Experience With "Sports Hernia" Spanning Two Decades

William C. Meyers, MD, Alex McKechnie, PT,† Marc J. Philippon, MD,‡ Marcia A. Horner,* Adam C. Zoga, MD,§ and Octavia N. Devon, MD**

Objective and Background: Athletic pubalgia (AP) is a leading cause of athlete loss from competitive sports. Commonly misnamed "sports hernia," AP is a set of pelvic injuries involving the abdominal and pelvic musculature outside the ball-and-socket hip joint and on both sides of the pubic symphysis. Prospective studies show that timely intervention and appropriate repair of selected injuries results in greater than 95% success.

Methods: The senior author reviewed his experience with 8490 patients and 5460 operations, looking primarily at the changes in patient characteristics over the last 2 decades and at some of the advances.

Results: Female proportion, age, numbers of sports, and soft tissue structures involved have all increased as have the number of syndromes identified and number of operations. MRI has improved greatly for both the diagnosis of hip and nonhip pathology in the pelvis. Increased understanding has led also to new rehabilitation and performance protocols.

Conclusions: Better understanding and recognition of the injuries has led to more satisfactory care and returned many athletes to successful careers, which has had a major impact on modern sport.

(*Ann Surg* 2008;248: 656–665)

Hip and pelvic injuries have shortened the careers of many athletes. These patients have a variety of types of pain, usually related to exertion. The differential diagnosis of pelvic pain is, of course, exhaustingly wide, and the gamut of injuries in this patient group is extensive.[1–3] A common way to think about the musculoskeletal injuries of the anterior pelvis is to consider injuries that occur either inside or outside of the "ball-and-socket" hip joint.[4–6] Accurate diagnosis of the athlete with pelvic pain remains challenging, but recent progress has shed considerable light on this topic and the care of these patients has improved.

Over the past 2 decades, the senior author has accumulated a large experience with these injuries. During this period of time, we have seen improvements in recognition of the injuries, identification of the various injury types, diagnosis, and treatment. In this paper, we shall review some of these developments as well as the theoretical bases behind them. We shall look primarily at the characteristics of the overall population of patients that have been treated, tracing some of the changes that have occurred over the past 2 decades. We shall also provide some overall results of treatment. The latter has been the subject of a number of other papers[2,6,7] and we are not ready to report our most recent results, but an overall perspective with respect to this large patient series seems appropriate.

The term "sports hernia" conveys 2 huge assumptions about the above injuries: (1) that the cause of the above set of injuries has something to do with occult hernias, and (2) that the above injuries can be lumped into one explanation and be treated the same way. Hopefully, there will be an appreciation from reading this manuscript that those assumptions have little basis; and that understanding these injuries leads to predictably successful management that is actually quite different from hernia repair.

Current understanding has been previously described.[3,6] Basically, we think in terms of there being 2 types of joints in the pelvis: the ball-and-socket hip joint, and the "pubic bone" joint, not the pubic symphyseal joint. In the second joint, we think in terms of the entire right and left pubic symphyses together acting as the center of activity for a lot of soft tissue structures that are normally symmetrically distributed, in terms of both anatomy and forces, around that bone.

METHODS

Patient Population

This series involves patients seen at 3 different academic institutions and in locker-rooms and training facilities of various sports teams and on visits to other patient care institutions from 1986 through January 2008. Many patients were included in a large prospective data-base, but others were retrieved from outpatient and inpatient files, operative logs, billing records, or other documentations of patient contact.

Patients whose medical records or imaging studies were reviewed only and who were never directly examined were excluded from this study. Because of the large number of different sources, the same detail was not available on all patients and several gaps in any patient information were identified. Therefore, comparisons from one decade to another were made with select groups of patients with comparable detail. The select groups necessarily include patients from previously published series, which shall be referenced.

From the *Department of Surgery, Drexel University College of Medicine, Philadelphia, PA; †Los Angeles Lakers, Los Angeles, CA; ‡Steadman-Hawkins Clinic, Vail, CO; and §Department of Radiology, Thomas Jefferson University, Philadelphia, PA.

Reprints: William C. Meyers, Department of Surgery, Drexel University College of Medicine, 245 North 15th St, Room 7150, Mail Stop 413, Philadelphia, PA 19102. E-mail: wmeyers@drexelmed.edu.

ISSN: 0003-4932/08/24804-0656
DOI: 10.1097/SLA.0b013e318187a770

Similarly, during the latter years of the study, more specific detail was available on patients because of increased understanding of the various afflictions and improved imaging tests. Therefore, many comparisons could not be made to earlier time periods when there was less understanding of the pathologies. The overall results do not reflect more recently recognized syndromes.

Clinical Considerations

Diagnosis of the various clinical entities were made by a combination of history and physical examination, and in more recent years supported by new magnetic resonance imaging techniques. The surgical procedures included various types of reattachments and/or releases of soft tissues that normally attach or cross the pubic symphyses.

The precise procedures depended on the specific injuries and are based on an understanding of the anatomy described previously.[1,3,6] Basically, the injuries are presumed to cause instability of the pubic joint, and the procedures are designed to either tighten and broaden the attachments of various structures that normally attach to the pubic symphysis and/or loosen the attachments or other supporting structures via selective epimysiotomy (like fasciotomy) or detachment. The operations depend on an intimate understanding of the pubic symphyis and surrounding structures including the aponeurotic plate and variations of muscular anatomy.

We have not completed the 2-year results of treatment for the past 2 years of patients because not enough time has elapsed. We believe that the last 2 years represent an important patient cohort because this is when we have been able to correlate the specific diagnoses with MRI findings.

Because of that limitation, we have chosen to list our longer term results in terms of return-to-play data. We define "return-to-play" as an athlete's actual returning to full competitive play. This definition does not include the athlete's or close associate's assessment as to whether this level of play was satisfactory. By nature, return-to-play only provides one point in time as the assessment point. As published previously,[2] we believe that the player's assessments at various time points up to 2 years are far superior to return-to-play data.

Various rehabilitation and training protocols have evolved during the time frame of the study in conjunction with the various professional and collegiate teams via on-site consulting and care of specific patients. Protocols are counted when these were officially introduced as part of the team's protocol(s) within 6 months of consultation.

Other Definitions

For clarity, we used the following definitions. Athletic pubalgia or "sports hernia" refers to the musculoskeleton of the pelvis outside the hip joint and arranged symmetrically around and including the pubic symphyses, but not including the sacrum or spine. We used the term athletic pubalgia synonymously with sports hernia. Hip joint refers to the ball-and-socket joint consisting of the acetabulum, ligamentum teres, articular and labral cartilage, head and neck of the femur, and other soft tissue enclosed within this space, for example, synovium. "Pubic joint" refers to the motion within the pelvis but outside the hip joint that involves symmetrically the soft tissues around the pubis and has at its center of activity both sides of the pubic symphysis.

The term athlete refers to patients currently or recently participating in competitive athletic activity as a livelihood or integral way of life. The patients themselves determined their highest level of competition and level of education and primary sport. For the database, all athletes had to choose one sport as their primary, so in this analysis, true, multiple sport athletes were represented by single data points. In other words, multiple sport athletes are present but not identifiable within these data.

Pelvic MRI

During the latter part of the series, MRI became an integral part of the evaluation of these patients. Whenever possible, we used a new technique[7] of pelvic MRI that correlates well with demonstrable injury. Additionally, this MRI technique uses both surface coil and a send-receive body coil, as well as oblique planes to maximize sensitivity and specificity for osseous and musculotendinous pathology of the pelvis. This objective way of demonstrating the injuries provides convincing evidence of the multiplicity of injuries and the overlap of hip injuries with the pelvic soft tissue injuries of athletic pubalgia. Differentiating hip problems was extremely important to the diagnosis of these patients. MR arthrography with sensorcaine was important to this differentiation.

Perioperative Sequelae

Postoperative sequelae, defined by undesirable findings leading to patient complaints within 6 weeks of surgery, were recorded for the entire series. For these purposes, followup was 100% at 7 days and 7 weeks after the surgery. As a best estimate of infection rate, we chose to use the National Surgical Quality Improvement Program (NSQIP) criteria and methodology for all of 2007. These data came from a combination of the nurse reviewer who kept track of all patients, not just those required by NSQIP, plus a clinical assistant. Prolonged length of stay was defined as greater than 24-hour hospitalization. All patients had LMA, general or local anesthesia with an intended 23-hour stay, although many patients were discharged the same day as surgery.

RESULTS

Overall Experience

In total during this time period, the senior author saw 8490 patients (Fig. 1). Five thousand two hundred and eighteen of those patients underwent surgery, resulting in 5460 operations. The surgery involved 26 different procedures and 121 different combinations of procedures. The increase in number of types and combination of operations has been primarily a function of the last 10 years compared with the earlier decade, because of increased understanding of the various syndromes that afflict these patients.

One can see from the graph (Fig. 1) that the number of patients seen per week has on the average increased from 2 to 25. The number increased from 2 to 5 over the first 7 years, to 8 over the next 7 years, and most pronouncedly from 8 to

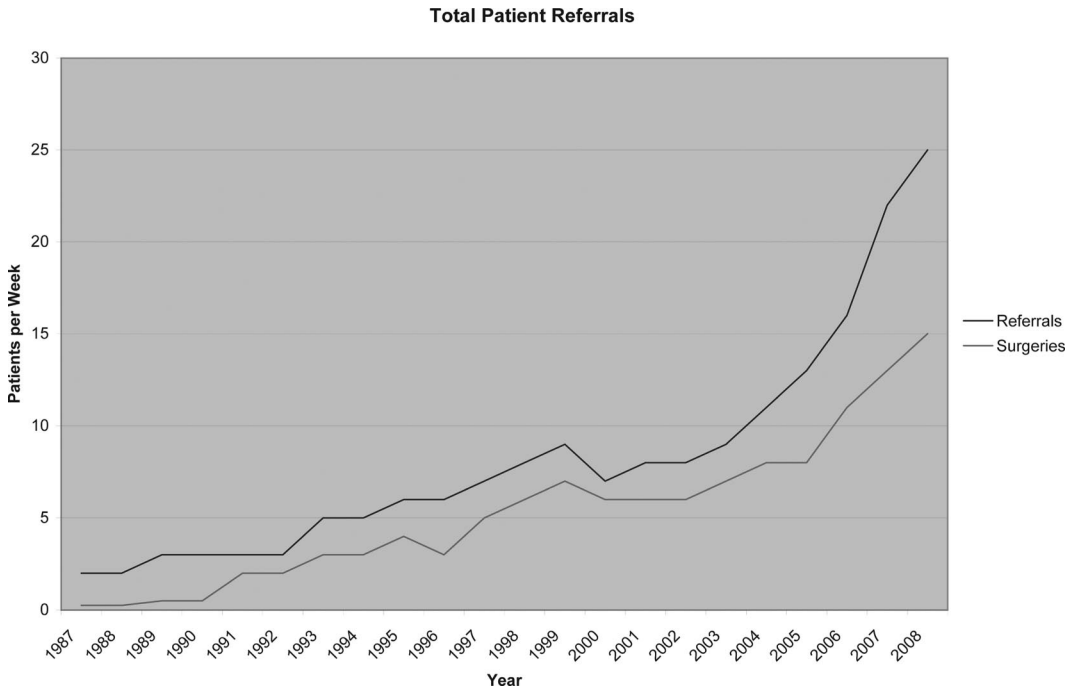

FIGURE 1. The graph depicts total new patients seen and the number of surgeries versus the year over a 20-year period. The units on the *y*-axis are the number of patients per year averaged per week based on a 48-work-week year.

25 over the most recent 5 years. Likewise, the number of surgical procedures per week increased within a similar pattern over the same time period: 1 to 3, 6, and 15.

From the graph, one can notice that in the first 5 years, the percentage of patients who underwent operations was initially low (24.5%), then increased for the next 10 years to 83.2%, and then lowered again for the past 5 years to 60.0%. During the initial phases of recognition of these injuries, there was more uncertainty with respect to the pathophysiology and results of surgery. Initially, patients were carefully selected. A number of patients were excluded such as all patients with osteitis pubis (Fig. 2) and patients whose symptoms changed from side to side without apparent reason.

As we understood the pathophysiology and results better, patients with osteitis and other conditions consistent with the increased understanding were included in the surgical group. Many patients, in fact, who had been previously excluded, were ultimately called back for surgery. During the past 5 years, we are seeing a larger variety of patients including more patients with primary hip problems and older patients who do not seem optimal surgical candidates.

Gender and Age

The male/female ratio of the patients has undergone a dramatic change. In the first decade of recognition of the injuries, females comprised less than 1% of the entire group,[2,8] whereas during the past 5 years they now comprise 15.2%. In the very first report reflecting data from the mid-80s there were no females.[8] In another report from data reflecting all patients evaluated in the mid-90s, there were 8.0%,[2] and in a recent profile of 5,283 recent patients with athletic pubalgia, women represented 8.2% of the entire group. Clearly, we are evaluating more women patients with suspected musculoskeletal pelvic injuries. As we understand better the female variants of these problems, we are also identifying more precisely their anatomic problems.

Another striking feature of this patient population has been the increasing age. Mean age of patients has increased from 24.7 in the mid-80s, to 26.3 in the mid-90s, to 28.6 in the past 3 years. In all instances the age range has also widened. Age range for the entire series of all patients evaluated was 8 to 88, and age range of patients who had surgery for athletic pubalgia was 11 to 71 years. Neither the 8- nor the 88 year olds qualified by our definition as athletes. The 11-year-old was a prodigious soccer player. The 71-year-old was a ranked amateur tennis player. The oldest professional player who had surgery was 66. He was a bowler on the senior circuit.

Athletes

According to our definition, we classified 82.8% of the entire evaluated patient population as athletes. Initially, 100% of evaluated patients were athletes,[8] compared with 91.1% in the mid-1990s[2] and 76.9% during the past 5 years. As mentioned above, the increase in number of nonathletes has increased over the past 5 years in part accounts for the smaller number of patients who underwent this elective surgery during those recent years. The total number of nonathletes who underwent surgery has also increased. Likewise, the number of women athletes who underwent surgery has increased, as has the ages of both female and male athletes and nonathletes who underwent surgery.

Over the past 2 decades the number of sports involved in the injuries has increased, and the most common sports

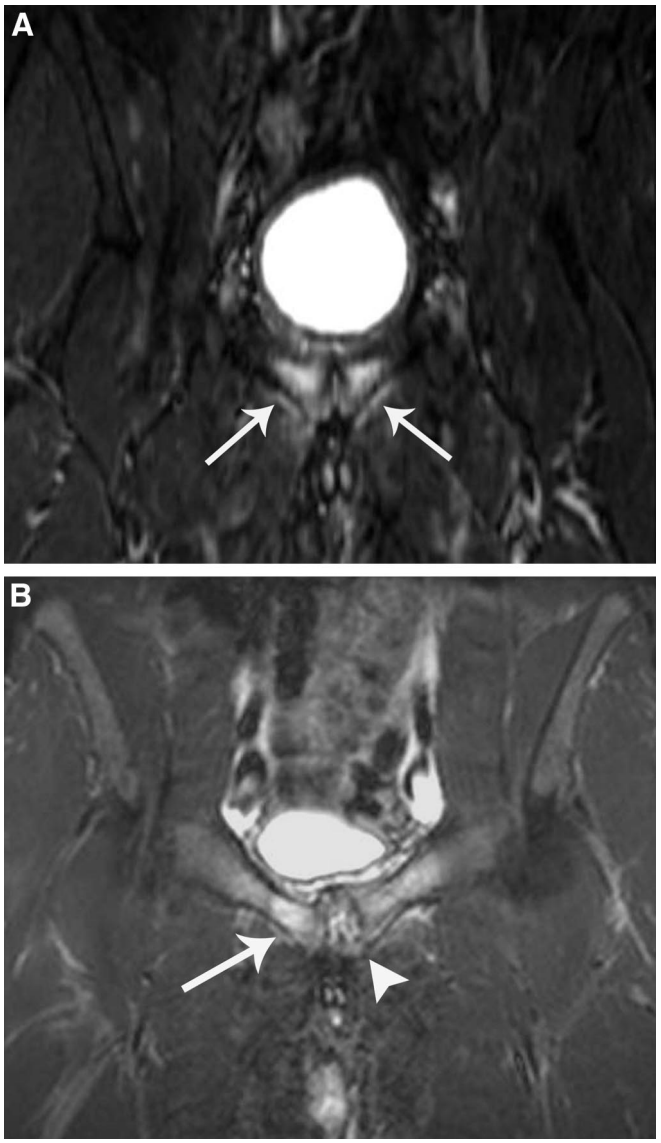

FIGURE 2. MRI appearance of osteitis pubis: Short tao inversion recovery (STIR) sequence in a coronal plane from a traditional musculoskeletal pelvis protocol (A) shows bright bone marrow edema (arrows) symmetrically across the pubic symphysis indicating an inflammatory process. Poor resolution limits evaluation of soft tissue attachments and osseous cortex. STIR sequence with the higher resolution of an athletic pubalgia protocol (B) shows the bone marrow edema (arrow), plus osseous productive change, and obvious articular erosion (arrowhead).

associated with the injuries has shifted slightly (Table 1). The number of sports has increased from 6[8] to 15[2] to 32 over the 1980s, 1990s, and 2000s. Soccer players remain the number one most afflicted athletes in the total patient population, although football has overtaken soccer as the number one sport seen by us in the past 3 years. Ice hockey is in a clear third place. We have seen a marked recent increase in the number of long distance runners and dancers. Also evolving are clear patterns in terms types and severity of injuries according to sport and even specific positions within a sport. For example, baseball pitchers and hockey goalies have a predisposition for a certain type of adductor injury and bull-riders as a group clearly get the most severe injuries.[6]

TABLE 1. Top Six Sports (Total 8490 Athletes)

	% of Entire Series	% of Last 2 Years
Soccer	44.6	27.2
Football	22.3	32.7
Hockey	8.1	10.2
Baseball	6.3	6.1
Basketball	6.2	5.3
Distance running	1.2	4.2

Overall, 95.3% of the athletes who underwent athletic pubalgia operations were able to return to full play within 3 months of surgery. Most patients were able to return to play well before 3 months, but our data are not specific enough to determine specific times of return. The precise time to return also depended on whether the operations were done during or after the playing seasons, and on the type or severity of injury. Within a season, many patients were directed to either a 3-week or 6-week return to play protocol. In a close assessment during the past year of 20 patients who chose the 3-week protocol, 18 of the 20 patients were able to play at full strength by their own assessments within that time frame. The former represented a group of patients with less severe injuries. In contrast, the entire group represents a wide variety of athletes in various sports and who had a broad variety of injuries. Some of the patients also had hip injuries that were either minor or treated before or after the athletic pubalgia surgery.

Perioperative Sequelae

The most common postoperative complaint, which occurred in nearly all patients, was minor bruising or edema involving the abdomen, thighs, genitals, and perineum (Table 2). Fourteen patients (0.3%) had hematomas felt significant enough to require reoperation. For 2007 the wound infection rate was 0.4%. All infections were superficial. Fourteen patients (0.3%) had dysesthesia related to ilioinguinal, genitofemoral, anterior or lateral femoral cutaneous nerve distributions. All but 2 of the complaints resolved within a year period. Seven patients (0.1%) had mild penile vein thromboses. None of these resulted in long-term sequelae or concerns. There were 7 (0.1%) other various minor anesthetic or surgical complications that prolonged hospitalization.

TABLE 2. Non-Infectious Perioperative Sequelae (5218 Patients, 5460 Procedures)

	Number of Patients (% of Surgical Patients)
Dysesthesias	14 (0.3%)
Hematomas	14 (0.3%)
Vein thromboses	7 (0.1%)
Other	7 (0.1%)

TABLE 3. Clinical Entities of Athletic Pubalgia

Structure/Syndrome	Incidence (%)	Defect	Possibly Indicated Procedure
Unilateral RA/unilateral AD	22	Tear and compartment syndrome (CS)	Repair and release
AD ongus (AL)	16		
Pectineus (P)	22		
AD brevis (AB)	8		
Pure AD syndromes	21	Usually CS	Release
Bilateral RA/bilateral AD	17	Aponeurotic plate disruption; tear and CS	
Unilateral RA	16	Tear	Repair
Bilateral RA	15	Tears	Repair
Severe osteitis variant	8	Usually tears, CS, and bone edema	Repair, release, and steroid injection
Unilateral/bilateral	7	Combination tear(s) and CS	Repair(s) and release(s)
Iliopsoas variant	4	Impingement and bursitis	Release
Baseball itcher/hockey goalie syndrome	4	AD tear and AD muscle belly CS	Release
Spigelian	4	Tear	Repair
Rectus femoris variant	3	Impingement	Release
High RA variant	2	Tear	Repair
Female variant	2	Medial disruption with lateral thigh compensation	Repair and release(s)
Round ligament syndrome	1	Inflammation with tear	Repair and excision
Dancer's variants	<1	Obturator internus/externus	Release(s)
Rower's rib syndrome	<1	Subluxation	Excision and mesh
Avulsions		Usually acute adductor injury	Repair and/or release(s)
AD/RA calcification syndromes	<1	Chronic avulsion	Excision, release
Midline RA variant	<1	Tears and muscle separation	Repair
Anterior schial tuberosity variant	<1	Posterior perineal inflammation, gracilis, hamstrings	Release
AD contractures	<1	Often associated with hip pathology	Release and hip repair
More uncommon variants	2	Eg, gracilis, quadratus, iliotibial band	Variable

Any of the soft tissues attached to or crossing the pubic symphysis can be involved alone or in combination with other injuries. Note that one can count the actual number of clinical entities or syndromes in various ways. For example, we see all the combinations of rectus abdominis injury and specific adductor injury, and both rectus abdominis and adductor injuries can be unilateral or bilateral. Listed are the involved anatomical structures and/or pseudonyms used for reference, with relative incidences and potentially indicated procedures. The percentages represent number of cases seen relative to total numbers of patients from 2006 and 2007. Note also that a patient can have more than one variant, accounting for the greater than 100% total incidence.

RA indicates rectus abdominis; AD, adductor.

Reoperation

The most common reason for reoperation was development of similar problems on the contralateral side after unilateral surgery (182 patients). The second most common reason for reoperation was adductor release for new or persistent adductor problems after surgery (28 patients). Eighteen of the latter group was in the first decade. Recurrent problems occurred in 16 patients, one to 11 years after the original surgeries.

Over the past 3 years, we have been operating on a seemingly increasing number of patients who had failed traditional hernia operations at other institutions. We did not keep strict data on these "redo" patients in the earlier part of the series. Perhaps reflecting this, in total 241 (4.6% of the 5218 surgical patients) had previously undergone unsuccessful traditional hernia repair surgery for treatment of their pain. Over a 3-month period in 2007, we identified 47 such patients who underwent subsequent repair. Forty of the 47 were able to return to play within 3 months of subsequent surgery.

Number of Recognized Clinical Problems

Over the past 2 decades, we have come to recognize an increasing number of distinct clinical entities that afflict these athletes, with at least an equal number of different treatments (Table 3, Figs. 2–5). In 1987, we thought there was 1 basic problem involved, the rectus abdominis being the primary culprit. In the mid-90s, we increased that number to 3, rectus abdominis alone or in combination with adductors, plus adductor alone[2] (Figs. 3–5). In 2008, we now recognize at least 17 different nonhip, soft-tissue structures as causes of primary pain.[3,6] Even though we have reported 18 or 19 distinct syndromes,[3,6,9–11] in fact, the number is much higher; recognizing that these soft tissue structures can be involved in various combinations in the same patient. For example, we no longer think in terms of there being just one adductor complex involved in the injuries. In fact, 3 different adductor muscles – adductor longus, adductor brevis, or pectineus – are involved in most of adductor injuries (Fig. 4). Plus, there are other adductors, eg, gracilis, adductor magnus, and obturator externus, which are sometimes involved. In addition, there are clear female variants of these problems that involve lateral compensatory pelvic structures after medial pelvic injury.[6]

MRI Advances (Figs. 2–5). Until 2005, we knew that MRI was occasionally helpful in the diagnosis of these injuries and that we could with some predictability identify a

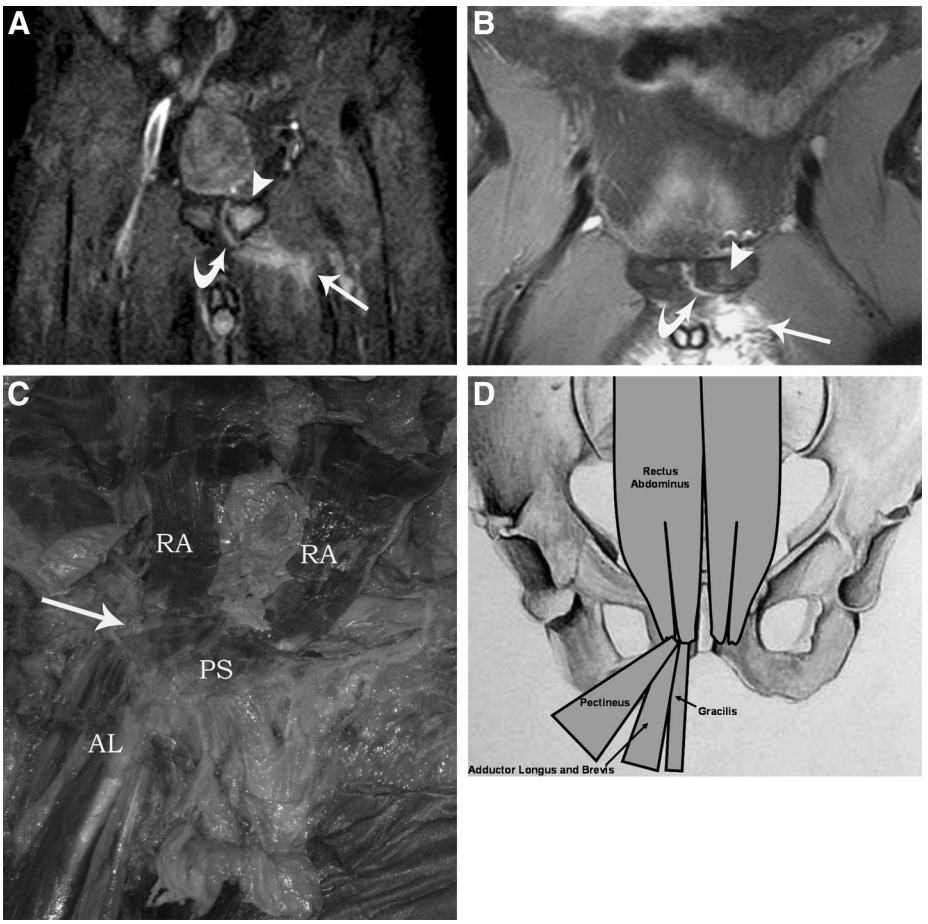

FIGURE 3. Unilateral rectus abdominis/adductor injury: Low resolution STIR MR image at 0.3 Tesla from traditional pelvis protocol in an NBA forward (A) and high resolution T2 weighted fat suppressed image at 3 Tesla from an athletic pubalgia protocol in a major league baseball infielder (B). Both show osseous and soft tissue edema at the left anterior pelvis (arrowheads). Note the difference in resolution. Soft tissue edema follows the course of the left adductor longus origin (arrow), and a secondary cleft on the left (curved arrow) indicates rectus abdominis detachment from its pubic attachment. Note the dark susceptibility artifact just cephalad to the superior pubic ramus in B, reflecting mesh from the patient's failed herniorhaphy. Photograph of a cadaveric dissection of the same region in a similar plane (C) shows a relative continuity of the caudal rectus abdominis (RA) with the anterior pubic symphysis (PS) and the thigh adductor longus origin (AL). The arrow shows the lateral edge of the rectus abdominis as it blends into this "aponeurotic plate." Schematic representation of the anterior pelvis (D) shows the close approximation of structures on the pubic symphysis.

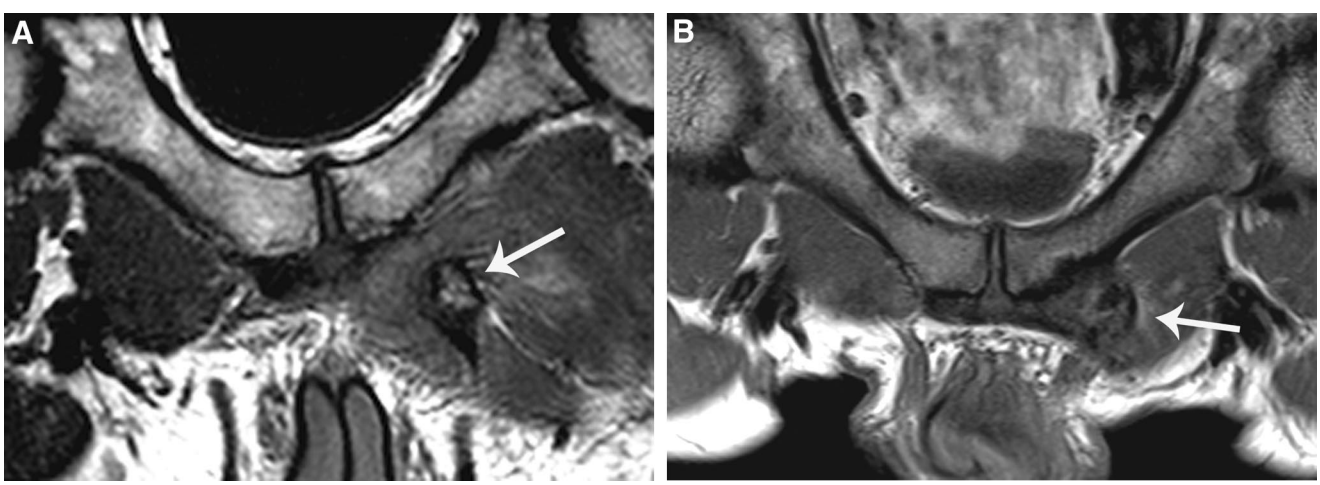

FIGURE 4. MRI of adductor variants: Proton density weighted MR image in a professional soccer player with acute left-sided groin pain (A) and long history of osteitis pubis shows an osseous avulsion of the pubic tubercle (arrow) and caudal retraction with entire proximal adductor longus. Similar proton density weighted image in a 46-year-old marathon runner (B) shows a more indolent injury at the adductor longus origin with enlargement, ill definition, and hypointensity (arrow) indicating hydroxyapatite deposition disease ("calcific tendinosis").

number of "soft findings" in these patients.[6,12] Studying the various attachments to the pubic bone and refining the MRI technique held the key to specific diagnoses.[13–15] In scans done by traditional techniques (Figs. 2A, 3A), what had been generally described as "osteitis pubis" turned out to lead to more specific diagnoses (Figs. 2B, 3B).

FIGURE 5. Continuous bilateral rectus abdominis aponeurotic plate disruption.

TABLE 4. Anatomical Defects Identified in 100 Consecutive MRIs of Athletic Pubalgia Patients in 2006

Structure	Incidence (%)
Pubic symphysis	93
RA	76
Adductor longus	46
Pectineus	38
Adductor brevis	20
Iliopsoas	6
Rectus femoris	2
Sartorius	1
Pubic ramus	1
Obturator ext	1
Gracilis	1
Hamstring	1
Adductor magnus	1
Hip	16

Note that more than one defect was common so the incidence adds up to greater than 100%.

We analyzed 100 consecutive pelvic MRIs done by our group in 2006. The distribution of anatomic structures involved is listed in Table 4. Like Table 3 suggests, the rectus abdominis in combination with adductor pathology predominated as the most common soft tissue defects. Adductor longus, pectineus, and adductor brevis pathology were the commonly afflicted adductors in that order. Iliopsoas, rectus femoris, and sartorius involvement were the most frequently afflicted nonadductor groups. Again, unilateral rectus abdominis/adductor injury was overall the most common diagnosis (Fig. 3), followed by pure adductor pathology (Fig. 4), and bilateral aponeurotic plate disruption (Fig. 5). We also found clinically relevant pathology seemingly remote to the pubic attachments. Interestingly, over 15% of the patients with MRI findings of athletic pubalgia also had evidence of hip pathology. Ten of the latter group had MRI-arthrography with positive sensorcaine tests confirming a clinical relevance and simultaneous injury.

Rehabilitation and Performance Protocols

Rehabilitation and performance protocols have developed that are relatively specific for the various injuries and sports. The rehabilitation protocols called for return to play at 3 days to 3 months postoperatively depending on the specific injury, sport, position, and choice of management. When 6 teams that strictly adhered to the protocols were analyzed, 18 of the 22 players were able to achieve return to play within the ascribed period. Eight of the 18 achieved full-play status ahead of the recommended time.

Over the same time period, new concepts of core stability training[16] have evolved that relate to these new pathophysiological understandings. As a result, new performance protocols developed for at least 16 different major league teams within the 4 major sports (football, basketball, hockey, and baseball). A standardized performance protocol also developed for professional soccer and for 9 NCAA school training programs.

DISCUSSION

This study demonstrates a rapidly enlarging knowledge base concerning abdominal, groin, and other pelvic musculoskeletal injuries in athletes. A 10-fold increase in the number of patients seen has occurred over a 20-year period. The cross-spectrum of patients shows that these injuries include both genders, a wide range of ages, a variety of sports, and a wide range of different levels of athletes. The increasing knowledge base has resulted in 18 or 19 distinct syndromes and 121 different combinations of procedures. At least 17 distinct musculoskeletal structures can be involved. Peri-operative and long term morbidity from the operations are low when the operations are done in experienced hands.

Most of the current understanding has resulted from an improved understanding of the anatomy and pathophysiology involved in these injuries.[3,6] Whereas careful history and physical examination by experienced care-givers remain the mainstays for diagnosis, new techniques of MRI[13–15] can show the same pathology as diagnosed by clinical examination and/or confirmed by surgery in 91% of cases.

The success rate from these procedures in athletes remains high. In 2000, we reported results on 276 patients. All patients had had at least 2 years follow-up. The overall success rate was 95.4% in returning the patients to what they subjectively felt was their previous level of experience. As we have continued to follow these patients closely, the success rates remain about the same despite a wider range of indications and more tailored types of surgery. Because our MRI advances are just 2-year-old, we are presently awaiting 2-year results of surgery for injuries confirmed preoperatively by MRI. These data, stratifying results according to specific injuries and the demographics mentioned in this report, should be forthcoming in subsequent publications.

The principal theme of the present study is that the term "sports hernia" is a gross misnomer. Although athletes in these age brackets can certainly develop true hernias, true hernias do

not cause these types of pain. Very few of these patients have even incidental hernias. The injuries have nothing to do with true inguinal hernias, and instead involve what we describe as the "pubic joint."[3,6] There are a variety of different injuries that can be involved with these muscles and other soft-tissue structures outside of the ball-in-socket hip joint. A detailed understanding of the anatomy and function of the pelvis is necessary to treat these patients effectively. As adjudged by the increasing number of athletes who seek out these operations and the new training programs that have been incorporated into sport, these approaches have become accepted by the sports medicine community at large.

A brief historical perspective seems appropriate for a more complete understanding of the development of the above series of patients.[6] The senior author developed an interest in this subject as a result of direct observation of these injuries in his younger days as an athlete and of participation in the care of Duke University athletic teams in the mid-1980s with doctors Frank Bassett and William Garrett. As a result of studies in the fresh cadaver laboratory, a greater appreciation of the anatomy and biomechanical forces led to the development of a set of highly successful procedures on competitive athletes who had been previously sidelined for long lengths of time.[2]

During the 1980s and 1990s, that author's experience as a gastrointestinal surgeon helped to separate the musculoskeletal disorders from a wide variety of other diagnoses. His association with a leading physical therapist, a coauthor, helped to understand the limitations of physical therapy and rehabilitation as a primary treatment of many of these abdominal and groin problems, and the roles of those modalities after surgery and in prevention of injuries. Subsequently, his association with several expert arthroscopic hip surgeons, one a coauthor, helped to understand the pathophysiology of the hip and the new advances in hip surgery.

In the 2000s, as the author learned more about the number and complexities of these injuries, he partnered with another coauthor in studying the radiologic anatomy of the pelvis and these injuries. In 2005, they realized that by correlating the clinical assessment of the patients with some creative magnetic imaging techniques and findings at surgery, one could identify preoperatively very precisely most of the injuries.

The above associations helped to solidify the primary concept upon which this series of patients is based—the pubic bone joint. Some of the evidence that supports this concept includes correlation of surgical and radiologic pathology, correlation of pathology with history and physical examination findings, the multiple sites of injury around the pubic symphyseal bones, and the fresh cadaveric studies.[6] Successful functional correction of the variety of problems by a variety of repairs and releases specific for the identified pathology adds support for the fundamental concept. Other evidence supports this concept including: the multiple sites of pain that often occurs in the same patient, development of opposite side problems without surgical treatment, the occurrence of osteitis pubis in athletes, and correctability of the osteitis by injury repair, and a large experience with successful repair after failed hernia surgery. With regard to the last mentioned evidence, we are now averaging over 3 "redo" operations per week on such patients.

Under-appreciated and perhaps implied from the large number of patients in this series is the magnitude of these type of injuries in competitive sports. When one considers the incidence of both hip and athletic pubalgia injuries as a group, which these data suggest we should do, these injuries emerge as one of the largest categories accounting for both loss of playing time and early retirement from sport because of injury.[17–19] No doubt, recognition and understanding of these injuries and satisfactory care shall continue to increase the number of athletes who return to successful careers and to impact modern sport and physical fitness.

When one looks at the large number of articles on athletic pubalgia or sports hernia in the sports medicine, physiatry, physical therapy and other literature, one comes away from this literature very confused. Most of the confusion comes from assumptions about pathophysiology, such as occult hernias, which are rarely found, or from limited data without compulsive patient follow-up. Two recent reviews characterize this confusion well.[20,21]

This paper simply provides an overview of one large experience with this injury. It documents the changing pattern of patients including the increasing number of females, sports involved, overall age of patients, and anatomic syndromes that have been identified. In addition, it documents huge advances that are taking place in the radiologic imaging of these problems and in the physical therapy and performance protocols for these problems and the acceptance of these concepts into the athletic communities.

REFERENCES

1. Meyers WC, Szalai L, Potter N, et al. In: *Extraarticular Sources of Hip Pain. Operative Hip Arthroscopy*. 2nd edn. New York, NY: Springer. 2005:86:–97.
2. Meyers WC, Foley DP, Garrett WE, et al. Management of severe lower abdominal or inguinal pain in high-performance athletes. *Am J Sports Med*. 2000;28:2–8.
3. Meyers WC, Greenleaf R, Saad A. Anatomic basis for evaluation of abdominal and groin pain in athletes. *Oper Tech Sports Med*. 2005;13: 55–61.
4. Byrd JWT. Gross anatomy. In: Byrd JWT, ed. *Operative Hip Arthroscopy*. New York, NY: Springer; 2005:100–109.
5. Ganey TM, Ogden JA. Pre- and post-natal development of the hip. In: Callaghan JJ, Rosenberg AG, Rubash HE, eds. *The Adult Hip*. Philadelphia, PA: Lippincott Williams and Wilkins; 1998:39–56.
6. Meyers WC, Yoo E, Devon O, et al. Understanding "sports hernia" (athletic pubalgia): the anatomic and pathophysiologic basis for abdominal and groin pain in athletes. *Oper Tech Sports Med*. 2007;15:165–177.
7. Omar IM, Zoga AC, Kavanagh EC, et al. Athletic pubalgia and the "sports hernia": Optimal MR imaging technique and findings. *Radiographics*. 2008;28. In press.
8. Taylor DC, Meyers WC, Moylan JA, et al. Abdominal musculature abnormalities as a cause of groin pain in athletes. *Am J Sports Med*. 1991;19:239–242.
9. Meyers WC, Lanfranco A, Castellanos AE. Surgical management of chronic lower abdominal and groin pain in high-performance athletes. *Curr Sports Med Rep*. 2001;1:301–305.
10. Meyers WC, Ricciardi R, Busconi BD, et al. Athletic pubalgia and groin pain. In: Garrett WE, Speer KP, Kirkendall DT, eds. *Principles and Practice of Orthopaedic Sports Medicine*. Philadelphia, PA: Lippincott Williams and Wilkins; 2000:223–232.
11. Mora SA, Mandelbaum BR, Meyers WC, et al. Extra-articular sources of

hip pain. In: Byrd JWT, ed. *Operative Hip Arthroscopy*. New York, NY: Springer; 2005:70–99.
12. Albers SL, Spritzer CE, Garrett WE, et al. MR findings in athletes with pabalgia. *Skeletal Radiol*. 2001;30:270–277.
13. Zoga AC, Kavanagh EC, Meyers WC, et al. MRI findings in athletic pubalgia and the "sports hernia." *Radiology*. 2008;247:797–807.
14. Zoga AC, Kavanagh EC, Meyers WC, et al. MRI of the rectus abdominis/adductor aponeurosis: Findings in the "sports hernia." Scientific paper presentation, Paper presented at: The American Roentgen Ray Society, Annual Proceedings, Orlando, FL, 2007.
15. Petersilge C. Imaging of the acetabular labrum. *Magn Reson Imaging Clin N Am*. 2005;13:641–652.
16. McKechnie A, Celebrini R. Hard Core Strength. Vancouver, BC. Available at: http://www.p2soccer.com/Content/Main%20Pages/Resource%20Centre.asp.
17. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train*. 2007;42:311–319.
18. Philippon M, Schenker M, Briggs K, et al. Femoroacetabular impingement in 45 professional athletes: associated pathologies and return to sport following arthroscopic decompression. *Knee Surg Sports Traumatol Arthrosc*. 2007;15:908–914.
19. Witnauer WD, Rogers RG, Saint Onge JM. Major league baseball career length in the 20th century. *Popul Res Policy Rev*. 2007;26:371–386.
20. Swan KG, Wolcott M. The athletic hernia: a systematic review. *Clin Orthop Rel Res*. 2006;455:78–87.
21. Farber AJ, Wilckens JH. Sports hernia: diagnosis and therapeutic approach. *J Am Acad Orthop Surg*. 2007;15:507–514.

Discussions

Dr. Keith D. Lillemoe (Indianapolis, Indiana): Some may wonder why Dr. Meyers asked me to discuss this paper. It is in part that he knows that I am a huge sports fan and that I have followed his career as a sports hernia surgeon for many years. He also knows I anticipated these results for many years.

Dr. Meyers, you describe your experience since 1987 with now over 9,000 patients and almost 6,000 operations. This number has increased dramatically over five years. My first question is: where were all these patients coming from and where were they in the past? Is this a totally new phenomenon, or are we just understanding it better?

Next, you speak of the valuable role of MRI, but you also state that this is a relatively new test for confirming the diagnosis and characterization of the disease. How did you make this diagnosis prior to the use of MRI? It is hard for me to imagine that with these million-dollar athletes you can make this diagnosis and offer surgical treatment based simply on a history and physical.

You describe 18 to 19 distinct syndromes. Do you have a different operation for each of these syndromes? Can you describe at least one of these procedures in a fashion that someone who at least understands an inguinal hernia repair and its associated muscle and facial layers can understand? Do you do it open or laparoscopically? Do you use mesh? Is this done under local or general anesthesia? Is this an operation to be performed by general surgeons or orthopedist? Are you training your fellows and surgical residents to do this procedure?

Finally, a tough question, I understand it was not the purpose of this paper to give results, and you cite prior publications, although none since 2000, but obviously there have been thousands of patients treated since that time. Yet this is a results-oriented organization that appreciates *p*-values and statistics, and I think you owe it to this Association and the *Annals of Surgery* to at least present some of your percentages of success and how you define what you consider a successful outcome in these high profile athletes. Data such as the time to full recovery and any adverse outcomes or complications associated with the procedures should be reported.

Finally, do you have comparative data between surgical procedures and nonoperative management? Until this data is provided, I am afraid that the outcomes for this syndrome will really only be known to those of us who follow the sports pages and listen to ESPN rather than by reading the peer-reviewed literature.

Dr. John G. Hunter (Portland, Oregon): I think Dr. Lillemoe asked a couple of my questions, but I want to amplify something previously mentioned and also to ask one additional question.

The conventional hernia repairs do not work for sports hernias, as you pointed out, because there is no relationship between pubalgia and inguinal hernia. Therefore, the term "sports hernia" should be abandoned if we want patients to be saved from unnecessary and potentially injurious surgery. Perhaps today we can abandon this term once and for all if you agree.

Secondly, imaging has been very helpful, as you pointed out, in defining the various injury patterns. It seems that you operated on a number of people with normal imaging. How do you determine who is likely to benefit in this group?

Lastly, just to amplify Dr. Lillemoe's question, who will learn about these injuries? Who will perform these procedures outside of Philadelphia? Will it be orthopedists or will it be general surgeons?

Dr. William C. Meyers (Philadelphia, Pennsylvania): It is absolutely appropriate to be skeptical about something that is new and for which the data are still relatively virgin in terms of analysis and validation. This is a complex set of injuries and proper treatment requires a detailed understanding of the anatomy and other orthopedic and visceral problems that afflict this area. I shall try to go through the various questions specifically.

With respect to Dr. Lillemoe's first question about where these patients have been for the past many years, there is no question in my mind that this problem has existed for many years. It is difficult to go back and get these data for multiple reasons. In fact, prior to recognition of the injury, many of these players were clearly passed off as malingerers because they articulated multiple mysterious complaints and were not playing well. The symptoms would oscillate from side to side and involve both the abdomen and the adduc-

tors. I imagine that many people in this audience can remember such patients – ones with such injuries who dropped off teams – in their own careers in sports.

This is definitely not a new phenomenon, and we do understand this better. There may be an increased incidence today, but this is not clear. As I mentioned, there has certainly been an increased recognition of this entity in both the medical and lay literatures. There are about 20,000 more articles on ESPN.com than in the established medical literature, which may be related to the fact that there are more sports stars with these injuries than in the past. There is also perhaps an overuse aspect to the development of this injury; more one sport athletes and repetitive training.

MRI has been a very useful adjunct to what we have already learned. The problems can actually be diagnosed on physical examination. In fact, history and physical examination is the gold standard still for precise diagnosis. You can pinpoint the area of pain and relate the pain to various resistance maneuvers. For example, you can separate each adductor with a combination of very precise maneuvers, but MRI is so much better, that you can diagnose many of these injuries with that modality alone. It is best to correlate MRI with the history and physical findings.

With respect to the different operations, there are a large number of operations that I perform depending on the specific problem involved. For example, consider one well-known baseball player who came in with a completely disrupted adductor longus. This occurred on television and was a long-time highlight. In fact the adductor longus was not the principal injury in this particular case. The rectus abdominus muscle was completely detached and the common aponeurotic plate on that side was nearly completely disrupted. At the time of surgery the rectus was up around his belly button where you could feel a ball. We had to bring that muscle all the way back down to the pubis at surgery. It is wrong to consider these injuries like hernias. The anatomy involves the pubic symphysis itself and should be considered as a joint. To repair these problems successfully, one should be thinking more like an orthopedic surgeon working on the knee than a hernia surgeon. One should aim to achieve stability of the pubic joint.

We see a variety of different injuries depending on the primary source of instability.

I perform the procedures usually under an LMA type anesthesia, and sometimes under local or full general anesthesia. You can perform minimal repair operations under local anesthesia and occasionally get the patient back to work in a few days, for example to a key playoff game. The problem with minimal repair operations is that sometimes they do not endure over the long term.

The way we define success depends on the patient's own subjective analysis of whether he is at the same level of performance as before the injury. We assess patients at 3 and 6 months, and at 1 and 2 years. The overall success rate in athletes is 95.4% at 2 years. We are in the process of subdividing the injuries and providing 2-year follow-up based on the more specific diagnoses and including MRI findings. Because the progress in MRI has only occurred over the past 2 years, such 2-year data is still forthcoming.

It is difficult to do comparative studies on these athletes because they have a season coming up and sometimes it is often easier to go ahead and perform surgery immediately in the off-season so they are ready to return to their sport. Trials of conservative therapy for most of these injuries do not work, although for certain types of injuries, non-operative therapy is better.

There is a study out of Holland that goes through a 5-year physical therapy regimen, and there is actually about a 60% to 70% clear improvement rate during that period of time. Most athletes that we deal with do not have that time window. Interestingly, there is a success rate with conventional open or laparoscopic hernia repairs for certain types of injury, but it is not nearly the success rate that we would like. Among the 15 to 17 operations per week that I perform, 3 to 4 are re-operations after failed hernia repair attempts.

Dr. Hunter, I agree that the term "sports hernia" should be abandoned. The comparison to knee injuries is much more pertinent than our understanding of hernias. As for training, we require a year fellowship with me before I endorse someone to go out and start treating these injuries on their own. The surgeon most fit to treat these injuries is one who understands this anatomy and has experience with the wide variety of injuries that occur.