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Lumbar zygapophysial (facet) joint injections

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Introduction

The bones of the spine articulate anteriorly by intervertebral discs and posteriorly by paired joints. These posterior, paired joints are commonly called "facet joints," more formally and precisely "zygapophysial joints," and briefly "z-joints." Pain can emanate from these joints. This position paper discusses the diagnostic and therapeutic values of injecting pharmacologic agents into the lumbar z-joints and around the nerve supply to these joints in patients with low-back and referred lower-extremity pain. This Contemporary Concepts paper serves as an updated revision of a previously published paper on this topic [1].

Historical review

In 1911, Goldthwait [2] first recognized lumbar z-joints as potential sources of back pain. In 1933, Ghormley [3] coined the term "facet syndrome." In 1963, Hirsch et al. [4] reproduced low-back and proximal leg pain in patients by injecting a physiologic irritant (hypertonic saline) in the regions of the z-joints. In 1976, Mooney and Robertson [5] and, again in 1979, McCall et al. [6] used fluoroscopy to confirm the location of lumbar z-joint injections in asymptomatic volunteers; these injections of hypertonic saline caused back and lower-extremity pain. In 1997, Fukui et al. [7] demonstrated the capacity of the z-joints and the medial branch divisions of the dorsal rami to cause referred pain. In 1976, Mooney and Robertson [5] first documented relief of low-back and lower-extremity pain in patients after injection of local anesthetic into the lower lumbar z-joints.

Historically, treatment for lumbar z-joint pain has included presumed percutaneous denervation using a scalpel [8]; percutaneous denervation using radiofrequency electrodes [9–13]; percutaneous denervation using chemical or cryogenic techniques [14,15]; intra-articular placement of corticosteroids [5,10]; and oral medications, physical therapy and mobilization/manipulation [16].

Notwithstanding this enthusiasm, controversy continues regarding the true prevalence, most accurate diagnostic methods and most efficacious treatment of symptomatic lumbar z-joints.

Rationale

Low-back pain has many causes and can originate from any of several pain-sensitive foci, among which are the z-joints. Eliminating sensation from a z-joint has been proposed as a way to allow an examiner to determine if that joint is responsible for the patient's pain. Injections of local anesthetic into the z-joint or around its nerve supply are clinical methods of eliminating pain from focal areas such as z-joints. Once a particular joint is determined to be the source of pain, long-term relief can be sought by directing therapeutic interventions at that joint. Included in potential treatment are z-joint injections of corticosteroid to reduce presumed inflammation or permanent denervation by means of percutaneous ablation of the nerve supply. The anatomic accessibility of the z-joints makes diagnostic blocks, therapeutic instillation of corticosteroids and focal nerve ablation particularly appealing.

Based on responses to single blocks, the prevalence of lumbar z-joint pain in patients with low-back pain ranges from 7.7% to 75% [17–30]. The wide variation in reported prevalence rates may reflect selection bias, variable population subsets referred to individual clinicians or false-positive or placebo responses. The lower prevalence rates were reported in larger samples with fewer inclusion criteria. However, even in the studies reporting a low prevalence,

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the authors acknowledge the existence of lumbar z-joint–mediated pain [27,29,31,32].

Using a more rigorous research design requiring an appropriate duration of pain relief after each of two independent z-joint blocks with different anesthetic agents (double blocks), the prevalence of z-joint–mediated chronic low-back pain was 15%. Patients in this study were largely younger, injured workers diagnosed at two tertiary spine centers [33]. In an older population of patients referred from rheumatologists (median age, 59 years), the prevalence of chronic z-joint pain was 40%. This study employed extra-articular placebo injections using normal saline in addition to sequential intra-articular z-joint blocks using bupivacaine [34]. Controlled diagnostic blocks have not been applied to a population with acute low back pain. Thus, the prevalence of z-joint pain in this population is unknown.

Anatomy

The z-joints are true synovial joints with a joint space, hyaline cartilage surfaces, a synovial membrane and a fibrous capsule. Lumbar z-joints are innervated with nociceptive fibers (pain-sensing nerves) [35–38]. Each lumbar z-joint is innervated by two medial branches of the dorsal rami [36,39].

The fibrous capsule of the lumbar z-joint is 1 mm thick, attaches 2 mm from the articular margins and is quite strong [40–42]. The capsule resists bending forces and counteracts a backward sliding motion during extension [40,43]. Overload of this richly innervated capsule potentially causes pain transmitted by means of nociceptive nerves [40,44]. Nerve fibers containing the pain-mediator substance P have been isolated in degenerative z-joint subchondral bone [45], and autonomic nerve fibers exist in the joint capsules [46]. In addition, the synovium has been shown to contain nociceptors [44]. Other researchers dispute the existence of synovial nociceptors and believe that synovial nerves are for regulation of blood flow only [47,48]. Mechanoreceptors have been demonstrated in rabbit z-joints [49] and more recently in human lumbar z-joint capsules [50].

At the superior and inferior ends of the z-joint capsule are two subcapsular recesses within which are fibroadipose meniscoids that project into the joint. Teleologically, it has been suggested that they protect exposed cartilaginous articular surfaces during movement [36,51].

Mechanics

The lumbar z-joints are comprised of two articular facets: the larger superior facet is concave and faces posterior and medially; the inferior facet has an anterior and lateral orientation. Sagittally (vertically) orientated joints protect against axial rotation (turning around the center), and coronally (face on) orientated joints protect against shearing forces (forward and backward sliding) [36]. The lumbar z-joints assist the disc in resisting compressive forces in lordotic postures. Maximal pressure in the lumbar z-joints occurs with extension [52]. The z-joints' capsular ligaments protect the posterior annulus of the disc from excess torsion and flexion stress [36,53]. Excessive extension can cause the inferior facet to slide past the superior facet to contact the laminae [54]. With full flexion, the sliding of the inferior articular process in relation to the superior articular process is about 5 to 7 mm [55]. An overloaded z-joint can stretch and potentially even rupture the joint capsule [54]. The load borne by the z-joints varies from 3% to 25% of the axial load and may be substantially higher when disc space narrowing or z-joint arthritis is present [52–54]. In prolonged standing with a lordotic spine, 16% of the axial load at each segmental level is transferred to the z-joints [53].

Pathology

The cause of most lumbar z-joint pain is unknown. Occasionally, the lumbar z-joints are affected by systemic, inflammatory arthritides, such as rheumatoid arthritis and ankylosing spondylitis [56,57]. Other rare conditions, such as villonodular synovitis, synovial cysts and infection, are sources of z-joint pain [58–60].

Microtrauma of the lumbar z-joints may also produce pain. Small fractures of the lumbar z-joints are not always evident on routine X-rays but can be detected on occasion with stereoradiography [61]. Fractures, capsular tears, splits in the articular cartilage and hemorrhage have been documented on postmortem studies of trauma victims who had normal X-rays [62]. Whether these abnormalities were painful was not recorded.

Osteoarthritis is another possible cause of lumbar z-joint pain. However, not all z-joint arthritis is painful, as radiographic changes of osteoarthritis are equally common in patients with and without low-back pain [63,64]. This is analogous to peripheral joints. Degenerative joints on computed tomography (CT) are not always painful [23,30,65], but some studies report severely degenerated joints are more likely symptomatic [18,19,25,66]. Even using placebo-controlled z-joint blocks, CT was found to poorly discriminate patients with and without z-joint–mediated pain [67]. In addition, radiographically normal lumbar z-joints can be painful, as established by pain relief after single intra-articular z-joint blocks [18,24,26,28,30,43,68]. Diagnostic intra-articular anesthetic injections demonstrate that lumbar z-joints may be a source of low-back and lower-extremity pain, whether or not arthritic changes are present in the z-joint and even if structural (asymptomatic) abnormalities of the intervertebral discs are present on CT or magnetic resonance imaging (MRI), such as degeneration or herniations [28,30,36,69,70].

Other theories for the etiology of lumbar z-joint pain include, but are not limited to, meniscoid entrapment and extrapment [71], synovial impingement [36,43,71], joint subluxation [70], chondromalacia facetae [68], capsular and synovial inflammation [35,36], mechanical injury to the joint's capsule [46] and "restriction" to normal articular motion from soft tissue or articular causes [36,69,70].

Diagnosis

To date, there are no pathognomonic, noninvasive radiographic, historical or physical examination findings that allow one to definitively identify lumbar z-joints as sources of low-back and referred lower-extremity pain [32,35,43,72]. MRI, CT, dynamic bending films and radionuclide bone scanning do not reliably predict symptomatic lumbar z-joints [23,28,30,67,73–75]. Preliminary evaluation of single photon emission CT (SPECT) as a means to identify symptomatic, metabolically active z-joint pathology has been undertaken but is not recommended for routine use [76–78].

Diagnosis of z-joint–mediated low-back pain is based on controlled diagnostic blocks of the joint or its nerve supply [10,79,80]. Even though there are no noninvasive pathognomonic findings in z-joint–mediated pain, one must approach diagnostic blocks in a rational and systematic fashion. Each clinician relies on a constellation of physical examination findings to guide which levels to investigate initially. One method begins with investigation of potentially painful z-joints at the sites of maximal tenderness upon deep palpation, at levels where mechanical, segmental provocation causes concordant pain and/or at levels demonstrating palpable "articular restriction" [69] in light of other segmental findings, such as facilitated muscle tone. If localizing signs are absent, L4–L5 and L5–S1 z-joints should be considered first for injection, because these levels are more commonly involved [43,72].

Results

Because most acute low-back pain episodes improve within 3 weeks [81,82], injection should generally be limited to those who have failed a directed, conservative treatment trial for at least 4 weeks. Exceptions may exist in those with severe function-limiting pain that is substantially exacerbated by active, conservative-care treatments, such as physical or manual therapy.

Contraindications to z-joint injection include bleeding diathesis, those on anticoagulants including antiplatelet agents, local or systemic infection or spinal malignancy. Zygapophysial joint injections should not be commonly employed in patients who have new neurological impairment of spinal origin as determined by dermatomal sensory loss, true muscle weakness and definite neural tension signs. In the absence of the preceding contraindications, nondermatomal sensory loss and lower-extremity pain complaints, including pain below the knee, are not contraindications to z-joint injection [22,72,76].

Abnormal imaging studies demonstrating disc pathology in neurologically intact patients are not contraindications for investigation with z-joint injections if z-joint–mediated pain is suspected. Similarly, neither normal images of the lumbar z-joints or spondylolysis are contraindications to injection.

Because pain relief can occur from intravenous midazalam alone [83], sedation during the injection should be minimal so that postblock assessments remain reliable. However, short-acting benzodiazepines are preferred over narcotic analgesics. Intravenous access is not required routinely. However, intravenous access may be prudent, especially in certain "high-risk" patients. If minimal sedation is required, intravenous access is recommended.

There are no scientific articles that advocate "blind" (nonfluoroscopic) z-joint injection procedures. One study on "blind" paravertebral injections concluded that such injections should not be performed without fluoroscopy and contrast medium because of potential complications and lack of diagnostic accuracy [84].

Once joint entry is perceived during intra-articular blocks, a small amount (0.2 to 0.3 mL) of contrast medium should be instilled to ensure intra-articular spread. A partial arthrogram ensures correct needle position and protects against false appreciation of joint entry and venous infiltration. Similarly, with medial branch blocks, a minimal amount of contrast should be instilled before the anesthetic injection to guarantee that contrast spread is anatomically appropriate and venous uptake does not occur. Inadvertent venous uptake has been shown to reduce the physiological effectiveness of lumbar medial branch blocks [85]. Intravascular injections may occur even after a negative aspiration for blood [86,87]. Maximum volume injected into the z-joints should be less than 2 ml, and most authors recommend approximately 1.5 ml of total injectate [27,29,35,43].

If diagnostic inquiry is the only goal, medial branch blocks can be performed in lieu of intra-articular blocks with equal diagnostic sensitivity [35,37,43,72,79,88]. The target specificity of lumbar medial branch blocks has been established [86], and the physiologic ability of medial branch blocks to anesthetize the z-joint occurs at a rate of 89% provided inadvertent venous uptake does not occur [85]. When joint entry cannot be obtained, medial branch blocks provide an equally valuable diagnostic option.

Diagnostic injection

Analgesia from controlled injections of local anesthetic into the lumbar z-joints or at their nerve supply has been accepted as the standard for diagnosis of z-joint pain [1,10,72,79,80].

Fairbank et al. [22] studied responses of 25 patients with previously undiagnosed and untreated low-back pain to intra-articular z-joint injections with anesthetic at the levels of maximal tenderness. The clinical features of those who achieved pain relief (responders) were not unique. However, several factors were statistically more common in the responders: acute back pain, pain aggravated by sitting and bending and straight leg raising causing back but not leg pain.

Helbig and Lee [23] retrospectively reviewed 22 consecutive patients to determine the signs and symptoms that predicted prolonged (greater than 6 months) pain relief after z-joint injection with anesthetic and steroid. Prolonged responses were seen in 67% of those with localized paravertebral tenderness, 67% of those with reproduction of symp-

toms with extension/rotation, 77% of those with nondermatomal decrease in leg sensation and 80% of those with the presence of groin and upper thigh pain.

In 1994, Schwarzer et al. [89], using controlled blocks, reported the diagnostic criteria used by Fairbank et al. [22], and those used by Helbig and Lee [23] were unreliable in distinguishing pain of zygapophysial joint origin from pain of other origins.

Jackson et al. [32] studied 390 patients who underwent diagnostic z-joint injections and evaluated 127 potentially predictive variables. No single clinical factor absolutely correlated with pain relief upon z-joint injection. Older age, history of low back pain, absence of leg pain, absence of exacerbation by Valsalva manueuver, normal gait, absence of "muscle spasm" and maximal pain on extension after forward flexion all correlated significantly with postinjection relief. The authors concluded that they were unable to accurately and reliably predict which patients would respond to lumbar z-joint injection [32].

Schwarzer et al. [72] studied 176 consecutive patients with chronic low-back pain who received fluoroscopically controlled z-joint blocks: either block of the medial branches of the dorsal rami supplying the joint or intra-articular injections. Of those who responded to an initial block with lidocaine, a confirmatory injection was performed with bupivacaine to exclude false-positive responders. Of those who responded to both injections, there were no clinical features that predicted responses. Specifically, pain on rotation combined with extension was seen in both responders and nonresponders to z-joint block. However, all responders did have pain upon extension and rotation. Referral of pain into the groin, buttock, thigh, calf and even foot did not predict relief by z-joint blocks. Patients with pain below the knee were equally distributed as to response and lack of response to z-joint blocks. Pain into the lower extremity from z-joint pathology is believed to reflect the phenomenon of referred sclerotomal pain and not radicular pain. Notably, no patients with central nonlateralizing back pain responded to diagnostic blocks of the z-joints. The major flaw in this study was that it included only 26 patients with definite z-joint pain, and this group was further subdivided by presenting signs and symptoms. The net result is a study biased toward not detecting significant differences [72].

Revel et al. [30] studied 40 patients to identify predictors of response to intra-articular z-joint blocks. Ninety maneuvers and symptoms were compared between responders and nonresponders after intra-articular injection. Twenty-two patients (55%) had pain relief after injection, and 17 of 40 (43%) had more than 90% relief. More frequent in the responder group were older age, absence of exacerbation by coughing, relief when recumbent, absence of exacerbation by forward flexion and when rising from the flexed position and absence of worsening by hyperextension and extension-rotation. Radiographic changes of z-joint degeneration were not more common in the responders. Although the clinical features traditionally believed to predict those with z-joint pain were no more common in the responders, the intensity of pain after activities and motions thought to stress the z-joints (lumbar extension, hip hyperextension, standing and walking) were diminished after the block [30].

Schwarzer et al. [90] studied pain provocation during z-joint injections in 90 patients and did not find it to be predictive of a symptomatic joint. Others have additionally questioned the value of pain provocation on injection [91,92].

Therapeutic injection

In open, uncontrolled clinical studies, the long-term relief (greater than 6 months) of back and leg pain from intra-articular lumbar z-joint corticosteroids has ranged from 18% to 63% [5,18–21,24–26,28,93]. These rates included all patients with chronic low-back pain who received injections and not just those who responded to an initial diagnostic injection of local anesthetic. Additionally, there have been reports of long-term relief after intra-articular injection of anesthetics [22] or saline only [17,93].

Only five studies of intra-articular corticosteroid lumbar z-joint injections have been performed to compare the results with those of a similar group not receiving intra-articular steroids [17,88,93–95]:

1. The trial by Lilius et al. [93] involved 109 patients with chronic unilateral, nonradicular low-back pain and included 27 patients with pain despite previous discectomy. All patients failed to respond to conservative treatment (medication and physical therapy) and had pain for more than 3 months. These patients were randomly put into three treatment groups involving injection into or around two lumbar z-joints: intra-articular lumbar z-joint injection with cortisone and local anesthetic; intra-articular injection with saline alone or pericapsular injection of cortisone and local anesthetic. Significant pain relief was seen in all groups for up to 3 months. Seventy of the 109 patients (64%) achieved initial pain relief at 1 hour after the injection, with 36% achieving pain relief lasting for 3 months. There was no statistically significant difference in response rate among the groups [93].
2. Carette et al. [17] reported a randomized, controlled study of 101 patients who achieved greater than 50% reduction in pain with a single intra-articular lidocaine block. Fifty-eight percent of the patients studied had a 50% or more reduction in pain after the lidocaine block. These responders were then randomized to receive either intra-articular saline or intra-articular methylprednisolone. At 1 month postinjection, 20 (42%) of the methylprednisolone group had significant pain reduction, whereas 16 (33%) of the saline group also achieved pain relief. The difference between these rates was not statistically significant. By 6 months, 46% of the methylprednisolone group and 15% of the saline group continued to experience

marked pain relief.The difference was statistically significant (p=.002) but believed to be limited by increased co-intervention in the methylprednisolone group. The authors concluded that intra-articular methylprednisolone lumbar z-joint injections "have very little efficacy in patients with low back pain" [17].

3. Lynch and Taylor [94] reported a controlled treatment trial on lumbar z-joint pain that was prospective but not randomized or blinded. In this study there were 50 patients with chronic (greater than 6 months) low-back pain with focal paraspinal tenderness and increased pain on hyperextension. Those with "true motor weakness or anesthesia," systemic arthropathy, spondylosis or spondylolisthesis were excluded from the study. Lumbar z-joint injections were attempted at the level considered to be symptomatic and the level above. Intra-articular placement of the corticosteroid without anesthetic was attempted in all 50 patients; however, in 15 patients the needle was noted to be extra-articular on injection of both joints and in 8 others, only one of the two injections was confirmed to be intra-articular upon injection of the contrast agent. The extra-articular injections were then used as a control group to which the intra-articular group was compared. Total pain relief occurred in 9 of 27 patients who received intra-articular corticosteroids in both joints compared with 0 of 15 patients who received only extra-articular corticosteroids. Only 2 patients in the intra-articular group did not obtain at least partial benefit, whereas 7 of the 15 control patients had no pain relief. The authors concluded that intra-articular injections were far more effective than extra-articular corticosteroids [94].
4. Marks and Houston [88] compared the effects of intra-articular anesthetic/corticosteroid versus medial branch blocks. The study concluded that "facet joint injections and facet nerve blocks may be of equal value as diagnostic tests, but neither is a satisfactory treatment for chronic low back pain." Eighty-six patients with chronic low-back pain were randomized to z-joint injections with anesthetic/corticosteroid or medial branch blocks. Follow-up was performed at 30 to 60 minutes and at 1 and 3 months postblock. A four-point subjective pain scale was used for follow-up assessment. There was no statistical difference between the groups immediately postblock or at 3 months, but at 1 month the intra-articular injection group was more improved than the medial branch block group and this was significant ($p<.05$) [88].
5. Nash [95] compared z-joint injections with medial branch blocks. The study concluded that "neither treatment was of any significant benefit." Sixty-seven patients were randomized to either lumbar z-joint injections or medial branch blocks with only a 1-month follow-up. Assessment included work status, pain level and drug intake. There was no appreciable difference in evaluations between the groups at follow-up [95].

Additional noncontrolled therapeutic studies

A study of 58 patients with low-back pain found those with abnormal z-joint uptake on SPECT scans had a 95% response rate at 1 month and a 79% response rate at 3 months to z-joint injections with steroid and anesthetic. In contrast, those with negative SPECT scans were unchanged after corticosteroid injections of their facet joints [76]. Relatively long-term relief has been reported in 5 of 11 patients (45%) with presumed symptomatic spondylolysis [96].

In 1985, it was first suggested that z-joint injections with corticosteroid may provide long-term relief of symptomatic spinal synovial cysts in those with secondary radicular pain [97]. A recent retrospective audit of 30 patients with radicular pain from symptomatic synovial cysts that underwent intra-articular corticosteroid injections was reported [98]. One-third of patients had long-lasting acceptable benefit of their radicular pain from z-joint injections with a mean follow-up of 26 months [98]. No studies exist that evaluate the efficacy of lumbar z-joint injections in patients with chronic low-back pain from a documented inflammatory disease such as rheumatoid arthritis.

Discussion

Diagnosis

Dual blocks of the z-joints or their nerve supply are recommended to obtain a more secure diagnosis of z-joint pain owing to an unacceptable false-positive or placebo rate associated with single blocks. Dual blocks protect against false-positive responders. Patients who respond to only one of the two blocks (nonphysiologic response) are not considered true responders. A study of 176 patients with chronic low-back pain demonstrated a false-positive rate of 38% using this dual-block protocol [99]. This parallels the results of another study that reported a placebo response rate of 32% with lumbar z-joint injections [100].

One study evaluated subjects with chronic neck pain with triple medial branch injections (lidocaine, bupivacaine [marcaine] blocks and a saline placebo) in a double-blind, controlled fashion [101]. The false-negative rate of time-contingent relief (longer relief with bupivicaine than lidocaine) with dual medial branch blocks was high (46%) against placebo, but the false-negative rate of non–time-contingent relief (not having longer relief with bupivacaine than lidocaine) with dual medial branch blocks was 0% (100% sensitivity). Eighty-eight percent (12% false-positive rate) of those with and 65% (35% false-positive rate) of those without time-contingent relief after dual medial branch blocks withstood (no pain relief) a placebo challenge. Dual medial branch blocks (lidocaine vs. bupivicaine) substantially reduce the likelihood of a false-positive or placebo response; however, only a placebo injection can absolutely exclude a true placebo response. Reproducible relief after dual medial branch blocks is a reasonable diagnostic compromise between single medial branch blocks

with their unacceptably high false-positive rate and triple blocks that incur additional time, expense and exposure to a true placebo injection. With this approach, sensitivity remains high (near 100%) while diagnostic specificity is greatly improved compared with single-session intra-articular or medial branch blocks.

Many clinicians prefer to make a more definitive diagnosis of z-joint–mediated pain by means of successful completion (adequate pain relief) of two sets of z-joint block procedures including at least one set of medial branch blocks before considering medial branch nerve denervation [15,102–104]. With this methodology, the nerves targeted for subsequent neurotomy are tested and the diagnosis is made more secure (less false positives). Medial branch denervation has been reported with phenol, cryoanalgesia and radiofrequency techniques [12,14,15,102].

A recent report suggests discogenic and z-joint–mediated pain are likely separate entities in chronic low-back pain. Only 3% of 92 patients in one study employing both discography and lumbar z-joint injections had both pain sources [33].

One study found pain relief in spondylolysis by anesthetic injection of one z-joint where there was communication between the z-joint and the area of the pars defect [96]. However, if there is filling of both the z-joints and the pars fracture, one cannot differentiate which of these structures is the pain generator [96,105]. Lastly, pain relief after z-joint injection is a poor predictor of clinical outcome of posterolateral lumbosacral fusions as based on single blocks [31, 106,107].

Therapeutic injection

The five controlled studies that evaluated the therapeutic effect of z-joint injections are critiqued.

1. Lilius et al. [93] reported their studies as randomized and controlled, but the research design contained several flaws and met only 4 of 32 criteria proposed for reporting of randomized controlled trials [108]. First, the selection criteria were overly broad. Lumbar z-joint–mediated pain was the presumptive diagnosis, but no attempt was made to confirm the diagnosis with anesthetic lumbar z-joint injections. Thus, the study population likely included those without isolated lumbar z-joint pain. Second, the volumes (3 to 8 ml) injected "into" the lumbar z-joints were excessive. Maximum lumbar intra-articular volumes have been estimated at 2 ml [29,109,110]. Larger volumes of anesthetics may cause extravasation onto other pain-sensitive structures in the epidural space, intervertebral foramen and paraspinal tissues, resulting in a loss of both diagnostic and therapeutic specificity [29]. Injecting 8 ml of saline into a space that physiologically holds only 2 ml may cause significant mechanical effects that can potentially modulate pain responses. Third, failure to exclude placebo responders from any of the groups dilutes any potential difference between groups. Finally, large standards of deviation for the variables measured and suboptimal outcome measures further limit the statistical power of this study.
2. The study of Carette et al [17] is well designed, meeting 22 of 32 criteria for reporting randomized controlled trials [108] but is not without limitations. Failure to exclude placebo responders may account for the relatively high incidence of patients with presumed lumbar z-joint pain compared with other false-positive/placebo-controlled prevalence studies showing a 15% to 40% prevalence. A mixed-subject population that includes both patients with the disease and patients without the entity in question contaminates the group being studied; the number of placebo responders included proportionately dilutes the findings of the true responses and makes detecting a difference between the study and control group more difficult. Additionally, a selection criterion of only 50% reduction in pain after single blocks may allow for those with combined painful entities rather than pure lumbar z-joint pain. Others argue the assumption that intra-articular saline is a true placebo, because it may break painful adhesions or modulate local nervous system loops [51]. Furthermore, saline is known to provide pain relief in excess of that expected from placebo in other pain syndromes, including myofascial pain and reflex sympathetic dystrophy [111–114]. Additionally, there was no assessment of differences between groups during the phase of maximum corticosteroid bioavailability (first 2 weeks) postblock. Finally, the effects of intra-articular lumbar z-joint corticosteroids were evaluated in isolation and not as part of a comprehensive conservative treatment plan provided equally to both groups. In fact, when cointervention occurred (22% in the corticosteroid vs. 12.5% in the saline group), there was some indication of significant benefit from the combination. The cointerventions largely took place 1 month or more after the active injections. Marked or very marked pain relief in 46% of the methylprednisolone group after 6 months is substantial considering that these were patients with pain for more than 6 months. The investigators attempted to discount the effects of the cointerventions but found that even when a "worst case analysis" was performed by assuming that none of the patients with cointerventions had improved after 6 months regardless of the study group, there was still statistical significance ($p=.05$), with the corticosteroid group more improved. When the results of the last evaluation (before cointerventions) were substituted for all subsequent evaluations in those patients who had cointerventions, statistical significance was lost ($p>.05$). These data perturbations only indirectly reinforce the concept that cointerventions (even 1 month after injection) may be truly synergistic with injected corticosteroids. Potentially, the analgesic effects of lumbar z-joint injections serve as a window of opportunity for

progression through a previously intolerable active conservative treatment. Optimally, co-interventions would be concentrated in the first 2 to 3 weeks after injection [17].

3. The limitations of Lynch and Taylor's study [94] include lack of randomization, poor outcome assessment tools, failure to select patients with isolated z-joint pain as determined by diagnostic injections, failure to "blind" the examining physician, the use of a physiologically active agent (periarticular steroids) for the control and no controlled monitoring or structuring of cointerventions.
4. Marks and Houston's study [88] is flawed in its selection criteria. Patients with low-back pain were included, not those with established z-joint pain by analgesic injections. Other limitations included failure to have a blinded, independent observer; poor limited outcome assessment tools; no assessment during the phase of maximal corticosteroid bioavailability; no control or placebo group; no control or monitoring of cointerventions and not providing structured cointerventions after blocks [88].
5. Nash's study [95] is limited by not establishing a diagnosis of z-joint pain before randomization and not assessing for the diagnosis after the blocks. Thus, potentially all patients in the study had a diagnosis other than z-joint pain, making the study invalid. Furthermore, the study had no blinded observer; poor assessment tools; no assessment during the phase of maximum corticosteroid bioavailability; no control or placebo group and no control, monitoring or structuring of cointerventions [95].

Additionally, all therapeutic z-joint injection studies are limited by a lack of precise knowledge regarding the therapeutic mechanism of intra-articular z-joint injections. The effects of the steroids on intracapsular inflammation is only presumptive based on known anti-inflammatory actions of steroids at other sites. No formal studies have addressed the mechanism of steroid action within the z-joint, nor have any formal studies documented intracapsular inflammation in those with z-joint pain. It is not known whether the reported beneficial effects of the steroids are the result of their anti-inflammatory actions, other regulatory effects on the local nerve endings, an "anesthetic"- like action or an inert effect such as lavage of the joint's surface that could be provided with other agents such as saline. Despite the uncertainty of their action, several authors endorse their use [5,19,21,24–26,94].

No long-term side effects from corticosteroid intra-articular z-joint injections have been reported [5,17,20,22–24,26,29,31,32,93]. The appropriate dose remains empiric. Several studies suggested that long-term relief is more common but not restricted to those with demonstrable degenerative changes in the lumbar z-joints [18,19,23]. In open trials, patients with and without significant z-joint degeneration or disc pathology have had long-term success from z-joint injection [24–26,28]. No common factors have been identified in these open clinical studies to predict which patients will have prolonged benefit from instillation of steroids into the z-joints.

Future studies

Additional studies should explore the relevance of false-positive and placebo responses to z-joint injections as they relate to the resolution of symptoms and improvement of function with various treatments. Individuals who obtain excellent relief from intra-articular steroids, saline or anesthetic should be studied to determine characteristics that distinguish them from other patients with low-back pain. Studies should compare intra-articular saline/anesthetic against extra-articular or muscular injections in a controlled, blinded fashion to establish whether intra-articular saline imparts a therapeutic benefit (by means of mechanical effects) apart from a placebo response. Previous studies evaluating the effectiveness of intra-articular steroids and anesthetics have used these injections in isolation or have not carefully controlled concomitant therapies. Future studies should address whether intra-articular anesthetic and anesthetic/corticosteroid injections followed by a more aggressive conservative program during the period of relative analgesia increase long-term efficacy. A postinjection conservative program may employ, for example, physical therapy and/or joint mobilization/manipulation [115]. Future studies should be designed to further isolate the factors that predict a long-term response to intra-articular corticosteroids. The therapeutic role of z-joint injections should be evaluated in the subpopulations of patients with subacute and chronic low-back pain, that is, 1 to 6 months' duration, and more than 6 months' duration. All studies should be randomized and controlled and should assess whether facet injections impart any advantage with and/or without particular controlled cointerventions during the state of anesthesia and/or corticosteroid analgesia. The natural history must be established for proven z-joint pain to allow comparisions of various interventions with the natural history in these various subsets. Evaluating whether stronger anesthetic agents in smaller volumes into the lumbar z-joints or around the medial branch nerves achieve a more specific, solid blockade remains to be determined.

Current recommendations

1. The primary role of z-joint injections is diagnostic. Intra-articular z-joint injections and medial branch blocks are able to provide a specific anatomic diagnosis of z-joint–mediated pain. Intra-articular z-joint injections and medial branch blocks are believed to have equal diagnostic specificity.
2. Lumbar z-joint injection procedures should generally be reserved for those patients with low-back pain who fail to respond to a directed, conservative treatment trial and have had pain for at least 4 weeks. Earlier use

of injections in routine cases is not justified, because the natural history of acute low-back pain is frequently one of spontaneous resolution. Rare exceptions may exist in those with severe functional limitations and a negative response to active conservative care.

3. The therapeutic benefit of z-joint injections remains controversial. If employed, their potential benefit for the individual case needs to be carefully weighed. In general, they should be used to facilitate more aggressive conservative care and not used as an isolated treatment. Certainly, if prolonged response to intra-articular steroids (for example, 3 months of relief) does not occur after the first injection, no further administration of corticosteroids is indicated. There is no role for a standard "series" of z-joint injections.
4. Injections should be performed only under fluoroscopic guidance. Contrast medium should be used for both intra-articular z-joint injections and medial branch blocks to ensure appropriate, subsequent injectant spread. Intravenous access is not routinely required unless sedation is used.
5. Normal or abnormal imaging should not be used solely to determine the need, or lack thereof, for z-joint injection procedures. However, in most cases, either radiographs or advanced imaging will have been obtained as part of the diagnostic workup and will allow the physician to exclude potential contraindications to injection procedures.
6. There are no known pathognomonic findings in low-back pain of z-joint origin. Patients selected for diagnostic z-joint injections must provide informed consent, and joints must be blocked in a systematic fashion. Although not proven to be of diagnostic benefit, many physicians start at the level with localizing signs. Others begin with the more commonly involved L4–L5 and L5–S1 joints.
7. Patients who respond to their initial z-joint block(s) are candidates for a second injection procedure (eg, medial branch blocks) typically with a different local anesthetic. Excellent, physiologic pain relief after both block sets provides the most accurate criterion for diagnosis of z-joint–mediated pain. Using this methodology, the sensitivity remains high while specificity is greatly improved over single z-joint blocks. Patients who achieve reproducible analgesia after both sets of z-joint block procedures (eg, intra-articular z-joint blocks and subsequent medial branch blocks) are potential candidates for medial branch neurotomy.

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