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Focus: Facet Joint Intervention

Morphologic changes in the lumbar spine after lumbar medial branch radiofrequency neurotomy: a quantitative radiological study

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Abstract

BACKGROUND CONTEXT: Medial branch radiofrequency neurotomy (RFN) is a common treatment for zygapophyseal joint pain. The lumbar medial branch innervates these joints and adjacent structures. The impact of the intended neurotomy on these structures remains unclear. No studies have yet verified quantitatively the effect of medial branch RFN on intervertebral discs, facet joints, and multifidus cross-sectional area.

PURPOSE: The aim of this study was to determine, using objective radiographic measures, whether there is a quantitative difference in the lumbar multifidus muscle cross-sectional area, facet joint degeneration, or intervertebral disc degeneration after segmental medial branch RFN.

STUDY DESIGN/SETTING: This is a retrospective single-cohort study performed at a university spine center.

PATIENT SAMPLE: The patient sample consisted of 27 patients treated with lumbar medial branch RFN, with pre- and posttreatment magnetic resonance images available for analysis.

OUTCOME MEASURE: The primary study outcome measure was interval change in fat-subtracted multifidus cross-sectional area, and intervertebral disc and zygapophyseal joint degeneration grade.

METHODS: In this retrospective study, segmental levels unaffected by RFN treatment were used as controls to compare against levels affected by treatment.

RESULTS: Levels affected by RFN demonstrated a significantly greater amount of disc degeneration compared with unaffected levels (14.9% vs. 4.6%; p=.0489). There was no statistical difference in the multifidus cross-sectional area or rates of deterioration in the zygapophyseal joints observed.

CONCLUSIONS: The full impact of RFN on multifidus function, morphology, and segmental anatomy is unknown. This retrospective study indicates that measurable changes in segmental morphology may occur after lumbar medial branch RFN. These findings require validation in a prospective, controlled study.

Keywords: Radiofrequency; Medial branch; Zygapophyseal joint; Back pain

Introduction

Low back pain is prevalent and has a multitude of potential sources. Most often implicated are the articulations of the spine including the intervertebral discs [1], zygapophyseal joints [2], and the sacroiliac joints [3]. Estimates of zygapophyseal joint involvement in chronic low back pain

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range between 15% and 40% [4,5]. A common interventional treatment for zygapophyseal joint pain is medial branch radiofrequency neurotomy (RFN) [6,7].

During RFN, the medial branch is coagulated thermally to interrupt pain signaled from the zygapophyseal joint. Although RFN is considered a low-risk procedure, with a 1.0% minor complication rate [6], serious complications can occur. Reports of injuries during radiofrequency lesioning include lumbosacral radiculopathy after radiofrequency ablation of a pelvic arteriovenous malformation [8], radiculopathy after lumbar medial branch RFN [9], and accidental transection of the lateral branches of the lumbar dorsal rami [10].

Other potential long-term complications of RFN, resulting from the intended neurotomy, have been theorized. The sensory function of the medial branch nerve is the target of RFN; however, its motor function to the multifidus muscle is unavoidably interrupted as well [11,12]. The long-term impact of RFN on the multifidus muscle remains unknown. This deserves investigation given the association between multifidus dysfunction and chronic low back pain [13]. Furthermore, the multifidus muscle is considered one of the primary muscles involved in segmental stabilization in the lumbar spine [14,15]. Thus, it is possible that changes in multifidus activity, combined with neurotomy-induced alterations in segmental proprioception, can have an impact on segmental stability, resulting in accelerated segmental degeneration involving the zygapophyseal joints and intervertebral discs. To our knowledge, no study has attempted to investigate the relationship between lumbar medial branch RFN and long-term changes in multifidus muscle size and segmental degeneration using objective outcomes measures. This study aimed to do so.

Methods

The data were collected retrospectively at one academic spine center after institutional review board approval, and was in compliance with the Health Insurance Portability and Accountability Act. All patients who received a lumbar RFN during the preceding 6 years were identified using billing codes unique to the RFN procedure. Their charts were reviewed to select patients meeting the following inclusion criteria: documented completion of a lumbar medial branch RFN procedure, no history of lumbar spine surgery, and institutional lumbar spine magnetic resonance (MR) images obtained both before and after the date of the RFN procedure. Only patients with institutional magnetic resonance imaging (MRI) examinations were included to ensure uniformity of the imaging studies. No patients meeting these criteria were excluded from the study.

Data collection

From each patient record, the following data were obtained: age, gender, date of RFN, duration of back pain before RFN, history of spine surgery or other medical conditions that could affect the spine, and dates of pre- and postprocedure MRI. Data regarding all RFN treatments included dates and medial branch nerves targeted. The institutional RFN electrode placement and technique corresponded with that reported by Dreyfuss et al. [12]

All pre- and postprocedure MR images were reviewed by one nonblinded physician investigator (RC), who measured intervertebral disc and facet joint degeneration grade for all segmental levels from L1–L2 through L5–S1. Intervertebral disc degeneration was classified using the Pfirrmann grading scale [16], and facet joint degeneration was classified using the Weishaupt lumbar facet joint disease severity grading scale [17]. The Pfirrmann grading system (Grades I–V) uses contemporary MRI and a grading algorithm based on MRI signal intensity, disc structure, distinction between nucleus and annulus, and disc height. The Weishaupt grading scale classifies the facet joints as follows: Grade 0, normal; Grade 1, mild degenerative disease; Grade 2, moderate degenerative disease; and Grade 3, severe degenerative disease. Grading is based on severity of disease, including joint space narrowing, osteophytes, articular hypertrophy, bone erosions, and/or subchondral cysts. The reliability of each scale has been documented [16,17]. Multifidus cross-sectional area (CSA) was measured on the right and left at L4–L5 and L5–S1, and was assessed using ImageJ (National Institute of Health, Bethesda, MD, USA), an open-source image processing software program [18]. For all the segmental measures, axial T2 images corresponding most closely to the middisc level were used. For the CSA measure, the image was calibrated by drawing a line along the centimeter ruler at the bottom of the MR image, thus determining the number of pixels per centimeter. Next, a freehand line was drawn around the multifidus muscle to determine the segmental muscle CSA. Because changes in muscle bulk can occur without substantial changes in overall CSA as a result of fatty replacement of muscle tissue, additional measures were performed to subtract fat. Specifically, a gray-scale cutoff was used to perform a dichotomous transformation of each pixel within the image. All pixels at or above the cutoff were converted to black (muscle) and all of those below, to white (fat). This allowed the program to calculate both the overall CSA and the fat-subtracted CSA, the latter being a measure of the overall CSA less the area indicated by the white pixels within the encircled area (Fig. 1). This fat-subtracted CSA measurement was used in all analyses.

For purposes of analysis, each measurement (on both the pre- and posttreatment MR image) was placed in one of two groups: levels affected by RFN treatment or levels unaffected. The RFN status corresponded with the documented anatomy of the multifidus muscle, the medial branch nerves, and their patterns of innervation [19]. For the disc and zygapophyseal measures, levels affected were defined as the segmental level or levels where the neurotomies affected the entire zygapophyseal joint or joints. Unaffected