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Thoracic radiofrequency ablation

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ABSTRACT

Thoracic spine pain is a relatively common condition. Pain in this region may be attributable to dysfunction of the thoracic facet joint. The true prevalence of thoracic facet pain remains somewhat elusive. Although challenging to diagnose at times, this joint is amenable to several therapeutic options. Radiofrequency neurotomy and thoracic medial branch blocks are normally used to treat facetogenic pain originating in the thoracic spine. Although demonstrating promise, larger, robustly designed trials are needed to further elucidate the appropriate treatment of this disorder.

Introduction

Mid-back pain is a relatively common condition of the spine and often as disabling as neck and low back pain.[1] Prevalence of thoracic spine pain have been reported to vary from 4%-72%.[2] These disparate numbers reflect challenges in recognition, diagnosis, and treatment of thoracic spine pain. Variations are attributed to factors such as the clinical biases of individual practitioners and dissimilarities in study inclusion criteria.[2] Overlapping pain referral zones from the cervical and lumbar spine that also contribute to diagnostic challenges. Predisposing factors for the development of thoracic spine pain include child or adolescent age group, female sex, concurrent musculoskeletal pain, and various work factors.[1,2]

The presence of thoracic pain is often considered a “red-flag,” requiring careful investigations of medical history and subjective complaints in eliminating suspicious and often life-threatening non-musculoskeletal sources of pain such as neoplasm and aortic aneurysm.[3]

When establishing a focused treatment strategy, identifying specific pain generators is an important step. Practically speaking, over time multiple pain generators are likely to coexist and contribute to pain. Thoracic zygapophyseal (facet) joints are a source of thoracic pain that may be amenable to treatment.[4] Contemplating these joints as a source of pain and subsequently identifying problematic or pathological levels is crucial for successful treatment.

Clinical anatomy

The thoracic facet joints are synovial joints with cartilage lining their articular surfaces.[5] The articular surfaces of T1-T11 are typically oriented in the coronal plane, whereas larger variations are noted between T11 and L1 because of the transition toward lumbar sagittal plane orientation.[5,6] There are meaningful exceptions that may be of greater clinical significance including side-to-side and intra-individual differences. These unpredictable asymmetries may result in cumulative facet movements that are different between facets joints within the thoracic spine during normal movement,[6] leading to intra- and inter-individual complexity with motion assessments and force transmission.

The importance of meniscoid folds has been a source of considerable debate. Schulte et al[4] found intra-articular cartilage lesion severity was greater in those joints with multiple meniscoid folds. Furthermore, the authors noted

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that 62% of 297 thoracic facet joints contained at least one intra-articular meniscoid fold. Severe lesions exhibited evidence of persistent bleeding within the joint. Interestingly, a direct connection was found between the fold and the epidural fat that courses through the yellow ligament suggesting a mechanism for pressure relief intrinsic to the facet joints. This explains how intra-articular injectate fills not only the joint space, but travels to enter the vertebral canal and may spread extra-spinally also.

It is well established that the posterior rami of the segmental spinal nerve is the conduit for sensory innervation to the thoracic facet joint.[5] Investigators have debated whether it is the medial branch of the posterior rami that provides the innervation,[6,7] or if a more proximal descending branch innervates the thoracic facet joint.[8] Chua and Bogduk[8] dissected 4 human cadavers, taking an extrathoracic approach, dissecting fascicle by fascicle. They exposed 84 medial branches, and traced the path of the medial branch of the posterior ramus from its origin off the posterior ramus just distal to the dorsal root ganglion. They noted the medial branch coursed dorsally, inferiorly, and primarily laterally outward toward the superolateral margin of the transverse process before turning and proceeding in a dorsal-medial direction. Along this path, they report the medial branch gives off subsequent branches to both the superior and inferior thoracic facet joints. Ishizuka et al[9] dissected 240 thoracic spinal nerves in 10 human cadavers; proceeding from an intrathoracic entry point and moving progressively dorsally and superficially outward. They noted upon resection of fibrous tissue they term the "laminotransverse ligament," a separate descending branch that first exited the posterior ramus proximal to its bifurcation into medial and lateral branches. Approximately, half of these descending branches projected fine branches into the facet joint capsule. In contrast to Chua and Bogduk,[8] Ishizuka et al[9] noted that no specimen exhibited medial branch innervation to the neighboring facet joints. Unfortunately, Ishizuka did not take sections of tissue and histologically stain them to confirm the presence of nerve fibers; furthermore their findings were inconsistent with findings in other regions of the spine, beyond the variability that would normally be expected.

The previously defined sensory nerve supply must be correlated to the specific pain patterns. Dreyfuss et al.[10] documented thoracic facet joint pain responses to provocative injections in 9 asymptomatic individuals. Of the 40 joints injected, 11 did not elicit pain upon capsular distention. The resultant pattern of pain induced in the remaining 29 joints was ipsilateral and spanned 4-5 vertebral segments around the injected joint. Similarly, Fukui et al[11] showed considerable overlap when reproducing facet pain by intra-articular injection in 15 patients with suspected facet joint mediated pain. Both studies illustrate the complex overlap of pain that appears to arise from thoracic facet joints despite direct comparison rendered difficult by fundamental design differences in the studies.

Pathology of thoracic facet joints

In the spinal motion segment, the facets are part of the 3-joint complex, with most of the weight-bearing occurring through the vertebral body-disk complex owing to the line of gravity being anterior to the kyphotic curve. Loss of disk height, hydration, and hydrostatic pressure typically increase the weight-bearing load upon the facet joint over time, contributing to concurrent loss of facet joint articular cartilage, and subsequent articular process hypertrophy.[12] Injury to the vertebral body-disk complex may contribute to the acceleration of facet joint degeneration.

Although visible on diagnostic imaging, degenerative disease does not reliably correspond to pain. In fact, Stolker et al[13] reported 37.5% of patients presenting for percutaneous facet denervation demonstrated normal radiographs. Further reinforcing the futility in overreliance on imaging, Wood et al[14] reported 73% of asymptomatic individuals demonstrated anatomical changes on thoracic magnetic resonance imaging, whereas Niemeläinen et al[15] reported 21.4% of men in a population-based study exhibited at least 1 moderate-to-severe degenerated disk between T6 and T12. These results reinforce the importance of clinical examination in corroborating imaging with diagnosis.

Various pathologies may lead to inflammation, capsular dysfunction, meniscoid entrapment, joint ankylosis, and instability. Furthermore, entrapment of nerve tissue coursing through the region may occur.[3,4] These pathologies may contribute to the development thoracic facet pain, they may occur as the result of trauma, degeneration or postural deformity, most notably in scoliotic patients. Individual patient response to persistent pathological changes could result in local mechanical nociception and peripheral and central sensitization.[16-22]

Prevalence of thoracic facet disorders

The prevalence of thoracic facet disorders has been estimated through controlled medial branch diagnostic blocks. A total of 46 patients who had not responded to conservative care were injected with lidocaine 1% followed 3-4 weeks later by bupivacaine 0.5% along the medial branch under fluoroscopic guidance.[23] Each spinal level evaluated was selected based on pain distribution history, facet joint tenderness, and symptoms reproduced with pressure. Success was determined by 80% relief of the patient's symptoms with previously painful movements. Facet pain prevalence was reported at 48%, being derived from those who received success from both blocks. This study in particular was riddled with methodological flaws including the lack of technical description of the procedure and the use of corticosteroid increasing the likelihood of false positive. Manchikanti et al[24] studied facet injection using a defined standardized medial branch block injection technique without use of corticosteroid, demonstrating similar results with 42% prevalence in another group of 72 patients. No prevalence studies were identified that used intra-articular blocks, possibly because of the complexity of pain overlap from various pain-producing structures, the challenges of accurate intra-articular placement as well as pleural puncture risk.[10,13] Therefore, the true prevalence of thoracic facet joint pain remains unknown because of the uncertainty of definitive facet innervation, the unknown number of individuals with facet pain who did respond to