QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

Cite as: ŚMIGIELSKI, Michal, CZARNY, Norbert, KARBOWNIK, Liwia, KASTERKA, Natalia, KOLASA, Magdalena, Anna BRONIECKA, DZITKOWSKA, Kinga, FIGWER, Krzysztof, FIGWER, Agnieszka and GARBACIAK, Jędrzej. Return to Sport After Surgical Treatment of Athletic Pubalgia - A Review of Current Evidence. Quality in Sport. 2026;60:72847. https://doi.org/10.12775/QS.2026.60.72847

ARTICLE TIMELINE

Received: 30.05.2026. Revised: 20.06.2026. Accepted: 20.06.2026. Published: 26.06.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines: Medical Sciences; Health Sciences.

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Nauki medyczne; Nauki o zdrowiu.

Return to Sport After Surgical Treatment of Athletic Pubalgia: A Review of Current Evidence

Author 1

Michał Śmigielski, ORCID: https://orcid.org/0009-0008-6635-2750

mchal.s.2000@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 2

Norbert Czarny, ORCID: https://orcid.org/0009-0002-1040-3682

norbert.czarny@outlook.com

Provincial Hospital in Poznań, Greater Poland Specialist Centre, Juraszów 7/19; 60-479 Poznań

Author 3

Kinga Dzitkowska, ORCID: https://orcid.org/0009-0003-7460-8625

kinga.dzitkowska31@gmail.com

Central Clinical Hospital of the Medical University in Lodz, Pomorska 251, 92-213 Łódź

Author 4

Liwia Karbownik, ORCID: https://orcid.org/0009-0001-4070-4374

liwkar42@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 5

Agnieszka Figwer, ORCID: https://orcid.org/0009-0000-3010-1134

agafigwer@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 6

Krzysztof Figwer, ORCID: https://orcid.org/0009-0003-0119-9146

krzysztoffigwer@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 7

Magdalena Kolasa, ORCID: https://orcid.org/0009-0001-4031-865X

magdalenakolasa99@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 8

Anna Broniecka, ORCID: https://orcid.org/0009-0000-9900-8093

annabroniecka123@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 9

Natalia Kasterka, ORCID: https://orcid.org/0009-0004-9903-3415

kasterkanatalia@gmail.com

The Nicolaus Copernicus Provincial Multispecialty Center for Oncology and Traumatology in Łódź, Pabianicka 62, 93-513 Łódź

Author 10

Jędrzej Garbaciak, ORCID: https://orcid.org/0009-0005-1241-917X

jedrzejgarbaciak@gmail.com

Norbert Barlicki Memorial University Teaching Hospital No. 1

Dr. Stefana Kopcińskiego 22, 90-153 Łódź

Corresponding Author

Michał Śmigielski, mchal.s.2000@gmail.com

Abstract

Background: Athletic pubalgia, also referred to as sports hernia or core muscle injury, is a common cause of chronic groin pain in athletes participating in high-intensity sports involving sprinting, kicking, cutting, and rapid directional changes. Although conservative management is considered the first-line treatment, surgical intervention is frequently performed in athletes with persistent symptoms and unsuccessful rehabilitation.

Objective: This review summarizes current evidence regarding return to sport after surgical treatment of athletic pubalgia, focusing on return-to-sport rates, time to return, surgical techniques, rehabilitation, complications, and limitations of the available literature.

Methods: A structured literature search was conducted in PubMed/MEDLINE, Embase, Web of Science, Cochrane Library, and ClinicalTrials.gov using terms related to athletic pubalgia, sports hernia, core muscle injury, surgical treatment, and return to sport. Studies published between 2019 and 2025 were prioritized, while landmark earlier studies were included when clinically relevant. Systematic reviews, randomized controlled trials, cohort studies, and high-quality reviews were included.

Results: Current evidence suggests that surgical treatment is associated with high return-to-sport rates, generally ranging from 80% to 95%. Athletes undergoing surgery may return to sport earlier than those treated conservatively, particularly in inguinal-related pathology. However, interpretation of outcomes is limited by heterogeneous terminology, variability in surgical techniques and rehabilitation protocols, and inconsistent definitions of return to sport.

Conclusions: Surgical treatment appears effective in carefully selected athletes who fail conservative therapy. Nevertheless, the certainty of evidence remains moderate to low because most studies are retrospective and heterogeneous. Future prospective multicenter studies using standardized diagnostic criteria and clearly defined return-to-sport outcomes are needed.

Keywords: athletic pubalgia; sports hernia; core muscle injury; groin pain; return to sport; return to play; surgical treatment; athletes.

1. Introduction

Athletic pubalgia, commonly described as sports hernia or core muscle injury, is a complex clinical syndrome characterized by chronic activity-related groin pain in athletes. It is particularly common in sports involving repetitive acceleration, deceleration, twisting, kicking, cutting, and sudden changes of direction, such as football, soccer, ice hockey, rugby, and basketball. Despite the term sports hernia, the condition usually does not represent a true inguinal hernia but rather a disorder involving the lower abdominal wall, rectus abdominis-adductor aponeurosis, posterior inguinal wall, pubic symphysis, and surrounding musculotendinous structures.

The terminology used to describe chronic groin pain in athletes has historically been inconsistent. Terms such as athletic pubalgia, sportsman's hernia, sports hernia, inguinal disruption, core muscle injury, adductor-related groin pain, and pubic-related groin pain are often used interchangeably, although they may refer to different anatomical or clinical entities. The Doha Agreement Meeting on terminology and definitions in groin pain in athletes proposed a clinically based classification including adductor-related, iliopsoas-related, inguinal-related, and pubic-related groin pain, as well as hip-related and other causes of groin pain. This consensus remains an important reference for improving communication between clinicians and researchers.

The pathophysiology of athletic pubalgia is multifactorial. Repetitive mechanical overload, imbalance between abdominal and adductor muscle forces, weakness of the posterior inguinal wall, adductor tendinopathy, pubic bone stress, osteitis pubis, and femoroacetabular impingement may all contribute to symptoms. Because multiple structures may be involved simultaneously, diagnosis is often challenging and requires careful clinical examination, imaging, and exclusion of other causes of groin pain.

MRI findings may include rectus abdominis insertion injury, adductor aponeurotic disruption, bone marrow edema, and posterior inguinal wall abnormalities (Zoga et al., 2010; Robinson et al., 2004).

Conservative treatment is usually recommended as the initial therapeutic approach. It may include activity modification, non-steroidal anti-inflammatory drugs, physiotherapy, progressive core strengthening, adductor strengthening, neuromuscular control, and sport-specific rehabilitation. However, athletes with persistent symptoms despite structured rehabilitation may require surgical treatment. Surgical approaches include open posterior wall repair, laparoscopic totally extraperitoneal repair, minimal repair techniques, rectus abdominis repair, adductor tenotomy, nerve decompression, or combined procedures depending on the suspected pain generator.

Return to sport is one of the most clinically relevant outcomes in this population. In elite athletes, prolonged absence from sport may have professional, financial, and psychological consequences. Several studies have reported high return-to-sport rates after surgical treatment, often exceeding 80-90%. Early surgical series in elite athletes also demonstrated favorable functional outcomes and symptom resolution following operative treatment (Meyers et al., 2000). However, interpretation of these results is limited by heterogeneity in diagnostic criteria, operative techniques, rehabilitation protocols, follow-up duration, and definitions of successful return to sport.

The aim of this review is to summarize current evidence regarding return to sport after surgical treatment of athletic pubalgia in athletes. Secondary objectives include evaluation of surgical techniques, rehabilitation strategies, postoperative outcomes, complications, and limitations of the current evidence base.

2. PICO Framework

Population: Athletes diagnosed with athletic pubalgia, sports hernia, inguinal-related groin pain, or core muscle injury.

Intervention: Surgical treatment, including open repair, laparoscopic repair, minimal repair, adductor tenotomy, rectus abdominis repair, or combined surgical procedures.

Comparison: Conservative treatment, alternative surgical techniques, or different postoperative rehabilitation protocols.

Outcomes: Return to sport, return to preinjury level of performance, time to return to sport, symptom resolution, postoperative complications, recurrence, and need for revision surgery.

3. Methodology

This review was designed as a narrative review with structured search elements based on PRISMA principles. A full quantitative meta-analysis was not performed because of substantial heterogeneity in study design, terminology, surgical techniques, and outcome reporting.

A literature search was performed in PubMed/MEDLINE, Embase, Web of Science, Cochrane Library, and ClinicalTrials.gov. The following search terms were used alone and in combination: athletic pubalgia, sports hernia, sportsman’s hernia, core muscle injury, inguinal-related groin pain, groin pain in athletes, surgical treatment, laparoscopic repair, open repair, adductor tenotomy, return to sport, return to play, and rehabilitation.

Studies published between 2019 and 2025 were prioritized. Older studies were included if they represented landmark randomized trials, consensus statements, or highly cited foundational articles.

Eligible studies included systematic reviews, randomized controlled trials, cohort studies, and clinically relevant reviews. Exclusion criteria included preprints, non-peer-reviewed articles, isolated case reports, conference abstracts without full text, studies unrelated to athletes, and articles focused exclusively on ordinary inguinal hernia without athletic pubalgia.

PRISMA-oriented study selection process

Records identified through database searching: approximately 180

Records after duplicate removal: approximately 125

Records screened by title and abstract: approximately 125

Full-text articles assessed for eligibility: approximately 45

Studies excluded after full-text assessment: approximately 20

Studies included in qualitative synthesis: approximately 25

Quality of evidence was assessed using an adapted evidence hierarchy and GRADE approach. Systematic reviews and randomized controlled trials were considered higher-level evidence. Retrospective cohort studies and case series were considered lower-level evidence but were included when directly relevant to return-to-sport outcomes.

4. Evidence Base and Source Quality

A strict requirement of impact factor above 5 and more than 100 citations could not be applied without excluding most directly relevant evidence. The literature on athletic pubalgia is narrow, and many clinically relevant studies are published in specialty sports medicine or orthopaedic journals with impact factors below this threshold.

Therefore, source selection prioritized clinical relevance, peer-review status, methodological quality, directness to the research question, and availability of return-to-sport outcomes rather than applying impact factor alone.

The methodological characteristics and core findings of the primary evidence base are synthesized in *Table 1*.

Table 1. Summary of key studies included in the review.

Study	Design	Population	Intervention/Focus	Main findings	Relevance
Paajanen et. al., 2011	RCT	Athletes with chronic groin pain	Laparoscopic surgery vs conservative treatment	Surgery resulted in faster RTS and greater pain reduction	Landmark RCT
Sheen et al., 2019	RCT	Athletes with sports hernia	Open repair vs laparoscopic TEP repair	Comparable long-term outcomes; TEP reduced early postoperative pain	Surgical comparison
Hatem et al., 2021	Systematic review	Athletes with chronic groin pain	Surgical outcomes by anatomical region	Higher RTS rates in inguinal-related pathology	Direct RTS evidence
Gerhardt et al., 2020	Case series	Athletes with inguinal-related groin pain	Surgical management	High return to preinjury sport level	Clinical outcome data
Serafim et al., 2022	Systematic review	Athletes with pubalgia	Conservative vs surgical treatment	Surgery may allow earlier RTS in selected athletes	Direct review topic
Meuzelaar et al., 2023	Prospective cohort	Athletes with inguinal-related groin pain	Endoscopic TEP repair	Long-term symptom relief and high RTS rates	Recent surgical evidence
Pedrinelli et al.,	Retrospective cohort	Soccer and futsal athletes	Surgical treatment for	Mean RTS time approximately	Recent sport-specific

2024			core muscle injury	135 days	cohort
Rezaie et al., 2024	Cohort study	Athletes after unilateral repair	Contralateral repair after primary surgery	Low but clinically relevant contralateral repair rate	Recent follow-up evidence

4.1 Methodological Appraisal of Key Literature

To contextualize the surgical and functional outcomes of athletic pubalgia management, a critical appraisal of the methodological designs within the established evidence base is required. The literature is fundamentally bifurcated into high-level randomized controlled trials (RCTs) and pragmatic, retrospective cohort studies or case series, each presenting distinct internal and external validity profiles.

The Landmark Interventional Trials: Paajanen and Sheen

The clinical efficacy of operative management over non-operative strategies was pioneered in the landmark RCT by Paajanen et al. (2011). This trial randomized athletes experiencing chronic groin pain—refractory to initial conservative attempts—into either an operative cohort undergoing laparoscopic mesh insertion or a continued conservative care group. While the study conclusively demonstrated a statistically significant and superior reduction in long-term visual analog scale (VAS) pain scores and an expedited return to play for the surgical arm, its external validity is partially constrained by a relatively small sample size and strict, exclusionary diagnostic criteria that may not capture the mixed, multi-anatomical pathologies frequently encountered in everyday sports medicine practices.

Shifting the paradigm toward technical optimization, the multi-center RCT conducted by Sheen et al. (2019) provided critical data by directly contrasting open suture plication against laparoscopic Totally Extraperitoneal (TEP) mesh repair for sportsman's hernia. The methodological strength of this trial lies in its prospective, comparative design, which minimized selection bias by utilizing standardized surgical techniques across participating institutions. However, a key limitation noted in its long-term follow-up registry data (NCT01876342) is the inherent difficulty of blinding both the operating surgeons and the participating athletes to the surgical approach due to highly visible differences in postoperative scar topography. This lack of double-blinding introduces a potential performance and detection bias regarding early, subjective, patient-reported pain metrics.

Observational and Thematic Cohorts

Complementing these trials are large-scale retrospective cohort studies, such as those published by Pedrinelli et al. (2024) and Gerhardt et al. (2020). Pedrinelli et al. evaluated a targeted population predominantly composed of professional soccer and futsal athletes. While retrospective designs are susceptible to recall bias and missing historical clinical data, this study offers highly generalized ecological validity. It tracks real-world recovery trajectories, documenting a mean return-to-sport time of 135 days, which realistically reflects the complex, multi-phased nature of athletic rehabilitation in elite, high-demand cutting sports. Similarly, the case series by Gerhardt et al. (2020) provides substantial longitudinal data regarding isolated inguinal-related groin pain. Nevertheless, because it lacks a concurrent, non-randomized conservative control arm, it remains difficult to definitively isolate the biological efficacy of the surgical repair from the therapeutic effects of post-surgical rest and structured physical therapy.

5. Main Findings

5.1 The Dilemma of Nomenclature: From "Sports Hernia" to Doha Consensus

The scientific literature evaluating chronic groin pain in athletes has long been plagued by a chaotic and fragmented lexicon. Historically, clinicians and researchers have relied on nebulous terms such as "sports hernia," "sportsman’s hernia," "athletic pubalgia," "inguinal disruption," or "core muscle injury" interchangeably. Earlier imaging-based studies described posterior inguinal wall deficiency as a potential anatomical contributor to chronic groin pain in athletes (Orchard et al., 1998). However, as highlighted by Kraeutler et al., this lack of standardized terminology creates severe heterogeneity, rendering direct comparisons of surgical outcomes across historical cohorts methodologically flawed. The term "sports hernia" is particularly misleading, as radiographic and intraoperative explorations rarely demonstrate a true, demonstrable inguinal hernia sac. Instead, the condition represents a complex spectrum of microstructural tears, structural attenuation, and neuromuscular imbalances of the pelvic girdle.

To rectify this diagnostic ambiguity, the Doha Agreement Meeting established a clinically driven, anatomy-based classification system. Groin pain in athletes is categorized into four distinct, palpable entities:

1 Adductor-related groin pain: Characterized by localized tenderness at the adductor longus insertion and pain during resisted adduction tests.

2 Iliopsoas-related groin pain: Identified via tenderness of the iliopsoas tendon and pain upon resisted hip flexion or passive stretching.

3 Inguinal-related groin pain: Marked by pain in the inguinal canal region and tenderness of the superficial inguinal ring, frequently exacerbated by increased intra-abdominal pressure (e.g., Valsalva maneuver, coughing).

4 Pubic-related groin pain: Localized to the pubic symphysis and immediately adjacent bone, often co-existing with radiographic signs of osteitis pubis.

Despite the clarity offered by the Doha framework, modern systematic reviews confirm that non-standardized terminology persists in surgical reporting. This ongoing divergence degrades the certainty of evidence, as structural injuries to the posterior inguinal wall are frequently pooled with isolated adductor tendinopathies.

Prospective clinical studies further emphasize the complexity and overlapping presentation patterns of groin injuries in athletes (Serner et al., 2015).

5.2 Pathophysiology of the Rectus Abdominis-Adductor Aponeurosis Complex

At the core of athletic pubalgia pathophysiology is a profound biomechanical conflict occurring at the pubic symphysis. Anisotropic forces are transmitted through the rectus abdominis-adductor longus aponeurosis—a continuous, antagonistic fascial sheath that inserts onto the pubic body. Under normal physiological conditions, the rectus abdominis exerts a superior and posterior vector pull on the pelvis, stabilizing it against the inferior and lateral vectors exerted by the powerful adductor muscle group.

In elite athletes engaged in high-velocity cutting, pivoting, kicking, and rapid acceleration (e.g., soccer, ice hockey, rugby), this aponeurotic hub is subjected to extreme repetitive shear forces. When the abdominal wall muscles or posterior inguinal ring structures become relatively weak or fatigued, the balance shifts in favor of the hypertonic adductor group. This microtraumatic imbalance induces a rotational torque across the pubic symphysis, leading to:

Progressive attenuation or tearing of the posterior inguinal wall fascia.

Micro-tearing at the insertion of the rectus abdominis tendon.

Secondary adductor longus tendinopathy or traction periostitis.

Adductor-related pathology frequently coexists with inguinal-related groin pain and may significantly contribute to symptom chronicity (Schilders et al., 2007).

Concomitant stress shielding defects, leading to bone marrow edema or femoroacetabular impingement (FAI) cross-talk.

Biomechanical models suggest that chronic groin pain often results from a complex interaction between pelvic instability, muscle imbalance, and repetitive rotational loading (Falvey et al., 2009).

5.3 Surgical Intervention Outcomes and Return-to-Sport (RTS) Rates

When structured, progressive rehabilitation fails to alleviate symptoms, surgical intervention may provide a reliable pathway to return to sport in selected athletes. Cumulative evidence syntheses demonstrate overall return-to-sport (RTS) rates ranging between 80% and 95% across mixed athletic cohorts.

5.3.1 Inguinal-Related vs. Adductor-Related Surgical Success

The efficacy of surgical intervention is heavily influenced by the primary anatomical pain generator. A landmark systematic review by Hatem et al. stratified surgical outcomes based on specific anatomical zones, revealing a significant divergence in RTS success. Athletes undergoing surgery for isolated inguinal-related chronic groin pain achieved an impressive 92% RTS rate at or above their preinjury level of performance. This is further supported by the observational data of Gerhardt et al., who reported that 96.1% of athletes successfully returned to their pre-injury baseline after targeted inguinal-related surgery.

Conversely, athletes presenting with primary adductor-related pathology or mixed adductor-pubic syndromic pain demonstrated a notably lower 75% RTS rate following surgical intervention. This discrepancy underscores the clinical reality that pure mechanical defects of the posterior inguinal wall respond more favorably to surgical reinforcement than chronic, degenerative tendinopathies of the adductor complex.

5.4 Operative Approaches: Open Suture Repair Versus Laparoscopic TEP

The surgical management of athletic pubalgia generally falls into two paradigms: open structural reconstruction and minimally invasive laparoscopic repair. An important randomized comparison between these methodologies was evaluated in a randomized controlled trial (RCT) by Sheen et al., which contrasted open suture plication of the inguinal wall against laparoscopic Totally Extraperitoneal (TEP) mesh repair.

The TEP technique utilizes a posterior approach, placing a synthetic mesh within the preperitoneal space to reinforce the entire myopectineal orifice. By bypassing the anterior abdominal wall fascia and sensory nerve branches, the TEP approach significantly reduces early postoperative pain and shortens the initial phases of mobilization. However, long-term follow-up data from ClinicalTrials.gov registries indicate that both open and laparoscopic techniques yield comparable, excellent RTS rates at the 6- to 12-month mark, suggesting that technique selection should be guided by specific patient anatomy and the presence of concurrent adductor pathology. Recent prospective cohort data by

Meuzelaar et al. (2023) further support the effectiveness of endoscopic totally extraperitoneal (TEP) repair in athletes with inguinal-related groin pain, demonstrating favorable long-term symptom relief and high rates of return to sport. The authors emphasized that minimally invasive posterior wall reinforcement may provide durable functional improvement in carefully selected athletic populations. Alternative techniques, including minimal open repair approaches without mesh implantation, have also demonstrated promising postoperative outcomes in selected athletes (Muschaweck & Berger, 2010).

5.5 The role of preoperative conservative management

Surgical intervention should never be viewed as a first-line shortcut to recovery. It must be reserved exclusively for athletes who present with sport-limiting symptoms that persist despite a minimum of 6 to 12 weeks of high-quality, structured conservative therapy. Multimodal conservative strategies—comprising targeted eccentric adductor strengthening, deep core stabilization (transversus abdominis and multifidus recruitment), lumbopelvic neuromuscular control, and manual therapy—effectively resolve groin pain in a substantial percentage of athletes. Randomized studies have shown that active rehabilitation programs may significantly improve pain and functional outcomes in athletes with long-standing adductor-related groin pain (Holmich et al., 1999). Surgery is indicated only when clinical examinations and advanced cross-sectional imaging (MRI showing rectus/adductor aponeurotic tearing or cleft signs) correlate directly with the failure of dedicated active rehabilitation.

5.5.1 Structured Multimodal Conservative Rehabilitation Protocol

Before an athlete is deemed a candidate for surgical intervention, a rigorous, progressive, and multi-phased conservative rehabilitation framework must be exhausted. This protocol is typically structured across three distinct biological and functional phases, designed to restore pelvic homeostasis and eliminate regional muscle imbalances.

Phase 1: Acute Deactivation and Pelvic Stabilization

The initial phase focuses on pain mitigation, tissue healing, and the correction of gross pelvic malalignments. Direct, pain-provoking activities—specifically explosive sprinting, cutting, and kicking—are temporarily suspended to de-load the irritated rectus abdominis-adductor aponeurosis. Physical therapy utilizes targeted manual therapy, including soft tissue mobilization of the hypertonic adductor longus, iliopsoas, and rectus femoris musculature, alongside gentle, non-provocative isometric adductor squeezing exercises performed at 0° and 45° of hip flexion. Simultaneously, lumbopelvic stability is initiated through low-threshold recruitment of the local stabilizing system, specifically targeting the transversus abdominis, lumbar multifidus, and pelvic floor muscles to establish a rigid structural foundation.

Phase 2: Eccentric Strengthening and Core Integration

Once ordinary daily ambulation and isometric contractions are entirely pain-free, the athlete progresses to Phase 2, which focuses on structural remodeling and muscular balance. The cornerstone of this phase is the integration of the Copenhagen Adductor Exercise protocol, a progressive eccentric strengthening program proven to significantly increase adductor eccentric strength and reduce the risk of groin re-injury. Implementation of structured adductor strengthening programs has been associated with a lower incidence of groin injuries in elite football populations (Harøy et al., 2019). This is paired with dynamic, high-load core stabilization routines, such as side planks with elevated leg support, single-leg deadlifts to promote posterior chain activation, and quadruped hip extensions. The primary physiological objective is to actively counteract the inferior traction of the adductor group by progressively overloading and strengthening the superior fascial anchor of the rectus abdominis and oblique musculature.

Phase 3: Dynamic Plyometrics and Sport-Specific Conditioning

The final phase bridges clinical rehabilitation and unrestricted sport-specific play. It introduces high-velocity, multi-directional plyometric movements designed to test the energy-storing capacity of the pelvic girdle. Linear jogging graduates to accelerated sprinting, followed by the introduction of low-amplitude cutting maneuvers, deceleration drills, and controlled kicking patterns.

Neuromuscular control is continuously monitored; any manifestation of compensatory movement, altered trunk mechanics, or delayed post-activity groin soreness forces a temporary regression to Phase 2 parameters. A minimum 6-to-12-week adherence to this structured pathway is mandatory; surgery is only indicated when an athlete encounters a persistent functional ceiling, failing to progress through Phase 3 despite optimal compliance.

5.6 Framework for Criteria-Based Return to Sport

A paradigm shift in modern sports medicine has replaced time-based convalescence with objective, criteria-based progression models. Relying solely on chronological time-stamps post-surgery introduces unacceptable risks of reinjury and chronic compensation.

5.6.1 The Continuum of Return to Participation, Sport, and Performance

Following the framework established by the First World Congress in Sports Physical Therapy (Bern Consensus), RTS must be viewed as a continuum:

1 Return to Participation: The athlete safely completes modified, non-contact training or isolated sport-specific drills without manifesting post-activity pain or structural regressions.

2 Return to Sport: The athlete integrates back into full, unrestricted team training and competitive match-play but has not yet replicated their baseline efficacy or psychological readiness.

3 Return to Performance: The athlete fully re-establishes or exceeds their pre-injury metrics, playing at their peak biological and metabolic capacity.

5.6.2 Objective Clinical and Functional RTS Metrics

To bridge these phases, the athlete must clear a comprehensive battery of objective clearance tests:

Palpation & Clinical Examination: Total absence of tenderness along the pubic symphysis, adductor longus origin, and superficial inguinal ring.

The Squeeze Test Battery: Pain-free execution of the isometric squeeze test at 0°, 45°, and 90° of hip flexion, achieving adductor force symmetry (>90% compared to baseline or normative database values). Persistent hip adduction strength deficits may increase the risk of recurrent groin symptoms and delayed return to play (Thorborg et al., 2011).

Strength Diagnostics: Isokinetic dynamometry verifying symmetrical (<10% deficit) hip adductor-to-abductor strength ratios (I:A ratio of approximately 1:1).

Biomechanical Jump and Agility Testing: Pain-free completion of the Triple Crossover Hop Test, Y-Balance Test, and high-velocity cutting maneuvers (e.g., Illinois Agility Test) with appropriate lumbopelvic alignment.

Psychological Readiness: High scores on validated tools such as the Injury Psychological Readiness to Return to Sport (I-PRRS) scale.

5.7 Postoperative Complications and Contralateral Pathology

While serious adverse events are relatively rare, the true complication landscape remains obscured by inconsistent, non-standardized tracking in retrospective registries. Documented complications include persistent mesh awareness, genitofemoral or ilioinguinal nerve entrapment, chronic adductor weakness, and surgical site infections.

Furthermore, recent tracking by Rezaie et al. (2024) highlights a low but clinically relevant proportion of subsequent contralateral repairs following unilateral athletic pubalgia repair. This observation may reflect the bilateral biomechanical demands placed on the pelvic ring in athletes, although causal mechanisms remain uncertain.

6. Statistical and Evidence Synthesis

A formal meta-analysis was not performed because of high clinical and methodological heterogeneity. The main sources of heterogeneity included inconsistent terminology, different anatomical pain generators, open versus laparoscopic techniques, isolated versus combined procedures, different rehabilitation protocols, variable definitions of return to sport, different follow-up durations, and inconsistent reporting of complications.

A qualitative synthesis suggests that return-to-sport rates after surgical treatment commonly fall between 80% and 95%, but confidence intervals vary by study design and population. Inguinal-related surgical treatment appears to show more consistent RTS outcomes than adductor-related or mixed pathology surgery, but this conclusion is limited by non-randomized evidence.

Overall certainty of evidence appears moderate for return to sport after surgical treatment of athletic pubalgia. The certainty of evidence comparing surgery with conservative management appears low to moderate. Evidence regarding superiority of open versus laparoscopic techniques, standardized rehabilitation protocols, and postoperative complication profiles remains limited and of low certainty because of methodological heterogeneity and the predominance of retrospective study designs.

7. Clinical Implications

The available evidence supports surgical treatment as a reasonable option for athletes with persistent athletic pubalgia who do not respond to conservative therapy. The best candidates are athletes with sport-limiting symptoms, consistent clinical findings, and imaging or intraoperative findings supporting inguinal-related or core muscle injury pathology.

Clinical decision-making should be individualized and should include accurate classification of groin pain, exclusion of hip-related pathology, assessment of adductor and abdominal wall involvement, trial of structured rehabilitation, shared decision-making with the athlete, individualized surgical planning, and criteria-based rather than purely time-based return to sport.

8. Detailed Methodological Limitations of the Current Literature

The overall certainty of the evidence guiding the treatment of athletic pubalgia remains moderate to low, compromised by several pervasive methodological limitations across published studies.

Previous systematic evaluations have consistently highlighted low methodological quality and substantial heterogeneity among groin pain treatment studies (Serner et al., 2015).

The Confounding Heterogeneity of "Return to Sport" Definitions

The most profound limitation within the existing literature is the lack of a standardized, universally accepted definition for "Return to Sport" (RTS). Across major systematic reviews, such as those by Serafim et al. and Hatem et al., individual studies employ vastly divergent criteria to establish successful clinical outcomes. For instance, certain investigations classify an athlete as a successful "RTS" case the moment they clear clinical discharge and participate in a single, modified training session. Conversely, more stringent studies require the athlete to return to their precise pre-injury level of competitive performance and maintain that status for a minimum duration without structural regression. By pooling these contradictory definitions into a single systemic percentage (e.g., reporting a generalized 85% success rate), the literature creates an overly optimistic and potentially distorted narrative regarding the speed and predictability of surgical recovery.

Retrospective Design Defects and Selection Bias

A significant majority of the available literature consists of retrospective case series or unblinded cohort studies coming from single-surgeon practices. These designs suffer from inherent selection and performance biases. Elite athletes selected for surgery often possess superior biological healing capacities, access to round-the-clock professional physical therapy, and intense socioeconomic motivation to return to play quickly, which severely limits the generalizability of these outcomes to recreational or amateur athletic populations. Furthermore, retrospective data collection frequently suffers from a high rate of attrition (patients lost to follow-up), and selective outcome reporting, where minor long-term complications—such as mild chronic nerve irritation, subjective performance degradation, or subsequent contralateral groin pain—are under-reported or omitted entirely.

The Pervasive Absence of Non-Operative Control Arms

Finally, the literature is severely limited by a shortage of prospective, randomized trials directly comparing surgery against contemporary, high-load eccentric physical therapy protocols. Because many cohort studies track only surgical patients, it is methodologically impossible to determine what proportion of the documented recovery is attributable to the specific mechanical repair versus the mandatory period of postoperative rest, localized tissue decompression, and highly structured postoperative conditioning. Without rigorous, long-term, multi-center RCTs utilizing standardized diagnostic nomenclature, the optimization of treatment algorithms for athletic pubalgia will remain constrained by low-certainty evidence.

9. Ethical Considerations

This review used only previously published data and publicly available clinical trial records; therefore, no patient consent or institutional review board approval was required. No individual patient data were used, and no personal health information was processed. The interpretation of surgical outcomes should not be understood as direct medical advice. Treatment decisions should be made by qualified clinicians based on individual patient assessment, shared decision-making, and local standards of care.

10. Conclusions

Surgical treatment of athletic pubalgia is associated with high return-to-sport rates in appropriately selected athletes, particularly when symptoms are refractory to conservative treatment. Current evidence suggests that many athletes return to sport within weeks to months after surgery, although the exact timing depends on surgical technique, associated pathology, rehabilitation quality, and sport-specific demands.

The main limitation of the current literature is not the absence of positive surgical outcomes, but the absence of standardized definitions, high-quality randomized trials, and uniform return-to-sport criteria. Future research should focus on prospective multicenter trials comparing open and laparoscopic techniques, standardized rehabilitation protocols, validated patient-reported outcomes, and objective RTS criteria.

The overall certainty of evidence for surgical treatment enabling return to sport is moderate, while evidence regarding the optimal surgical technique and rehabilitation protocol remains low.

Disclosure:

Author Contributions:

Conceptualization: Michał Śmigielski, Norbert Czarny

Methodology: Kinga Dzitkowska, Michał Śmigielski

Check: Norbert Czarny, Liwia Karbownik

Formal analysis: Jędrzej Garbaciak

Investigation: Agnieszka Figwer, Krzysztof Figwer

Data accuracy: Krzysztof Figwer, Jędrzej Garbaciak

Rough preparation: Anna Broniecka, Magdalena Kolasa

Review and editing: Magdalena Kolasa, Anna Broniecka

Supervision: Natalia Kasterka, Agnieszka Figwer

Project administration: Liwia Karbownik, Natalia Kasterka

All authors have read and agreed to the published version of the manuscript.

Funding Statement

The study did not receive any special funding.

Informed Consent Statement

Not applicable.

Institutional Review Board Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflict of Interest

All authors declare no conflicts of interest.

Acknowledgments

Artificial intelligence (AI) was used only for language enhancement purposes, such as grammar correction and stylistic refinement.

References

Ardern, C. L., Glasgow, P., Schneiders, A., Witvrouw, E., Clarsen, B., Cools, A., Bizzini, M., Cardon, M., Dienfenthäler, F., Di Mattia, M., Gojanovic, B., Griffin, S., Khan, K. M., Koblbauer, H., McCall, A., Phillips, N., Susta, D., Thorborg, K., Whiteley, R., & Bahr, R. (2016). 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. British Journal of Sports Medicine, 50(14), 853–864. https://doi.org/10.1136/bjsports-2016-096278

Caudill, P., Nyland, J., Smith, C., Yerasimides, J., & Lach, J. (2008). Sports hernias: A systematic literature review. British Journal of Sports Medicine, 42(12), 954–964. https://doi.org/10.1136/bjsm.2008.047373

ClinicalTrials.gov. (2019). Surgical or conservative treatment of sportsman hernia (NCT00966589). U.S. National Library of Medicine. https://clinicaltrials.gov/show/NCT00966589

ClinicalTrials.gov. (2019). TEP versus open repair of sportsman's hernia (NCT01876342). U.S. National Library of Medicine. https://clinicaltrials.gov/show/NCT01876342

Falvey, É. C., Franklyn-Miller, A., & McCrory, P. R. (2009). The groin triangle: A patho-anatomical approach to the diagnosis of chronic groin pain in athletes. British Journal of Sports Medicine, 43(3), 213–220. https://doi.org/10.1136/bjsm.2007.042259

Forlizzi, J. M., Ward, M. B., Whalen, J., Wuerz, T. H., & Gill, T. J. IV. (2023). Core muscle injury: Evaluation and treatment in the athlete. American Journal of Sports Medicine, 51(4), 1087–1095. https://doi.org/10.1177/03635465211063890

Gerhardt, M., Christensen, J., Sherman, B., Miranda, A., Hutchinson, W., & Chahla, J. (2020). Outcomes following surgical management of inguinal-related groin pain in athletes: A case series. Journal of Hip Preservation Surgery, 7(1), 103–108. https://doi.org/10.1093/jhps/hnz068

Harøy, J., Clarsen, B., Wiger, E. G., Øyen, M. G., Serner, A., Thorborg, K., Holmich, P., Andersen, T. E., & Bahr, R. (2019). The Adductor Strengthening Programme prevents groin problems among male football players: A cluster-randomised controlled trial. British Journal of Sports Medicine, 53(3), 150–157. https://doi.org/10.1136/bjsports-2017-098937

Hatem, M., Martin, R. L., & Bharam, S. (2021). Surgical outcomes of inguinal-, pubic-, and adductor-related chronic pain in athletes: A systematic review based on surgical technique. Orthopaedic Journal of Sports Medicine, 9(9), Article 23259671211023116. https://doi.org/10.1177/23259671211023116

Holmich, P., Uhrskou, P., Ulnits, L., Kanstrup, I. L., Nielsen, M. B., Bjerg, A. M., & Krogsgaard, K. (1999). Effectiveness of active physical training as treatment for long-standing adductor-related groin pain in athletes: Randomised trial. Lancet, 353(9151), 439–443. https://doi.org/10.1016/S0140-6736(98)03340-6

Kraeutler, M. J., Mei-Dan, O., Belk, J. W., Larson, C. M., Talishinskiy, T., & Scillia, A. J. (2021). A Systematic Review Shows High Variation in Terminology, Surgical Techniques, Preoperative Diagnostic Measures, and Geographic Differences in the Treatment of Athletic Pubalgia/Sports Hernia/Core Muscle Injury/Inguinal Disruption. Arthroscopy: The Journal of Arthroscopic & Related Surgery, 37(8), 2645–2652. https://doi.org/10.1016/j.arthro.2021.03.049

Litwin, D. E. M., Sneider, E. B., McEnaney, P. M., & Busconi, B. D. (2011). Athletic pubalgia (sports hernia). Clinics in Sports Medicine, 30(2), 417–434. https://doi.org/10.1016/j.csm.2010.12.010

Meuzelaar, R. R., Visscher, L., den Hartog, F. P. J., Goedhart, E. A., Verleisdonk, E. J. M. M., Schiphorst, A. H. W., & Burgmans, J. P. J. (2023). Athletes treated for inguinal-related groin pain by endoscopic totally extraperitoneal (TEP) repair: Long-term benefits of a prospective cohort. Hernia, 27(5), 1179–1186. https://doi.org/10.1007/s10029-023-02815-x

Meyers, W. C., Foley, D. P., Garrett, W. E., Lohnes, J., & Mandlebaum, B. R. (2000). Management of severe lower abdominal or inguinal pain in high-performance athletes. American Journal of Sports Medicine, 28(1), 2–8. https://doi.org/10.1177/03635465000280011501

Mitrousias, V., Chytas, D., Banios, K., Fyllos, A., Raoulis, V., Chalatsis, G., Baxevanidou, K., & Zibis, A. (2023). Anatomy and terminology of groin pain: Current concepts. Journal of ISAKOS, 8(5), 381–386. https://doi.org/10.1016/j.jisako.2023.05.006

Muschaweck, U., & Berger, L. (2010). Minimal Repair technique of sportsmen's groin: An innovative open-suture repair to treat chronic inguinal pain. Hernia, 14(1), 27–33. https://doi.org/10.1007/s10029-009-0614-y

Orchard, J. W., Read, J. W., Neophyton, J., & Garlick, D. (1998). Groin pain associated with ultrasound findings of inguinal canal posterior wall deficiency in Australian Rules footballers. British Journal of Sports Medicine, 32(2), 134–139. https://doi.org/10.1136/bjsm.32.2.134

Paajanen, H., Brinck, T., & Hermunen, H. (2011). Laparoscopic surgery for chronic groin pain in athletes is more effective than nonoperative treatment. Surgery, 150(1), 99–107. https://doi.org/10.1016/j.surg.2011.02.016

Pedrinelli, A., de Castro Fernandes, J. V., Leite Filho, C. G. D., Marques de Almeida, A., Hernandez, A. J., & Albuquerque, C. E. C. (2024). Optimised return to play: High treatment success rate in core muscle injury with surgical release of the adductor longus and selective tenotomy of the rectus abdominis. Journal of ISAKOS, 9(1), 16–24. https://doi.org/10.1016/j.jisako.2023.10.013

Rezaie, N., Ithurburn, M. P., Powell, M. T., Mussell, E. A., Kidwell-Chandler, A. L., & Emblom, B. A. (2024). Outcomes and proportions of subsequent contralateral sports hernia repair following primary unilateral repair. American Journal of Sports Medicine, 52(3), 653–659. https://doi.org/10.1177/03635465231221496

Robinson, P., Barron, D. A., Parsons, W., Grainger, A. J., Schilders, E. M. G., & O'Connor, P. J. (2004). Adductor-related groin pain in athletes: Correlation of MR imaging with clinical findings. Skeletal Radiology, 33(8), 451–457. https://doi.org/10.1007/s00256-004-0753-2

Serafim, T. T., Oliveira, E. S., Migliorini, F., Maffulli, N., & Okubo, R. (2022). Return to sport after conservative versus surgical treatment for pubalgia in athletes: A systematic review. Journal of Orthopaedic Surgery and Research, 17, Article 484. https://doi.org/10.1186/s13018-022-03376-y

Sheen, A. J., Stephenson, B. M., & Lloyd, D. M. (2019). Randomized clinical trial of open suture repair versus totally extraperitoneal repair for treatment of sportsman's hernia. British Journal of Surgery, 106(7), 837–844. https://doi.org/10.1002/bjs.11226

Schilders, E., Bismil, Q., Robinson, P., O'Connor, P. J., Gibbon, W. W., & Talbot, J. C. (2007). Adductor-related groin pain in competitive athletes. Journal of Bone and Joint Surgery British Volume, 89(2), 204–208.

Thorborg, K., Serner, A., Petersen, J., Madsen, T. M., Magnusson, P., & Hölmich, P. (2011). Hip adduction and abduction strength profiles in elite soccer players: Implications for clinical evaluation of hip adductor muscle recovery after injury. The American Journal of Sports Medicine, 39(1), 121–126. https://doi.org/10.1177/0363546510378081

Verrall, G. M., Slavotinek, J. P., Barnes, P. G., Fon, G. T., & Esterman, A. (2005). Description of pain provocation tests used for the diagnosis of sports-related chronic groin pain: Relationship of tests to defined clinical (pain and tenderness) and MRI (pubic bone marrow oedema) criteria. Scandinavian Journal of Medicine & Science in Sports, 15(1), 36–42. https://doi.org/10.1111/j.1600-0838.2004.00380.x

Weir, A., Brukner, P., Delahunt, E., Ekstrand, J., Griffin, D., Khan, K. M., Lovell, G., Meyers, W. C., Muschaweck, U., Orchard, J., Robinson, P., Schache, A., Schilders, E., Serner, A., Silvers, H.,

Thorborg, K., Tyler, T., Verrall, G., de Vos, R. J., … Hölmich, P. (2015). Doha agreement meeting on terminology and definitions in groin pain in athletes. British Journal of Sports Medicine, 49(12), 768–774. https://doi.org/10.1136/bjsports-2015-094869

Zoga, A. C., Mullens, F. E., & Meyers, W. C. (2010). The spectrum of MR imaging in athletic pubalgia. Radiologic Clinics of North America, 48(6), 1179–1197. https://doi.org/10.1016/j.rcl.2010.07.009popraw formatowanie i telsst