

## Dilemmas with denervation: to do or not to do (that is the question)

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Across the spectrum of clinical care, there are no perfect treatments—therapies that provide clear benefit without associated or potential harm. Although this principle is well-recognized, a complete understanding of the benefits and risks for any treatment is only achieved with the accumulation of experience and evidence. Governed by the Hippocratic oath, physicians are charged with the responsibility to evolve their practices with gained knowledge so that we ultimately “do no harm.” This ethical imperative has ushered doctors away from prescribing heroin (derived from the German term “heroisch,” which means large and powerful) elixirs as general panaceas, or performing lobotomies for a host of psychiatric indications, among countless other examples across history.<sup>20,28</sup> In this context, the paradoxical effects of radiofrequency neurotomy (RFN) of the lumbar medial branches in treating facet-mediated chronic low back pain (LBP) at the expense of causing multifidus atrophy has received a surge of recent attention and warrants further investigation.

Although other groups of supportive spinal musculature exist, biomechanical studies have demonstrated that the multifidus contribute up to two-thirds of the necessary lumbosacral spine stability required for dynamic movement.<sup>12,32</sup> Consequently, multifidus atrophy secondary to arthrogenic muscle inhibition has been associated with compromised spinal neuromuscular control and propagation of LBP.<sup>4,9,23</sup> Motor control and dynamic stabilization programs aimed at strengthening the multifidus have proven successful in reducing LBP and associated functional limitations.<sup>8,18</sup> Recently developed restorative neurostimulation treatments, which selectively stimulate the lumbar medial branches, have also been effective in improving pain and function in patients with LBP and associated multifidus atrophy.<sup>13</sup>

In this issue of *PAIN*, Guven et al.<sup>15</sup> conducted a retrospective study investigating asymmetries in multifidus morphology after unilateral RFN. As noted on MRIs obtained at least 2 years post-RFN, there was a greater increase in multifidus fatty infiltration and decrease in cross-sectional area in the treated vs untreated

“control” muscle. As other investigators have shown that multifidus atrophy is more prevalent on the ipsilateral side of pain at baseline, muscle atrophy may represent the natural course of LBP pathology.<sup>3,17,25</sup> The concordance of ipsilateral multifidus atrophy and pain prevalence also suggests that using the contralateral multifidus as a “control” for comparison may be inappropriate when studying the denervation effects of RFN. A study comparing multifidus morphology across multiple time points in patients with LBP treated with and without RFN would more definitively implicate RFN as a causative factor. Interestingly, the findings by Guven et al. are contradictory to those by Oswald et al.<sup>22</sup> who found no evidence of asymmetrical paraspinal muscle or fat distribution between treated and untreated sides when studied across a similar time frame post-RFN. Alternatively, multifidus atrophy may also represent a red herring as Crawford et al. showed that multifidus atrophy was present and increased with age in a cohort of healthy volunteers without LBP.<sup>7</sup>

Whereas post-RFN multifidus atrophy was not clearly established in their study, Smuck et al. found a greater prevalence of disk degeneration in treated lumbosacral levels.<sup>26</sup> Given that accelerated disk degeneration is a harbinger of accelerated lumbar spondylosis, the long-term risks of RFN should be questioned, especially in younger populations who can develop facet-mediated LBP after athletic, occupational, or military-related injuries. These populations are not only at increased risk for facetogenic pain (ie, traumatic arthritis) but the consequences of paraspinal muscle atrophy may also be greater. Even in non-high-risk populations, the unclear long-term harms for multifidus-mediated spinal instability are concerning, especially if repeat RFN procedures are performed at short time intervals; studies have shown that the final phase of continuous muscle denervation consists of irreversible, interstitial fibrosis, wherein muscle tissue is replaced by adipocytes.<sup>1,5</sup> Because the L5 dorsal ramus rather than the medial branch is denervated at the most commonly affected L5-S1 facet joint, the lateral- and intermediate branch-innervated erector spinae muscles could be additionally denervated at lower levels.<sup>6</sup> The magnitude of these risks is further amplified given that long-term durability of RFN is unclear and the cumulative success rate of repeat procedures tends to decline, albeit on a shallow curve.<sup>27</sup>

Even if implicated as a direct mechanism for multifidus atrophy, RFN represents a viable treatment for patients with lumbar facet-mediated LBP, for which there are no other evidence-based alternative therapies. Given that this cohort carries a high risk for opioid utilization and disability, the use of opioid-sparing treatments should be optimized.<sup>2,10,11</sup> Moreover, this population is also at a higher risk for lumbar fusion surgeries, which carry a much greater risk than RFN and can cause paraspinal muscle

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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*PAIN* 00 (2024) 1–3

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<http://dx.doi.org/10.1097/j.pain.0000000000003224>

atrophy secondary to surgical disruption of the branches of the dorsal rami.<sup>23,24,30</sup> When contextualized, there likely exists a percentage of patients with facet-mediated LBP who may be better served with RFN procedures as an adjunct treatment to optimize functional mobility and quality of life. On the contrary, spinal immobility and deconditioning in this population may be independent risk factors for worsening chronic LBP and eventual opioid use or surgical management.<sup>4,10,11,21</sup>

So how do we reconcile preliminary, conflicting findings and modify clinical practice? Similar to neuropathic and nociplastic pain conditions, there are likely phenotypes of degenerative LBP for whom different treatment modalities need to be incorporated.<sup>6,16,31</sup> Shifting away from RFN en masse might lead to unintended but predictable consequences of avoidable suffering and increased opioid and spine surgery utilization in a population already at high risk for opioid use.<sup>10,11</sup> Therefore, recognizing the hazards of RFN and weighing them against the potential risks of multifidus atrophy and functional spinal segment instability is imperative. The use of nonablative therapies such as restorative neurostimulation or peripheral nerve stimulation have shown promise to enhance multifidus activation and warrant further consideration.<sup>13,14</sup> Although clearly inferior to RFN, pulsed radiofrequency may serve as a motor sparing alternative, especially in patients who are younger or may require repeat procedures.<sup>19,29</sup> Lastly, an emphasis on spinal conditioning programs should continue to be emphasized in all patients, especially those with radiologic evidence of multifidus atrophy. Updates to consensus practice guidelines for lumbar facet joint interventions will hopefully address these concerns and provide future directions for clinical practice.<sup>6</sup>

### Conflict of interest statement

S.P.C.: Consultant in 2022 for Avanos (Alpharetta, GA, manufacturer of cooled radiofrequency equipment) and SPR Therapeutics (Cleveland, OH, manufacturer of Sprint peripheral nerve stimulation). All named authors meet the ICMJE criteria for authorship, take responsibility for the integrity of this work, and have given their approval for publication. J.K. reports no disclosures.

### Acknowledgements

This work was partly supported (partial effort for S.P.C.) by the U.S. Department of Defense, Uniformed Services University, Department of Physical Medicine & Rehabilitation, Musculoskeletal Injury Rehabilitation Research for Operational Readiness (MIRROR) (HU00011920011). This organization played no role in the preparation of this manuscript.

### Article history:

Received 7 February 2024

Received in revised form XXXX

Accepted 9 February 2024

Available online 6 March 2024

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