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Percutaneous radiofrequency facet capsule denervation as an alternative target in lumbar facet syndrome

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ABSTRACT

Objectives: Percutaneous radiofrequency denervation of the medial dorsal branch is often used in chronic low back pain of intervertebral facet etiology, which is sometimes difficult to perform and recurrence of pain often ensues. We theorized that shifting the target of RF coagulation to the facet joint capsule would provide an easier target and a longer-lived pain relieving response.

Patients and methods: A prospective randomized controlled trial where 120 patients diagnosed with CLBP of a confirmed facet origin were randomly divided into three equal groups, the first was submitted to percutaneous radiofrequency coagulation of the facet joint capsule, the second underwent percuataneous denervation of the medial dorsal branch and the third did not receive radiofrequency lesioning. All the three groups received local injection of a mixture of local anesthetic and steroid. Cases were followed for up to 3 years.

Results: 87(72.5%) patients were females. By 3 months' post procedure, improvement in VAS was significantly better than pretreatment levels in all groups ($p < 0.05$). The control group lost improvement by 1-year follow-up ($p = 0.017$). At 2 years' follow-up, the joint capsule denervation group maintained significant improvement ($p = 0.033$) whereas the medial branch denervation group lost its significant effect ($p = 0.479$). By the end of follow-up period, only joint capsule denervation group kept significant improvement ($p = 0.026$).

Conclusion: In CLBP of facet origin, shifting the target of percutaneous radiofrequency to the facet joint capsule provides an easier technique with an extended period of pain relief compared to the medial dorsal branch of the facet joint.

1. Introduction

Lumbar zygapophyseal (intervertebral facet) joints have been implicated as the source of chronic low back pain (CLBP) in approximately 45% of cases [1,3,14,22]. Each facet joint is innervated by the medial branch of the dorsal ramus of the nerve root (nerve of Luschka) at the same level and the level above [5,23,24]. Blocking facet joint innervation via injecting long acting local anesthetic with or without a long acting steroid has been widely used to verify the facet joint as the offending source of CLBP. A reduction of 50% or more of LBP in response to the test block was considered sufficient to warrant performing radiofrequency (RF) lesioning of the medial dorsal branch supplying the facet joint with the intent of providing an extended period of pain relief [19,26]. Percutaneous RF denervation of facet joints for symptomatic amelioration of CLBP attributed to these joints has become common practice over the last decades. Geurts et al. in a recent systematic review came to a conclusion that there was moderate evidence that RF denervation of the intervertebral facet joints is more effective for CLBP than placebo [31]. However, targeting the medial branch of the dorsal ramus is not without limitations. It can sometimes be technically challenging and, moreover, even after successful RF denervation, pain usually recurs after 1–3 years implying possible nerve regeneration [27]. In this study, we theorized that shifting the target of facet joint denervation towards the joint capsule instead of the conventionally-employed medial dorsal branch can provide a technically easier target and, more importantly, may extend the duration therapeutic response owing to attacking the usually non-regenerating nerve receptors impeded in the joint capsule.

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2. Material and methods

This study was conducted in the Department of Neurosurgery, Faculty of Medicine, Alexandria University, Egypt in the period extending from June 2011 till August 2015.

Type of the study: A prospective randomized controlled double-blind clinical trial.

Inclusion criteria:

- Patients complaining of continuous CLBP with or without radiating pain into the upper leg lasting for at least one year without demonstrating satisfactory improvement in response to at least 3 months of conservative treatment e.g. analgesics and physiotherapy.
- Clinical manifestations suggesting a facet origin of pain (e.g. paraspinal tenderness and increasing pain on spinal extension).
- Initial VAS score of at least 7.
- Achieving complete or near complete reduction of pain on the VAS30 minutes after fluoroscopically-guided injection of a long acting local anesthetic (bupivacaine 0.5%) as a diagnostic test blockade of the medial dorsal branch of segmental nerve roots L3, L4 and L5 supplying the facet joints. This positive result must be obtained on two different occasions separated by at least two weeks.
- Age of the patient must be at least 18 years.

Exclusion criteria:

- Surgical causes of LBP e.g. spondylolisthesis, fracture spine .... etc.
- Patients who did not experience complete or near complete reduction of LBP on the VAS30 minutes after the test block.
- Prior lumbar surgery.
- Associated major comorbidities e.g. uncontrolled diabetes mellitus, uncontrolled hypertension, cardiac diseases, malignancy and bleeding diathesis.
- Prior RF treatment for LBP.
- Presence of radicular syndromes i.e. sensory or motor deficits and positive straight leg raising test.
- Infection at the injection site.
- Pregnancy.
- Allergic reaction to the local anesthetic used in the procedure.
- Patients with possible work compensation litigations.
- Mental handicap or psychiatric condition precluding adequate communication.
- Scoring 50 or more on the Zung Self Rating Depression Scale.

2.1. Methods

Patients were recruited from the outpatient clinic. All patients considered for inclusion in the study were submitted to history-taking, complete general and neurological examination, radiological investigations in the form of plain X-ray of the lumbosacral spine; anteroposterior, lateral, oblique and dynamic views and computerized tomography (CT) as well as magnetic resonance imaging (MRI) of the lumbosacral spine. Over the recruitment period, 213 patients satisfied the inclusion and exclusion criteria and were offered participation in the study, of whom, 179 agreed joining the study.

2.2. Diagnostic block

Patients were first submitted to diagnostic block in the operating theater, aseptically injecting a long-acting local anesthetic (bupivacaine 0.5%) supplied in a 10 ml syringe. At each injection site, 0.5 cc of the local anesthetic was administered guided by C-arm image intensifier (Cios Connect, Seimens, Germany) using a 3.5 inches, 22-gauge spinal needle targeting the junction of the superior articular process with the transverse process where the medial branch of the dorsal ramus to the facet joint (nerve of Luschka) is coursing. This was performed bilaterally at the levels L3-4, L4-5 and L5-S1 facet joints.

Patients who reported complete or near complete reduction of CLBP on the VAS measured 30 min after the injections on two different occasions separated by at least two weeks were marked as positive respondents and were considered for inclusion in the study. Patients included in the study were assigned sequential numbers and the first 120 positive respondents were randomly assigned to either of three equal groups each comprising 40 patients by using computer-generated simple randomization employing blocks of three. The first group underwent RF denervation of the facet joint capsule, the second group was submitted to RF denervation of the medial dorsal branch supplying the facet joint whereas the third group was the control (sham) group that had the electrodes and thermocouple probe positioned similar to the treatment groups setup and the RF machine was turned on without switching on the RF current. Patients were guaranteed that in case they experienced no pain relief after sham treatment, a RF treatment would be offered.

2.3. Therapeutic procedures

The C-arm image intensifier was used to fluoroscopically guide a thermocouple electrode (RF Electrodes w/3 m Cable (CSK), 20 cm in length with a 10 mm active tip) to the desired destination. Patients were put in prone position on a radiolucent operating table and non-pulsed mode of RF (RFG-1A, Cosman Medical Inc., Burlington, MA 01803, United States) was adopted in both treatment groups. The electrode active tip was placed parallel to and touching the target, the joint capsule in the first group and the medial dorsal branch in the second one. Motor and sensory stimulation were done at first at 2 and 50 Hz respectively to exclude close proximity of the electrode tip to the nerve root. Sensory and motor stimulation thresholds were required to be less than 0.5 V. In case of absence of ipsilateral lower limb muscle contraction or paraesthesia thereby ruling out close proximity of the electrode tip to the nerve root, sedation was induced through IV infusion of propofol (Deprivan) at a rate of 0.1 mg/kg/min. A lesion was then created at a temperature of 85 °C for 90 s. In the group submitted to facet joint capsule denervation, each facet joint capsule received two lesions, one on its medial aspect and a second one on the lateral aspect (Figs. 2 and 3). After the lesion was completed on one side of the joint capsule, the needle was withdrawn for 2–3 cm and then redirected to the other side without complete retrieval of the needle from the skin. In the group submitted to medial dorsal branch denervation, the tip of the needle was destined towards the junction of the superior articular process and the transverse process where the medial dorsal branch courses and care was taken for the electrode tip not to project past the ventral border of the facet column. The lesion was repeated at three different locations along the course of the medial branch, at an increment of 3 mm to provide effective denervation (Fig. 1).

In both procedures, lesions were performed at L3-4, L4-5 and L5-S1 levels bilaterally. Patients in the control (sham) group were submitted to the same electrode set-up with the RF generator switched on but without delivering current to the thermocouple electrode. All the patients in the treatment and control groups received 1 cc of a mixture of equal volume of both a long-acting local anesthetic, bupivacaine 0.5% and a long-acting steroid, Depo-Medrol® injectable Suspension (methylprednisolone acetate, 40 mg/ml, Pfizer, USA) at the end of the procedure through the electrode needle at the site of the performed lesion (in the treatment groups) or at the junction of the transverse process and the