



## 10-year results of the Nesovic procedure combined with adductor release for groin pain in 33 competitive athletes

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The authors present a 10-year review of the postoperative bilateral release of the adductor brevis and gracilis muscles combined with a bilateral abdominal myo-fascio-plasty according to Nesovic for groin pain in competitive athletes.

We present the 10 years results of 33 patients operated on between April 2002 and May 2006 diagnosed with a "sports hernia". The injury was treated with a bilateral abdominal procedure according to Nesovic combined with a bilateral adductor release after unsuccessful conservative treatment of at least 2 months. There were 32 male patients between 18 and 43 years and one female patient aged 25 years with a mean age of 28.8 at time of surgery. All procedures were bilateral. Patients were seen in the postoperative clinic and a questionnaire was collected after 2 years and 10 years.

Within 16 weeks, 30 patients (90,9 %) returned to the same or a higher level of sports activities. 10 years after surgery 31 patients (93,9%) remained free of pain. 1 patient has minor pain after training (VAS 0-1) and only 1 patient still experiences pain (VAS  $\geq 5$ ) after heavy work. 13 patients (39,3%) are still performing sports today, and 19 of 20 patients (95%, 57% of total cohort) were pain free to the end of their sporting careers.

The bilateral Nesovic procedure with bilateral adductor release has a high success rate for the competitive athlete with chronic groin pain. It also is a procedure that gave most athletes suffering from a certain type of groin pain a solution till the end of their sporting careers.

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### INTRODUCTION

Approximately 5% of all sports injuries are related to the groin area (44). Groin pain originating in a sports hernia is a challenging combination of symptoms and pathology with a variety in the differential diagnosis (Table I) (14). There is considerable evidence to support that inguinal canal disruptions without a detectable hernia, are not uncommon causes of chronic groin pain in athletes, especially in cases resistant to conservative treatment (21,34).

A correct diagnosis is mandatory to obtain success after surgery and persistent pain symptoms after conservative treatment in the competitive

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Table I. — Differential diagnosis of groin pain

1. Snapping hip
2. Traumatic myositis ossificans
3. Osteo-articulair lesions
4. Testicular pathology
5. Inguinal/crural hernia
6. Cam/Pincer Lesions
7. Chronic adductor strain
8. Osteitis Pubis
9. Adductor tendinitis
10. Obturator neuropathy
11. Stress fractures
12. Muscle strain
13. Referred pain Lumbar spine
14. Referred pain Sacro-Iliac joint
15. Urinary tract pathology
16. L5 spondylolisthesis
17. Bursitis
18. Tendo-periosteal lesions
19. Hip arthritis

athlete must raise suspicions for other pathologies the groin area. Chronic groin pain is often an association of osteitis pubis, a painful adductor tendon origin and a “sports hernia” but the three are independent entities.

The sports hernia, in Europe also known as Gilmore’s groin (11), is a specific pathology. It is mainly caused by repetitive ad- and abduction actions combined with twisting and turning movements that create shearing forces between the symphysis pubis and the posterior inguinal wall (“athletic pubalgia”). Most authors agree that these friction forces result into micro trauma at the posterior inguinal wall. These micro traumata even increase the physiological imbalance between the strong adductor muscles and the weaker oblique and rectus abdominal muscles (12,21,34,48,49,51).

It often is characterized by elongation (with or without tears) of the external oblique aponeurosis with a weakening of the posterior inguinal wall in the absence of a true palpable hernia.

These repetitive movements, which are often done by soccer players, are the basis of muscular imbalance. Athletes often complain of chronic pain

located deeper and more proximal than a typical groin strain. Pain is first noticed near the end of exercise or thereafter.

After some time pain can persist during daily life activities.

Although it may occur in many sports (1,3,12,34,49) in Europe it is seen mainly in athletes that require frequent bending, twisting and turning at speed - such as in soccer, rugby, football and hockey.

Adductor tendinopathy is a painful insertion of the adductors on the pubic bone and is the result of chronic and repetitive micro trauma during resisted abduction and forced adductions. It is a very common cause of groin pain in athletes (23,24).

Groin pain is comparatively uncommon in women. In more than 200 cases of sports hernia, less than 5% have been diagnosed in women. The diagnosis in women is even more challenging than in men, but surgical repair is as successful (22).

## MATERIAL AND METHODS

Between 2002 and 2006, 33 athletes underwent a bilateral Nesovic (15) myo-fascio-plasty combined with bilateral adductor brevis and gracilis muscle release for chronic groin pain. In this prospective cohort study all patients were operated by the same surgeon (D.P.) for the same indication by the same technique and had the same postoperative management (Table II).

All patients gave their informed consent prior to inclusion in the study.

Table II. — Postoperative physiotherapy protocol

2 weeks postop: start stretching adductor muscles
4 weeks postop: start cycling and swimming
6 weeks postop: start jogging
8 weeks postop: start acceleration exercises
10 weeks postop: start individual soccer training
12 weeks postop: start official soccer training
16 weeks postop: start competition game

Table III — Patients pre- and postoperative sports levels at 2 years

Pre-operative sport level	Patients N (%)	Post-operative sport		
		Lower	Same	Higher
Competitive soccer	25 (75,7%)	1	22	2
Competitive marathon	2 (6%)		2	
Competitive badminton	1 (3%)	1		
Competitive motor cross	1			1
Competitive karate	2	1	1	
Competitive basketball	1		1	
Competitive athletics	1		1	

All 33 patients were competitive athletes (Table III) with at least 2 training sessions of at least 2 hours a week. The majority of patients (25/33) were soccer players and 94% participated in an additional weekly competition event. The groin pain was of a progressive manner and increased at the end of the training or game. All patients had to abandon their sport activities or were no longer effective because of their pain, but were desperate to continue their careers.

### Clinical examination

A detailed orthopaedic examination was carried out with specific attention to the lumbar spine, hips, pelvis and the inguinal and pubic area.

Clinical examination revealed unilateral or bilateral tenderness on palpation of the lower abdomen and superficial inguinal ring. A positive Malgaigne's sign (spindle shaped protuberance in the infero-lateral zone of the abdominal wall) and pain during the Valsalva manoeuvre (sneezing and coughing) was documented in 78%. Pain during resisted sit-ups was documented in 21 patients (63,6%). All the patients had objective signs of bilateral adductor weakness and noted pain at the insertion during resistance as seen in the adductor squeeze test. 11 patients of the whole cohort had unilateral abdominal pain and 5 patients had bilateral abdominal pain during resisted sit-ups. Whilst training or playing a game, most soccer players experienced difficulties making a long distance pass or during accelerations and sliding tackles.

Braking suddenly, cutting movements and high kicks were painful for all athletes.

All patients were completely worked up by all members of the groin pain team to rule out co-existing pathology. A special interest went to excluding obturator neuropathy, a frequently missed cause of pubic groin pain radiating to the inner thigh (4).

### Imaging Studies

All patients had an ultrasound performed by the same radiologist with a specific training in sports pathology (Table IV).

Routinely he examined the adductor, oblique and rectus abdominis muscles and the inguinal canal. The hips and scrotum were checked as well. A MRI scan was requested only in cases in which history, physical examination and ultrasound reports were not conclusive.

MRI is becoming increasingly useful in the differential diagnosis of groin pain and other soft tissue and bone marrow conditions and is probably the best imaging study to differentiate the cause of the groin pain (28,29,43,54).

Only patients with a positive history, a suspicious clinical examination and positive ultrasound findings with no other cause of groin pain were included in this study.

### Conservative treatment

All patients first had an episode of conservative treatment consisting of local ice application,

Table IV. — The results of the pre-operative ultrasound

	Add. Tendinitis Uni / Bi		Adductor tear	Hernia / weakened post wall		Obliques aponeurosis inflammation Uni / Bi		Testicular pathology/ intra-articular hip fluid		Inflammation rectus abdominus insertion Uni / Bi	
1		+	-	-		+		-	-	+	
2		+	-	-		+		-	-	+	
3		-	-	-	+	+		-	-		-
4		+	-	-			-	-	-	+	
5		+	-	-		+		-	-	+	
6		+	-	-			-	-	-		-
7		-	-	-			+	-	-		+
8		+	-	-			-	-	-		+
9	+		-	-		+		-	-		-
10		+	-	-			+	-	-		-
11	+		-	-	+	+		-	-	+	
12		+		-		+		-	-	+	
13	+		-	-		+		-	-	+	
14		+	-	-	+	+		-	-	+	
15		+	-	-			+	-	-		+
16	+		-	-	+		+	-	-	+	
17		+	-	-	-		-	-	-		-
18		+	-	-	-		-	-	-		-
19		+	-	-	-		+	-	-		+
20	+		+	-	-	+		-	-	+	
21	+		-	-	-		-	-	-	+	
22	+		-	-	+		+	-	-	+	
23		+	-	-	-	+		-	-		+
24	+		-	-	-		+	-	-		+
25		+	+	-	-	+		-	-	+	
26		-	+	-	+	+		-	-	+	
27	+		-	-	-		-	-	-		-
28	+		+	-	-		+	-	-		-
29	+		-	-	-		-	-	-	+	
30		+	+	-	+		+	-	-		+
31	+		+	-	+		-	-	-	+	
32		+	-	-	-		-	-	-		-
33		-	-	-	+	+		-	-		+

non steroid anti-inflammatory medication and a maximum of three local infiltrations of cortisone® combined with adjusted physiotherapy to stretch the adductor and hamstring muscles and strengthen the abdominal muscles. If symptoms were not resolved or at least improved after 2 months of conservative therapy, the decision was made to operate, on condition that other potential causes of pubic pain were ruled out.

### Operative Technique

The main goal of surgery is to restore the muscle imbalance between the strong adductors and the weak abdominal muscles and to re-establish the force balance at the pubic bone.

To accomplish this, the senior author (DP) performed a bilateral percutaneous tenotomy of the adductor brevis and gracilis muscles and a bilateral fascioplasty of the rectus abdominis muscles according to Nesovic who based his technique on the well-known Bassini procedure for repair of inguinal hernia (41,49).

The patient is placed in a supine position under general anaesthetic. The resident keeps the hips and knees flexed. 10 cc of Local Xylocaine 2%-Adrenaline 1:80000 (Astra Zeneca, USA) is injected just postero-inferior to the adductor longus and a bilateral percutaneous release of the brevis and gracilis muscle is carried out while the resident is abducting the legs. Attention is made not to release the adductor longus tendon. Swabs are rolled together and are put in the groins whilst the legs are extended again to prevent haematoma resulting from the percutaneous release.

A para-inguinal skin incision according to Nesovic is made on the proximal 2/3 between the symphysis and the anterior superior iliac spine. After that a careful dissection and opening of the aponeurosis of the external oblique muscle in the line of its fibres is performed. Often one sees a (traumatic) distension of the anterior abdominal wall indicating weakening (Fig. 1). The ilio-inguinal and ilio-hypogastric nerves are identified. By lifting the tunnelled spermatic cord, one can see and palpate the weakened sometimes bulged but intact posterior inguinal wall (Fig. 2 and 3). Three non-absorbable sutures (FiberWire®

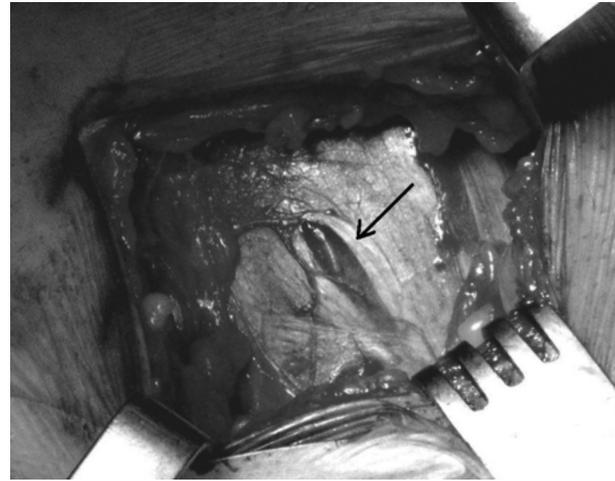


Fig. 1. — Traumatic tear of the external oblique muscle fascia

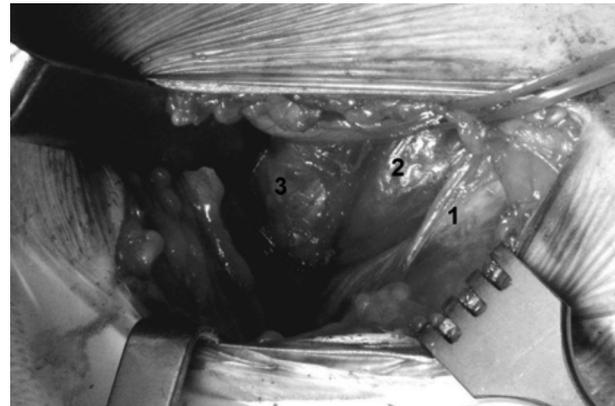


Fig. 2. — The sports hernia - 1. Cooper ligament - 2. Weakened posterior wall - 3. Rectus abdominis muscle

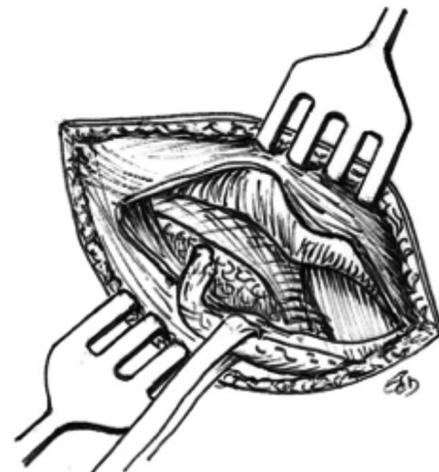
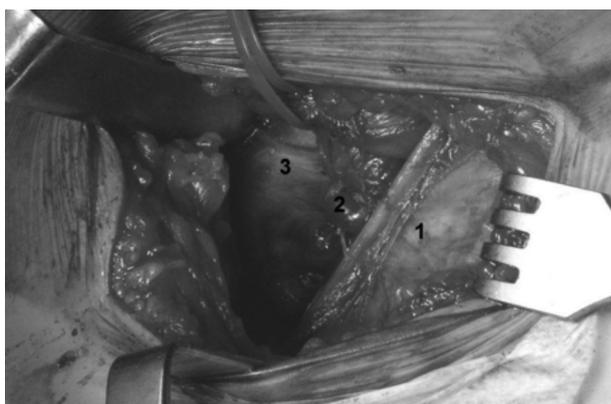
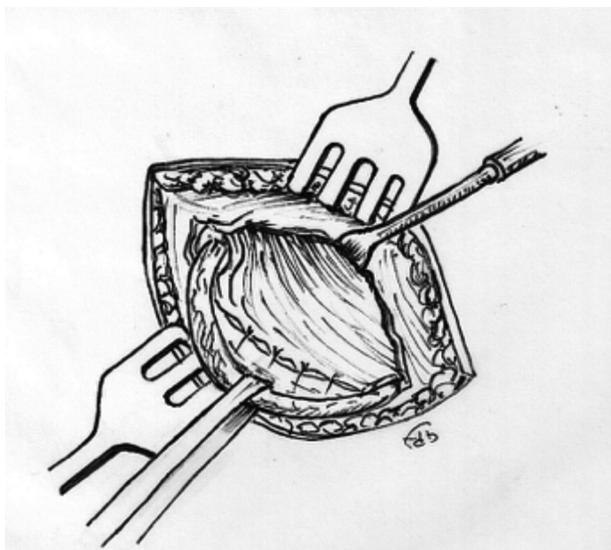


Fig. 3. — Drawing of sports hernia

2/5 metric Arthrex, Naples, Florida, USA REF AR-7202) approximate the infero-lateral edge of the rectus abdominus to Poupart's ligament and assure reinforcement of the posterior inguinal wall. This is also known as Nesovic's myo-fascio-plasty (49) or 'pelvic floor repair' (38) and hereby reduces the Hasselbach's triangle (Fig. 4 and 5). Attention is made neither to damage the iliac vessels nor to strangulate the spermatic cord. The repair is finished by approximation and strengthening of the external oblique aponeurosis over the spermatic cord (superficial fascio-plasty). This repair deals with the weakened posterior as well the anterior inguinal wall.



**Fig. 4.** — Repair of the sports hernia - 1. Cooper ligament - 2. Reinforced posterior wall weakening - 3. rectus abdominus



**Fig. 5.** — Drawing of the repair

Two tight 'figure of eight' compression bandages (Fig. 6) were applied for 3 hours to prevent postoperative haematoma.

All patients were discharged after a final wound check at 48 hours, and received LMW (Low Molecular Weight) heparin (Fraxiparine 0,4 GlaxoSmithKline, UK) subcutaneously for 10 days. A wound check was done by the GP at day 4. Follow up appointments were given at 6,12 and 16 weeks.

A strict postoperative scheme was to be followed according to table 2. After 8 weeks a rigorous warm-up and gentle stretching period was advocated prior to training or competition to prevent muscle injuries during action (40, 56).

### Follow-up

All 33 patients returned for follow up at 6, 12 and 16 weeks.

Wound check, haematomas and adductor muscle force were documented, as well the patients' subjective feeling during training sessions.

A postoperative questionnaire (Table V) was sent 2 and 10 years follow up. All of them were answered. The minimal follow up at the moment of the first questionnaire was 24 months (24-36 months).



**Fig. 6.** — Postoperative compression bandage

Table V. — Patient Questionnaire

Questionnaire

1. What kind of sport were you taking part in before your groin pain and at what level?
2. What kind of sport are you taking part in at the moment and at what level?
3. If you are now taking part in another sport or at another level, would you relate this to the operation or because of other reasons (no time, family, etc.)?
4. Are you experiencing any groin pain at the moment?
  - a. None
  - b. After training or competition
  - c. During training or competition
  - d. Constantly
5. Mark an 'X' on the line to match the level of your pain sensation.  
 0-----5-----10  
 No Pain            Moderate            worst possible pain
6. What do you do to compensate for pain if you feel any at all?
7. Since your operation you have a
  - a. Normal sport activity
  - b. A less sport activity
  - c. No sport activity
8. If you answered 'b' or 'c' in the previous question, would you relate this to the operation?
9. After your operation, you were able to restart
  - a. Light training at ... Weeks
  - b. Full training at ... Weeks
  - c. Official competition at ... Weeks
10. Your operation has
  - a. cured you completely
  - b. helped you
  - c. not made a difference
  - d. worsened the situation
11. Are you satisfied?
  - a. Absolutely
  - b. Moderate
  - c. Not at all
12. Would you advise this operation to a friend?
  - a. Yes
  - b. No

10-year follow up extra questions

13. Have you quit competition?
  - a. Yes
  - b. No
14. If 'a', were you satisfied till the end of your career?
  - a. Absolutely
  - b. Moderate
  - c. Not at all

Similar to the Meyers et al paper (38), we used 'successful', 'moderately successful' and 'unsuccessful' to analyze the results of the operation. Patients were categorized as successful only if they returned completely pain free to the pre-operative sport level within 16 weeks and answered 'a' to questions 10, 11 and 12 of the questionnaire. He or she was considered 'moderately successful' if the athlete returned to a level of performance similar to his pre-operative level but was not completely pain free with a maximum score of 2/10 on the VAS (table VI) or if he or she answered 'a' or 'b' to questions 10 and 11 and recommended the operation to a friend. 'Unsuccessful' meant no or minimal improvement with no return to pre-operative sports level and dissatisfied with the persistent level of disabling pain.

The patients' subjective impressions were analysed by the answers given to question 10, 11 and 12 in the questionnaire (Table V and Table VII, VIII).

As stated above the same questionnaire with some minor changes was sent at 2 and 10 years

follow up. By extensive search all 33 patients were found and responded to the questionnaire. At 10 years, a 13th question was added to ask if the athletes had ceased competing.

If so, a 14th question was asked if they were satisfied with the procedure to the end of their sporting careers.

## RESULTS

A patient population of 33 patients was reviewed at 2 years and 10 years. Mean age was 28.8 years at the time of surgery. 32 were males and one was a female.

Postoperative complications were seen in 2 patients (6%). One superficial wound infection and one scrotal haematoma, which resolved in two weeks. Between 6 and 8 weeks after surgery 21 (63,6%) patients experienced a discomfort in one or both groins during light training as described in Hackney's paper (22).

The patients were informed about this common problem and were advised to continue training.

Table VI. — Patients' pain-VAS during or after competition game at 2 years

VAS	0	1	2	3	4	5	6	7	8	9	10
	27	2	1		1	1		1			

Table VII — Patients' subjective opinion about the operation at 2 years

Operation result?	Success	Improved	Status quo	Worsened
	26 (78,7%)	4 (12,1%)	2 (6%)	1 (3%)
Satisfied?	Absolutely	Quite	No	
	27 (81,8)	3 (9%)	3 (9%)	
Recommendable?	Yes	No		
	30 (90,9%)	3 (9%)		

Table VIII. — Patients' subjective opinion about the operation at 10 years

Operation result?	Success	Improved	Status quo	Worsened
	28 (84,8%)	6 (18,1%)	0 (0%)	1 (3%)
Satisfied?	Absolutely	Quite	No	
	28 (84,8)	4 (12,1%)	1 (3%)	
Recommendable?	Yes	No		
	31 (94%)	2 (6%)		

Pain persisted in 5 patients in whom cortisone® infiltrations given near the adductor insertions were successful with a complete relief of pain after 2 weeks.

27 patients (81,8%) had a very successful postoperative result and returned within 16 weeks to pre-operative sports level without any pain at all (VAS = 0) (table VI,IX,X,XI).

These patients considered themselves to be completely cured from their groin pain. They were very satisfied and would definitely recommend this type of surgery to a friend in response to the review questionnaire.

The moderately successful group had 3 patients (9%) and they all returned to the same level of sport but were not completely pain free. All 3 experienced some kind of inconvenience after sport activities with one athlete having a maximum of 2/10 on the VAS (table VI,IX,X). The three patients did not have any pain during training or competition and the short lasting postoperative pain settled down spontaneously. All 3 patients' groin pain

was markedly improved and they considered their operation as very successful and would recommend it to someone else. The fact that their VAS was not 0/10 makes them moderately successful.

3 patients (9%) were considered to be unsuccessful and could not return to their pre-operative sport level, were in pain during sport (VAS  $\geq$  4/10) or were not satisfied and did not recommend the operation to others.

The patients' subjective opinion about the operation result is documented in table VII and VIII.

After a minimum follow up of 10 years the patients were contacted again. 31 patients (93,9%) did not experience any groin pain anymore (VAS 0/10) and could be categorized as successful. 2 patients of the unsuccessful group started training again after 3 years and returned to sports at a lower level. 30 of 33 patients (91%) returned to the same or higher sports level within 2 years as stated in the first questionnaire.

1 patient has minor pain after training (VAS  $\leq$  2) and only 1 patient still experiences pain (VAS  $\geq$  5) after heavy work. 10 years later 31 patients would recommend the operation to others (93,9%).

13 patients (39,3%) are still performing sports today, and 19 of 20 patients (95%; 58% of total group) were free of pain till the end of their careers.

Table IX. — When does the pain occur (2 years)

Pain VAS	None	After training or competition		During training or competition	Constantly
		$\leq$ 2/10	$\geq$ 4/10		
	27 (81,8%)	$\leq$ 2/10	$\geq$ 4/10	$\geq$ 5/10	0
		3 (9%)	1 (3%)	2 (6%)	

Table X. — When does the pain occur (10 years)

Pain VAS	None	After training or competition		During training or competition	Constantly
		$\leq$ 2/10	$\geq$ 4/10		
	31 (93,9%)	$\leq$ 2/10	$\geq$ 4/10	$\geq$ 5/10	0
		1 (3%)	0 (0%)	1 (3%)	

Table XI. — Return to sport time table

	$\leq$ 8 weeks postop	$\leq$ 12 weeks postop	$\leq$ 16 weeks postop	$\leq$ 20 weeks postop	$\geq$ 20 weeks postop
Light training	25	5	3		
Official training	2	25	5	1	
Competition		3	27	1	2

## DISCUSSION

Over the last 25 years, there have been many reports of success following open surgery around the inguinal canal for the treatment of chronic groin pain, but debate still persists about the exact cause and the best possible operative technique (13,26,31,34,27,51,52). There is a lack of randomized controlled trials concerning the best possible operation for chronic groin pain. Present evidence is based on clinical experience.

Concerning conservative therapy there is no evidence-based consensus regarding the type and period of the therapy for groin pain in the (semi) professional athlete. There is level I evidence on the positive effects of an active physical therapy program on strengthening the muscles stabilizing hip and pelvis. This is based on only one RCT (randomized controlled trial) (Hölmich et al. (25)). There is some evidence available that conservative treatment for pubic pain has a high satisfaction rate (90%) (1,5), but other published data have satisfaction rates as low as 38% (35). Results in short term appear positive and mid-term results are moderately positive. The risk for recurrence is high (55). Fredberg et al. (16) concluded in their paper that there is no justification for the condition of sports hernia and that groin pain settles in 3 months without any kind of surgery.

Although most authors agree on a minimum of 4 weeks and a maximum of 16 weeks conservative treatment (20), recent published data states that non-operative measures are unsuccessful (8,26,50).

Whatever scheme is used, it needs to be adapted to the patients' criteria: age, level of sport, patients' motivation, the specific pathology and the pain intensity. It mainly consists of tendon stretching exercises, re-education and re-enforcement training (5,32), flexibility training (15), NSAID and local infiltration of steroids.

The fact that there are several different procedures described (open versus laparoscopic) and performed by different specialists (orthopaedic versus abdominal surgeon) for treating a sports hernia demonstrates the lack of consensus among the specialists.

There is one moderate quality RCT (level II) that shows that surgical intervention by use of a Bassini hernia repair and neurotomy has better results than conservative or no treatment in athletes with persistent groin pain (11).

Literature supports the operative treatment of chronic groin pain is most successful in the (semi) professional athlete or in the high endurance patient and less predictable in the normal population (15,17). MRI is the only scan which simultaneously highlights the pubic bone, the fibro cartilage of the symphysis and the insertion of the adductors and

rectus abdominis muscles. It should not be used routinely for all pubic region pathology (9), but probably is the first choice in case of doubt or in chronic groin pain where it may help in establishing the correct aetiology of groin pain and especially the differential diagnosis (17,28,29,38,43). In this study we emphasised using only ultrasound for diagnosis.

Several papers highlight the importance of a multidisciplinary team (orthopaedic and abdominal surgeon, urologist, neurologist and radiologist) and the use of different technical investigations like ultrasound, MRI and bone scan to obtain the correct diagnosis (9,31,39).

Some authors base their surgical strategy on the MRI findings (6), but this is not advisable considering the high prevalence of non-specific findings and the low prevalence of positive scans (38). The use of endoscopy to diagnose and treat sports hernia has been proven to be very reliable for unsolved chronic groin pain (7,17,30) in high-performance athletes with a quick functional recovery from endoscopy and excellent long-term results. It is not the time since injury, but how soon the abdominal muscles recover that determines a quick return to sport activities. Most papers report full recovery for the open repair between 8 and 16 weeks.

Several techniques have been described ranging from laparoscopic herniorrhaphy (17, 19, 30, 46) with or without an interposition mesh to the classic or modified Bassini repair (8,10,11, 19,37,49,52,53) with or without elastic doubling of each abdominal layer.

Not many papers present the result of the classic bilateral Nesovic (5,8,38,49) procedure and even fewer papers document this technique combined with a bilateral adductor brevis and gracilis tenotomy (35).

The original Nesovic procedure describes a unilateral abdominal approach transferring the lateral rectus abdominus muscle towards Poupart's ligament hereby reducing Hasselbach's triangle and reinforcing the posterior inguinal wall. Taking the muscle imbalance theory in account, we believe that a unilateral approach of the problem would only enhance the muscle imbalance. In fact, the senior author has done unilateral approaches in the

past and had to operate the contra lateral side for persisting symptoms at a later stage (unpublished data). Recent papers confirm the importance of a bilateral approach (17,33).

Although one study shows a faster return to sports with a minimal repair technique in comparison with the modified Bassini repair (10), most authors advocate the use of the modified Bassini repair (5,11,19,20,52,53). This technique focuses on protection of the inguinal floor near the internal ring. Therefore, we believe that this is a valuable option in case of a genuine hernia with a tear in the conjoined tendon. The procedure we used is minimally invasive to the 'healthy' abdominal soft tissues reinsuring a quick recovery.

Although literature reports rates of associated adduction weakness as high as 40%, we found this condition in all our patients even after specialized physiotherapy. Several papers are written about the effect of releasing the adductor longus (18,37,42,47) versus the brevis and gracilis (35). Our experience supports the theory of releasing the brevis and gracilis rather than the adductor longus muscle because it does not leave the patient with a significant weakening of the adductor muscles and thereby a possible slower recovery. Some papers provide evidence that weakening of the adductor force does not influence an athlete's performance (1,2) and some papers provide excellent long term results with tenotomy of the adductor longus (37). On the other hand, in the experience of the senior author adductor longus tenotomy not only delays early recovery but appeared to be without benefit, especially in soccer players. Releasing the longus should be performed only in case of a true adductor longus tendonitis without any evidence of weakened abdominal muscles (36,45).

The literature describes success rates varying from 63% to 97%. In this study the authors have used a very strict criterion to define a patient as being successful. 81,8 % of the operated patients returned completely pain free to pre-operative competition level within 16 weeks. The questionnaire provides a useful reflection of the patient's pain and his/her impression about the final result (table VII,VIII). Three patients in the 'moderately successful' group had a VAS maximum of 2/10. This was the only

reason being in this suboptimal group and therefore having an overall success rate of 81,8 instead of 90,9 %. These patients were very happy with the end result but experienced a minor discomfort (VAS: 1 or 2/10) after competition and which disappeared spontaneously within a few hours.

The three patients being in the 'unsuccessful' group were unable to resume their pre-operative sport levels and remained painful. Two of them were the oldest of the patient's population and practiced their sport at a pre-operative less intensive level. The third patient had superficial wound infection which completely healed, but kept on complaining of his right groin. A MRI scan revealed a genuine hernia which was operated on by the general surgeon. The patient resumed sport activities at a lower level but still is not completely pain free.

10 years post-operatively 96.9% didn't experience any groin pain at all. 95% of patients who stopped their sport activities were free of pain till the end of their sports careers.

To the best of our knowledge, this study has the longest follow up (>10 years) to date for the bilateral Nesovic procedure combined with a bilateral adductor release. A comparable study of Messaoudi et al. (37) showed similar results performing a modified Bassini with a bilateral tenotomy of adductor longus tendon with an average follow up of 4 years.

All patients were operated by the same surgeon who used the same technique in every patient. No patient was lost to follow up. The patients' subjective opinion was gathered from the questionnaires.

This study is limited because of its limited number of patients. Second the hip joint was not routinely checked with imaging to exclude hip joint abnormalities. Third, it is not a randomized control trial to compare the results with other operative techniques.

More high quality RCT's between the different operation techniques seem to be necessary to obtain good scientific evidence for the best treatment of chronic groin pain in competitive athletes resistant to conservative treatment.

## CONCLUSION

A “sports hernia” by definition is caused by muscle imbalance between strong adductor muscles and a weakened posterior wall of the inguinal canal as a result of abdominal hyperextension and thigh hyper abduction, with the pivot point being at the pubic symphysis. Conservative treatment is very likely to fail and then surgery is mandatory for a select group of motivated high-performance athletes.

The bilateral Nesovic procedure combined with bilateral adductor brevis and gracilis release has a 81,8% chance to return the patient pain free (VAS=0) to the preoperative sport level within 16 weeks. 90,9% returned to a similar or higher sports level within 16 weeks but with 9% (N=3) having a minor discomfort (VAS=1 or 2/10) after competition, which disappeared spontaneously.

2 years after surgery 27 patients (81,8%) did not experience any discomfort at all. 3 patients had little pain (VAS $\leq$ 2) and 1 patient more pain (VAS $\geq$ 4) after training whereas 2 patients had pain during sports ( $\geq$ 5/10).

10 years after surgery 31 patients (93,9%) did not experience any groin pain anymore. 1 patient has little pain after training (VAS $\leq$ 2) and only 1 patient still experiences pain (VAS $\geq$ 5) after and during heavy work. 13 patients (39,3%) are still performing sports today, and 19 of 20 patients (95%) were pain free till the end of their career.

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## REFERENCES

1. **Akermark C, Johansson C.** Tenotomy of the adductor longus tendon in the treatment of chronic groin pain in athletes. *Am J sports Med.* 1992 ; 20 : 640-643.
2. **Atkinson HD, Johal P, Falworth MS, Ranawat VS, Dala-Ali B, Martin DK.** Adductor tenotomy: its role in the management of sports-related chronic groin pain. *Arch Orthop Trauma Surg.* 2010 Aug ; 130 :965-70.
3. **Balduini F.** Abdominal and groin injuries in tennis. *Clin Sports Med.* 1988 ; 7 : 349-357.
4. **Bradshaw C, McCrory P, Bell S et al.** Obturator nerve entrapment: a cause of groin pain in athletes. *Am J Sports Med.* 1997 ; 25 : 402-408.
5. **Brunet B, Brunet-Guedij E, Genty J, Comtet J.** A propos du traitement des pubalgies. *J Traumatol Sport.* 1984 ; 1 : 51-55.
6. **Christel P, Djian P, Roger B, Wittevoet J, Demarais Y.** Apport de l'IRM dans la stratégie du traitement chirurgicale des pubalgies. *J Traumatol Sport.* 1996 ; 13 : 95-101.
7. **Christel P, Djian P, Wittevoet J.** La pubalgie: un syndrome du sportif correspondant à une pathologie loco-régionale. *Rev Prat (Paris).* 1993 ; 43 : 729-732.
8. **Dojčinović B, Sebečić B, Starešinić M, Janković S, Japjec M, Čuljak V.** Surgical treatment of chronic groin pain in athletes. *Int Orthop.* 2012 ; 36 : 2361-5.
9. **Drew MK, Osmotherly PG, Chiarelli PE.** Imaging and clinical tests for the diagnosis of long-standing groin pain in athletes. A systematic review. *Phys Ther Sport.* 2014; 15: 124-9.
10. **Economopoulos KJ, Milewski MD, Hanks JB, Hart JM, Diduch DR.** Sports hernia treatment: modified bassini versus minimal repair. *Sports Health.* 2013 ;5:463-9.
11. **Ekstrand J, Ringborg S.** Surgery versus conservative treatment in soccer players with chronic groin pain: a prospective randomised study in soccer players. *Eur J Sports Traumatol Rel Res.* 2001 ; 23 : 141-145.
12. **Evans DS.** Groin pain in athletes (sports hernia): the transabdominal laparoscopic management. *BJS.* 1999 ; 86 : 20-21.
13. **Farber AJ, Wilckens JH.** Sports hernia: diagnosis and therapeutic approach. *J Am Acad Orthop Surg.* 2007 ; 15 : 507-14.
14. **Ferguson M, Patricios J.** What is the relationship between groin pain in athletes and femoroacetabular impingement? *Br J Sports Med.* 2014 ; 48 : 1074-5.
15. **Fournier JY, Richon CA.** Revue critique de 25 patients traits pour pubalgie par myorrhaphie inguinale (operation de Nesovic) *Helv Chir Acta.* 1992 ; 59 : 775-778.
16. **Fredberg U, Kissmayer-Nielsen P.** The sportsman's hernia-fact or fiction? *Scand J Med Sci Sports.* 1996 ; 6 : 201-204.
17. **Genitsaris M, Goulimaris I, Sikas N.** Laparoscopic repair of groin pain in athletes. *Am J Sports Med.* 2004 ; 32 : 1238-1242.
18. **Gill TJ, Carroll KM, Makani A, Wall AJ, Dumont GD, Cohn RM.** Surgical technique for treatment of recalcitrant adductor longus tendinopathy. *Arthrosc Tech.* 2014 ; 28 : 3 : 293-7.
19. **Gilmore OJ.** Gilmore's groin. *Sportsmed Soft Tissue Trauma.* 1992 ; 3 : 1 2-14.
20. **Gilmore OJ.** Groin pain in the soccer athlete: fact, fiction and treatment. *Clin Sports Med.* 1988 ; 17 , 4 : 787-793.
21. **Hackney RG.** The sports hernia: a cause of groin pain. *Brit J Sports Med.* 1993 ; 27(1) : 58-62.

22. **Hackney RG.** The sports hernia. *Sports Med Arthrosc Rev.* 1997 ; 5 : 320-325.
23. **Hanson P, Angerine M, Juhl L.** Osteitis pubis in sports activities. *Phys Sports Med.* 1978 ; 10 : 111-114.
24. **Harris NH, Murray RO.** Lesions of the symphysis in athletes. *BMJ.* 1974 ; 4 : 211-214.
25. **Hölmich P, Uhrskou P, Ulnits L, Kanstrup IL, Nielsen MB, Bjerg AM, Krosgaard K.** Effectiveness of active physical training as treatment for long-standing adductor-related groin pain in athletes: randomised trial. *Lancet.* 1999 ; 6 : 439-443.
26. **Ingoldby CJ.** Laparoscopic and conventional repair of groin disruption in sportsmen. *Br J Surg.* 1997 ; 84 : 213-215.
27. **Jansen JA, Mens JM, Backx FJ, Kolfshoten N, Stam HJ.** Treatment of longstanding groin pain in athletes: a systematic review. *Scand J Med Sci Sports.* 2008 ; 18 : 263-74.
28. **Jansen JA, Mens JM, Backx FJ, Stam HJ.** Diagnostics in athletes with long-standing groin pain. *Scand J Med Sci Sports.* 2008 ; 18 : 679-90.
29. **Kavanagh EC, Koulouris G, Ford S, McMahon P, Johnson C, Eustace SJ.** MR imaging of groin pain in the athlete. *Semin Musculoskelet Radiol.* 2006 ; 10 : 197-207.
30. **Kluin J, Hoed P, Linschoten R, Ijzerman J, Van Steensel C.** Endoscopic evaluation and treatment of groin pain in the athlete. *Am J Sports Med.* 2004 ; 32 : 944-949.
31. **Kopelman D, Kaplan U, Hatoum OA et al.** The management of sportsman's groin hernia in professional and amateur soccer players: a revised concept. *Hernia.* 2014 Nov 8.(Epub ahead of print).
32. **Macintyre J, Johson C, Schroeder EL.** Groin pain in athletes. *Curr Sports Med Rep.* 2006 ; 5 : 293-9.
33. **Maffulli N Loppini M, Longo UG, Denaro V.** Bilateral mini-invasive adductor tenotomy for the management of chronic unilateral adductor longus tendinopathy in athletes. *Am J Sports Med.* 2012 ; 40 : 1880-6.
34. **Malycha P, Lovell G.** Inguinal surgery in athletes with chronic groin pain: the 'sportsman's' hernia. *Aust NZ J Surg.* 1992 ; 62 : 123-125.
35. **Martens M, Hansen L, Mulier C.** Adductor tendinitis and rectus abdominus muscle tendopathy. *Am J Sports Med.* 1987 ; 15 : 353-356.
36. **Mei-Dan O, Lopez V, Carmont MR et al.** Adductor tenotomy as a treatment for groin pain in professional soccer players. *Orthopedics.* 2013 ; 36 : 1189-97.
37. **Messaoudi N, Jans C, Pauli S, Van Riet R, Declercq G, Van Cleemput M.** Surgical management of sportsman's hernia in professional soccer players. *Orthopedics.* 2012 ; 35 : 1371-5.
38. **Meyers WC, Foley DP, Garrett WE, Lohnes JH.** Management of severe lower abdominal or inguinal pain in high performance athletes. *Am J Sports Med.* 2000 ; 28 : 2-8.
39. **Minnich JM, Hanks JB, Muschaweck U, Brunt LM, Diduch DR.** Sports hernia: diagnosis and treatment highlighting a minimal repair surgical technique. *Am J Sports Med.* 2011 ; 39 : 1341-9.
40. **Möller MHL, Öberg BE, Gilquist J.** Stretching exercise and soccer: effects of stretching on range of motion in the lower extremity in connection with soccer training. *Int J Sports Med.* 1985 ; 6 : 50-52.
41. **Moyen B, Mainetti E, Sansone V, Pedotti E.** Il trattamento chirurgico della pubalgia resistente alla terapia conservativa. *Ital J Orthop Traumatol.* 1993 ; 19 : 43-49.
42. **Neuhaus P, Gabriel T, Maurere W.** Adduktoreninsertions-tenopathie, operative therapie und resultate. *Helv Chir Acta.* 1982 ; 40 : 667-670.
43. **Omar IM, Zoga AC, Kavanagh EC et al.** Athletic pubalgia and "sports hernia": optimal MR imaging technique and findings. *Radiographics.* 2008 ; 28 : 1415-38.
44. **Renstrom R, Peterson L.** Groin injuries in athletes. *Br J Sports Med.* 1980 ; 14 : 30-36.
45. **Robertson IJ, Curran C, McCaffrey N, Shields CJ, McEntee GP.** Adductor tenotomy in the management of groin pain in athletes. *Int J Sports Med.* 2011 ; 32 : 45-8.
46. **Rossidis G1, Perry A, Abbas H, Motamarry I et al.** Laparoscopic hernia repair with adductor tenotomy for athletic pubalgia: an established procedure for an obscure entity. *Surg Endosc.* 2015 ; 29 : 381-6.
47. **Schilders E, Dimitrakopoulou A, Cooke M, Bismil Q, Cooke C.** Effectiveness of a selective partial adductor release for chronic adductor-related groin pain in professional athletes. *Am J Sports Med.* 2013 ; 41 : 603-7.
48. **Simonet WT, Saylor HL, Sim L.** Abdominal Wall muscle tears in hockey players. *Int J Sports Med.* 1995 ; 16 : 126-128.
49. **Smoldlaka VN.** Groin pain in soccer players. *Phys Sports Med* 1980 ; 8 ; 57-61.
50. **Swan KG jr, Wolcott M.** The Athletic Hernia; a systematic review. *Clin Orthop* 455 ; 78-87.
51. **Taylor DC, Meyers WC, Moylan JA.** Abdominal musculature abnormalities as a cause of groin pain in athletes. *Am J Sports Med.* 1991 ; 19 : 239-242.
52. **Urquhart DS, Packer GJ, McLatchie GR.** Return to sport and patient satisfaction levels after surgical treatment of groin disruptions. *Sports Exerc Inj.* 1996 ; 19 : 239-243.
53. **Van Der Donckt K, Steenbrugge F, Van den Abbeele K, Verdonk R, Verhelst M.** Bassini's hernial repair and adductor longus tenotomy in the treatment of chronic groin pain in athletes. *Acta Orthop Belg.* 2003 ; 69 : 35-40.
54. **Verrall GM, Slavotinek JP, Fon GT.** Incidence of pubic bone marrow oedema in Australian rules football players: relation to groin pain. *Br J Sports Med.* 2001 ; 35 : 28-33.
55. **Weir A, Jansen J, van Keulen J, Mens J, Backx F, Stam H.** Short and mid-term results of a comprehensive treatment program for longstanding adductor-related groin pain in athletes: a case series. *Phys Ther Sport.* 2010 ; 11 : 99-103.
56. **Wiktorsson-Möller M, Öberg BE, Ekstrand J, Gillquist J.** Effects of warming up, massage and stretching on range of motion and muscle strength in the lower extremity. *Am J Sports Med.* 1983 ; 11 : 249-252.