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SURGICAL TECHNIQUES FOR SPORTS HERNIA REPAIR IN ATHLETES - MINIMIZING COMPLICATIONS AND ENSURING SAFE RETURN TO SPORT

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ABSTRACT

Athletic pubalgia or sports hernia is a multifactorial and dynamic condition frequently found in sportsmen engaged in high-level sports involving sudden change of direction with repetitive stress to the groin. The present surgical strategies to repair sports hernia in sportsmen are discussed below, keeping in mind the precautions against complications and early safe return to sport. The pathophysiology of sports hernias is composed of core instability, recurrent microtrauma, and potential systemic and genetic connective tissue disorders. Proper diagnosis - aided by both physical examination and high-technology imaging studies such as MRI and dynamic USG - is needed to distinguish true hernias from the myriad other causes of groin pain. While conservative treatment in certain cases may be beneficial, surgery is the yardstick for symptomatic or refractory athletes. The open and laparoscopic techniques, including the Lichtenstein, TAPP, and TEP techniques, share similar benefits based on anatomical and technical criteria. Innovations such as robot-assisted repair and biomaterial creation of biocompatible mesh material, i.e., self-adhesive and biologic types, have also promoted good results. Prevention of early postoperative complication, in the form of chronic pain and infection, is founded on careful technique selection, mesh optimization, and reduction in risk factors. A carefully planned, phase-specific rehabilitation protocol - early mobilization, core strengthening, and sport-specific training is crucial to successful functional recovery. Last but not least, success with surgery relies on careful patient selection, rehabilitation compliance, and coordination of a multidisciplinary provider. This combined strategy provides superb rates of return to play and results on the long term from a clinical point of view, such that surgical treatment is an extremely effective method of treatment of sports hernia in sporting people.

KEYWORDS

Hernia, Athletic Pubalgia, Inguinal Hernia, Sports Hernia

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1. Etiology and Epidemiology of Athlete Hernias

Groin pain is a highly common complaint in sports. It typically follows muscle damage or bone trauma, most commonly resulting from microtraumas. Most frequent of these etiology injuries in athletes is: inguinal hernia, femoral hernia, adductor muscle tendinopathy, pre-pubic aponeurotic complex injury, adductor muscles strain, osteopathy of the pubis, and iliopsoas tendonitis. Hernias are one of the most common disorders (Santilli et al., 2025).

In the past two years, work has been conducted on the mechanism of the development of inguinal hernia. Most of them are multifactorial in origin: muscle failure to destabilize, training overload, and core instability (Kopscik et al., 2023). It most commonly occurs in soccer and ice hockey players according to the nature of the sport (Elattar et al., 2016). Constant and repetitive motion of the body and prolonged effort lead to muscle fatigue, and therefore, vulnerability to injury.

Initially, such kinds of injuries would be limited to professional players, but since there was an increase in the popularity of sports, today this is a huge issue among a huge number of amateur players too (Kopelman et al., 2016). Pain in the inguinal area is the cause of 6% of total sport pathology and 4% of sports injuries among professional footballers (Bou Antoun et al., 2018).

Inguinal hernia presentations have traditionally been confused with pain due to weakness of the posterior inguinal wall secondary to defect or rupture of the external, internal oblique, and transverse muscles or transversalis fascia. This is among the etiologies of inguinal hernia development, and there has been research conducted that clarifies anatomical variation between women and men as it pertains to hernia development. Women are less likely to herniate through the superficial ring of the inguinal canal due to the distinctive pelvis alignment (Bisciotti et al., 2025).

Follow-up studies confirmed that deficiency of tissue inhibitors of metalloproteinases (TIMP-1, -2,) and high levels of matrix metalloproteinases (MMP-1, -2, -9, -13) are the reason behind decreased elasticity of the transversalis fascia. It is due to the structural depletion of the extracellular matrix of the site. Overload irradiation of the site leads soon to damage and the formation of an inguinal hernia (Bracale et al., 2023).

Therefore, this discovery is not just to be taken as an anatomical trauma but also a potential sign of disease of the body system in its entirety. Abnormalities of collagen production can also lead to weakening of the abdominal wall fascial tissue and predispose the patient to the development of a hernia. Collagen changes have been noted also in patients with recurrent hernias, suggesting a systemic vulnerability to defective connective tissue and deficiencies in healing that underlie also postoperative hernias (Henriksen et al., 2016).

These findings encouraged researchers to search for genetic pathways to hernia formation. Four new susceptibility loci of inguinal hernia in the EFEMP1, WT1, EBF2, and ADAMTS6 genomic areas were found in a cohort study. Analysis of the results suggested a critical role of EFEMP1 and WT1 in the structural function of the connective tissue (Jorgenson et al. 2015). Additional research is able to present more advanced knowledge about the issue and initiate more universal diagnostic processes.

2. Preoperative Diagnosis and Evaluation

Accurate diagnosis is important as it enables the application of correct treatment and avoiding patients being exposed to surgery unwarrantedly. Pain that disappears on resting is most common complaint of most patients who seek a doctor's attention. Very common pain which typically refers to the scrotum and medial thigh. Other vital physical examination results of clinical importance are: spot tenderness over the pubic tubercle of the conjoint tendon insertion, tenderness over the deep inguinal ring, tenderness and/or pain over the external ring with no palpable hernia, pain at the point of attachment of the adductor longus tendon.

The discomfort is not just experienced during training but also on the normal daily activities that cause increase in intra-abdominal pressure, such as sneezing or coughing, and also with the dynamic maneuvers.

The region surrounding the inguinal canal contains several life-threatening structures, and differential diagnosis should include orthopedic, gynecologic, gastroenterologic, and genitourinary system diseases (Minnich et al., 2011). Physical examination can differentiate femoral and inguinal hernias with appropriate techniques following the Valsalva maneuver.

Dynamic ultrasonography is highly useful in diagnosis because its relative non-invasiveness and the visualization of real-time structures of the inguinal canal can accelerate detection. But not all institutions possess an operator who is trained to perform the diagnosis. Soft tissue pathology that can be appreciated on ultrasound includes anechoic defects, partial or full-thickness discontinuity of the tendon attachments that signify tears, disruption of the normal fibrillar architecture, thickening, and hypoechogenicity of tendon attachments occurring in tendinopathy. With an ultrasound transducer, the symptom may be provoked under raised pressure to precisely locate the tender area. Proper care should be taken not to mix up a preperitoneal fatty bulge in the groin region with a hernia since it will lead to a false diagnosis (Kopscik et al., 2023).

Greater technique accuracy is computed tomography (CT). CT enables one to see bony structures or causative stress injuries that are responsible for the pathogenesis of sports hernia. It also aids in differentiation between a real hernia and other diseases with a same overlapping clinical presentation in the area under consideration, and rule out osteoarthritis or femoroacetabular impingement. A cohort study demonstrates CT will diagnose occult hernias in 30% of patients with chronic, inexplicable groin discomfort (Garvey et al., 2012). Most detected hernias were indicated for surgery. Magnetic Resonance Imaging (MRI) has also been another useful imaging modality for diagnosis.

It permits a correct localization of the patient's pain, which, by its anatomic position, may initially refer to other pelvis conditions. In MRI ordering, pubic symphysis and surrounding soft tissue structures must be kept under special attention. There are certain authors who have defined an imaging protocol for hernia in the context of groin pain. These are T1-weighted and T2-weighted (with fat saturation) in greater than one plane, in which axial, sagittal, and oblique coronal planes have to be processed further. Large field-of-view sequences (28–36 cm) can begin the protocol for the elimination of pathology at a distance. Sequences thereafter can be obtained using a surface coil positioned over the pubic symphysis. For increased visualization of inflammation or pathological structures, intravenous contrast media can be utilized (Bou Antoun et al., 2018).

3. Surgical Repair of Hernia

The appropriate treatment must be chosen. For inguinal hernia, management without operation is also possible. Symptomatic or mildly symptomatic inguinal hernias are managed expectantly in men. It is a safe method; however, nearly 68% of the patients did undergo surgery within 11.5 years of follow-up. This has been due to the progression of the condition and worsening pain symptoms (Fitzgibbons et al., 2013). The records by the U.S. Nationwide Readmissions Database indicate that among emergently hospitalized symptomatic inguinal hernia patients, non-operative management is the most common method used (Drolshagen et al., 2021). They are at higher risk of rehospitalization than post-operative patients. Non-operative management with a trial can be attempted for 6–12 weeks with progressive return of physical activity.

Rest and physiotherapy are primarily recommended. Rehabilitation consists of initial stretching of the muscles of the hip adductor group and exercises for core stabilization. Later on, eccentric strengthening of the rectus abdominis and oblique muscle and adductor group and ultimately sport-specific functional exercise is advised. In addition to these, corticosteroid injection under ultrasound guidance and nonsteroidal anti-inflammatory drugs are also used. Evidence supports its efficacy in patients with low symptoms. The patient should be cautioned that when the clinical result turns worse or the symptoms turn worse, surgery would have to be done. Surgery is also divided into laparoscopic and open surgery.

In open surgery, the hernia is fixed through tissue approximation or tension-free mesh repair.

The most renowned of them is the Lichtenstein technique, in which posterior inguinal wall tension-free repair with a mesh is performed. It is intended to negate the detrimental effects of suture tension like in other techniques. Lichtenstein operation entails an insertion of a polypropylene mesh between the external oblique aponeurosis and the inguinal floor. Intraperitoneal pressure increase upon movement presses against the mesh, which in turn results in a support effect. The mesh minimizes sutures and use of compromised tissue, thus improving the efficiency of surgery. There were intermittent cases of technique failure; mesh enlargement (7.5 × 15 cm), 2 cm overlap at the site of the pubic tubercle, overlapping the edges of the mesh over the spermatic cord, and using interrupted sutures on the superior edge of the mesh rectified such mistakes. Recurrent rates of hernia have thus been reduced to as low as 1% (Messias et al., 2024). This technique remains the preference for most surgeons. In the current Spanish cohort study, out of 263,283 patients undergoing inguinal hernia repair, up to 94.3% chose the open method (Guillaumes et al., 2021). Laparoscopic techniques include TAPP (transabdominal preperitoneal) and TEP (totally extraperitoneal).

Both techniques place the mesh in front of the lining of the peritoneum of the abdominal wall.

TAPP cuts into the abdomen to insert the mesh, while with TEP the mesh is passed through outside the peritoneal cover. Peritoneum is sutured over the mesh, placing it in between preperitoneal tissues and abdominal wall, where it is incorporated into the fibrous tissue (Andresen et al., 2024). TEP is less complex, such as less likelihood of injuring internal organs and less adhesions leading to bowel obstruction, because it doesn't go into the peritoneal cavity. It requires greater technical proficiency on the part of the surgeon.

TAPP is, however, performed by entering intraperitoneal space, bringing in the mesh through a peritoneal incision into the preperitoneal space, and then covering it up with peritoneum afterwards. The advantage of TAPP is that it has the ability to both diagnose and fix contralateral hidden hernias (Wake et al., 2005). Both are done with an equal rate, and no definite evidence can be observed to establish one superior to the other. Laparoscopy fares better in minimal invasiveness, less post-op pain, smaller incisions, and faster recovery to work. The choice of doing TAPP or TEP depends upon the case presentation (e.g., big hernia, incarcerated hernia, prior pelvic surgery) and surgeon preference and expertise. The robot-assisted operative techniques are gaining popularity in current times due to their many benefits: enhanced instrument articulation and enhanced surgeon ergonomics.

Inguinal hernia may be operated on with robot-assisted TAPP or TEB (totally extraperitoneal robotic repair).

Both methods offer access to the preperitoneal space without intraperitoneal entry. The patient lies in the same position as laparoscopic TAPP—in Trendelenburg position and adducted legs and arms. Two trocars placed without intraperitoneal entry cut recovery time. Advantages of robotic surgery: increased accuracy and coordination with complex maneuvers and mesh deployment, improved visualization of anatomy during surgery, less painful smaller wounds, fewer complications (infection, hernia recurrence), surgeon's increased comfort. Mechanized methods have limitations, however. Increased operating times were found in statistical analysis relative to laparoscopic surgery and are accountable for the robotic procedure learning curve. Another is the greater cost of robotic herniorrhaphy. Another is decreased accessibility, though more robotic platforms have become available on a progressive scale in recent years (Peltrini et al., 2022).

4. Prevention of Postoperative Complications

The meshes are used to support the weakened abdominal wall segment. The tension-free repair is achieved through the implanted mesh with engagement of the fibrous-collagenous tissue. The main purpose in the use of mesh was to reduce the rate of recurrence of hernia by 50–75%, and secondly, there were fewer pains during postoperative times (Baylón et al.,2017). There are various meshes available in the market. 90–95% of cases use synthetic meshes. (Hatewar et al., 2024) Four of the largest synthetic devices are used mostly for hernia mesh production: polypropylene (PP), polytetrafluoroethylene (PTFE), expanded polytetrafluoroethylene (ePTFE), and polyester (PE). The most utilized and gold standard is polypropylene mesh due to the fact that it gives resistance to infection, is flexible, strong, easy to handle, and causes a suitable tissue response. Polypropylene was found to be the most biocompatible by B. Orenstein et al. in a 2012 study (Orenstein et al., 2012).

Another one is self-adhesive Adhesix® mesh, half-absorbable, and hydrophilic and which is used for closing extraperitoneal abdominal wall defects.

7.2% rate of recurrence was reported from a May 2023 study in which 125 patients were treated with this mesh (Ferrer Martínez A et al., 2023). This mesh can be particularly useful for hernia repair in athletes since it reduces surgery time and postoperative pain, but, the authors say, it needs further investigation. Biologic meshes are also applied, human, bovine, or porcine in origin and decellularized to leave a residual matrix of collagen.

These serve as a bridge to ensure the formation and deposition of the newly synthesized collagen. Sterilization processes of biological tissue may, nevertheless, undermine biocompatibility as well as foreign body reaction. This has offered a reoccurrence hernia rate of over 50% after 3 years, thereby making this option less than ideal for athletes to recover (FitzGerald JF et al., 2014). The most severe postoperative complication would likely be infection, which manifests at the surgical site as redness, tenderness, burning, and fever.

Infection in 69% of the cases requires mesh removal, causing further pain to the patient and an increased recovery time (Hawn et al., 2011). The highest risk factors for infection reported are the design of the mesh and the type and duration of the procedure. The most common cause is bacterial contamination of the implanted mesh surface. Laparoscopic surgery has been more favorable in this respect because the risk of infection following herniotomy by open repair is 6–9% (Eriksen et al., 2007). Postoperative pain, the second major issue for the patient, is directly proportional to the size of the operation, type of technique employed, and the mesh employed. The healing area can be sensitive to the foreign body and perceived by the patient; however, meshes reduce tissue tension compared to sutures.

When the issue of surgical procedures is considered, laparoscopy will be less likely to result in chronic pain, with a 17.2% estimate (Liang et al., 2013). Lifestyle modification is of significance in the recovery period post-surgery. Risk factors for infection caused by mesh include a history of smoking, type 2 diabetes, and obesity, leading to such undesirable postoperative outcomes in around 4% of the population (Quiroga-Centeno et al., 2022).

5. Rehabilitation Rules and Postoperative Rehabilitation

Rehabilitation from sports hernia surgery typically progresses in a stepwise manner, beginning with mobilization and ultimately high-level activity. Stepping carefully in this fashion is needed to avoid the athlete compromising the repair by coming back too quickly to high-level activity (Paajanen et al., 2011).

5.1 Phase 1: Early Mobilization and Pain Management

The initial rehabilitation phase focuses on early walking and minimal movement to enhance healing and avoid stiffness. Comfortable movement is facilitated through pain management techniques, such as the application of analgesics, icing, and electrical stimulation (Paajanen et al., 2011; Brown et al., 2013).

5.2 Phase 2: Core Strengthening and Resistance Training

With progressing levels of the sportsperson, strengthening of the core and resistance training is the area of focus. Exercises of the abdominal, hip, and lower back muscles are incorporated to restore stability and strength to the pelvic region. Restoration of muscular support for sports is one of the greatest functions of this phase (Elattar et al., 2016; Palumbo et al., 2022).

5.3 Phase 3: Functional and Sport-Specific Training

The final phase of rehabilitation is sport-specific and functional training. The players are made to perform movements that simulate the sport's demands, including sport-specific movement, sprinting, and agility training. This phase aims to restore the player's confidence and prepare him/her for a safe return to competition (Palumbo et al., 2022; Elattar et al., 2016).

6. Predictors of Success and Prevention of Recurrence

Several predictors have been found to be able to predict successful return to sport and recurrence prevention following sports hernia repair. They are the surgical technique utilized, whether the athlete complied with the rehabilitation program, and whether there is a multidisciplinary team.

6.1 Surgical Technique

The surgical technique utilized has a significant role in determining success in sports hernia repair and recurrence prevention. There is research that has proven that the laparoscopic mesh repair is very successful and has witnessed a return of approximately 96% of the athletes to full sport after six weeks (Paajanen et al., 2011). The open repairs also have very successful outcomes where almost 92.8% of the athletes have been successful in returning to sport (de Sa et al., 2016; Kopscik et al., 2023). Usage of tension-free mesh during surgical reconstruction has also been extremely beneficial, with research indicating a success rate of return to sport at 93% reported (Preskitt, 2011; Kopscik et al., 2023).

Laparoscopic repair has been associated with lower recurrence and quicker return to sport compared to open repair. Laparoscopic intervention, here, involves reconstruction of the posterior abdominal wall through meshing, which is said to provide strength and reduce risk of recurrence (Panici Tonucci et al., 2024; Sheen et al., 2019).

Conversely, open surgical techniques such as the Bassini and Shouldice repair have been successful but complicated by a greater risk of recurrence if not performed cautiously. Modified Bassini repair, involving tightening and stabilization of the inguinal canal using stitches, has lower recurrences than other open techniques (Sheen et al., 2019). Furthermore, use of ultra-lightweight or lightweight polypropylene mesh in open repair has been proven to reduce recurrence risk by providing the compromised abdominal wall with the extra strength (Preskitt, 2011).

6.2 Compliance with Rehabilitation

Adherence to a rehabilitative regimen is a significant predictor of outcome and prevention of recurrence. Those sportspersons who strictly follow the step-wise rehabilitative regimen, i.e., early mobilization, core strengthening, and functional training, tend to recover maximally and achieve the pre-injury level of performance (Varrel et al., 2007; Paajanen et al., 2011; Brown et al., 2013).

6.3 Multidisciplinary Support and Lifestyle Changes

Multidisciplinary management by sports surgeons, physical therapists, and athletic trainers is necessary to achieve the final recovery and safe return to sport. Systematic treatment of physical and psychological rehabilitation is provided by the team (Meyers et al., 2008).

In addition to surgical intervention and rehabilitation, lifestyle adaptation and preventive strategies also contribute significantly to preventing recurrence. Regular body weight is also advised in athletes as elevated BMI has been found to be associated with increased recurrence risk (Bhardwaj et al., 2024). Quitting smoking is also advised as smoking is found to disrupt the process of healing and carry a complication risk (Bhardwaj et al., 2024).

Additionally, the athletes need to incorporate normal core strengthening and flexibility exercises in the training to provide stability and strength to the pelvic region. In the preventive approach, it could also help to prevent the development of sports hernias and recurrence (Hemingway et al., 2003).

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