroid: Triamcinolone acetonide (10-13), Methylprednisolone acetate (14-16) and Betamethasone sodium phosphate/betamethasone acetate (17-18).

One of the hypotheses to explain this arterial obliteration is the formation of particulate macro aggregates, which are larger than red blood cells (19). Triamcinolone, Methylprednisolone and Betamethasone Sodium Phosphate/Betamethasone Acetate contain many particles that tend to form macro aggregates that can exceed 10 times the size of the particles that could form an embolus and occlude small arterioles (20-21).

Dexamethasone sodium phosphate, the only non-particulate corticosteroid currently available in France, is widely used internationally, especially in the

United States. If cervical infiltration or lumbar foraminal infiltration is indicated, this corticosteroid appears to be associated at present with a more limited risk of neurological complication in a patient with no previous surgical history (22-23).

We did not have any complications with the use of prednisolone 2,5 gr (Hydrocortancyl).

Finally, in our study, the CT-guided transforaminal periradicular infiltration is a semi-invasive and fast procedure, well tolerated, moreover with a reduced comorbidity and without or with very few complications, as confirmed by the literature.

The main limitations of our study is that it is not a multicenter study; also, we have not analyzed the benefit of long-term and very long-term of the CT-guided infiltration; however, the aim of it was rather focused on the safety and efficacy of the procedure in the short term.

In conclusion, the CT-guided transforaminal periradicular infiltration is a semi-invasive and well tolerated procedure, moreover with a reduced comorbidity and without major or minor complications.

The CT foot switches and MPR evaluation could help to make the procedure more efficient.

**Conflicts of interest:** Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

## References

1. Gruenberg MF, Petracchi M, Valacco M, Solá C. Use of CT-guided periradicular injection for the treatment of foraminal and extraforaminal disc herniations. *Evid Based Spine Care J.* 2011 Aug;2(3):19-24.
2. Cluff R, Mehio AK, Cohen SP, Chang Y, Sang CN, Stojanovic MP. The technical aspects of epidural steroid injections: a national survey. *Anesth Analg* 2003;95:403-408.
3. Ali Harman, Enes Duman, Adnan Ozdemir. The effectiveness of computed tomography-guided lumbar epidural steroid injections for spinal pain management: A single center experience with 2 year follow-up. *Biomedical Research* 2017;28(18):7775-7778.
4. Depriester C, Setbon S, Larde A, et al. CT-guided transforaminal cervical and lumbar epidural infiltrations. *Diagn Interv Imaging.* 2012;93(9):704-710.
5. Houten JK Errico TJ. Paraplegia after lumbosacral nerve root block: Report of three cases. *Spine J* 2002;2:70-75.

6. Huntoon M, Martin D. Paralysis after transforaminal epidural injection and previous spinal surgery. *Reg Anesth Pain Med* 2004;29:494-495.
7. Somyaji HS, Saifuddin A, Casey ATH, Briggs TWR. Spinal cord infarction following therapeutic compute tomography-guided left L2 nerve root injection. *Spine* 2005;30:E106-108.
8. Kennedy DJ, Dreyfuss P, Aprill CN, Bogduk N. Paraplegia following image-guided transforaminal lumbar spine epidural steroid injection: Two case reports. *Pain Med* 2009;19:1389-1394.
9. Atluri S, Glaser SE, Shah R, et al. Needle position analysis in cases of paralysis from transforaminal epidurals: consider alternative approaches to traditional technique. *Pain Physician*. 2013;16(4):321-334.
10. Brouwers PJ, Kottink EJ, Simon MA, Prevo RL. A cervical anterior spinal artery syndrome after diagnostic blockade of the right C6-nerve root. *Pain*. apr 2001;91(3):397-9.
11. Chang Chien GC, Candido KD, Knezevic NN. Digital subtraction angiography does not reliably prevent paraplegia associated with lumbar transforaminal epidural steroid injection. *Pain Physician*. dec 2012;15(6):51-523.
12. Glaser SE, Falco F. Paraplegia following a thoracolumbar transforaminal epidural steroid injection. *Pain Physician*. jul 2005;8(3):309-14.
13. Tiso RL, Cutler T, Catania JA, Whalen K. Adverse central nervous system sequelae after selective transforaminal block: the role of corticosteroids. *Spine J Off J North Am Spine Soc*. Aug 2004;4(4):468-74.
14. Bose B. Quadriparesis following cervical epidural steroid injections: case report and review of the literature. *Spine J Off J North Am Spine Soc*. oct 2005;5(5):558-63.
15. Hodges SD, Castleberg RL, Miller T, Ward R, Thornburg C. Cervical epidural steroid injection with intrinsic spinal cord damage. Two case reports. *Spine*. 1 oct 1998;23(19):2137-2142.
16. Houten JK, Errico TJ. Paraplegia after lumbosacral nerve root block: report of three cases. *Spine J Off J North Am Spine Soc*. feb 2002;2(1):70-7.
17. Kennedy DJ, Dreyfuss P, Aprill CN, Bogduk N. Paraplegia following image-guided transforaminal lumbar spine epidural steroid injection: two case reports. *Pain Med Malden Mass*. nov 2009;10(8):1389-1394.
18. Windsor RE, Storm S, Sugar R. Prevention and management of complications resulting from common spinal injections. *Pain Physician*. oct 2003;6(4):473-483.
19. Diehn FE, Murthy NS, Maus TP. Science to Practice: What Causes Arterial Infarction in Transforaminal Epidural Steroid Injections, and Which Steroid Is Safest? *Radiology*. jui 2016;279(3):657-659.
20. Benzon HT, Chew T-L, McCarthy RJ, Benzon HA, Walega DR. Comparison of the particle sizes of different steroids and the effect of dilution: a review of the relative neurotoxicities of the steroids. *Anesthesiology*. feb 2007;106(2):331-338.
21. Derby R, Lee S-H, Date ES, Lee J-H, Lee C-H. Size and aggregation of corticosteroids used for epidural injections. *Pain Med Malden Mass*. mars 2008;9(2):227-234.
22. Laemmel E, Segal N, Mirshahi M, Azzazene D, Le Marchand S, Wybier M, et al. Deleterious Effects of Intra-arterial Administration of Particulate Steroids on Microvascular Perfusion in a Mouse Model. *Radiology*. jun 2016;279(3):731-740.
23. Laredo J-D, Laemmel E, Vicaut E. Serious neurological events complicating epidural injections of glucocorticoid suspensions: evidence for a direct effect of some particulate steroids on red blood cells. *RMD Open*. 2016;2(2):e000320.

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**Correspondence:**

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Dott. Luca Saba

Humanitas Mater Domini

Via Gerenzano, 2, 21053 Castellanza VA, Italy

Tel: 0331476111

E-mail: lukas\_red@hotmail.it