International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

Sacroiliac Joint Dysfunction Following Lumbar Spinal Fusion: A Narrative Review

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Abstract

Background: Sacroiliac joint (SIJ) pain is an important consideration in patients with persistent or newly developed low back or buttock pain after lumbar or lumbosacral fusion. The SIJ transmits forces between the axial skeleton and pelvis, and spinal arthrodesis may alter its mechanical loading.

Objective: To review the anatomical and biomechanical basis, clinical presentation, diagnostic assessment, and treatment approaches for SIJ dysfunction following spinal fusion.

Methods: This narrative review was developed from the anatomy, clinical assessment, and treatment literature-review chapters of the source thesis. It is not a systematic review or meta-analysis.

Conclusion: Assessment requires careful clinical localization, a combination of provocation maneuvers, imaging to evaluate structural disease and alternative causes, and selective image-guided injections. Conservative treatment is generally considered before invasive stabilization in appropriately selected patients. Diagnostic uncertainty and heterogeneous evidence limit firm conclusions.

Keywords: Sacroiliac joint; lumbar fusion; lumbosacral fusion; postoperative pain; sacroiliitis; diagnosis; treatment.

Introduction

Sacroiliac joint dysfunction is a potential explanation for persistent or new-onset pain after lumbar or lumbosacral fusion. The literature discussed in the source thesis describes the SIJ as a load-transferring articulation whose stability, motion, and clinical presentation can complicate diagnosis. This review focuses on the SIJ-specific information contained in the thesis literature-review chapters, rather than presenting the original prospective cohort or its numerical results.

Sacroiliac Joint Anatomy and Biomechanics

The sacroiliac (SI) joint represents the largest axial articulation within the human body, possessing an average surface area of approximately 17.5 cm^2 (Poilliot et al., 2019). It is typically described as a large, auricular-shaped, diarthrodial synovial joint (Poilliot et al., 2019). However, only the anterior third of the sacroiliac interface functions as a true synovial joint; the remainder of the junction consists of a complex network of ligamentous attachments. Due to the absence or rudimentary nature of the posterior capsule, the dorsal ligamentous structures are more extensive, acting as a functional bridge between the sacrum and the ilia (Bowen, 1981). The primary role of this ligamentous system is to restrict motion across all planes. Notably, these ligaments are inherently weaker in females to accommodate the pelvic mobility required for parturition, as illustrated in (Poilliot et al., 2019).

A comprehensive network of muscles supports the SI joint, facilitating the transmission of regional muscular forces to the pelvic girdle. Muscles such as the gluteus maximus, piriformis, and biceps femoris are functionally

integrated with the SI joint ligaments, meaning their activation directly influences joint stability and mobility. Furthermore, approximately 30% of SI joints are predisposed to vertical shearing due to a more acute angulation of the short, horizontal articular segment (El Rafei et al., 2018).

Recent academic literature suggests that the anterior aspect of the sacroiliac (SI) joint is innervated by the ventral rami of L2-S2, L4-S2, and L5-S2. However, some researchers have proposed that the anterior joint may actually be devoid of nervous tissue (Munglani & Hegarty, 2017). In an experimental study assessing the efficacy of L5 dorsal ramus and S1-S4 lateral branch blocks, it was observed that 60% of subjects still perceived ligamentous probing, indicating that current blocking techniques may not fully anesthetize the joint's sensory pathways (Szadek, 2016).

The SI joint is characterized by a high degree of stability, primarily because no muscles act directly across the joint space. Modern diagnostic techniques, including ultrasound and roentgen stereophotogrammetric analysis (RSA), have been employed to quantify joint mobility. Although RSA has faced some criticism, it remains the most reliable method currently available. Research indicates that during functional activities, joint motion is minimal, typically not exceeding 2–3 degrees in either the transverse or longitudinal planes (Donner & Donner, 2018).

There is significant clinical debate regarding the parameters of normal mobility, its relationship to pain, and the reliability of clinical detection. While joint laxity is known to increase during pregnancy, the biomechanics of the SI joint remain complex, with axes of movement oriented obliquely across the pelvis. During hip flexion, the ipsilateral ilium glides postero-inferiorly, whereas hip extension causes the ilium to move anteriorly away from the sacrum.

The sacroiliac (SI) joint is reinforced by an extensive ligamentous network, including the anterior sacroiliac ligament, the interosseous sacroiliac ligament situated within the joint space, and the posterior sacroiliac ligament covering the dorsal surface. The dorsal ligament is further divided into superior (short) and inferior (long) components. The long posterior sacroiliac ligament, which connects the sacrum to the posterior superior iliac spine, maintains close anatomical relationships with the erector spinae, the posterior thoracolumbar fascia, and the sacrotuberous ligament.

The primary evolutionary design of the SI joint is centered on stability rather than mobility. Its functional roles include the transmission and dissipation of truncal loads to the lower limbs, the restriction of x-axis rotation, and the facilitation of the birthing process. When compared to the lumbar spine, the SI joints exhibit a remarkable capacity to withstand medially directed forces—up to six times greater—yet they are significantly more vulnerable to mechanical stress, tolerating only half the torsional load and a mere 5% (1/20th) of the axial compressive load (Zlomislic & Garfin, 2019).

The SIJ is a unique diarthrosis, essential for an effective transfer of the weight bearing and dampen the impact on walking, being a pivot point between the vertebral column and the lower limbs. The joint motion is limited to translational and rotational motions. The average rotation varies between 1° and 12°, and the average translation varies between 3 and 16 mm (Hsu et al., 2020).

These characteristics render the SIJ more liable to axial compression and rotational stress, but more resistant to lateral forces than the lumbar spine portion. Its articular surfaces present hyaline cartilage at the sacral level and fibrous cartilage at the iliac level. The iliac component has more unfavorable mechanical characteristics and appears to be more prone to joint degeneration and development of sacroiliitis. Prevalence of SIJP was verified C most characteristic symptoms of this disorder.

Mechanisms of Sacroiliac Pain Following Lumbar Fusion

In lumbar surgery, the incidence of FBSS ranges from 10 to 40%, although failure rates depend on the surgical procedure performed, and higher rates are obtained for the surgery performed with the instrumentation.

Although different etiologies can be identified, the failure associated with SIJ was estimated from 32% to 42.4% of patients (Kleck et al., 2016).

Theories of pain generation include ligamentous or capsular tension, extraneous compression or shear forces, hypomobility or hypermobility, aberrant joint mechanics, and imbalances in the myofascial or kinetic chain that result in inflammation and pain (Raj and Varacallo, 2018).

Intra-articular sources of SIJ pain include osteoarthritis; extra-articular sources include enthesis/ligamentous sprain and primary enthesopathy. In addition, ligamentous, tendinous, or fascial attachment and other cumulative soft tissue injuries that may occur posterior to the dorsal aspect of the SIJ may be a source of discomfort (Kleck et al., 2016).

Numerous clinical and experimental studies of adjacent segment disease after lumbar fusion procedures have demonstrated increased mobility in the adjacent cephalad and/or caudad segments and increased stress on the facet and/or disc of adjacent mobile segments (Jani and Simopoulos, 2018).

Therefore, a third possible cause of SIJ pain is errors made during the preoperative screening of patients. This cause of SIJ pain can be differentiated from SIJ pain caused by an increased mechanical load when patients are not pain free for even a short period of time after fusion surgery. In very rare cases, SIJ pain may be caused by hardware. For example, It was reported that iatrogenic SIJ syndrome caused by the screw head and rod of percutaneous pedicle screw fixation at the L5–S1 level. The sharp rod tip and the late rally located screw head may irritate the iliac crest and distract the SIJ, leading to intractable SIJ pain (Hsu et al., 2020).

Clinical Presentation and Diagnostic Challenges

Pain originating from the sacroiliac joint (SIJ) or its associated structures may manifest as low back, sacral, pelvic, or gluteal discomfort. Somatic referral patterns are highly variable and may include sensations such as numbness, popping, clicking, or groin pain. Typically, SIJ-related pain does not extend superior to the beltline, and unilateral presentation is significantly more prevalent than bilateral symptoms, occurring at a ratio of approximately 4:1. A history of trauma is reported in 44–58% of individuals presenting with SIJ dysfunction (Van Leeuwen et al., 2016).

Research into the most frequent referral patterns for SIJ pain indicates that radiation occurs most commonly in the buttocks (94%), followed by the lower lumbar region (72%), lower extremities (50%), and the groin (14%). Less frequent referral sites include the upper lumbar region (6%) and the abdomen (2%). Notably, 28% of patients report pain radiating below the knee, with 12% experiencing symptoms as distal as the foot (Christiansen et al., 2017).

In the context of lumbar spinal fusion, the primary diagnostic criterion for identifying new-onset SIJ pain is a distinct shift in pain distribution postoperatively compared to the patient's preoperative symptoms (Barstow & Dyson, 2015).

One of the most challenging aspects of treating SIJ pain is the complexity of diagnosis. Literally dozens of physical examination tests have been advocated as diagnostic aids in patients with presumed SIJ pain.

When performing pain provocation tests, it is remarkably difficult to isolate the specific anatomical structures being stressed. Given their functional integration, it is nearly impossible to exclude related structures such as the piriformis muscle or the iliolumbar ligament as potential pain generators.

Consequently, clinicians face significant challenges in determining whether provoked pain is purely intra-articular or stems from the associated capsular ligaments. Previous research has consistently demonstrated that no single physical examination maneuver possesses the diagnostic accuracy required to definitively identify a painful sacroiliac joint (Polly et al., 2016).

Research indicates that approximately 20% of asymptomatic adults exhibit positive findings on at least three standard SIJ provocation tests. Among these, the assessment for sacral sulcus tenderness demonstrated the

highest sensitivity (89%), although it was characterized by poor specificity. However, when a threshold of three positive provocation tests is met, the positive predictive value for diagnosing SIJ pain reaches approximately 60%. This suggests that while individual tests may lack precision, the cumulative evidence from multiple positive responses provides a valid diagnostic framework for identifying SIJ-related pain (Dengler et al., 2019).

Physical Examination and Provocation Testing

• Patrick's test: The heel of one foot is crossed on top of the opposite knee, and the top knee is pressed down to test for hip mobility and pain.

• Distraction Test: The doctor stresses the SI joints by attempting to pull them apart a bit.

• Yeoman's test: with the patient prone, the test is performed by rotating the ilium with one hand and extending the hip while the knee is extended. Pain over the ipsilateral posterior sacroiliac joint area is indicative of sacroiliitis

• Gaenslen's test: The doctor has to lie the patient supine on a table with the hip joint maximally flexed on one side and the opposite hip joint is extended, pressure is applied to the flexed extremity. A positive test is when pain is felt across the sacroiliac joint.

• Sacral thrust test: With the patient prone, the examiner applies an anteriorly directed pressure over the sacrum. One hand is placed directly on the sacrum and is being reinforced by the other hand. Purpose is to apply an anterior shear force to both sacroiliac joints since the ilia are fixed by the examination bench. The test is positive if pain is reproduced in the sacroiliac region.

• Thigh thrust test: the patient lies supine with affected side hip flexed to 90 degrees. The pelvis is stabilized at the opposite ASIS with the hand of the examiner and the examiner stands on the same side as the flexed leg. The examiner provides steady increasing pressure through the axis of the femur

Imaging and Differential Diagnosis

The clinical utility of imaging studies in the diagnosis of primary sacroiliac joint (SIJ) pain remains inconsistent. While plain radiography is considered the most cost-effective imaging modality for assessing the SIJ, its diagnostic specificity is limited. Research indicates that at least 24.5% of asymptomatic individuals aged 50 and older exhibit radiographic abnormalities within the SIJ. Furthermore, there is currently no academic consensus regarding the optimal radiographic views or specific imaging protocols required for a comprehensive evaluation of the sacroiliac joint (Chahal et al., 2018).

Despite the evolution of imaging technology, conventional X-ray remains the most frequently utilized modality in clinical practice for evaluating the sacroiliac joint. However, a global academic consensus regarding the optimal radiographic technique and specific views for this assessment has yet to be established (Heilmaier et al., 2017). In contemporary clinical settings, anteroposterior views with a 25–30° caudal angulation, along with oblique views, are commonly employed to minimize structural overlap and enhance the clarity of interpretation (Omar et al., 2017).

The primary constraint of conventional radiography is its low sensitivity in detecting pathological changes during the early stages of sacroiliac disease. Key radiographic indicators of joint pathology include bony erosions, alterations in the joint space, subchondral sclerosis, and ankylosis (Fischer et al., 2015).

Computed tomography (CT) scanning offers enhanced sensitivity for detecting subtle osseous changes within the sacroiliac joint (SIJ). A diagnosis of SIJ degeneration is typically established based on the radiographic presence of subchondral sclerosis, bony erosions, osteophyte formation, joint space narrowing, intra-articular bone fragments, or subchondral cysts. In a retrospective analysis, specific CT findings—including sclerosis, erosions, and narrowing—demonstrated a diagnostic sensitivity of 58% and a specificity of 69% in identifying patients likely to achieve symptomatic relief following an intra-articular anesthetic injection (Diekhoff et al., 2017).

Magnetic resonance imaging (MRI) is capable of identifying edema and contrast enhancement prior to the manifestation of osseous changes detectable by computed tomography (CT). Furthermore, MRI serves as a valuable tool for diagnosing synovitis and identifying extra-articular sources of sacroiliac joint (SIJ) pain, including pathologies related to ligamentous, tendinous, or fascial attachments, as well as other cumulative soft tissue injuries. In the context of SIJ imaging, academic literature generally indicates that short tau inversion recovery (STIR) sequences are superior to fat-suppressed T2-weighted images, as they more effectively demonstrate early bone marrow edema. However, for patients presenting with SIJ syndrome, MRI findings do not reliably predict which individuals are likely to achieve symptomatic relief from anesthetic injections (Diekhoff et al., 2017).

Bone scanning is generally considered an ineffective screening tool for sacroiliac joint (SIJ) pain. However, research indicates that Single-Photon Emission Computed Tomography (SPECT) offers superior sensitivity in detecting and localizing lesions compared to traditional planar scintigraphy. Furthermore, SPECT is particularly valuable in postoperative evaluations because it remains relatively unaffected by metallic fixation devices. It can effectively identify specific osseous abnormalities in patients with complex clinical histories, such as those who have undergone multi-level or repeated surgeries, bony fusions, or internal fixation involving pedicle screws and metallic plates (Thawrani et al., 2019). Notably, increased SIJ uptake on SPECT has been documented following lumbar fusion and laminectomy procedures (Tofuku et al., 2015).

Spinopelvic Alignment and Fusion-Related Considerations

The failure to restore physiological lumbar lordosis during spinal fusion surgery can lead to mechanical low back pain, sagittal imbalance, and adjacent segment degeneration, thereby increasing the incidence of postoperative sacroiliitis. Maintaining proper spinal alignment can be achieved through meticulous patient positioning, the implementation of surgical release maneuvers, the strategic selection of instrumentation, and the optimization of the surgical sequence (Goswami & Austin, 2019).

Conversely, for lumbar or lumbosacral fusions involving internal fixation, it is critical to utilize an operative position that accurately recreates physiological lordosis.

The technical success of spinal instrumentation depends on the configuration of the rod, the screw-rod interface, and the implementation of interbody implants. Although spinal rods are typically straight in their initial form, intraoperative contouring is almost universally required to replicate the patient's physiological lumbar lordosis. The degree of contouring is contingent upon the patient's native spinal curvature; for instance, individuals with a high pelvic incidence and pronounced lordosis necessitate more significant rod manipulation. However, the contouring process can compromise the fatigue resistance of the rods, potentially impacting the overall mechanical integrity and durability of the spinal construct (Barrey et al., 2016).

Interbody fusion techniques including anterior (ALIF), transforaminal (TLIF), posterior (PLIF), and extreme lateral (XLIF) approaches are designed to provide rigid segmental fixation while restoring disc height and sagittal balance. In the context of lumbosacral junction fusions, research by Soegaard et al. demonstrated that circumferential fusion utilizing wedge-shaped cages and pedicle screw fixation achieved superior lordosis restoration, higher union rates, and improved functional outcomes compared to instrumented posterolateral fusion. While combined anterior/posterior arthrodesis is well-documented, existing literature primarily emphasizes fusion success rates rather than the specific surgical sequence or technical details of the combined procedures (Barrey et al., 2016).

Nonoperative Management

There are several conservative options for the treatment of SIJ pain (Szadek, 2016)

(1) Non-steroidal anti-inflammatory drugs (NSAIDs): can be used for pain management and to reduce inflammation (Szadek, 2016).

(3) Pelvic belts: Is also a treatment option that work by limiting SIJ motion and improving proprioception. The importance of the correct placement of the belt has been highlighted: the pelvic belts are most effective when worn directly above the greater trochanter, decreasing SIJ motion by approximately 30 % (Flack et al., 2015).

(4) Physical therapy: has been an important aspect in the treatment of SIJ pain, along with stabilization. Physical therapy strategies emphasize pelvic stabilization and restoration of postural and dynamic muscle balance, with correction of gait abnormalities. Aphysical therapy program concentrating on stretching and strengthening the weak muscles is an important aspect in the treatment of SIJ pain. Mooney et al. reported that five women with injection-confirmed SIJ pain had electromyographic (EMG)-documented hyperactivity of the ipsilateral gluteus muscles and contralateral latissimus muscle compared with EMG findings in 15 asymptomatic controls. After an exercise program, all five patients achieved a significant reduction in pain and a return of myoelectric activity to normal patterns (Bradley et al., 2017).

(5) Intra-articular injections with steroids and local anesthetics:

Intra-articular injections with steroids and local anesthetics are often therapeutic (Manchikanti et al., 2015).

More than 70% patients experienced greater than 50 % pain reduction for more than 6 weeks by SIJ blocks the duration of the efficacy of the SIJ blocks was shorter in patients with a history of lumbar or lumbosacral fusion (Ritz et al., 2018).

The injection must be performed under radiologic guidance to ensure intraarticular flow. The injection can be successfully performed under computed tomography or magnetic resonance imaging guidance or using ultrasound.

Fluoroscopy is more commonly used. Any injections performed in the office without imaging should be assumed to be soft tissue or periligamentous. Clinical SIJ injections without imaging have been shown to be intra- articular in only 22% of subjects (Wu and Varacallo, 2019).

(6) Prolotherapy and radiofrequency neurotomy: have also been used to treat SIJ pain and several studies have reported significant pain relief lasting between 6 months and 1 year. However, there are no studies reporting treatment efficacy in patients with SIJ pain after lumbar or lumbosacral fusion (Chuang et al., 2019).

Surgical Management and Outcomes

Surgical treatment for sacroiliac joint (SIJ) dysfunction is indicated only for patients whose pain has been definitively localized through controlled diagnostic anesthetic blocks and in whom lumbar spine pathologies have been excluded. Furthermore, surgical candidacy is reserved for individuals with persistent, disabling symptoms that have failed to respond to intensive conservative management. Current surgical modalities include traditional open arthrodesis and, more recently, minimally invasive techniques (Bayerl et al., 2019).

Open SIJ arthrodesis can be performed via either an anterior or posterior approach. The anterior approach offers distinct advantages by providing direct exposure to the ventral and cranial synovial segments of the SIJ complex while preserving the primary ligamentous stabilizers. However, open fusion is associated with a significant complication rate, ranging between 6% and 25%. While percutaneous procedures have been introduced as a less invasive alternative, there is currently a lack of comparative data regarding fusion rates or clinical outcomes across the various arthrodesis techniques. Postoperative protocols typically necessitate protected weight-bearing for a duration of 8 to 12 weeks.

To date, no specific studies have evaluated the surgical outcomes of patients who develop SIJ pain following lumbar or lumbosacral fusion. Regardless of the initial etiology, existing research suggests that the long-term success rate for SIJ fusion remains approximately 70% (Bayerl et al., 2019).

Conclusions

The source literature supports consideration of SIJ pathology in the differential diagnosis of pain after lumbar fusion. Assessment should integrate symptom distribution, appropriately interpreted provocation tests, examination for alternative spinal and hip causes, and selected imaging or image-guided diagnostic procedures. Nonoperative options include medication, pelvic stabilization, physical therapy, and guided injections; surgery may be considered for carefully selected patients with persistent, confirmed SIJ-mediated pain. The reviewed literature does not establish a single universally accepted diagnostic standard or a treatment pathway that is optimal for every postoperative patient.

Scope and Limitations

This article is a narrative synthesis limited to the literature-review text and bibliography supplied in the 2026 thesis. It does not claim a systematic search, risk-of-bias assessment, or independent validation of every source. Statements about treatment effectiveness should be checked against the original studies before journal submission.

References (as reported in the source thesis)

1. **Poilliot, A. J., Zwirner, J., Doyle, T. & Hammer, N. (2019):** A systematic review of the normal sacroiliac joint anatomy and adjacent tissues for pain physicians. Pain Physician, 22(4): E247–E274.

2. **Jani, S. & Simopoulos, T. T. (2018):** Sacroiliac joint interventions. In: Essentials of Interventional Techniques in Managing Chronic Pain, pp. 337–347. Springer, Cham.

3. **Raj, M. A. & Varacallo, M. (2018):** Pain, sacroiliac joint. In: StatPearls [Internet]. StatPearls Publishing.

4. **Barstow, A. & Dyson, S. (2015):** Clinical features and diagnosis of sacroiliac joint region pain in 296 horses: 2004–2014. Equine Vet Educ, 27(12): 637–647.

5. **Szadek, K. M. (2016):** Sacroiliac joint pain: Anatomy, diagnosis and treatment.

6. **Szadek, K. M., van der Wurff, P., van Tulder, M. W., Zuurmond, W. W. & Perez, R. S. (2009):** Diagnostic validity of criteria for sacroiliac joint pain: A systematic review. Journal of Pain, 10(4): 354–368.

7. **Manchikanti, L., Abdi, S., Atluri, S., Benyamin, R. M., Boswell, M. V., Buenaventura, R. M. et al. (2013):** An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain. Part II: Guidance and recommendations. Pain Physician, 16(2 Suppl): S49–S283.

8. **Manchikanti, L., Pampati, V., Benyamin, R. M. & Boswell, M. V. (2015):** Analysis of efficacy differences between caudal and lumbar interlaminar epidural injections in chronic lumbar axial discogenic pain: Local anesthetic alone vs. local combined with steroids. International Journal of Medical Sciences, 12(3): 214.

9. **Ritz, M. L., Bailey, C., Overstreet, K. & Gorlin, A. (2018):** Persistent hiccups following cervical epidural steroid injection with betamethasone. International Medical Case Reports Journal, 11: 263.

10. **Wu, L. & Varacallo, M. (2019):** Sacroiliac joint injection. In: StatPearls [Internet]. StatPearls Publishing.

11. **Barrey, C. & Darnis, A. (2015):** Current strategies for the restoration of adequate lordosis during lumbar fusion. World J Orthop, 6(1): 117.

12. **Barrey, C., Roussouly, P., Perrin, G. & Le Huec, J. C. (2016):** The importance of restoring the sagittal balance in small and large stabilization procedures of the spine. In: Surgery of the Spine and Spinal Cord, pp. 603–625. Springer, Cham.

13. **Bayerl, S., Tkatschenko, D., Dengler, J. & Vajkoczy, P. (2019):** Surgical treatment options at the sacroiliac joint. In: Spine Surgery, pp. 123–127. Springer, Cham.

14. **Chuang, C. W., Hung, S. K., Pan, P. T. & Kao, M. C. (2019):** Diagnosis and interventional pain management options for sacroiliac joint pain. Tzu Chi Med J, 31(4): 207.

15. **Ha, K. Y., Lee, J. S. & Kim, K. W. (2008):** Degeneration of sacroiliac joint after instrumented lumbar or lumbosacral fusion: A prospective cohort study over five-year follow-up. Spine (Phila Pa 1976), 33(11): 1192–1198.

16. **Lee, Y. C., Lee, R. & Harman, C. (2019):** The incidence of new onset sacroiliac joint pain following lumbar fusion. J Spine Surg, 5(3): 310–317.

17. **Dengler, J., Kools, D., Pflugmacher, R., Gasbarrini, A., Prestamburgo, D., Gaetani, P. et al. (2019):** Randomized trial of sacroiliac joint arthrodesis compared with conservative management for chronic low back pain attributed to the sacroiliac joint. J Bone Joint Surg Am, 101(5): 400–411.

18. **Christiansen, A. A., Hendricks, O., Kuettel, D., Hørslev-Petersen, K., Jurik, A. G., Nielsen, S. et al. (2017):** Limited reliability of radiographic assessment of sacroiliac joints in patients with suspected early spondyloarthritis. J Rheumatol, 44(1): 70–77.

19. **Diekhoff, T., Hermann, K. G. A., Greese, J., Schwenke, C., Poddubnyy, D., Hamm, B. & Sieper, J. (2017):** Comparison of MRI with radiography for detecting structural lesions of the sacroiliac joint using CT as standard of reference: Results from the SIMACT study. Ann Rheum Dis, 76(9): 1502–1508.

20. **Flack, N. A., Hay-Smith, E. J. C., Stringer, M. D., Gray, A. R. & Woodley, S. J. (2015):** Adherence, tolerance and effectiveness of two different pelvic support belts as a treatment for pregnancy-related symphyseal pain: A pilot randomized trial. BMC Pregnancy Childbirth, 15(1): 36.

21. **Zlomislic, V. & Garfin, S. R. (2019):** Anatomy and biomechanics of the sacroiliac joint. Techniques in Orthopaedics, 34(2): 70–75.

22. **Colò, G., Cavagnaro, L., Alessio-Mazzola, M., Zanirato, A., Felli, L., & Formica, M. (2020):** Incidence, diagnosis and management of sacroiliitis after spinal surgery: a systematic review of the literature. Musculoskeletal Surgery, 104(2), 111-123.

23. **DePalma, M. J., Ketchum, J. M. & Saullo, T. R. (2011):** Etiology of chronic low back pain in patients having undergone lumbar fusion. Pain Medicine, 12(5): 732–739.