Adductor Tenotomy as a Treatment for Groin Pain in Professional Soccer Players

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abstract

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Chronic, exercise-related groin pain is a debilitating condition. Nonoperative treatment has limited efficacy, but surgical intervention on the adductor-abdomino complex may be used to alleviate symptoms and allow return to play (RTP). The purpose of this study was to report the outcome of adductor tenotomy and hernioplasty for professional soccer players with groin pain.

Between 2000 and 2006, a total of 155 professional and recreational soccer players with recalcitrant groin pain (with or without lower abdominal pain) and resistance to conservative treatment were included in this retrospective analysis. Ninety-six patients were treated with adductor tenotomy and 59 patients were treated with combined adductor tenotomy and hernioplasty. No difference in pre- or postoperative parameters was detected between groups, apart from abdominal wall muscle defects revealed during ultrasound for patients in the combined group. The RTP time and subjective and objective outcome measures were compared. A combined score was developed to evaluate outcomes that consisted of overall satisfaction (50%), RTP time (15%), and Tegner scores (35%). Mean RTP was 11 weeks (range, 4-36 weeks). Postoperative Tegner score remained 8.2 (same as the preinjury Tegner score). Subjective outcome was rated 4.3 of 5. The combined score indicated 80% of good or excellent results for both groups.

Surgical intervention allows RTP at the same level in professional soccer players following failure of nonoperative treatments. Athletes with adductor syndrome and accompanying sportsman's hernia may benefit from adductor tenotomy alone.

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Chronic exercise-related groin pain is a debilitating condition and a major diagnostic and therapeutic challenge. Groin pain among athletes has an estimated incidence rate of 0.5% to 6.2%.[1] It is particularly common in sports such as soccer, which involve running, cutting, and kicking.[2,3] Groin pain may represent 5% to 7% of all injuries in soccer, with incidences as high as 10 to 18 groin injuries per 100 players.[4]

The anatomy of the groin and inguinal area is complex and results in various pathological conditions presenting as groin pain.[2,3,5-10] The differential diagnoses of groin pain in an athlete includes femoroacetabular impingement, enthesopathies of the adductor and abdominal muscles, hernias, pelvic bone and joint pain, and pain referred to the groin from nerve entrapment and other distant pathology.[8] Patients may localize the site of the discomfort,[11] and clinical examination may reveal local tenderness, a restricted range of motion, or pain[12] on resisted contraction of the hip adductors.[13] Imaging modalities, including plain radiographs, ultrasound, magnetic resonance imaging, or bone scintigraphy, are used to clarify the pain etiology and can reveal symphyseal changes, femoroacetabular impingement, enthesopathies, or muscle wall defects.[14,15]

Nonoperative treatment includes rest, physical therapy,[9,16] nonsteroidal anti-inflammatory drugs, and local injections.[17-19] Early studies have shown poor results with conservative management, with only 38% of injuries resolving.[20] Paajanen et al[21] reported that 27% of 30 patients with sportsman's hernia receiving conservative therapy returned to play within 3 months compared with 90% of those receiving surgical mesh augmentation of the abdominal wall.

Surgical interventions within the adductor-abdomino complex subtly alter load transmission from the lower limb to the pelvis. These generally consist of release of the adductor tendons with or without repair and augmentation of abdominal wall defects.[22,23]

The purpose of this study was to report the authors' experiences with the treatment of adductor-related groin pain through either adductor tenotomy only or combined adductor tenotomy and hernioplasty in professional soccer players.

Materials and Methods

Between 2000 and 2006, a total of 155 professional and recreational soccer players were surgically treated at the authors' institution for persistent groin pain. A retrospective review of the medical records was undertaken after institutional review board approval and informed consent was obtained from all participants.

Players were questioned regarding the location and severity of pain, the presence of abdominal pain, and the aggravating and alleviating factors. They were assessed for the presence of tenderness of the adductor and abdominal muscles, palpable defects, and range of motion of the hip. Imaging consisted of hip and pelvic radiographs or ultrasound, magnetic resonance imaging, and bone scintigraphy. Leg dominance, playing position, type and duration of previous treatments, and player's compliance with physiotherapy were noted. All had completed conservative management consisting of oral nonsteroidal anti-inflammatory drugs, therapeutic modalities (eg, cryomassage, laser, ultrasound, or electric stimulation), and a progressive rehabilitation program, but no standardized nonoperative protocol was used.

Patients reporting groin pain that failed to resolve with nonoperative therapy and who were unable to compete at the desired competitive level due to the pain were considered for surgery. Surgical candidates had adductor tendon insertion pain, a positive squeeze test (with or without pubic bone tenderness), and/or tenderness of the surrounding aponeurosis.

The allocation of patients to the different treatments was made by the senior author (R.B.C.) according to the groin pain characteristics in combination with sonographic findings. The 2 groups were defined retrospectively according to the surgical management patients received. Patients' demographics and surgical results were then analyzed. One group comprised patients who underwent an adductor tenotomy only and the other group comprised patients who underwent an adductor tenotomy and hernioplasty, which was performed for patients if they had inguinal tenderness and either weakness in the posterior wall or a sports hernia demonstrable on ultrasound.

Surgical Technique

Adductor Tenotomy

All patients received a standard surgical technique through a 3-cm oblique incision lateral to the spermatic cord and the origin of the adductor longus tendon. Using diathermy, both adductor longus tendons were exposed and released 0.5 to 1.0 cm from their origin. The adductor brevis was left untouched, and a tenotomy of the gracilis tendon was performed only if it appeared to be pathological.

Hernioplasty

Hernioplasty was performed using a laparoscopic transabdominal preperitoneal approach with the assistance of a general surgeon using an established technique.[24] This procedure involved the preperitoneal placement of polypropylene mesh and restoration of the peritoneum. Umbilical portals provided access, and, with the hernia reduced, the peritoneum and the sac were dissected from the symphysis pubis to the anterior superior iliac spine. The psoas fascia was left intact. The mesh was placed with its long axis in the transverse plane and secured using a tack device. Portals and pneumoperitoneum were closed in a routine fashion.

Postoperatively, return to play (RTP) and subjective and objective outcome measures were documented. A standard rehabilitation program was prescribed that

required patients to wear a groin abduction pillow for 1 week postoperatively to avoid stump approximation, followed by a strengthening program of the hip flexors and extensors. Emphasis was placed on adductor stretching and eccentric strengthening, avoiding adductor concentric motion. Straight-line running was initiated at 3 weeks postoperatively, whereas pivoting and kicking was initiated once the patient was pain free, approximately 5 weeks postoperatively.

Long-term assessment was performed retrospectively. Charts were reviewed and used to contact patients for telephone interviews. Evaluation consisted of the side, nature, location, and duration of symptoms and the conservative treatment used, as well as the athlete's compliance, current playing position, and current playing status. Patients' subjective assessment of outcome was measured on a graded 5-point scale, where 1 corresponded with the worst outcome possible and 5 corresponded with an excellent outcome. Tegner level was retrospectively documented at baseline (before initiation of symptoms) and at last follow-up.

A formula was also developed to quantify surgical success as a combined score. This formula was the combination of the subjective evaluation of the patient regarding the surgical outcome (50% of the score), the Tegner score (35%), and the duration prior to RTP (15%). The subjective evaluation was graded as 5 (excellent, 50 points), 4 (good, 35 points), and 3 (satisfactory, 20 points). Zero points were given for a grade lower than 3. The last documented Tegner score was compared with the level of play prior to the onset of symptoms. If the athlete resumed the same level of activity or higher, the maximum of 35 points was given. If the postoperative Tegner score was 1 grade lower than the preinjury score, 15 points were given. No points were given for more than 1 level decrease. Lastly, RTP time was assessed. If a player's RTP time was less than 2 months postoperatively, the maximum 15 points were given; an RTP time of 2 to 4 months resulted in 10 points; and an RTP time more than 4 months was equal to 5 points, which was awarded as long as the athlete stayed active in his sport. Total scores of 90 to 100 were considered excellent, 80 to 89 were considered good, 70 to 79 were considered fair, and below 70 were considered poor.

Table 1

Group Descriptive Statistics and Outcome Measures

	Tenotomy Group[a] (n=96)		Combined Group[b] (n=59)		
Variable	**No.**	**Mean±SD**	**No.**	**Mean±SD**	***P***
Age, y	84	22.8±4.2	55	23.3±3.0	.41
Onset of pain, mo[c]	85	5.6±5.6	55	7.3±7.0	.11
PT compliance[d]	82	4.0±1.1	55	3.6±0.9	.06
PT time spent, wk	84	9.8±5.9	55	7.4±4.6	.01
Rehab PT compliance, wk	84	4.4±1.0	54	4.2±0.9	.22
RTP, wk	84	11.7±5.4	54	10.3±3.8	.10
Tegner preop	84	8.3±0.6	55	8.3±0.6	.86
Tegner FU	83	8.2±1.9	55	8.3±0.6	.66
Subjective outcome[e]	83	4.4±0.9	54	4.3±1.0	.69
Delta Tegner	83	−0.1±1.8	55	0±0.3	.67
Combined score[f]	85	85.1±18.2	55	85.3±20.1	.94

Abbreviations: FU, follow-up; preop, preoperatively; PT, patient; rehab, rehabilitation; RTP, return to play.
[a]*Patients underwent adductor tenotomy only.*
[b]*Patients underwent both adductor tenotomy and hernioplasty.*
[c]*Time since onset of pain.*
[d]*Compliance as reported by patient's own assessment of compliance on a 1-5 scale: 1=bad compliance; 5=excellent compliance.*
[e]*Subjective outcome measured on a 1-5 scale: 1=worst; 5=excellent.*
[f]*Combined score composed of subjective evaluation, Tegner score, and return to play. Outcomes categorized as excellent (90-100), good (80-89), fair (70-79), poor (<70).*

In addition, to evaluate the effectiveness of tenotomy vs combined tenotomy and hernioplasty in patients with a positive ultrasound finding of sports hernia, a retrospective evaluation of the data was conducted looking at the results of the respective surgeries. Among patients with an ultrasound positive for sports hernia, the incidence of postoperative complications, compliance with rehabilitation, RTP time, subjective outcomes, and Tegner scores were compared between groups.

Statistical Analysis

All documented demographics, as well as pre- and postoperative parameters, were analyzed to find significant differences between the 2 groups using analysis of variance with repeated measures and Pearson's chi-square test. To compare pre- and postoperative clinical characteristics, a paired *t* test was used. To look for statistically significant differences related to positive ultrasound findings between study groups, an F test was also used. All statistical tests with *P* values were 2-sided, and the selected level of significance for all variables was $\alpha = .05$. SPSS version 12.0 statistical software (SPSS Inc, Chicago, Illinois) was used for data analysis.

Table 2

Preoperative Ultrasound Findings

Ultrasound Finding	No. (%) Tenotomy Group[a] (n=96)	Combined Group[b] (n=59)	Total
Sportsman's hernia/hernia			
Negative	36 (57)	1 (2)	37 (33)
Positive	15 (24)	41 (84)	56 (50)
Abdominal wall weakness	12 (19)	7 (14)	19 (17)
Total[c]	63 (100)	49 (100)	112 (100)

[a]*Patients underwent adductor tenotomy only.*
[b]*Patients underwent both adductor tenotomy and hernioplasty.*
[c]*A total of 22 patients in the adductor tenotomy group and 6 patients in the combined group did not have ultrasounds completed.*

Table 3

Combined Score Results[a]

Score	Frequency, No. (%)	Cumulative %
10	3 (2.1)	2.1
30	1 (0.7)	2.9
35	1 (0.7)	3.6
40	1 (0.7)	4.3
45	4 (2.9)	7.1
50	1 (0.7)	7.9
60	5 (3.6)	11.4
65	8 (5.7)	17.1
70	2 (1.4)	18.6
75	1 (0.7)	19.3
80	4 (2.9)	22.1
85	17 (12.1)	34.3
90	23 (16.4)	50.7
95	43 (30.7)	81.4
100	26 (18.6)	100.0
Total	140 (100.0)	100.0

[a]*Combined score based on the main 3 outcome measures used to evaluate treatment success (Tegner score, return to play, and subjective outcome evaluation). Outcomes categorized as excellent (90-100), good (80-89), fair (70-79), and poor (<70).*

Results

During the 66-month study period, 155 patients presented to the clinic with groin pain recalcitrant to nonoperative therapy. Ninety-six patients were treated with adductor tenotomy and 59 were treated with combined adductor tenotomy and hernioplasty. Eleven (11%) patients from the tenotomy group and 4 (7%) from the combined group were lost to follow-up, resulting in 140 patients with sufficient data for analysis.

Descriptive statistics and outcome measures for each group are outlined in Table 1. No statistically significant differences were found between the 2 groups regarding the majority of the preoperative parameters or the surgical outcome measures. Statistically significant differences were found between groups in the time spent on physical therapy before electing to have surgery (higher in the tenotomy group) and positive preoperative sports hernia ultrasound findings (higher in the combined group) (Table 2). However, 28 (20%) patients did not undergo ultrasound examination prior to their surgical procedure: 22 (26%) from the tenotomy group and 6 (11%) from the combined group. In addition, 32% (27/84) of the patients in the tenotomy group presented with positive ultrasound findings but underwent tenotomy without hernioplasty (Table 2).

Mean duration of preoperative symptoms was 5 months (range, 2-24 months). All patients were men with a mean age of 23±3.7 years (range, 16-36 years) who participated in competitive soccer and had a mean preinjury Tegner score of 8.3±0.6 (range, 8-10). Mean RTP time was 11.6±5.4 weeks (range, 4-36 weeks). Mean postoperative Tegner score was the same as the preoperative score (8.3), with only 2.8% (4/140) of patients having a reduced follow-up score. The Tegner score was increased postoperatively in 7.8% (11/140) of patients (greater than or equal to 1 level above baseline Tegner). Mean subjective outcome was 4.4±0.9 of 5 (range, 1-5). The combined score revealed excellent results in 65% (92) of patients, good in 15% (21), fair in 2.5% (n=3), and poor in 17% (n=24) (Table 3).

The 3 main outcome measures used to evaluate treatment success were postoperative Tegner score, RTP time, and the patient's subjective assessment of the outcome, which were used to formulate the combined score. No differences were found between the 2 groups for the 3 main outcome measures and the combined score.

In the subgroup of patients with positive sonographic findings for sports hernia and adductor pain, 27 patients were in the tenotomy group and 48 were in the combined group. No significant differences were found between the groups in terms of complications (Table 4) or compliance with rehabilitation. Patients returned to play at a mean of 11.6 weeks in the tenotomy group and 10.3 weeks in the combined group, but no significant difference was found between the groups (P=.202). Subjective outcomes with the combined score were similar between surgical groups, as was the change in Tegner scores (Tables 5, 6).

Discussion

The authors report the surgical results of a large series of high-level athletes

Table 4

Incidence of Complications in Ultrasound-positive Patients[a]

Complication	No. (%) Tenotomy Group[b] (n=96)	No. (%) Combined Group[b] (n=59)
None	26 (96.3)	42 (87.5)
Hematoma	1 (3.7)	3 (6.25)
Infection	0 (0)	3 (6.25)
Total	27 (100)	48 (100)

[a]*No significant difference found between groups with respect to complication rate (P=.218).*
[b]*Patients underwent adductor tenotomy only.*
[c]*Patients underwent both adductor tenotomy and hernioplasty.*

Table 5

Comparison of Subjective Outcomes Between Ultrasound-positive Patients Using Combined Score[a]

Combined Score	No. (%) Tenotomy Group[b] (n=96)	No. (%) Combined Group[b] (n=59)
1	1 (3.7)	1 (2.1)
2	0 (0)	2 (4.3)
3	4 (14.8)	3 (6.4)
4	7 (25.9)	12 (25.4)
5	15 (55.6)	29 (61.1)
Total	27 (100)	47 (100)

[a]*No significant difference found in subjective combined score outcomes (P=.508).*
[b]*Patients underwent adductor tenotomy only.*
[c]*Patients underwent both adductor tenotomy and hernioplasty.*

Table 6

Comparison of Change in Tegner Scores Between Ultrasound-positive Patients[a]

Change in Tegner Score[b]	No. (%) Tenotomy Group[c] (n=96)	No. (%) Combined Group[d] (n=59)
0	25 (92.6)	44 (91.7)
1	2 (7.4)	3 (6.2)
−1	0 (0)	1 (2.1)
Total	27 (100)	47 (100)

[a]*No significant difference was found between groups in the change in Tegner score whether, in the presence of a positive ultrasound, patients received tenotomy or tenotomy and hernioplasty (P=.628).*
[b]*Change from pre- to postoperatively.*
[c]*Patients underwent adductor tenotomy only.*
[d]*Patients underwent both adductor tenotomy and hernioplasty.*

with adductor-related groin pain who underwent either adductor tenotomy alone or combined adductor tenotomy and hernioplasty. This series demonstrates a high level of satisfaction among athletes requiring surgical management of groin pain. Good or excellent results were reported in 80% of patients. No postoperative differences were found in Tegner score, RTP time, or subjective assessment of outcome between the 2 groups. Postoperative recovery prior to RTP was similar between the groups, despite more surgical trauma necessary in the combined group. In addition, in a subgroup of patients with positive ultrasound findings for sports hernia, no difference in outcomes was found between those patients treated with adductor tenotomy only vs combined adductor tenotomy and hernioplasty.

Several studies report the outcome of patients receiving an adductor tenotomy or hernia repair for chronic groin pain (Table 7). Groin pain can present as adductor origin or lower abdominal pain. These 2 distinct locations are closely related and share anatomical structures, including tendon attachments and aponeurosis.[11] As a result, the surgical treatment for these athletes traditionally includes adductor tenotomy or lower abdominal hernia reconstruction or repair. Treatment decisions are made according to the clinical and radiographic scenario and the practitioner's experience.[33,38-40]

In the current study, after undergoing either adductor tenotomy or combined tenotomy and hernioplasty, 98% (83/84) of patients returned to the same or higher level of competition, although some reported less-than-ideal subjective satisfaction. Akermark and Johansson[33] reported the results of a series of adductor tenotomies performed for chronic groin pain in athletes. The surgical technique used was similar to that in the current study, and all patients were either symptom free or had improved at follow-up. Seventy-five percent of athletes were able to return to competitive sport at 14 weeks following surgery, but only one-third were able to resume their previous level of play.[33] Atkinson et al[29] and Robertson et al[32] reported improvement with tenotomies alone. In their retrospective series, Robertson et al[32] reported that 91% (99/109) of patients improved, and the best improvement was made in those with the worst preoperative symptoms. Similar improvements were noted by Atkinson et al,[29] who reported a Tegner score improve-

Table 7

Studies Reporting Outcomes of Patients Receiving Adductor Tenotomy or Hernia Repair for Chronic Groin Pain

Study	Inclusion Criteria	Entity Studied	Outcome
Martens et al[20]	Subcutaneous adductor tenotomy and/or rectus abdominis tenotomy plus facioplasty	Adductor tendinitis and/or rectus abdominis tendinopathy defined by pain, local tenderness, and restricted contraction; radiographs negative in most cases	Operation successful in 75/81 patients
Paajanen et al[21]	Chronic groin pain	Randomized controlled trial conservative therapy vs endoscopic application of retropubic mesh	90% of those with mesh returned to play within 3 mo compared with 27% of those with conservative therapy; of the conservative group, 23% went on to have surgery
Genitsaris et al[22]	Groin pain; bilateral laparoscopic transabdominal preperitoneal mesh inserted	Dilated external ring inguinal canal; laparoscopic findings only; no routine imaging studies; 62% unilateral defect, 30.5% bilateral defect, 40% no correlation symptoms	1 recurrence (not specified)
Ahumada et al[25]	Sports hernia consisting of point tenderness, pain resisted adduction, and no palpable hernia	Internal oblique flap reinforced with a mesh performed; 4 had adductor tenotomy[49]	83.3% excellent, 16.6% satisfactory
Canonico et al[26]	Groin pain in absence of palpable hernia; sutureless mesh		16 cases excellent; full preinjury level of sporting activity in 31 d
van Veen et al[27]	Chronic groin pain undiagnosed	Endoscopic total extraperitoneal mesh placed; incipient hernia diagnosed in all cases	All returned to normal activity at 3 mo
Ziprin et al[28]	Groin pain with symptoms and signs of sportsman's hernia	Transabdominal preperitoneal mesh applied	Median return to sports, 42 d; all but 1 reached previous level of activity
Atkinson et al[29]	Chronic adductor-related groin pain	Received percutaneous tenotomy	Mean return to sports, 18.5 wk; 54% returned to preinjury levels
Muschaweck & Berger[30]	Sportsman's groin	Short-term results minimal repair technique	78.9% completely pain free by 4 wk postoperative; 87 (67%) professional athletes; 98.8% return to sports at 4 wk postoperatively; 83.7% reported return to full performance within 4/52
Mann et al[31]	Groin pain	Tenderness at insertion and no overt hernia; no preoperative imaging performed; laparoscopic inguinal tenotomy	74% considered match fit by 4 wk; 88% reported return to full fitness
Robertson et al[32]	Groin pain in athletes	Received percutaneous tenotomy; retrospective case series of 109 athletes	91% improvement; best results achieved in patients with greatest preoperative discomfort
Akermark & Johansson[33]	Chronic groin pain; tenotomy of adductor longus performed	Groin pain; active and passive muscle testing; isolated pain reappearing at adductor longus tendon; 7 of 16 patients had pain on isokinetic testing; normal radiographs	All symptom free or improving
Malycha & Lovell[34]	Chronic undiagnosed groin pain	Surgical exploration and inguinal hernia repair	80% had deficiency on inspection at surgery; 93% returned to normal activities
Meyers et al[35]	Adductor pain undergoing anterior pelvic floor repair broad reattachment of the inferolateral edge of the rectus abdominis muscle	4 groups, suspected musculoskeletal abnormality in inguinal region; athletic pubalgia, groin exertional pain, no palpable hernia; 88% pain on resisted hip adduction; tenderness to pubic adductor inguinal regions in varying numbers; most had MRI; 26/149 patients had osteitis pubis on MRI; 8 of 17 patients bone scans positive for osteitis pubis	97% returned to previous level of performance
Bidert et al[36]	Chronic symphysis syndrome: combination of abdominal, groin, and adductor pain	Epimysial adductor release and spreading lateral border of rectus sheath; pain felt lateral to sheath of rectus abdominis, medial to inguinal ligament, and proximal to pubis with tenderness to palpation	High overall subjective and objective rating; return to full sporting activity noted
Kluin et al[37]	Undiagnosed chronic groin pain; radiography, scintigraphy, and ultrasound performed to exclude other causes	Tenderness on palpation; transabdominal or extraperitoneal endoscopy performed; 17 groins had mesh placed	At 1 y, 1 patient had minor symptoms; 1 had persistent symptoms; 93% returned to full activity in 3 mo.; 39 occult/sports hernia occurrences

Abbreviation: MRI, magnetic resonance imaging.

ment from 6.1 to 7.7, although it is worthy of note that players did not return to their preinjury level of play.

Surgical adjustment of imbalance in the adductor-abdomino complex may also be performed by repair and augmentation of the abdominal wall muscles in addition to adductor release. Meyer et al[35] reported 157 athletes who underwent pelvic floor repair for abdominal/inguinal pain. Twenty-three percent had concurrent adductor release with varying selection criteria and extent of release. Ninety-seven percent returned to their level of performance prior to developing adductor pain.[35] In the current study, 96% (53/55) of patients who underwent combined adductor tenotomy and hernioplasty had a successful outcome, returning to the same level of activity or higher.

Ultrasounds were performed on many patients in this study investigating for the presence of sports hernias. Ultrasounds were positive in 27 patients in the tenotomy group, and when these patients were compared with patients in the combined group, results were the same in terms of RTP time, subjective outcome, and Tegner score. More complications were reported in the combined group, although not statistically significant, which is not surprising given the more invasive surgery faced by patients in this group. Further study is needed in this area, but these results suggest that it may be possible to treat patients with sports-related groin pain with an adductor release even in the presence of lower abdominal wall weakness or hernia. The release of the adductor longus tendon changes the biomechanical force across the abdominal-adductor complex, allowing symptomatic relief.

The current authors developed a formula to attempt to quantify surgical success that allows for representation of both subjective and objective measurements. First, the athlete graded the outcome according to his own perception, assigning a score from 1 to 5. Second, objective measures were considered, including the Tegner score and the RTP time. According to this combined outcome score, 80% of the soccer players treated achieved good to excellent results (above 80% overall grade).

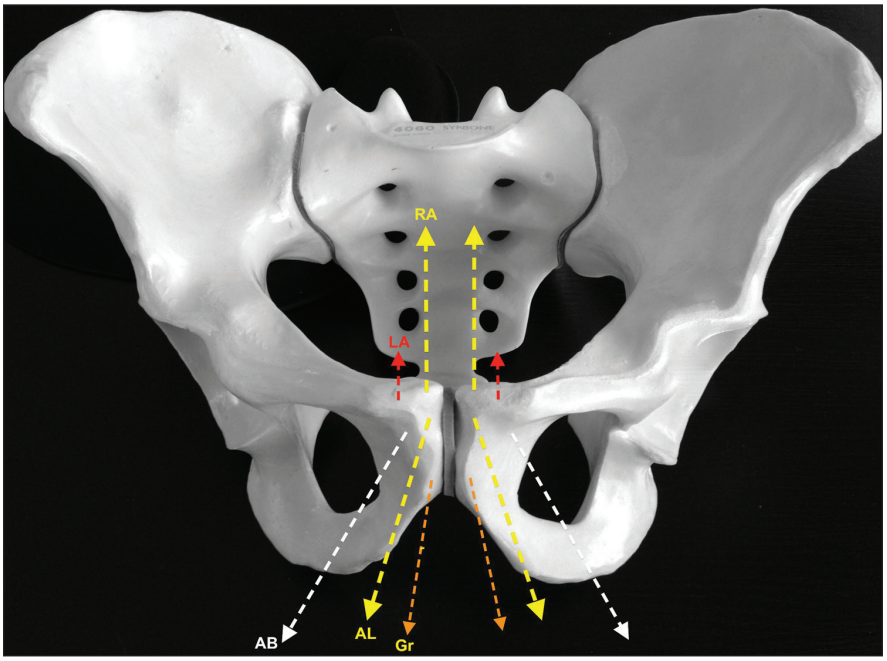

Figure: Anterior view of the pubic ramus with schematic depiction of the main forces that act on the pubic joint. Abbreviations: AB, adductor brevis; AL, adductor longus; Gr, gracilis; LA, lavator ani; RA, rectus abdominis.

A concern following adductor tenotomy is the potential for loss of hip adductor strength, although this does not appear to affect function following recovery.[29] Elite athletes are a special group of patients. Even the smallest loss of adduction strength, undetectable by manual testing, can result in decreased acceleration and strength and may be enough for the athlete to lose his or her competitive edge.[41] The current data suggest that adductor tenotomy, although known to reduce adductor muscle strength, does not clinically influence outcome.

The overlapping nature of the symptoms, particularly when bilateral, may lead to diagnostic difficulty. However, this is representative of a typical presentation. Symptoms have been alleviated with unilateral surgery despite visible abdominal wall defects on the asymptomatic side during endoscopy, which demonstrates the lack of complete understanding of the entity of groin pain.[22]

The complex anatomy of the groin is likely responsible for the variety of groin pain presentations; however, most seem to arise from the same underlying pathomechanism.[42] Both adductor longus tendons and the lower abdominal muscles share the same insertion and aponeurosis around the pubis symphysis, and each is pulling in a different direction in a "Mercedes Benz" configuration (Figure). As a result, the loads and stresses are being transferred from 1 point to the other, causing various symptoms. Noncontractile tissue injury may occur from shearing forces as a result of imbalance between the comparatively strong hip adductor muscles and the weak lower abdominal muscles.[6,43]

The literature is clear that both adductor release and abdominal muscle augmentation can alleviate groin pain in athletes. The surgical intervention may restore the natural balance of the adductor-abdomino complex to allow RTP after appropriate rehabilitation. The aim of the adductor tenotomy is to reduce muscle pull from the tendon origin and allow for healing of the

enthesopathic insertion and restoration of pain-free adductor muscle function.[33] The current authors believe that a unilateral procedure would not achieve that goal, and bilateral releases were performed in all patients.

Meyers et al[35] found asymmetrical edema in the posterior aspect of the muscle in preoperative magnetic resonance imaging; however, the pain usually improved after pelvic floor repair. In the series, an additional adductor tenotomy was needed in only 23% of patients (29% of those having adductor pain). The adductor pathology was considered a secondary phenomenon.[35] Cadaveric studies supported this hypothesis as the pelvis tilted anteriorly after rectus abdominis injury creating increased pressure on the adductor compartment.[35] This pressure was then relieved by epimysial adductor release.

The current study comprised 2 groups, both of which had patients with similar clinical presentations of groin pain. The authors acknowledge that no randomization was performed and allocation to treatment groups was made according to the patient's groin pain characteristics and sonographic findings. The initial reason for the different treatment strategy applied (the addition of the hernia repair to the established adductor tenotomy technique) was the senior author's hypothesis that addressing the abdominal muscle weakness, or hernia, may be beneficial for this group of patients. This study has shown no benefit to patients with combined adductor tenotomy and hernioplasty, so the authors have reverted to adductor tenotomy only for their current patients. An important strength of this study is that the authors found no difference in outcomes in patients with ultrasound-verified sports hernias regardless of whether they received hernioplasty, provided they underwent adductor tenotomy.

Short-term results of this study found good RTP and subjective outcomes, but it would be reasonable, given the study results, to assume that many of these players had femoroacetabular impingement, which is believed to be a major contributing pathological finding in patients with groin pain.[44] It was recently shown that 94% of those with long-standing groin pain have radiological signs of femoroacetabular impingement.[45] A recent study has suggested that outcomes were suboptimal when surgery only addressed either the athletic pubalgia or intra-articular hip pathology in this patient population. The surgical management of both disorders concurrently or in a staged manner led to improved postoperative outcome scoring and an unrestricted RTP in 8% of hips.[46]

The influence of femoroacetabular impingement on the playing career and continued symptoms following retirement requires further research. The authors appreciate that with the increased understanding of femoroacetabular impingement over the past few years, it is possible that some of these patients had symptomatic femoroacetabular impingement and, if managed today, may have been treated differently.

This study has some limitations. The retrospective data collection is subject to recall bias. The lack of randomization also places limits on the data analysis. Furthermore, a decade ago, when the reported surgeries were conducted, the understanding of groin pathology was lacking regarding hip-related pathology, specifically femoroacetabular impingement. As a result, interpretation of the radiographs concentrated on the pubic bones and likely overlooked radiographic findings of femoroacetabular impingement. The physical examination of patients with femoroacetabular impingement was not understood until recently, so documentation of hip internal rotation and flexion would not have been recognized to the same extent.

The distinction between the precise diagnoses of players with groin pain is difficult. The authors have shown surgical intervention to be successful when conservative management has failed. Given the results of this study, the authors believe that athletes with an adductor syndrome and accompanying occult (sports) hernia may benefit from adductor tenotomy only. Further research in a well-controlled study would help further elucidate this hypothesis.

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