Retrospective Study

Evaluation and Treatment of Sacroiliac Joint Pain in Patients with History of Vertebral Compression Fractures: A Retrospective Case Series

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Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 08-15-2023
Revised manuscript received: 10-23-2023
Accepted for publication: 11-14-2023

Free full manuscript: www.painphysicianjournal.com

Background: Vertebral compression fractures (VCFs) can affect the entire spinopelvic complex and cause unpredictable patterns of back pain due to their effects on spinal tensegrity and biomechanical compensation. They can lead to significant morbidity and mortality in the aging population and are difficult to diagnose. We aimed to establish a relationship between VCFs and sacroiliac (SI) joint pain.

Objectives: Demonstration of SI joint (SIJ) pain relief at up to 6 months after kyphoplasty (KP) in patients with VCFs and diagnosed SI dysfunction.

Study Design: Retrospective study.

Setting: All patients were from a private chronic pain and orthopedics practice in the northeastern United States.

Methods: Fifty-one patients with VCFs diagnosed through imaging and SIJ dysfunction diagnosed through 2 diagnostic SIJ blocks who had failed conservative management were considered for KP. Numeric Rating Scale (NRS 11) scores were recorded at the baseline, after each SIJ block, and at 4 weeks and then 6 months after KP.

Results: Forty-nine patients underwent KP. At 4 weeks after the procedure, there was an 84% average reduction in NRS scores from the baseline ($P < 0.01$). At 6 months after the procedure, there was an 80% reduction in NRS scores from the baseline ($P < 0.01$).

Limitations: Larger sample sizes and a randomized control trial would be important steps in furthering the relationship between VCFs and SIJ.

Conclusion: VCFs can cause a referred pain pattern to the SIJ that is best treated by KP for long-term management.

Key words: Vertebral compression fracture, sacroiliac joint, vertebral augmentation, kyphoplasty, referred pain, axial pain, spinal tensegrity, lower back pain

Pain Physician 2024: 27:E337-E343

Vertebral compression fractures (VCFs) are a common cause of debilitating lower back pain, affecting more than 700,000 new patients a year (1). They account for significant morbidity and mortality, and their incidence increases with an aging population (1-3). The United States Vertebral Augmentation Registry found that patients with VCF had an average Roland Morris score of 21 out of 24 points, indicating significant dysfunction in activities of daily living, emotional health, and general sense of health (2). The surgeon general estimates that women with at least one VCF have a 1.2-fold increase in age-adjusted mortality rate when compared to women without VCFs (3). Risk factors for a VCF include osteopenia, osteoporosis, cancer, increasing age, female gender, chronic use of steroids, smoking, and depression. Among patients with osteoporotic bone disease, spine fractures are nearly twice as common as prototypical hip fractures (1).

Unfortunately, VCFs can be difficult to diagnose and are easily missed on examination and in x-ray imaging (2). This issue occurs because VCFs impinge on nearby structures in a tight space, creating complicated radicular pain and somatic referral patterns that are not fully understood. Patients may present with vague lower back pain, but more than two-thirds of the time, they are asymptomatic at the site of fracture (2). Although many patients have normal physical exams, the current dogma includes patients presenting with midline pain and some extension into the paravertebral space.

The spine is a complex arrangement of bone and soft tissues that work in harmony to promote proper sagittal balance. Cervical and lumbar lordosis, sandwiched by the thoracic kyphosis, are supported by the foundation of the spine—the pelvis. Lumbar lordosis sits in opposition to the superior lying thoracic kyphosis in such a way that the body's center of gravity passes through the posterior side of the femoral head. This congruence is demonstrated by the plumb line test in healthy individuals (Fig. 1).

Alterations to this spino-pelvic complex, such as those caused by vertebral compression fractures, can lead to patterns of referred pain away from the site of primary injury. Throughout adulthood, the incidence of change to the spino-pelvic complex is uncommon. However, the impact that appears after compression fractures may be related to the stress and changes of force on the sacroiliac complex, which consequently impacts proper nonpainful function (4,5). Sacroiliac joint (SIJ) pain has already been demonstrated to occur commonly in conjunction with compression fractures (4-6). In this case series, we propose that VCFs can present with SIJ dysfunction patterns, whether through referred pain or biomechanical changes.

Methods

Patients with subacute and chronic lower back pain and evidence of vertebral compression fractures who had failed conservative treatment with physical therapy and nonsteroidal antiinflammatory drugs (NSAIDs) were identified through retrospective chart review. The duration of conservative treatment was noted for each patient. Of the cohort, 51 individuals were found to have both back pain and focal SIJ dysfunction as demonstrated through 3 or more provocative tests eliciting pain. Each of these patients underwent one to 2 diagnostic fluoroscopy-guided SIJ blocks one month apart to confirm the diagnosis. The first injection contained 5 mL of 1% lidocaine and 40 mg of triamcinolone. The second injection consisted of 2.5 mL of 1% lidocaine, 2.5 mL of 0.25% bupivacaine, and 0.5 mL of 20 mg triamcinolone. The purpose of the local anesthetic in the injectate was to potentially cause a biomechanical change that would allow for a diagnosis of the pain pattern, and the steroid was meant to lead to a mechanical change that would let us determine if an inflammatory process was present. Given the short-term improvement that appeared after the local anesthetic and steroid injection, vertebral augmentation was considered. Because of the anatomy of the SIJ and the biomechanical stress that affected the posterior and anterior portions of the joint, vertebral augmentation was recommended to reduce and unload the potential pelvic stress. Radiofrequency ablation was not considered as a treatment option in these cases due to the limited access to the anterior innervation and ligaments (7). These patients then underwent vertebral augmentation (one to 3 levels). Fractures of the vertebrae were confirmed with magnetic resonance imaging (MRI) and/or computed tomography (CT) scans.

A retrospective data collection was conducted with the 11-point Numeric Rating Scale (NRS) for pain (0 meaning no pain and 10 representing the most severe pain imaginable) after conservative management, after each diagnostic block, after kyphoplasty (KP) at day 0, and at the 4- and 6-month marks. The length of symptom relief after the diagnostic blocks was also recorded.

Notably, all data were collected at an outpatient

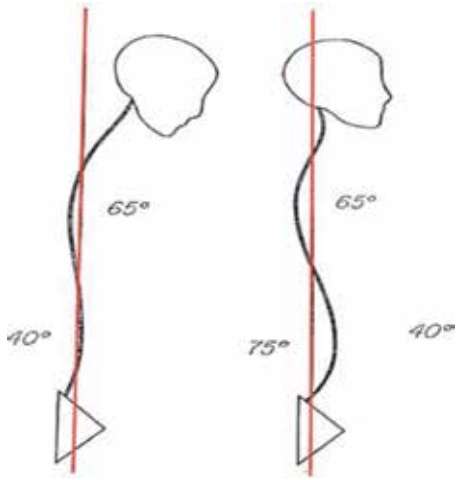

Fig. 1. *Plumb line demonstrating the center of gravity (COG) and the changes seen in hyperkyphosis (left) and a normal exam for comparison (right).*

pain clinic in the northeastern United States, and procedures were performed by the same physician.

Results

A total of 51 patients with vertebral compression fractures were enrolled. One patient had 4 VCFs (T11, T12, L2 and L3), 4 patients had 3 VCFs each, 14 patients had 2 VCFs, and the remaining 32 patients had one VCF each. The most common locations of VCFs were T11 and L3. All fractures were seen between T8 and L5.

Each patient had an average of 11.2 weeks of conservative treatment including rest, physical therapy, NSAIDs, and acetaminophen (range 2-52 weeks). The average NRS score prior to any intervention was 7.3 (median = 7). After the first SIJ block, the average pain score went down to 3.3 (median = 3), and patients reported relief for an average of 7.2 days. Two patients, both of whom reported post-SIJ-block NRS scores of one for over 55 days, did not receive a second injection or KP. Another 8 patients, all of whom reported NRS scores of one but for shorter durations, did not receive a second injection but did receive KP. The remaining 41 patients received a second (therapeutic) SIJ block and reported an average of 3.5 days of relief.

A total of 49 patients received KP at between one and 3 levels. The average NRS score at 4 weeks after KP decreased by 84% from its pre-procedure rating to 2.06 ($P < 0.01$) (Table 1). At 6 months, the average NRS score remained low, at an 80% reduction from the baseline ($P < 0.01$) (Fig. 2). Figure 3 shows the

Table 1. *Symptom relief 4 weeks after kyphoplasty (KP) by levels of procedure.*

Levels of Kyphoplasty	Average NRS Scores Prior to Interventions	Average of Symptom Relief after KP of SI Joint Pain at 4 weeks_%
1	7.2	88.1%
L2	7.6	86.4%
L3	6.3	90.0%
L4	8.0	80.0%
L5	7.3	93.3%
T11	8.0	50.0%
T12	7.1	90.6%
T8	6.0	100%
2	7.5	74.0%
L1, L3	7.5	75.0%
L1, L4	8.0	80.0%
L2, L3	7.0	62.5%
L3, L5	7.5	95.0%
L3, T12	6.0	75.0%
T11, L1	8.0	70.0%
T11, L2	8.0	30.0%
T11, T12	8.0	50.0%
T12, L3	5.0	100.0%
T9, T11	10.0	90.0%
3	8.0	90.0%
T10, L3, L4	6.0	70.0%
T11, T12, L1	9.0	100.0%
T6, 7, 8	9.0	100.0%
Grand Total	7.3	83.9%

Table 1 shows symptom relief in relation to level of kyphoplasty (KP). In general, patients with multilevel VCF had higher pre-procedure pain scores. After KP, pain scores decreased but not in any relation to the amount of KP done. SI: sacroiliac.

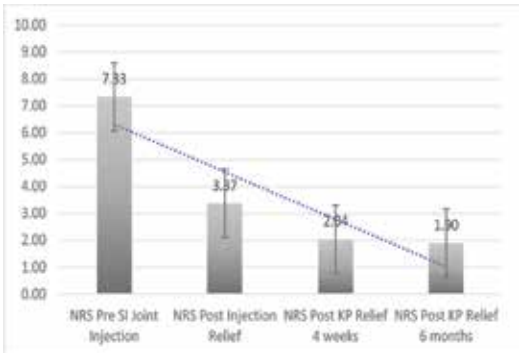

Fig. 2. *Average pain scores.*

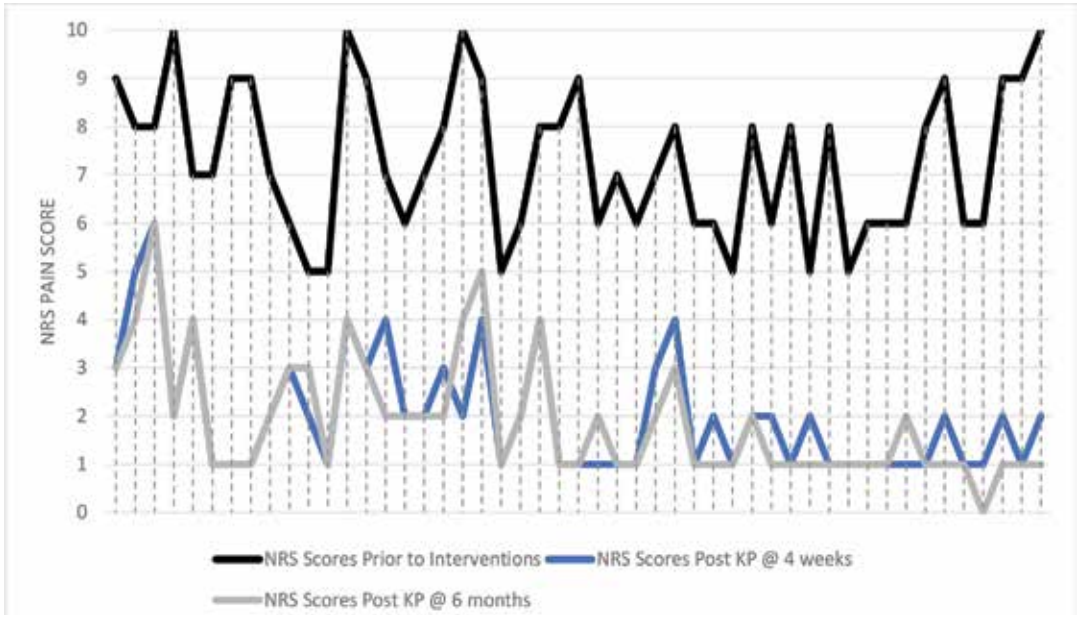

Fig. 3. *Matched NRS pain scores before and after kyphoplasty (KP).*

change in NRS scores for each patient before and after kyphoplasty.

Subgroup analysis showed that patients with single-level VCFs had no statistically significant difference in pre-KP pain scores from patients with multilevel VCFs (7.0 vs. 7.6; $P = 0.24$), suggesting that increasing levels of VCF did not lead to worsening SIJ pain in a treatment-dependent manner. The 2 groups both experienced pain relief with KP, with no statistically significant difference in the level of pain relief at either the 4-week or 6-month marks (P4 weeks = 0.18, P6 months = 0.21). However, both groups did continue to have significant pain relief when analyzed individually, at both 4 weeks and 6 months (Psingle-level @ 4 weeks < .01, Psingle-level @ 6 months < 0.01, Pmultilevel @ 4 weeks < 0.01, Pmultilevel @ 6 months < 0.01).

Discussion

VCFs impact major essential functions of the body, including the kinetic chain of movement and pelvic-sacral alignment, which can result in SIJ dysfunction. These functional consequences include pain, instability, increased fall risk, and overall, an impaired quality of life (5).

SIJ dysfunction is a common cause of lower back pain, accounting for anywhere from 10 to 38% of all lower back pain (8). However, SIJ dysfunction's diagnosis and treatment remain challenging. This difficulty is due to the SIJ's specific structure, which begets its unique role in maintaining spinal tensegrity. Although ordered in the workup of chronic lower back pain, imaging is a poor marker of SIJ dysfunction and the pain it generates (9). Radiographs show abnormal SIJs in as many as 25% of asymptomatic patients (9). MRI may reveal inflammation in the SIJ but often does not correlate with symptoms or actual areas of pain generation. Currently, diagnosis is often made through provocative tests, including the FABER test, Gaenslen's test, a thigh thrust test, and distraction tests, and sacral thrust tests. Of these, the positive FABER test shows the highest sensitivity (10). There is no gold standard for diagnosing SIJ dysfunction, although it is commonly agreed that 3 positive provocative tests are enough to make the clinical diagnosis (9,10). The confirmatory test used most commonly in clinical practice is an SIJ block with local anesthetic done under fluoroscopy, which provides a safe diagnostic and therapeutic intervention (9,11). Our group of 50 patients with VCFs met these criteria—all had demonstrable pain on at least 3 provocative tests and a 54% reduction in NRS scores after the ensuing diagnostic SIJ blocks. (The average NRS score decreased from 7.28 to 3.28.) These results are in line with expert opinions, which traditionally target a 50-75% reduction in pain scores after injection (11-12).

Current treatment of SIJ pain ranges from conservative management with physical therapy and NSAIDs to interventional and surgical treatments like radiofrequency ablation and sacral spinal fusion. Fusion has been shown to decrease the joint's range of motion and should theoretically decrease the need for support from the surrounding muscles and ligaments. However, SIJ fusion is at best mediocre in resolving symptoms, with studies showing that up to 37% of post-fusion patients still have residual SIJ pain (13,14). If stabilizing the SIJ is not fully curative, this problem raises the question of where the pain is actually generated.

Johnson et al (15) referred to the pelvis as "the pedestal for the spine" not only for its importance in maintaining normal sagittal balance, but also for the compensatory mechanisms that arise from de novo imbalances anywhere in the trunk. Since the pelvis is rigid bone, the only source of mobility comes from the SIJ. The SIJ's portions are, however, stabilized by strong ligaments and thus, in healthy individuals, display minimal movement (15). Jacob et al (16) showed that in healthy individuals, total rotation was 3 degrees, and average translation was 0.7 mm. Thus, the SIJ functions mainly as a shock absorber, dispersing loads from the proximal spine.

Pelvic incidence is a measured, reproducible, and independent variable that reflects the harmony between the lumbar spine and the pelvis. This variable is defined as the measure of the angle between the vertical axis of the pelvis and the vertical axis of the spine and normally measures around 45 to 55 degrees (Fig. 4). Pelvic incidence changes in children but stabilizes in adults and remains stagnant in healthy individuals (6). Any change in pelvic incidence alters the alignment of the entire thoracolumbar spine (Fig. 3). It is then reasonable to conclude that alterations in pelvic incidence can lead to pain anywhere in the chain of spinal movement.

All 50 of the patients in the study received KP at the sites of their compression fractures. The most common sites of fractures were T11 and L3, both of which alter these patients' plumb line tests and pelvic incidences (Fig. 1). These fractures lead to migration of previously immobile spinal segments in a tight area without much room for translation. VCFs also lead to increased vertebral wedging, which results in loss of sagittal balance (5). Over time, this issue causes a steady increase in kyphosis (4). Luo et al (17) aptly describe the effect of VCFs as occurring over time coupled with the postural changes.

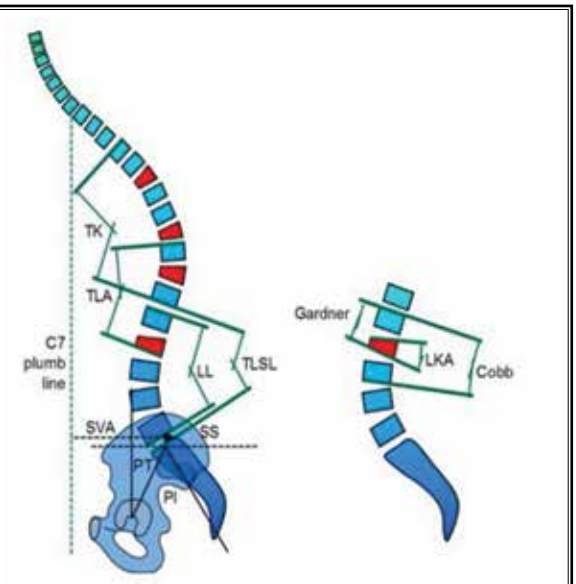

Fig. 4. *Depiction of thoracolumbar anatomy.*
Gardner: Gardner angle, Cobb: Cobb angle, LL: lumbar lordosis, PI: pelvic incidence, PT: pelvic tilt, SS: sacral slope, SVA: sagittal vertical alignment, TK: thoracic kyphosis, TLA: thoraco-lumbar alignment, TLSL: thoraco-lumbo-sacral lordosis. Adapted from Pumberger et al (18).

Vertebral augmentation procedures such as KP can give back some of the stiffness, disc height, and strength lost by the fractured vertebral body (Fig. 5). Studies have shown that vertebral augmentation has the potential to restore some degree of kyphosis angles and intradiscal pressures to pre-fracture levels (17). The results of this procedure allow for decreases in Cobb angles and Gardner angles, as well as the normalization of sagittal vertical alignment (18,19). Thus, augmentation can lead to the restoration of normal load-sharing throughout the spine, which in turn can unload the stress on the SIJ and the supporting ligaments.

Our patients received KP at between one and 3 levels. After 4 weeks, the patients had an average NRS pain score reduction of 84% (average NRS 2.06) from the baseline. At the 6-month mark, the data remained convincing, with an average NRS score of 1.9. These reductions in SIJ pain after KP demonstrate that VCFs and the resultant spinal imbalances are important and often overlooked causes of referred SIJ pain.

Further research may incorporate pre- and post-KP measures of pelvic incidences, sacral slopes, wedge angles, and plumb line testing to further elucidate VCFs as sources of pain far from the sites of injury. More analysis of the referred pain patterns of VCFs is also needed.

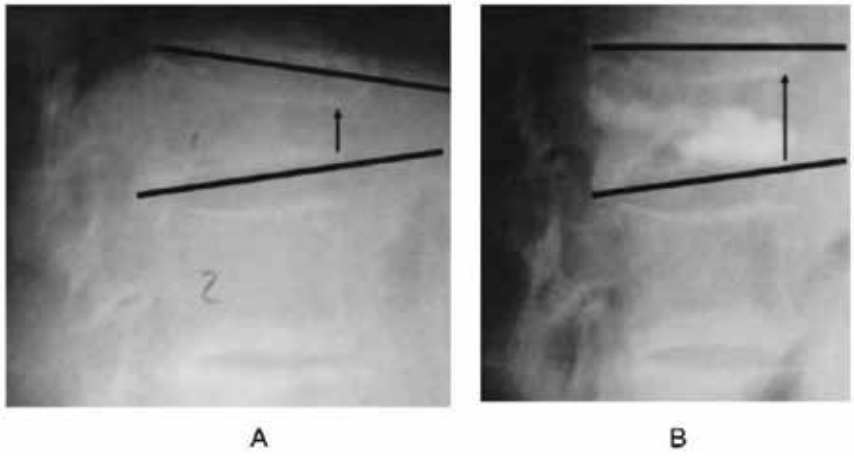

Fig. 5. *A) the wedging seen as a result of vertebral compression fracture and B) post kyphoplasty return of disc height.*

Conclusion

Clearly, compression fractures can have a significant impact on patients' quality of life and functioning. The pain patterns for compression fractures are difficult to ascertain. However, the advent of MRI has helped immensely. Referral patterns can be misleading, and combining clinical assessment of patients with imaging is paramount. SIJ pain and syndrome can be caused by compression fractures and/or patients' attempts at biomechanical compensation. Vertebral augmentation plays a large role in managing the pain caused by compression fractures, and this study demonstrates that a biomechanical adjustment can help with the sequelae and biomechanical changes that may occur. Furthermore, in a patient with a compression fracture and a typical pain pattern for SIJ syndrome, the compression fracture should receive a treatment that will lead to long-term improvement.

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