

Surgery for the Painful, Dysfunctional Sacroiliac Joint

A Clinical Guide

Bruce E. Dall
Sonia V. Eden
Michael D. Rahl
Editors

 Springer

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Preface

This textbook is a first of its kind in the medical surgical literature. Despite the fact that surgeries on the painful, relatively stable, sacroiliac joint have been discussed in the literature for almost a century, there has never been a textbook written to bring all this information together for the surgeon or for the clinician dealing with surgical options for intractable sacroiliac joint pain. The authors creating this detailed discussion have very early on understood that the sacroiliac joint does cause pain, that this pain can be extremely disabling, and that in our modern medical society it is still grossly ignored or misunderstood. These practitioners have each spent a considerable portion of their careers working to further understand the painful, dysfunctional sacroiliac joint and creating ways, both conservative and surgical, to help patients with this diagnosis. This book shares with its audience the vast knowledge base that is being amassed concerning sacroiliac joint pain, the severe disability it can cause, associated pathological conditions, ways to navigate through making a definitive diagnosis and creating a valid treatment plan, multiple ways to operate on this joint and avoid the multiple pitfalls that may present themselves, and how to rehabilitate the postoperative patient with this condition. The authors are all very excited to share their years of experience treating patients with disabling pain from a dysfunctional sacroiliac joint and hope, as a result of reading this material, that surgeons and clinicians will develop the necessary learning to proactively be diagnosing and appropriately be treating this condition in their respective practices.

Kalamazoo, MI, USA

Bruce E. Dall, M.D.

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Bruce E. Dall

Introduction

This chapter defines the diagnosis of “dysfunctional sacroiliac joint” and explains why a book on this subject matter is needed in the literature. It covers high points in the surgical history of treatment for a sacroiliac joint (SIJ) having this diagnosis and the evolution of that treatment during the past century. After discussing what this book intends to cover, the sources for the material covered in this book are explained. The objectives hoping to be accomplished for both the surgeon treating a dysfunctional SIJ and the therapist rehabilitating a patient after surgical intervention are discussed.

Definition of a Dysfunctional Sacroiliac Joint

The definition that will be used in this book for the dysfunctional SIJ is “a SIJ that is chronically painful, essentially stable, and has become disabling to the patient” [1, 2]. It will be understood that there are a myriad of causes for a SIJ to become dysfunctional, each of which will be discussed (Chap. 5); however, acute fracture, infection, and tumor will not be considered in this book as each of those represents entities that have their own well-discussed treatment methods in the literature and surgical treatments discussed here, in general, will not apply.

Current Literature

Currently, there are no surgical textbooks available that discuss surgery for the painful, stable, dysfunctional SIJ despite the fact that surgery has been performed for this diagnosis for almost a century. The first publication discussing surgery was by Smith-Pedersen in 1926 [3]. It was published when most all low back and radiating leg pain was considered to be emanating from the SIJ. In 1934, when Mixter and Barr published their landmark article on the injured herniated lumbar disk, the SIJ as a pain generator slipped into obscurity [4]. This continued until the 1980s when the SIJ once again made its debut in the

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surgical literature as a cause for chronic pain [5]. Since that time, there has been a steady increase of papers on surgery for the dysfunctional SIJ; however, the majority of these have consisted of series of cases followed retrospectively (Chap. 2).

The FDA and Surgery for the Sacroiliac Joint

In 2008, the Federal Drug Administration (FDA) granted a 510(k) to SI-BONE, Inc. for the iFuse™ minimally invasive SI Joint Fusion System to treat conditions including degenerative sacroiliitis and SIJ disruptions [6]. The 510(k) designation makes it possible for corporations to get a device into the market quickly for far less cost than the other option of “pre-market approval” which typically entails spending tens of millions of dollars and potentially delays getting a device into the market for several years. The SI-BONE surgical method is a lateral approach and is similar to the approach used for decades by trauma surgeons to stabilize an acutely fractured SIJ. Since 2008, there have been several other surgical device companies that have also obtained a 510(k) clearance for their laterally placed fixation/fusion devices. Surgeons now have effective minimally invasive surgical treatment options for elective SIJ fusion. For the first time, because of the availability of these minimally invasive solutions, many surgeons are now interested in and aware of the SIJ as a pain generator. And as a result of the above, many surgeons and other health-care providers now include the evaluation of the SIJ in their diagnostic evaluation of patients with lower back pain.

Current Education and Societal Commitments for This Condition

The SIJ is a subject matter that is thoroughly taught in universities of osteopathy, anesthesiology, physical therapy, physiatry, and chiropractic. The anatomy and physiology are taught as well as a multitude of clinical diagnostic methods and conservative treatment regimens to include a

multitude of invasive types of varied injections. It has been and currently remains a very ignored entity in the disciplines of orthopedic surgery, orthopedic spine surgery, and neurosurgery, even though it is the lowest joint in the spine and a key joint in the pelvis. At the time of this writing, no surgical society has laid claim to the dysfunctional SIJ [6]. This will change as the old myths concerning the lack of pain generation from this joint continue to be dispelled, as more and more SIJ injections by pain management doctors are found to be giving temporary relief and as patients continue to be more and more self-educated via the Internet and seeking out surgeons with an interest in treating the painful dysfunctional SIJ.

Sources of Information for This Textbook

The sources for the information covered in this textbook are varied. It should be reiterated that there are no textbooks on the subject and the literature is lacking in prospective and randomized studies from which to ascertain solid information about both conservative treatment and fusion for the dysfunctional SIJ. Thus, we have to rely on individuals and institutions, of which there are several, that have long been involved in the diagnosis and treatment of this dysfunctional joint and have pursued continued research to further their ongoing learning experience. The Borgess Brain and Spine Institute (BBSI, Kalamazoo, MI; Fig. 1.1) has been involved in diagnosing and treating, both conservatively and surgically, the dysfunctional SIJ since 1991. Long before that, it was involved surgically with this joint in terms of trauma and infection.

Since 1991, BBSI has generated several publications in peer review journals [7–10], created an algorithm for the diagnosis and treatment of the dysfunctional SIJ [11], devised new methods of approach to the SIJ, invented new types of SIJ fixation, and worked with engineers in the cadaver lab to further understand the biomechanics of the ligament injured SIJ (Chap. 4). As a result, the BBSI has become an international referral center for patients with the diagnosis of a



Fig. 1.1 Borgess Brain and Spine Institute (BBSI), Kalamazoo, MI. *Used with permission from Borgess Health*

dysfunctional SIJ. It should be noted that many of the surgeries and illustrations from BBSI in this textbook represent our posterior oriented surgical experience prior to 2008 and the subsequent development of adequate lateral instrumentation to perform straight lateral minimally invasive fusions. The posterior midline approach was used extensively by us for the treatment of the dysfunctional SIJ for many years as the only other option available was the trauma way of placing two screws laterally across the joint with no real fusion as part of the process. Since the advent of very good lateral fixation devices, the current main operation now being used at BBSI is the minimally invasive lateral approach. As a result of having such a varied surgical history with the SIJ, BBSI is in the unique position of being able to choose between multiple techniques to obtain the desired fusion of the SIJ depending on the individual circumstances of the patient. These different circumstances will be discussed throughout this book, as well as the many varied ways to approach, instrument, and fuse the SIJ.

The authors responsible for the creation of this textbook comprise between them over 80 years

of performing surgeries on the dysfunctional SIJ and bring their collected experience of thousands of patients from major referral centers covering all parts of the country. Each author will provide their reasons for using a certain approach and define situations where it is best utilized and possibly where it should be avoided.

The current literature (Chap. 2), published in peer review journals since the 1980s, contains unique information that will also be sited throughout this book by multiple chapter authors.

The Philosophical Approach for the Creation of This Textbook

The philosophical approach to the organization of surgical information in this textbook is to discuss the various previously published techniques along with new techniques in groups according to the approach used to perform them. The approaches are defined by their potential to be invasive and their anatomical locations with reference to the SIJ. So, for example, one of the most utilized surgeries today would be found

in the chapter entitled “the lateral approach, minimally invasive.” The emphasis in this book is to provide information on approaches and not specific types of instrumentation to perform those approach-driven procedures. It should be noted here that the anterior approach will not be discussed in this textbook. All the authors agree that this is a very rarely used approach for the dysfunctional SIJ, and only in an extremely unusual circumstance would a surgeon consider using that approach. These types of rare situations would most likely be associated with some acute event or a trauma. In this book, different authors do favor different types of instrumentation, and their bias will show through in their illustrations and images. It is the editors’ expectation that all the writings in this textbook are being provided for general SIJ treatment information and not as a medium for solicitation of devices.

Book Objectives

Through the writing of this book, the authors hope to accomplish several objectives for the surgeon treating a dysfunctional SIJ patient and the physical therapist in charge of rehabilitating such a patient, either in the midst of conservative treatment or postoperatively after a SIJ fusion. The surgeon will be educated about the anatomy and physiology of the SIJ as a pain generator. They will understand how to diagnose a dysfunctional SIJ and learn the conservative and all the available surgical methods to treat a patient with this diagnosis. Surgeons will understand the multiple pitfalls that can exist when operating on the SIJ and the complications most common with each surgical approach. They will learn methods from various authors to choose the most appropriate procedure for a given patient and the best ways to rehabilitate the patient postsurgery. The physical therapist will learn the latest anatomy and physiology of the dysfunctional SIJ and learn the most recent successful techniques in treating a patient with this diagnosis. They will understand what an important role they play in the algorithm for treating the dysfunctional SIJ and the appropriate

measures to take when treating the postoperative SIJ fusion patient. The final chapter in this textbook (Chap. 16) is a “Roundtable Discussion” concerning important timely questions that a surgeon or a physical therapist might have asked and discussed by the chapter authors. Hopefully, it will serve as a springboard for those on the edge of wanting to learn more about the dysfunctional SIJ to get started doing so.

“Off-Label” Uses of Products

Except for Chap. 8, the lateral approach, minimally invasive, and portions of Chap. 11, the lateral approach, open, all the material discussing instrumentation going through or into the SIJ and the use of bone morphogenic protein (Infuse, Medtronic) is used “off-label.” Within each chapter, the individual authors will restate the FDA status of the devices they are discussing as they are presented.

Disclaimer There currently is no established standard for the surgical treatment of the dysfunctional SIJ or for the resulting rehabilitation of the patient after such a surgery. The reader must understand that this textbook represents a collection of techniques to diagnose and treat the dysfunctional SIJ from multiple sources. Not all these techniques have been fully tested or have been published in peer-reviewed journals. Those that have are listed as such throughout the book. The information provided here represents procedures and techniques that have worked well for these authors for the patients they have treated. Any surgeon or therapist deciding to use these procedures and techniques to treat patients does so knowing that the authors claim no responsibility for the related outcomes of such treatments.

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Surgical Treatment for the Painful, Stable Sacroiliac Joint: What Does the Literature Tell Us?

2

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Introduction

Low back pain (LBP) represents the second most common cause of visits to primary care physicians with the loss of productivity, income, and associated medical expenses resulting in a \$60 billion expenditure in the USA on an annual basis [1]. The sacroiliac joint (SIJ) has been identified as one of the causes of LBP 15–30 % of the time at the initial office visit [1]. The SIJ is a true synovial joint that primarily handles forces between the spine and pelvis [2, 3]. In its normal state, the SIJ gains all of its stability from numerous associated ligamentous structures and its undulating oblique structure allows it to withstand significant loads under normal physiologic conditions [3].

The painful, stable SIJ has recently been designated as a dysfunctional SIJ [4]. Although this is a recent definition, procedures to treat this joint have been in existence for nearly a century. The first publication offering evidence in support of this condition with a primary diagnosis of

traumatic arthritis was published in 1926 [5]. Consideration for the SIJ's potential to cause pain temporarily slipped into obscurity when Mixter and Barr published their work on the injured herniated lumbar disc in 1934 [6]. Interest in the SIJ as a treatable pain generator has resurfaced, especially during the last decade. This is partially due to the emergence of pain clinics and the increasing number of diagnostic and potentially therapeutic SIJ injections being performed. In addition, with the increased utilization of instrumented lumbar or lumbosacral fusions to treat various spinal pathologies, the awareness of adjacent level degeneration affecting the SIJ and resulting in the painful, stable SIJ has surfaced [7–9]. Common causes for painful, stable SIJs include inflammatory arthritis, postpartum syndrome, adjacent osteoporosis, Paget's disease, direct or indirect trauma, and adjacent segmental degeneration secondary to a previous lumbosacral fusion [10, 11].

When patients suffering from painful, dysfunctional SIJs have failed conservative treatment measures and their symptoms result in significant inhibition of function, arthrodesis and/or stabilization of the joint may be considered. Again, along with an increase in diagnosis, there has been a resurgence of operations to fuse and/or stabilize the stable, painful SIJ during the past decade. Despite evidence of the existence of the painful, stable SIJ in the general population, the knowledge base for surgically treating the painful, stable SIJ remains limited.

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This article will systematically review the literature to better understand what our current knowledge base is concerning surgeries for the painful, stable SIJ. We will examine the indications for SIJ surgical procedures as well as the published surgical techniques, outcomes, and complications following these procedures in hopes of gaining a better understanding of the optimal treatment options for patients with painful, stable SIJs.

Methods Used to Review the Literature

In order to generate the initial source articles, we conducted an electronic search in MEDLINE (OVID), EMBASE, CINAHL, and Web of Knowledge databases using the following Medical Subject Heading (MESH) terms: sacroiliac concept, surgery, fusion concept, outcomes concept, and complications concept. The search was restricted to articles related to human subjects and included articles in peer-reviewed journals between January 1, 1966, and April 1, 2013. Similar searches were conducted in each of the databases. Please refer to Appendix A for the complete search document. This search was performed using the established criteria laid out in the Quorum Statement for the conduct and reporting of systematic reviews [12, 13].

Studies of varying design, scale, and duration were included in this review. Studies were deemed eligible for this review if they (1) were published in English in peer-reviewed journals; (2) had relevant surgical treatment of the degenerative, stable sacroiliac joint; (3) were either randomized controlled trials, retrospective series, prospective series, observational or population-based studies, or case series; (4) reported quantitative results; and (5) studied patient populations within the USA. Studies were classified as randomized controlled trials, prospective cohort studies, or retrospective studies [14]. Case reports were excluded from this review. Studies pertaining to surgical treatment of the SIJ for trauma, tumor, or infection were also excluded from this review. Please refer to Appendix A for the full search strategies.

Results of the Literature Review

Of the 281,909 articles indexed in MEDLINE related to the surgical treatment of the SIJ, 18 (0.00006 %) of the articles pertained to the surgical treatment of the painful, stable SIJ. A total of 277 items pertaining to the dysfunctional SIJ were identified in MEDLINE (OVID), EMBASE, CINAHL, and Web of Science. One reviewer (SE) examined abstracts from all of the publications identified by the search and eliminated irrelevant articles and duplicates. Once the duplicates were discarded, the remaining 195 items were reviewed and screened by the reviewer (SE) for the above inclusion criteria. Of these articles, 11 (0.0004 %) met criteria to be included in this review. One additional article that met inclusion criteria was selected from other database searches, yielding a total of 12 articles.

The results of the review are summarized based on the surgical approach used in the included studies. The three approaches utilized are (1) open, dorsal approach (five articles); (2) minimally invasive lateral approach (five articles); and (3) minimally invasive, dorsal approach (two articles). For the purpose of this review, minimally invasive approaches are defined as those performed either via a percutaneous approach or through a skin incision of less than 1 in. [15]. Three of the studies were prospective analyses [16–18]. The remaining nine studies were all retrospective in nature. None of the reviewed studies utilized a randomized control design.

Open, Dorsal Approach

Five of the studies that met our inclusion criteria focused on outcomes following SIJ arthrodesis performed via open, dorsal approaches. A total of 118 patients underwent sacroiliac arthrodesis by this approach, of which 42 patients underwent bilateral SIJ fusions. Four of the studies were retrospective case reviews and one study was a prospective case review. The surgical techniques, treatment indications, and diagnostic and primary outcome measures are summarized in Table 2.1.

Table 2.1 Open, dorsal approach

Article	# joints fused	Study design	Fusion technique	Outcome measures	Outcomes	Complications	Fusion revision rates
Buchowski et. al.	20	Retrospective	Modified Smith-Peterson technique	SF-36 health survey improvements (post-pre)	Physical functioning: (0.0072); bodily pain(0.0009); vitality(0.0047); physical summary (0.0252); mental summary(0.0105)	Two post-op wound infections requiring debridement	15 %
Keating et. al.	26	Retrospective	Joint debridement with allograft bone and compression screws placed across joint	VAS: 1-10 reduction: pre-post	Mean: pre[61.]-post[2.9] ($p < 0.01$)	None reported	None reported
Kibsgard et. al.	75	Retrospective	Dorsal trans-iliac fusion or intra-extra-articular fusion	VAS: 1-10 reduction: pre-post	Mean reduction morning: [24](90.029) Mean reduction evening: [28](0.011)	1:icterus 1:pulmonary embolism 1:pin tract infnx. 1:appendicitis 1:SBO	None reported
Schutz et. al.	34	Retrospective	Dorsal bilateral interlocking technique	VAS: 1-10 reduction: pre-post		3:excision of scar tissue 10:hardware removal 5:fusion revision	29.4 %
Giannikas et. al.	5	Prospective	Placement of two large bi-cortical bone plugs across the joint	Satisfaction with symptom resolution	4/5 (80 %)	None	0

Table 2.2 Minimally invasive dorsal approach

Article	# Fusions	Study design	Fusion technique	Outcome measures	Outcomes	Complications	Fusion re-vision rates
Wise et. al.	19	Prospective cohort analysis	Posterior MIS approach with threaded cage, BMP	VAS: 1–10 reduction (average)	Lower back pain: 4.9 (≤ 0.001) Leg pain: 2.9(0.013) Dyspareunia: 2.6(0.0028)	None	5.3 %
Haufe et. al.	38	Retrospective analysis	SIJ debridement without bony fusion	VAS: 1–10 % reduction	23/38: 50–100 % reduction 20/38: >75 % reduction 3/38: 25–50 % reduction Avg. reduction: 4.1	None	0

Two of the five studies showed statistically significant pain reduction scores when comparing the preoperative and postoperative visual analog scores ($p < 0.01$ in the Keating study and $p = 0.029$ in the Kibsgard study) [10, 19]. Giannikas et al. demonstrated complete resolution of the symptoms in 80 % of the study patients [17]. Buchowski et al. demonstrated a statistically significant improvement in all SF-36 outcomes ($p < 0.05$) except for general and mental health ($p < 0.4706$ and $p < 0.0604$, respectively) [11]. The Schutz study was the outlier of the five studies, reporting an 18 % patient satisfaction rate, a 65 % reoperation rate, and 35 % fusion rate in the patients undergoing SIJ fusions in their series [20]. Moreover, there were minimal improvements in the patients' postoperative pain scores pre- and postsurgery in the study.

Complications were varied and only reported in two of the five studies [10, 11]. The Buchowski study reported a 15 % reoperation rate for nonunion (three patients). Following the revision fusion, two of the three patients developed deep wound infections requiring debridement and delayed pseudoarthrosis requiring additional revision surgery via an anterior approach. A few unusual complications were reported in the Kibsgard study, all of which were self-limiting (Table 2.1). There were no complications in the Giannikas patient cohort and complications were not mentioned in the Keating and Schutz papers.

Minimally Invasive Dorsal Approach

Two studies focused on minimally invasive dorsal techniques to treat the stable, dysfunctional SIJ. A total of 51 patients underwent SIJ surgeries via this approach and six of the patients underwent bilateral SIJ fusions. The Wise study was a prospective study and the Haufe study was retrospective. Wise et al. demonstrated statistically significant reductions in pain as measured on the preoperative and postoperative visual analog scales ($p < 0.001$) [16]. They also reported an overall fusion rate of 89 %. A formal statistical hypothesis could not be derived from the Haufe study [15]. However, they reported that 61 % of the fused patients had 50–100 % reductions in their VAS and 53 % of the study patients had greater than 75 % improvement for at least 2 years postoperatively (Table 2.2). The Haufe study utilized a novel technique of debriding the SIJ to treat the pain. There were no reported complications or reoperations in either of these studies.

Minimally Invasive Lateral Approach

The remaining five studies focused on lateral, percutaneous approaches to treat the symptomatic, stable SIJ. One hundred and thirty-nine patients underwent statistical analysis following SIJ arthrodesis via this approach.

The Mason study was a prospective analysis and the four other studies were all retrospective analyses. All studies demonstrated statistically significant improvements in pain levels as measured by various validated outcome scales [1, 18, 21–23]. Significant pre- and postreductions in the visual analog scale were seen in the Al-Khayer, Mason, Rudolf, and Sachs studies ($p < 0.002$, $p < 0.0001$, $p < 0.0001$, and $p < 0.0001$, respectively). The Khurana study showed statistically significant improvements in the SF-36 pain score ($p < 0.031$).

No complications occurred in the Khurana and Sachs studies. The three remaining studies had a 33 % complication rate between them. These complications resulted in a 17 % reoperation rate. It is with this approach that reported complications involved nerve pain, significant post-op hematomas, malpositioning of the hardware, and a fracture of the ilium (Table 2.3).

Discussion

Although the first article describing an SIJ arthrodesis was published in 1926, nearly a century ago, our literature review suggests that data regarding the surgical treatment for the SIJ is remarkably limited [5]. Out of 281,909 articles indexed in MEDLINE related to the surgical treatment of the SIJ, 18 (0.00006 %) of the articles pertained to the surgical treatment of painful, stable SIJ. Only 11 (0.0004 %) of these articles met search criteria for inclusion in our review, with one additional article from the other searched databases.

Waisbrod's 1987 article that was published 60 years after the Smith-Peterson article marks the beginning of the modern era for both the diagnosis and surgical treatment of the painful, stable SIJ [24]. He reported the results of a series of 21 patients who underwent surgery for a painful, stable SIJ. The approach was very similar to the approach described by Smith-Peterson in his sentinel paper. However, this time, in addition to abandoning the drastic gluteal muscular dissection, he inserted ceramic blocks into the posterior ligamentous aspect of the SIJ. His follow-up was

30 months with a 70 % success rate in decreasing patient's original pain by at least 50 %. There were two nonunions, one infection, and no reported revision surgeries. Another hiatus of 14 years occurred before Belanger published the second paper in the modern era on fusing the painful, stable SIJ [2]. In this study he introduces a new approach for reaching the SIJs. This approach is a midline fascial splitting approach, which is the same approach as described by Hutchinson in his paper on a new way to approach the iliac wing and harvest bone graft while avoiding the cluneal nerves, which were cut with the then standard arched incision over the rim of the iliac crest [25]. This was also the first time that pedicle screw instrumentation was used in achieving stabilization for this fusion surgery. This procedure also introduced a new way to fixate a screw to the ilium, allowing for bone graft to be placed directly into the prepared SIJ and allowing for compression across the SIJ by the instrumentation. Patients were braced in a pantaloony brace, and for the first time after such a surgery, they were allowed to be immediately full weight bearing on the surgical side. The four patients in the study were followed for up to 9 years, and all went on to solid fusions. There were no major complications. The long-term success rate was determined to be 80 % with two patients having their hardware removed prior to final follow-up due to one of the pelvic screws being point tender. This pain resolved with hardware removal in each case.

The diagnosis of the painful, stable SIJ up to this time in history had been made by a combination of the surgeon's clinical exam, various imaging studies, and, more recently, extra articular injections of a local anesthetic. The Waisbrod and Belanger studies are significant as they represent attempts to utilize more modern thought and devices to address SIJ dysfunction which translated into more sophisticated methods of diagnosis, treatment, and follow-up methods [2, 24].

It was in 2005 that specific outcome measures (ODI, VAS, and SF-36) were first used to evaluate patients having an SIJ fusion procedure. These studies also used standardized intra-articular injections under image to diagnose SIJ