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Cochrane Database of Systematic Reviews 2013, Issue 6. Art. No.: CD009565.

DOI: [10.1002/14651858.CD009565.pub2](https://doi.org/10.1002/14651858.CD009565.pub2).

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[Intervention Review]

Conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain

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ABSTRACT

Background

Musculoskeletal, ligamentous and osseous groin injuries are common in athletes and may result in a delay of several months to resume sports. Even then, this may not be at the former level of sport activity. The treatment of exercise-related groin pain is mainly conservative (non-surgical), using interventions such as exercises, electrotherapy, manual therapy and steroid injections.

Objectives

To assess the effects (benefits and harms) of conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain.

Search methods

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (December 2011); the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 4); MEDLINE (1948 to November week 3 2011); EMBASE (1980 to Week 49 2011); CINAHL (1982 to December 2011); LILACS (1982 to December 2011); PEDro (1929 to December 2011), SPORTDiscus (1985 to December 2011), OTseeker (to December 2011), reference lists of papers and conference proceedings (2000 to 2011).

Selection criteria

Randomized controlled trials and quasi-randomized controlled trials evaluating conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain were included. Studies comparing conservative with surgical treatments were excluded.

Data collection and analysis

Two review authors independently extracted data and conducted risk of bias assessments. There was no pooling of data.

Main results

Two studies, involving a total of 122 participants who had experienced adductor-related groin pain for at least two months, were included in this review. All but one of the participants were male athletes aged between 18 and 50 years old. Both studies were assessed as 'high risk of bias' for at least one source of bias domain. The 'successful treatment' outcome reported in both studies was based primarily on pain measures.

Conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain (Review)**1**

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One study, based on an intention-to-treat analysis, found a significant difference favouring exercise therapy (strengthening with an emphasis on the adductor and abdominal muscles and training muscular co-ordination) compared with 'conventional' physiotherapy (stretching exercises, electrotherapy and transverse friction massage) in successful treatment at 16-week follow-up (25/34 (74%) versus 10/34 (29%); risk ratio (RR) 2.50, 95% CI 1.43 to 4.37, $P = 0.001$). Similarly, of those followed-up significantly more athletes treated by exercise therapy returned to sport at the same level (23/29 (79%) versus 4/30 (13%); RR 5.95, 95% CI 2.34 to 15.09, $P = 0.0002$). Although still favouring the exercise group, the differences between the two groups in patients' subjective global assessment at 16 weeks and successful treatment at 8 to 12 years follow-up were not statistically significant.

The second study (54 participants) found no significant differences at 16-week follow-up between a multi-modal treatment (heat, manual therapy and stretching) and exercise therapy (the same intervention as in the above study) for the outcomes of successful treatment (14/26 (54%) versus 12/22 (55%); RR 0.99, 95% CI 0.59 to 1.66, $P = 0.96$) and return to full sports participation (13/26 (50%) versus 12/22 (55%); RR 0.92, 95% CI 0.53 to 1.58, $P = 0.75$). Those returning to full sports participation returned on average 4.5 weeks earlier after receiving multi-modal therapy (mean difference -4.50 weeks, 95% CI -8.60 to -0.40, $P = 0.03$) than those in the exercise therapy group. This study reported that there were no complications or side effects found in either intervention group.

Authors' conclusions

The available evidence from the randomized trials is insufficient to advise on any specific conservative modality for treating exercise-related groin pain. While still low quality, the best evidence is from one trial which found that exercise therapy (strengthening of hip and abdominal muscles) in athletes improves short-term outcomes (based primarily on pain measures) and return to sports compared with physiotherapy consisting of passive modalities. Given the low quality of the available evidence from both included trials, further randomized trials are necessary to reinforce their findings.

PLAIN LANGUAGE SUMMARY

Conservative treatment for exercise-related groin pain

Exercise-related groin pain is common in sports especially those involving running, kicking and changing directions, such as in soccer and hockey. Athletes may have a delay of several months before being able to resume the sport, and this may not be at their former level of sports activity. Usually the treating clinician deals with the coexistence of two or more disorders, such as muscle, tendon and ligament strains and a bony stress reaction. Conservative interventions are generally the first choice for treatment and include an initial period of rest; strengthening of the muscles stabilising the pelvis and hip joints; stretching the hip muscles; electrotherapy (for example, transcutaneous electrical stimulation (TENS), laser and ultrasound therapy); manual therapy; non-steroidal anti-inflammatory drugs; steroidal injections or prolotherapy (injection of growth factor production stimulants to induce growth and repair of normal tissue).

Two randomized controlled trials, involving a total of 122 athletes with exercise-related groin pain, were included in this review. Participants were aged between 18 and 50 years and all but one were male. They had had groin pain for at least two months. One trial demonstrated positive results in athletes treated by exercise therapy (strengthening of hip and abdominal muscles, and training muscular co-ordination) in comparison with 'conventional' physiotherapy consisting of passive modalities (stretching exercises, electrotherapy and transverse friction massage) 16 weeks after the end of treatment, for 'successful treatment' (based primarily on pain measures) and for the rate of return to sports at the same level without groin pain. The second study compared multi-modal treatment (heat, manual therapy and stretching) with exercise therapy and found no significant difference between groups for 'successful treatment' and return to sports, but did show an earlier return to sport for those athletes who achieved this outcome following the multi-modal treatment.

The available evidence is exclusively related to athletes and is limited because of the low number of studies and low number of participants for each outcome. Further randomized controlled trials are needed to ratify these results.

BACKGROUND

Description of the condition

Musculotendinous, ligamentous and osseous (bony) groin pain is related to and aggravated by exercise and is characterized by overuse (Lynch 1999; Orchard 2000; Pizzari 2008). Given this link, we generally use the term 'exercise-related groin pain' to describe this injury. Potential contributing factors towards the etiology of this injury are muscle imbalances between the abdominal wall musculature and the hip adductor muscles that, combined with excessive loads, result in an abnormal distribution of forces in this region (Pizzari 2008; Rabe 2010). Hip adduction involves moving the legs together. The converse movement is hip abduction, where the legs are moved apart. The primary adductor muscles of the hip are the pectineus, adductor longus, gracilis, adductor brevis and adductor magnus, while the primary hip abductor muscles include the gluteus medius, gluteus minimus and the tensor fasciae latae (Neumann 2010). It has been demonstrated that restricted hip range of motion (Verrall 2005a; Verrall 2007a), greater hip abductor to adductor muscle strength ratio, or adductor weakness (Engelbrechtsen 2010; Maffey 2007) may be important risk factors for the development of groin pain.

Currently there is no recommendation in the literature regarding the definition of groin pain, which makes the diagnosis of this condition a challenge for clinicians (Hölmich 2007; Jansen 2008a). Usually the clinician deals with the coexistence of two or more disorders, such as adductor strains and pubic bone-related dysfunction, which are the most frequent musculoskeletal causes of exercise-related groin pain (Ekberg 1988; Hölmich 2007; Lloyd-Smith 1985). Any type of hernia, sacroiliac dysfunction, piriformis syndrome, nerve entrapments, lumbar spine, gynaecological or urological diseases, and hip pathologies must first be excluded (Jansen 2008a; Machotka 2009). The most common symptoms are pain and tenderness on palpation of the pubis symphysis and tubercle, which may be referred to the surrounding area including the lower abdominal musculature and adductors, as well as pain provoked by resisted adduction (Hölmich 2004; Verrall 2005b). After clinical evaluation, magnetic resonance imaging (MRI) has been suggested as an important diagnostic tool to visualize any abnormalities of the involved structures (Jansen 2008a).

Musculotendinous, ligamentous and osseous groin pain is related to sports, especially those that involve running, kicking, changing directions, twisting and cutting, such as soccer and hockey (Ekstrand 1999; Emery 1999; Paajanen 2011a). Among male soccer players, the incidence of groin pain is between 8% to 12% per year (Ekstrand 1999; Hawkins 2001; Paajanen 2011a). A study conducted during the Australian Football League season indicated that this condition was responsible for players missing many games, at a cost of AUD 1.7 million in player unavailability during this period (Pizzari 2008).

The prognosis of exercise-related groin pain is not straightforward and patients may wait more than six months to return to practicing sports without restrictions (Hölmich 1999; Weir 2010). It is not unusual for athletes to play with some symptoms even 24 weeks after the end of treatment, and the rate of failure to return to their prior level of sports function can reach more than 25% (Verrall 2007b; Weir 2011).

The treatment of exercise-related groin pain is not well-established in the literature (Jansen 2008b), but conservative modalities, such as physical therapy, are usually tried before surgery is considered. Conservative treatment appears to be a safe, low-cost and accessible option for patients with exercise-related groin pain.

Description of the intervention

Conservative treatment is generally based on an initial period of rest or modification of sports activities, pharmacotherapy and physical therapy, which may involve electrotherapy modalities, manual therapy (a clinical approach utilizing a hands-on technique to treat soft tissues and joint structures (Carnes 2010), including but not limited to manipulation or mobilization), and mainly the strengthening of the abdominal and hip muscles to improve core stability (Verrall 2007b; Vitanzo 2001; Williams 2000). Although exercise therapy appears to be effective, a standardized protocol does not exist and the exercises are usually prescribed based on the therapist's experience (Machotka 2009). When initial conservative treatment fails, steroid injections and dextrose prolotherapy (a technique which involves the injection of growth factor production stimulants to induce growth and repair of normal tissue (Topol 2005)) may be used (Jansen 2008b).

How the intervention might work

As exercise-related groin pain is defined as being the result of overuse, a period of rest and reduction of activities that place high loads on the groin region are proposed in order to re-establish the zone of homeostasis (Pizzari 2008). Improving the hip range of motion, specifically internal and external rotation, has been proposed as a possible method to reduce stress across the pubic symphysis and surrounding structures (Verrall 2005a; Verrall 2007a).

Muscular imbalances between abdominal and hip muscles may contribute towards overloading and loss of optimal functional stability of the groin region (Hölmich 1999). The adductors are essential stabilisers of the pelvis in activities such as running, pivoting and kicking, and these are almost always activated, together with the gluteus, hamstrings and abdominal muscles (Biedert 2003). Thus, it may be possible that improving control of and strengthening the abdominal (Cowan 2004) and hip stabilising muscles may improve the functional stability of the pelvis and therefore restore the functional unit of the groin region.

Why it is important to do this review

Musculoskeletal, ligamentous and osseous groin injuries are common in athletes (Ekstrand 1999; Hawkins 2001; Paajanen 2011a) and have a large economic impact since patients may need more than six months for full return to sports (Hölmich 1999; Weir 2010). There are no recommendations in the literature nor consensus about the effectiveness of the conservative therapeutic approaches (Jansen 2008b; Machotka 2009). This uncertainty motivated us to conduct this systematic review which, through the use of rigorous methods and a comprehensive and up-to-date search, may help to provide the information needed to support decision making.

OBJECTIVES

To assess the effects (benefits and harms) of conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials (RCTs) and quasi-randomized (method of allocating participants to a treatment which is not strictly random, for example by date of birth, hospital record number or alternation) controlled trials evaluating conservative interventions for treating exercise-related musculotendinous, ligamentous and osseous groin pain were included.

Types of participants

People with a diagnosis of exercise-related groin pain caused by pubic bone-related dysfunction, enthesopathy or muscles strains, established by the primary studies, were included. Excluded were groin pain from any type of hernia, sacroiliac dysfunction, piriformis syndrome, nerve entrapments, lumbar spine, gynaecological or urological diseases, and hip pathologies.

Types of interventions

Included were all forms of conservative treatment for exercise-related groin pain, such as strengthening of the muscles stabilising the pelvis and hip joints, stretching of the hip muscles, electrotherapy (for example, laser and ultrasound therapy), manual therapy, non-steroidal anti-inflammatory drugs (NSAIDs), steroidal injections or prolotherapy. The interventions could be single interventions or complex interventions, such as programmes incorporating different types of exercises or combinations of different interventions. Studies comparing conservative with surgical treatments were excluded.

Our main comparisons were:

- conservative intervention (single or complex intervention) versus placebo intervention;
- one conservative intervention (single or complex intervention) versus another conservative intervention (single or complex intervention).

All of the interventions could be set in the context of other interventions being provided to all trial participants.

Types of outcome measures

Primary outcomes

1. Pain relief at rest, on palpation and during physical activity (visual analogue scale, numeric rating scale, and others)
2. Function (Short Form-36 (SF-36) physical component, and others)
3. Successful treatment

Secondary outcomes

1. Patient subjective global assessment (for example, classified as much better, better, not better, worse and much worse)

2. Return to sports or normal activities
3. Adverse events (e.g. burns from cryotherapy, reports of severe discomfort from or intolerance of interventions)

If possible, the outcomes were evaluated in the short term (four to six weeks after the end of treatment, for example); mid-term (12 to 16 weeks after the end of treatment, for example), and long term (one year after the end of treatment, for example).

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (December 2011); the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2011, Issue 4); MEDLINE (1948 to November week 3 2011); EMBASE (1980 to Week 49 2011); CINAHL (1982 to December 2011); *Latin American and Caribbean Health Sciences* (LILACS) (1982 to December 2011); PEDro, the Physiotherapy Evidence Database (1929 to December 2011); SPORTDiscus (1985 to December 2011); and OTseeker, the Occupational Therapy Systematic Evaluation of Evidence Database (to December 2011). No language restrictions were applied.

The subject-specific strategy was combined with the sensitivity-maximizing version of the Cochrane highly sensitive search strategy (Lefebvre 2011) to identify randomized trials in MEDLINE. Complete search strategies are shown for CENTRAL, MEDLINE, EMBASE and LILACS in [Appendix 1](#).

We searched [Current Controlled Trials](#) for ongoing studies.

Searching other resources

We contacted professional experts in this field and searched reference lists of papers and conference proceedings (2000 to 2011), such as of the American College of Sports Medicine Annual Meetings; American Physical Therapy Association; American Academy of Physical Medicine and Rehabilitation Annual Assembly; Canadian Physiotherapy Association Annual Congresses; Australian Physiotherapy Association Conferences.

Data collection and analysis

The intended methodology for data collection and analysis was described in our published protocol (Almeida 2012), which was based on the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Selection of studies

Two review authors (MOA and BNGS) independently selected and assessed potentially eligible articles for inclusion in the review. Any disagreements were discussed and resolved by consensus. Where necessary, a third author (MSP) acted as adjudicator. There was no blinding of authors, institution or journal of publication at any stage.

Data extraction and management

Two review authors (MOA and RBA) independently extracted data from selected articles using a standard extraction form. Data extracted included study methods, the characteristics of participants, interventions, outcome measures and results. When necessary, requests were sent to trial authors for additional information or data.

Data entry into RevMan was by three review authors (MOA, BNGS, RBA).

Assessment of risk of bias in included studies

As recommended by The Cochrane Collaboration (Higgins 2011), two review authors (MOA and RBA) independently assessed the risk of bias for each included study. Disagreements were resolved by a third review author (MSP). The following domains were evaluated for risk of bias: random sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessment; incomplete outcome data; selective outcome reporting; and other sources of bias. Risk of bias for the individual domains was assessed as either 'low risk of bias', 'high risk of bias' or 'unclear risk of bias'.

Measures of treatment effect

Dichotomous outcome data were expressed as risk ratios (RR), with 95% confidence intervals. For continuous outcomes, mean differences (MD) were used if the studies use the same instrument of evaluation. However, if the primary trials assessed the same variables using different scales, we planned to use the standardized mean difference (SMD). The estimated effects were reported together with the 95% confidence intervals (95% CI).

Unit of analysis issues

The unit of analysis was based on the individual patient. Due to the biological and epidemiological characteristics of exercise-related groin pain, cluster randomized controlled trials and cross-over randomized controlled trials were not expected.

Dealing with missing data

For missing data (for example, publication bias, outcome not measured, incomplete reporting, lack of intention-to-treat analysis, attrition from the study) we planned to adopt the following strategies.

- Whenever possible, we would contact the original investigators to request missing data.
- Make explicit the assumptions of any methods used to cope with missing data, for example, that the data were assumed to be missing at random, or that missing values were assumed to have a particular value such as a poor outcome.
- Perform sensitivity analyses to determine how sensitive the results were to reasonable changes in the assumptions that were made.
- Address the potential impact of missing data on the findings of the review in the Discussion section.

Assessment of heterogeneity

We planned to assess heterogeneity by visual inspection of the forest plot (analysis) along with consideration of the Chi² test for

heterogeneity (with a level of significance of $P < 0.1$) and the I^2 statistic. We considered that there was probably substantial heterogeneity where $I^2 > 50\%$.

Assessment of reporting biases

We planned to assess the likelihood of publication bias using funnel plots, if there were at least 10 trials contributing to a primary outcome.

Data synthesis

In the absence of significant clinical and statistical heterogeneity, we planned to use a fixed-effect model and 95% confidence intervals for pooling the results of trials testing comparable interventions. However, if we had found diversity in clinical or methodological characteristics, or unexplained heterogeneity, we would have considered using a random-effects model for analysis. Where possible, we planned to perform intention-to-treat analysis.

Subgroup analysis and investigation of heterogeneity

If data had been available, we planned to investigate heterogeneous results for specific patient groups, performing subgroup analyses according to gender, duration of symptoms, and activity (recreational versus professional athletes). We planned to investigate whether the results of subgroups were significantly different by inspecting the overlap of confidence intervals and performing the test for subgroup differences that is available in RevMan.

Sensitivity analysis

Where possible, we planned sensitivity analyses examining various aspects of study and review methodology, such as the inclusion or not of studies at high risk of bias (specifically from lack of allocation concealment, assessor blinding, and incomplete outcome data) and inclusion or not of trials only reported in abstracts. We also planned to conduct sensitivity analyses to look at the effects of missing data.

RESULTS

Description of studies

Results of the search

For our search, completed in December 2011, we screened a total of 1549 records from the following databases: Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (3 records); CENTRAL (142), MEDLINE (405), EMBASE (466), CINAHL (15), LILACS (12), PEDro (9), SPORTDiscus (409), OTseeker (1), and Current Controlled Trial (87). After discarding duplicates and obviously ineligible references, 37 references remained. Of these, 30 were excluded because they were clearly not reports of randomized controlled trials. The study flow diagram is presented in [Figure 1](#).

Figure 1. Flow diagram showing the reference screening and study selection.

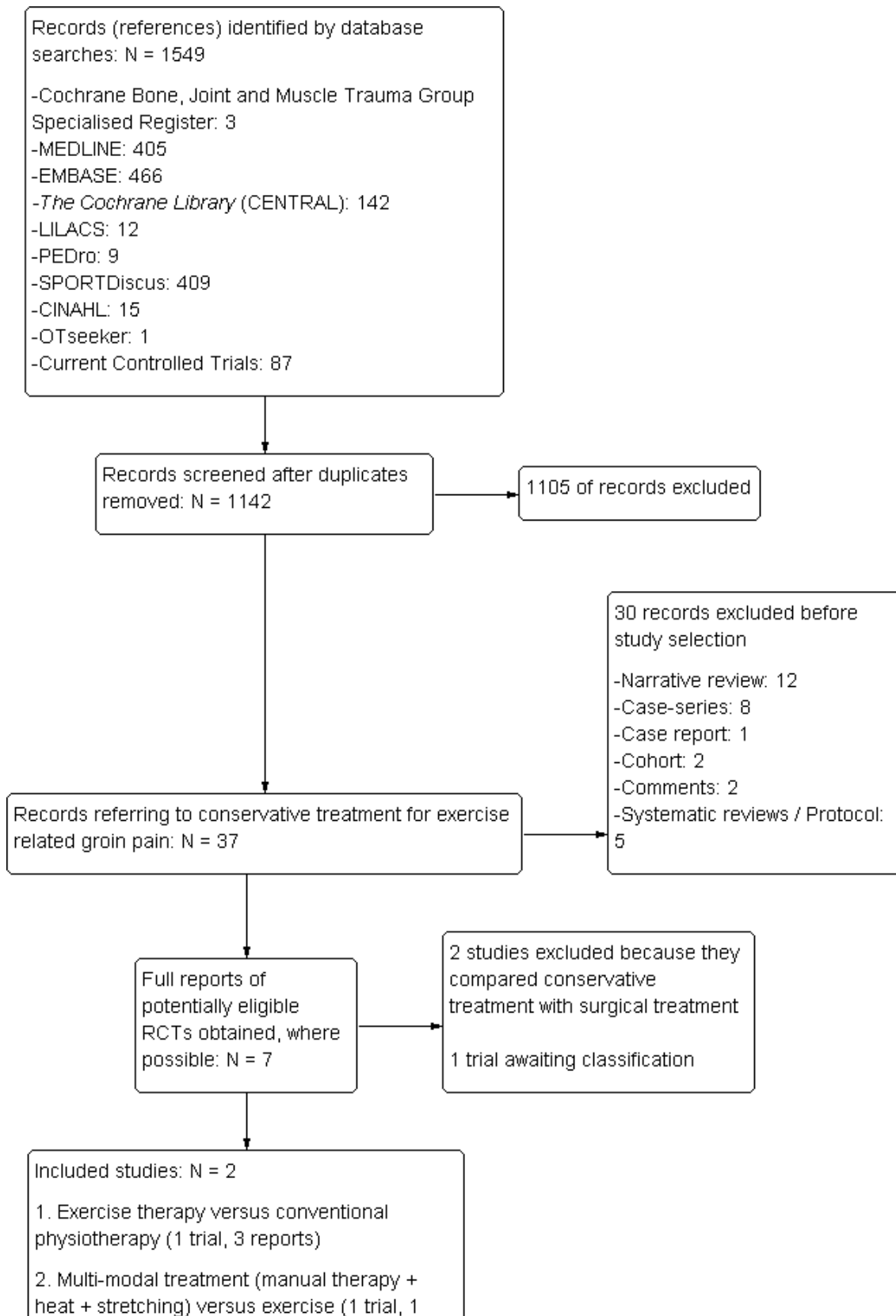


Figure 1. (Continued)

2. Multi-modal treatment (manual therapy + heat + stretching) versus exercise (1 trial, 1 report)

Where possible, full reports were obtained for the seven potentially eligible studies. Upon study selection, two were included ([Hölmich 1999](#); [Weir 2011](#)), two were excluded ([Ekstrand 2001](#); [Paajanen 2011](#)), and one is awaiting classification ([Backx 2009](#)). The other two articles were additional reports of [Hölmich 1999](#); one was a conference abstract and the other ([Hölmich 2011](#)) was a longer-term follow-up (eight to 12 years after the original study).

Thus, overall there were two included trials, two excluded studies and one study awaiting classification.

Included studies

Both studies included in the review ([Hölmich 1999](#); [Weir 2011](#)) were randomized clinical trials reported in English language journals. They recruited a total of 122 athletes, all with adductor-related groin pain of at least two months duration.

[Hölmich 1999](#) recruited 68 male athletes aged between 18 and 50 years. The study was carried out in Copenhagen (Denmark). [Hölmich 1999](#) compared exercise therapy (strengthening with emphasis on the adductor and abdominal muscles, and training muscular co-ordination) with conventional physiotherapy consisting of passive modalities (transverse friction massage, laser therapy, transcutaneous electrical nerve stimulation (TENS), and stretching of adductor, hamstring and hip muscles). The outcomes assessed were 'successful treatment' (based on pain measures), patients' subjective global assessment, and return to sports at the same level without groin pain. [Hölmich 1999](#) reported on the outcomes at four months and, in another report ([Hölmich 2011](#)), at eight to 12 years.

[Weir 2011](#) recruited 53 male athletes and one female athlete aged between 18 and 50 years. The study was carried out in Leidschendam (Netherlands). The study compared multi-modal treatment (consisting of heat followed by manual therapy and stretching of adductor muscles) with exercise therapy (this was the

same programme as in [Hölmich 1999](#): strengthening with emphasis on the adductor and abdominal muscles, and training muscular co-ordination). The outcomes assessed were 'successful treatment', maximum pain during sports, return to sports at the same level without groin pain, time to return to sports, and adverse effects. [Weir 2011](#) reported on the outcomes at 16 weeks.

For further details about the included studies, see the [Characteristics of included studies](#).

Excluded studies

Two studies ([Ekstrand 2001](#); [Paajanen 2011](#)) were excluded because they compared conservative treatment with surgical treatment (see the [Characteristics of excluded studies](#)).

Studies awaiting classification

[Backx 2009](#) aimed to randomize 80 male athletes with groin pain for at least six weeks to receive either pelvic-stabilising muscle training or usual care. The outcomes measures listed in the trial registration document are pain, general disability, global change, sport participation, time to return to full athletic activity and recurrences of the same complaints. Participants were evaluated after the period of treatment and 26 and 52 weeks after the start of treatment. Although the trial is indicated as completed in the trial registration document, contact with the trial investigator by email revealed this was not the case and that, in consequence, the trial results have not been published ([Backx 2013](#)).

For more details, see the [Characteristics of studies awaiting classification](#).

Risk of bias in included studies

Details of the risk of bias assessment for each trial are shown in the [Characteristics of included studies](#), and the judgements are shown visually in [Figure 2](#).

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Hölmich 1999	+	+	-	?	?	?	-
Weir 2011	+	+	-	?	?	?	+

Allocation

Randomization

Hölmich 1999 and Weir 2011 clearly reported that the process of randomization involved sequentially numbered opaque envelopes, and were classified as 'low risk of bias'.

Allocation concealment

As both Hölmich 1999 and Weir 2011 used envelopes independently administered by a secretary, they were judged at low risk of selection bias relating to allocation concealment.

Implementation

Hölmich 1999 reported a statistically significant (P = 0.008) and clinically important difference in the baseline proportions of participants with bilateral groin pain in the two groups (5/34 (15%) versus 15/34 (44%)). Hölmich 1999, however, reported that the findings for the 'successful treatment' outcome remained statistically significant for the exercise group when this was adjusted for using either univariate or multiple logistic-regression analysis. In Weir 2011, the allocation was implemented successfully

because no significant difference was found in the baseline characteristics of the treatment groups. Our judgements for selection bias thus remained unaltered.

Blinding

Performance bias

Both studies (Hölmich 1999; Weir 2011) were considered to have high risk of bias because blinding of participants and therapists was not possible due to the nature of the interventions. Therefore, this bias was unavoidable.

Detection bias

In Hölmich 1999 and Weir 2011, the examining physicians were unaware of the treatment allocation, but there were subjective outcomes (that is, successful treatment, patients' subjective global assessment) that meant that the participants, who were not blinded, were the key outcome assessors. Hence both studies were considered as 'unclear risk of bias'.

Incomplete outcome data

[Hölmich 1999](#) was classified as at 'unclear risk of bias' since the analyses were not entirely intention-to-treat analyses; the assumptions for the missing participants in the intention-to-treat analysis for the outcome 'successful treatment' were not described. A per protocol analysis was performed for the other outcomes (patients' subjective global assessment and return to sports at the same level without groin pain). The percentage of participants lost at 16 weeks follow-up was 13% (9/68), and 31% (21/68) at eight to 12 years. Patient flow within the study was clear, missing data were balanced across groups, and reasons for missing data were provided. However, the characteristics of lost participants were not described.

[Weir 2011](#) was also classified as 'unclear risk of bias' because it used a per protocol analysis. Despite the percentage of participants lost to follow-up being quite small (6/54 (11%)), and missing data being well reported and balanced across groups (three participants in each group), the characteristics of lost participants were not reported.

Selective reporting

Despite the absence of suspected selective outcome reporting, [Hölmich 1999](#) and [Weir 2011](#) were classified as 'unclear risk of bias' because neither study evaluated function, a clinically relevant primary outcome. Furthermore, data from the short-term follow-up were not reported in the publications of both included studies. On contact, authors of both studies reported that these data were not available ([Hölmich 2012](#); [Weir 2012](#)). These issues can be considered a potential source of reporting bias.

Other potential sources of bias

In [Hölmich 1999](#), there was no explicit information from participants about supplementary treatment and physical activity during the follow-up period (eight to 12 years) and the study was therefore considered as 'high risk of bias' for this follow-up outcome. [Weir 2011](#) appeared to be free of other sources of bias and was classified as 'low risk of bias'.

Effects of interventions

Given that the two included studies evaluated different comparisons, these are presented separately below.

Both studies reported on 'successful treatment'. This outcome was assessed based on the following measures: no pain at palpation of the adductors tendon or during resisted adduction; no pain in connection with or after athletic activity in the same sport and at the same level of competition; and return to sports at the same level without groin pain. If all three measures were reached, the result was labelled excellent; if two measures were reached, the result was good; if one measure was reached, the result was fair; and if no measures were reached, the result was poor. Successful treatment was considered for results labelled as excellent and good in the included studies. Given this outcome was based primarily on pain measures, we included this under our intended primary outcome of pain relief at rest, on palpation and during physical activity (visual analogue scale, numeric rating scale, and others).

Exercise therapy versus conventional physiotherapy

Primary outcomes

Pain relief at rest, on palpation and during physical activity

[Hölmich 1999](#) reported 'successful treatment' at follow-up at 16 weeks using an intention-to-treat analysis, which showed significantly better results in the exercise group (25/34 (74%) versus 10/34 (29%); risk ratio (RR) 2.50, 95% CI 1.43 to 4.37, $P = 0.001$) (see [Analysis 1.1](#)). This difference was not maintained at eight to 12 years follow-up (21/24 versus 18/23; RR 1.12, 95% CI 0.86 to 1.45, $P = 0.41$). As [Hölmich 1999](#) used a per protocol analysis in this follow-up, we carried out a sensitivity analysis to test the differences using an intention-to-treat analysis, where a poor outcome was assumed for the missing participants of both groups. This, likewise, showed no statistically significant difference between the two groups (RR 1.17, 95% CI 0.77 to 1.76, $P = 0.46$).

Function

[Hölmich 1999](#) did not report this outcome.

Secondary outcomes

Patients' subjective global assessment

In [Hölmich 1999](#), the participants were asked about their groin problems compared with their situation before the treatment. At the 16-week follow-up, all participants of the exercise therapy group reported that they were 'much better' or 'better', whereas only 27 out of 30 reported this in the physiotherapy group. The difference between the two groups for this outcome was not statistically significant either using a per protocol analysis (29/29 (100%) versus 27/30 (90%); RR 1.11, 95% CI 0.97 to 1.97, $P = 0.13$) (see [Analysis 1.2](#)) or a sensitivity analysis where it was assumed that all missing participants had a poor outcome (RR 1.07, 95% CI 0.86 to 1.34, $P = 0.53$).

Though the results still tended to favour the exercise group, a similar lack of statistically significant differences between the two groups was found at long-term follow-up, either using a per protocol analysis (20/24 versus 16/23; RR 1.20, 95% CI 0.87 to 1.66, $P = 0.27$) (see [Analysis 1.2](#)) or a sensitivity analysis (intention-to-treat analysis) where missing participants were assumed to have a poor outcome (RR 1.25, 95% CI 0.79 to 1.97, $P = 0.34$).

Return to sports in the same level without pain

In [Hölmich 1999](#), the proportion of athletes who returned to sports at the same level without pain after 16 weeks was significantly higher in the exercise therapy group (23/29 (79%) versus 4/30 (13%); RR 5.95, 95% CI 2.34 to 15.09, $P = 0.0002$) (see [Analysis 1.3](#)). In the sensitivity analysis (intention-to-treat analysis where missing participants were assumed not to have returned to sports), the difference between groups remained statistically significant in favour of the exercise therapy group (RR 5.75, 95% CI 2.23 to 14.86, $P = 0.0003$).

Adverse events

[Hölmich 1999](#) did not report this outcome.

Uptake of treatment

[Hölmich 1999](#) reported that the median number of treatments in terms of physiotherapy attendance was 15 in the exercise group and 14 in the physiotherapy group.

Multi-modal therapy versus exercise therapy

Primary outcomes

Pain relief at rest, on palpation and during physical activity

Weir 2011 found no significant difference between the two groups in the achievement of 'successful treatment', see above definition (14/26 (54%) versus 12/22 (55%); RR 0.99, 95% CI 0.59 to 1.66, $P = 0.96$) (see [Analysis 2.1](#)). The same finding applied for a sensitivity (intention-to-treat) analysis where the three lost to follow-up in each group were assumed to have had unsuccessful treatment (RR 1.01, 95% CI 0.6 to 1.71, $P = 0.96$).

Weir 2011 also reported the maximum pain during sports (visual analogue score, 0 to 100: worst pain) in the 25 participants who had returned to full sports participation. While favouring exercise therapy, the difference between the two groups for this subgroup was not statistically significant (MD 15.10, 95% CI -7.29 to 37.49, $P = 0.19$) (see [Analysis 2.2](#)).

Function

Weir 2011 did not report this outcome.

Secondary outcomes

Patients' subjective global assessment

Weir 2011 did not report this outcome.

Return to sports in the same level without pain

Weir 2011 found no statistically significant difference between the two groups in the numbers who returned to full sports participation (13/26 (50%) versus 12/22 (55%); RR 0.92, 95% CI 0.53 to 1.58, $P = 0.75$) ([Analysis 2.3](#)). The same finding applied for a sensitivity analysis where the three in each group lost to follow-up were assumed not to have returned to full sports participation (RR 0.93, 95% CI 0.53 to 1.66, $P = 0.82$). However, the trial participants in the multi-modal group who returned to full sports participation took significantly less time to do so than those in the exercise group (12.6 weeks versus 17.3 weeks; MD -4.5 weeks, 95% CI -8.60 to -0.40, $P = 0.03$) (see [Analysis 2.4](#)).

Adverse events

Weir 2011 reported that there were no complications or side effects found in either intervention group.

Uptake of treatment

Weir 2011 noted that in the multi-model group, 11 athletes received one treatment and 15 received two treatments. In the exercise group, the mean number of sessions performed was 75% of the programme. They reported that there was no correlation between the dose of treatment and outcome in either group.

DISCUSSION

Summary of main results

The available evidence is limited to two small trials, each of which compared a different comparison. Together the two studies involved 122 participants who had experienced adductor-related groin pain for at least two months. All participants were young male athletes, except for one female athlete.

Evidence from Hölmich 1999 (68 participants) showed that exercise therapy produced significantly better results at 16 weeks follow-up than conventional physiotherapy consisting of passive modalities (stretching exercise, electrotherapy and transverse friction massage) for the outcomes of 'successful treatment' (based primarily on pain measures) and return to sports at the same level without groin pain. Although still favouring the exercise group, the differences between the two groups in patient's subjective global assessment and 'successful treatment' at eight to 12 years follow-up were not statistically significant.

The second study (54 participants) found no significant differences at 16 weeks follow-up between a multi-modal treatment and exercise therapy for the outcomes of 'successful treatment' and return to full sports participation. For those returning to full sports participation, Weir 2011 found no significant difference in the maximum pain experienced at 16-week follow-up. However, athletes receiving multi-modal treatment returned on average 4.5 weeks earlier than those treated by exercise therapy. Weir 2011 reported that there were no complications or side effects found in either intervention group.

Overall completeness and applicability of evidence

When interpreting the findings of this review one should be aware of the characteristics of the participants, the types of interventions and the outcomes assessed. The participants were predominantly young male athletes; only one was female. Therefore the evidence found cannot be generalized for both genders because of their anatomical and physiological differences. The high prevalence of male participants was expected because groin pain is more common in sports practiced more by males than females, such as soccer and hockey (Ekstrand 1999; Emery 1999; Paajanen 2011a). The evidence is strengthened by the consistency between the two trials in the population, the exercise intervention and outcome assessment. However, 'successful treatment' as defined in these two trials is a crude and non-validated measure for assessing outcome.

In clinical practice, physical therapists commonly treat patients with groin pain with the interventions used in the included studies. The studies did not use a single intervention but rather one therapeutic modality in combination with others. This approach is widely used for treating chronic musculoskeletal conditions. It is important to note that, despite the limited evidence, the exercise therapy based on strengthening and co-ordination exercises appears to be more effective than a more passive treatment (stretching, electrotherapy and transverse friction massage) (Hölmich 1999). Strengthening abdominal and hip muscles seems reasonable because muscular imbalance may contribute to functional instability of the pelvis and the groin region (Cowan 2004).

Quality of the evidence

Neither study was assessed as 'low risk of bias' in all domains. It is encouraging to note that both included studies (Hölmich 1999; Weir 2011) reported quite clearly the process of sequence generation and allocation concealment, and were thus classified as at low risk of selection bias. For the domains of detection bias, attrition bias and reporting bias, there was insufficient information to judge the included studies, and so they were considered at 'unclear risk of bias'. Both studies were assessed as at high risk of performance

bias because the nature of the interventions made blinding of participants and personnel impossible. Although this source of bias is unavoidable, it still should be recognized and reported. We judged the long-term follow-up outcomes for [Hölmich 1999](#) at high risk of other bias because of the lack of information about the trial participants' supplementary treatments and physical activity during this follow-up period.

Both studies were small and the available evidence cannot be considered conclusive. While the results for [Hölmich 1999](#) are strongly in favour of exercise compared with conventional physiotherapy for 'successful treatment', with a 79% return to sports at 16 weeks, [Weir 2011](#) found only 55% in their exercise group had returned to full sports by 16 weeks. The imbalance between groups in the baseline incidence of bilateral groin pain in [Hölmich 1999](#) favoured the exercise group and, as shown in [Hölmich 1999](#), is likely to have exaggerated the effect size. [Weir 2011](#) reported a sample size calculation for the outcome 'time to return to sports without groin pain', requiring 21 athletes in each group. While [Weir 2011](#) found a statistically significant earlier return in the multi-modal therapy group (MD -4.5 weeks, 95% CI -8.60 to -0.40), this promising result only applies to the subgroup of 25 participants who had returned to sports.

Potential biases in the review process

This systematic review used an adequate search strategy with high sensitivity to avoid missing any randomized controlled trials on conservative treatments for patients with exercise-related groin pain. There were also no language restrictions in our searches. It is still possible, however, that we have missed unpublished studies or those published in journals that are not listed in the various databases.

The change in the primary outcomes measures between the protocol and the review should be reported as a limitation of the review and a potential selective reporting bias. Unfortunately, there is no consensus on which outcomes should be evaluated for exercise-related groin pain. When planning the primary outcomes in the protocol, we intended to approach the ideal and more common method of evaluating participants, but both included studies ([Hölmich 1999](#); [Weir 2011](#)) used different criteria. In the protocol of this review we defined pain as one of the primary outcomes, but both included studies assessed pain associated with another outcome (return to sports), resulting in the outcome 'successful treatment'. Accordingly, we decided to include 'successful treatment' (despite not being listed in the protocol) as a primary outcome in the review because pain was the main basis for categorising the patient outcome.

Another potential source of bias in the review was our approach to dealing with missing dichotomous data. Both included studies used a per protocol analysis to report some outcome measures, so we decided to do a sensitivity analysis through an intention-to-treat analysis by imputing the worst-case outcomes for the missing participants. Although this approach might not reflect reality, we opted for the worst-case scenario because the treatment is more likely to be successful if it works even when assuming the worst-case scenario for those who dropped out of the study regardless of the reason.

Agreements and disagreements with other studies or reviews

We located two other reviews ([Jansen 2008b](#); [Machotka 2009](#)) that focused on the treatment of patients with exercise-related groin pain. Both pre-date the publication of [Weir 2011](#).

[Jansen 2008b](#) investigated the evidence on all interventions (conservative or surgical) in the treatment of patients with longstanding groin pain. As well as covering a more extensive scope of interventions and patients, [Jansen 2008b](#) included non-randomized studies. Its conclusion that exercise therapy should be the first choice of conservative treatment was based primarily on the results of the only identified randomized controlled trial ([Hölmich 1999](#)).

[Machotka 2009](#) focused on the evidence for exercise therapy and, similar to [Jansen 2008b](#), included evidence from other study designs, such as case reports and case series. [Machotka 2009](#) concluded that an exercise intervention focused on strengthening of hip and abdominal muscles can lead to favourable results for the return to sports; this again was based on the limited evidence from [Hölmich 1999](#).

AUTHORS' CONCLUSIONS

Implications for practice

The available evidence from the randomized trials is insufficient to advise on any specific conservative modality for treating exercise-related groin pain. While still low quality, the best evidence is from one trial which found that exercise therapy (strengthening of hip and abdominal muscles) in athletes improves short-term outcomes (based primarily on pain measures) and return to sports compared with physiotherapy consisting of passive modalities (stretching exercises, laser therapy, transcutaneous electrical nerve stimulation, and transverse friction massage).

Implications for research

Further randomized controlled trials are needed to confirm or refute the possible favourable effects of exercise therapy, multi-modal treatments, and other conservative modalities for treating patients diagnosed with exercise-related groin pain. Future research should include long-term follow-up and evaluate pain through standardized instruments, such as the visual analogue score or numerical rating score. The use of standardized outcome assessment would facilitate future data synthesis, particularly where the sample size is small. In addition, single outcome measures should be adopted to improve accurate assessment, instead of the combined criteria used in the trials included in this review.

Function should also be evaluated in future trials as it is important to evaluate whether athletes demonstrate limitations during sports activities, and not only the presence of pain or whether they returned to sports or not. It is insufficient to evaluate only return to sports because athletes may return to sports in an inadequate condition. Although there is no validated questionnaire that evaluates function for exercise-related groin pain, the recently developed and validated Copenhagen Hip and Groin Outcome Score ([Thorborg 2011](#)), which assesses groin symptoms and function during activities of daily life and sports activities, seems a reasonable substitute.

ACKNOWLEDGEMENTS

We are grateful for valuable comments about this version of the review from Xavier Griffin, Helen Handoll and Gisela Sole. We also thank Per Hölmich, Adam Weir and Frank Backx for their attention and prompt return when contacted by email.

We also gratefully acknowledge Joanne Elliott who helped us with the development of the search strategies; and Helen Handoll and Gisela Sole for their helpful feedback at editorial review of the protocol.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES
Characteristics of included studies [ordered by study ID]
Hölmich 1999

Methods	Study design: single-blinded randomized controlled trial Setting: Clinic of Sports Medicine, Department of Orthopaedic Surgery, Amager University Hospital, Copenhagen, Denmark
Participants	<ul style="list-style-type: none"> • N = 68 (exercise therapy group, n = 34; physiotherapy without active training group, n = 34) • Athletes • Age range: 18 to 50 years • Gender: males • Groin pain at least 2 months • Desire to continue sports at the same level of competition as before the injury • Pain at palpation of the adductor tendons or the insertion on the pubic bone, and during active adduction against resistance
Interventions	1. Exercise therapy (AT): 8 to 12 weeks; 3 times a week <i>Module 1: first 2 weeks</i> - Static adduction against soccer ball placed between feet when lying supine (10 rep. of 30s, each) - Static adduction against soccer ball placed between knees when lying supine (10 rep. of 30s, each) - Abdominal sit-ups both in straightforward direction and in oblique direction (5 series of 10 rep.) - Combined abdominal sit-ups and hip flexion, starting from supine position and with soccer ball between knees (5 series of 10 rep.) - Balance training on wobble board (5 min) - One-foot exercises on sliding board, with parallel feet as well as with 90 angle between feet (5 sets of 1 min continuous work with each leg and in both positions)

Hölmich 1999 (Continued)

Module 2: 2 to 6 weeks

- Leg abduction and adduction exercises performed in side lying (5 series of 10 rep. of each exercise - twice)
- Low-back extension exercises prone over end of couch (5 series of 10 rep. - twice)
- One-leg weight pulling abduction/adduction standing (5 series of 10 rep. for each leg - twice)
- Abdominal sit-ups both in straightforward direction and in oblique direction (5 series of 10 rep. - twice)
- One-leg coordination exercise with flexing and extending knee and swinging arms in same rhythm (5 series of 10 rep. for each leg - twice)
- Training in sideways motion on mini-skateboard (5 min)
- Balance training on wobble board (5 min)
- Skating movements on sliding board (5 sets of 1 min continuous work)

2. Conventional physiotherapy (PT): 8 to 12 weeks; twice a week

- Laser treatment with a gallium aluminium arsen laser. All painful points of the adductor-tendon insertion at the pubic bone received treatment for 1 min, receiving 0.9 mJ per treated point. The probe was in contact with the skin at 90° angle. The laser was fitted with an 830 nm (± 0.5 nm) 30 mW, diode beam divergence was 4° and area of probe head was 2.5 mm²
- Transverse friction massage for 10 min on painful area of adductor-tendon insertion into pubic bone
- Stretching of adductor muscles, hamstring muscles, and hip flexors. The contract-relax technique was used. The stretching was repeated three times and the duration of each stretch was 30 s
- Transcutaneous electrical nerve stimulation was given for 30 min at painful area. The apparatus used was a Biometer, Elpha 500, frequency 100 Hz and a pulse width of one and a maximum of 15 mA (100% effect)

Treatment was given or instructed by physiotherapists and in both groups a return to running program was done after 6 weeks.

Outcomes

- Successful treatment
- No pain at palpation of the adductors tendon or during resisted adduction
- No pain in connection with or after athletic activity in the same sport and at the same level of competition
- Return to sports at the same level without groin pain

If all three measures above were reached, the result was labelled excellent, if two measures were reached, the result was good, if one measure was reached, the result was fair and if no measures were reached, the result was poor.

- Patients' subjective global assessment
- Return to sports at the same level without pain

Outcomes were evaluated at 16 weeks and long-term (8 to 12 years) follow-up.

Notes

- The participants from AT group were treated in groups with two to four patients, while in PT group the treatment was individual
- A longer- term follow-up of Hölmich 1999 (8 to 12 years from the original study) was included (Hölmich 2011)

Hölmich 1999 (Continued)

- Percentage of lost participants (follow-up of 16 weeks): 13% (9/68); 5 losses from AT group and 4 from PT group

- Reasons for withdrawn (follow-up of 16 weeks): knee injury (one patient); immigration to Australia (one); loss to follow-up at 4 months (two); did not want the treatment they were assigned (two patients assigned AT); could not get sufficient time off from work to complete the study (three)

- Percentage of lost participants (follow-up of 8 to 12 years): 31% (21/68); 10 losses from AT group and 11 from PT group

- Reasons for withdrawal (follow-up of 8 to 12 years): 5 individuals could not be located; 4 because of lack of current address 1 because of emigration; 5 were not interested primarily because they would have to take time off work to attend the examination, and 2 could not participate because they had suffered serious disability due to an accident not related to their groin problem

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Patients were randomly allocated by sealed, opaque, and serially numbered envelope to AT or PT group by means of block randomisation (block size four)"
Allocation concealment (selection bias)	Low risk	Quote: "Patients were randomly allocated by sealed, opaque, and serially numbered envelope to AT or PT group by means of block randomisation (block size four)" Quote: "The examining physician was not involved in the randomisation procedure and remained unaware of the treatment allocation"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and physiotherapists could not be blinded to allocation treatment
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	While the examining physician was not involved in the randomization procedure and remained unaware of the treatment allocation, there were subjective outcomes (successful treatment and patients' subjective global assessment) assessed by the trial participants, who were not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	While the study participant flow was clear and the missing data were balanced across groups, with reasons for missing data provided, the characteristics of lost participants were not described. The analyses were not entirely 'intention to treat', nor were sensitivity analyses to address decisions regarding handling missing data. Quote: "The subjective global assessment of the effect of treatment in the two groups based solely on results from patients completing the study (per-protocol analysis)"
Selective reporting (reporting bias)	Unclear risk	Function (an important primary outcome) was not evaluated. No protocol available.
Other bias	High risk	There was no explicit information about supplementary treatment and physical activity of participants during the follow-up period (8 to 12 years).

Weir 2011

Methods	<p>Study design: single-blinded randomized controlled trial</p> <p>Setting: The Hague Medical Centre, Antoniushove hospital, Department of Sports Medicine. Leidschendam, the Netherlands</p>
Participants	<ul style="list-style-type: none"> • N = 54 (exercise therapy group, n = 25; multi-modal treatment group, n = 29) • Athletes • Age range: 18 to 50 years • Gender: 53 male/1 female • Groin pain during and after sporting activities for at least 2 months • Desire to return to active sports participation at pre injury level • Pain located at the proximal insertion of adductor muscles on the pubic bone, and during active adduction against resistance
Interventions	<p>1. Multi-modal treatment group (MMT): heat + manual therapy + stretching.</p> <p>- Maximum two sessions of manual therapy and heat, and 15 days of stretching (the stretches were done after a 5 min warming-up using jogging or cycling). Before the manual therapy the adductor muscle group is warmed using paraffin packs for 10 min</p> <p>- The manual therapy technique consists of: with the patient in a supine position, the contralateral hand is used to control the tension in the adductor muscles while the ipsilateral hand is used to move the hip from a neutral position into flexion, external rotation and abduction while keeping the knee in extension. The treating physician controls the tension subjectively and applies the maximum tolerable stretch to the adductor muscles. After the movement has been performed the adductor muscle group is compressed with one hand while the other hand moves the hip into adduction and slight flexion. This circular motion followed by compressions lasts about 25 s and is repeated three times in one treatment session</p> <p>2. Exercise therapy group (ET): 8 to 12 weeks; 3 times a week.</p> <p><i>Module 1: first 2 weeks</i></p> <ul style="list-style-type: none"> - Static adduction against soccer ball placed between feet when lying supine (10 rep. of 30s, each) - Static adduction against soccer ball placed between knees when lying supine (10 rep. of 30s, each) - Abdominal sit-ups both in straightforward direction and in oblique direction (5 series of 10 rep.) - Combined abdominal sit-ups and hip flexion, starting from supine position and with soccer ball between knees (5 series of 10 rep.) - Balance training on wobble board (5 min) - One-foot exercises on sliding board, with parallel feet as well as with 90 angle between feet (5 sets of 1 min continuous work with each leg and in both positions) <p><i>Module 2: 2 to 6 weeks</i></p> <ul style="list-style-type: none"> - Leg abduction and adduction exercises performed in side lying (5 series of 10 rep. of each exercise-twice) - Low-back extension exercises prone over end of couch (5 series of 10 rep. – twice) - One-leg weight pulling abduction/adduction standing (5 series of 10 rep. for each leg – twice) - Abdominal sit-ups both in straightforward direction and in oblique direction (5 series of 10 rep. – twice) - One-leg coordination exercise with flexing and extending knee and swinging arms in same rhythm(5 series of 10 rep. for each leg – twice)

Weir 2011 (Continued)

- Training in sideways motion on mini-skateboard (5 min)
 - Balance training on wobble board (5 min)
 - Skating movements on sliding board (5 sets of 1 min continuous work)
- In both groups a return to running program was done after treatment.

Outcomes

- Successful treatment:
 - No pain in connection with or after athletic activity in the same sport and at the same level of competition
 - No pain during resisted adduction or on palpation of the adductors tendon at the pubic bone insertion
 - Return to sports at the same level without groin pain
- If all three measures above were reached, the result was labelled excellent, if two measures were reached, the result was good, if one measure was reached, the result was fair and if no measures were reached, the result was poor.
- Maximum pain during sports (Visual analogue scores, 0-100)
 - Time to return to sports
 - Range of motion of the hip joint (internal and external rotation): It was used a goniometer with the patients lying and the hip and knee flexed to 90°
- Outcomes were evaluated at 16 weeks follow-up.

Notes

The participants from exercise therapy (ET) were not supervised while performed the exercises. They were only instructed on how to perform it.

Percentage of participants lost to follow-up: 11% (6/59); 3 losses from ET group and 3 from MMT group

Reasons for withdrawal: did not want the treatment they were assigned (three patients); ankle injury (one patient); low-back pain (one patients); and lost to follow-up (one patient)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "After informed consent and inclusion the athletes were randomised using sealed envelopes. The athlete chose one of 100 opaque envelopes in the presence of the department's secretary"
Allocation concealment (selection bias)	Low risk	Quote: "After informed consent and inclusion the athletes were randomised using sealed envelopes. The athlete chose one of 100 opaque envelopes in the presence of the department's secretary" Quote: "The examining physician was not involved in the randomisation process and remained unaware of the treatment allocation"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and physiotherapists could not be blinded to allocation treatment
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	While the examining physician was not involved in the randomization procedure and remained unaware of the treatment allocation, there were subjective outcomes (Successful treatment) assessed by the trial participants, who were not blinded

Weir 2011 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Although missing data were balanced across groups and reasons for missing data were provided, the characteristics of the lost participants were not described. Furthermore, a per protocol analysis was done
Selective reporting (reporting bias)	Unclear risk	Function (an important primary outcome) was not evaluated. No protocol available
Other bias	Low risk	No other source of bias was detected

rep. = repetitions

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Ekstrand 2001	Conservative treatment versus surgical treatment; not in review scope
Paajanen 2011	Conservative treatment versus surgical treatment; not in review scope

Characteristics of studies awaiting assessment [ordered by study ID]

Backx 2009

Methods	Randomized controlled, parallel group trial
Participants	Male athletes, 18 to 45 years old, hip adduction-related complaints, for a period of at least six weeks, strong desire to compete in sports
Interventions	Two different kinds of physiotherapeutic treatments are given for the population. Both treatment strategies are already in use in daily practice. Patients are randomized to receive either pelvic-stabilizing muscle training or usual care
Outcomes	1. Severity of the pain over the last three days (11-point visual analogue scale (VAS)) 2. Participation in sports (11-point VAS) 3. General disability (adapted Quebec low back pain disability scale) 4. Global change (six-point Likert scale) 5. How long before return to full athletic activity 6. Recurrences of the same complaints Parameters 1, 2, 3 are measured before and directly after the period of treatment and 26 and 52 weeks after the start of treatment. Parameters 4, 5 and 6 are only measured at 26 and 52 weeks after treatment.
Notes	The author of this study was contacted via email and reported that the trial was not completed as a randomized clinical trial and therefore the results have not been published.

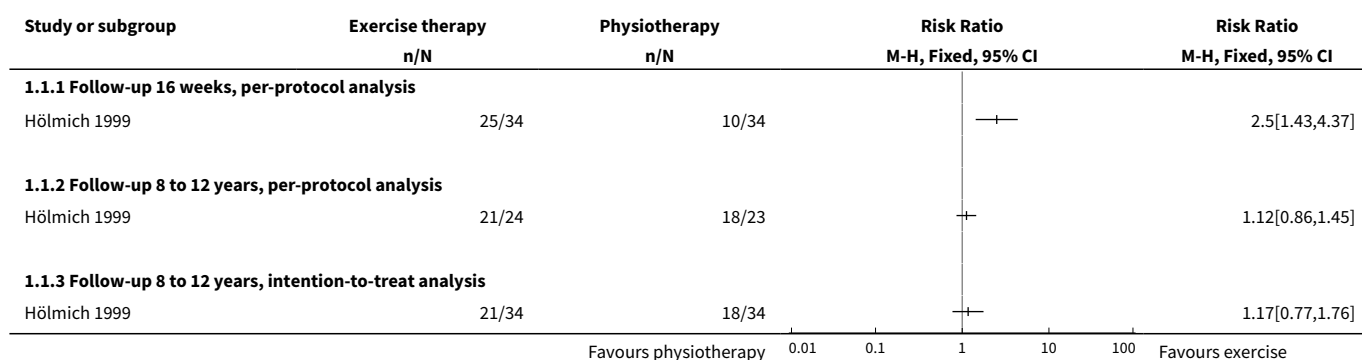
VAS = visual analogue scale

DATA AND ANALYSES

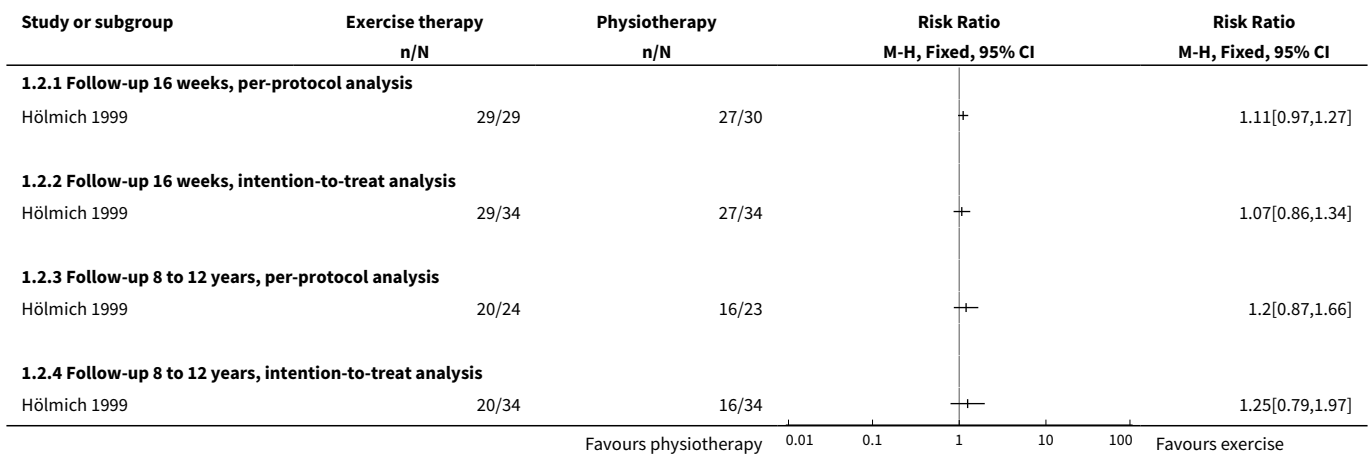
Comparison 1. Exercise therapy versus conventional physiotherapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 'Successful treatment'	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 Follow-up 16 weeks, per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Follow-up 8 to 12 years, per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Follow-up 8 to 12 years, intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Patients' subjective global assessment (better or much better)	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.1 Follow-up 16 weeks, per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Follow-up 16 weeks, intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.3 Follow-up 8 to 12 years, per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.4 Follow-up 8 to 12 years, intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Return to sports	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.1 Per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3.2 Intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

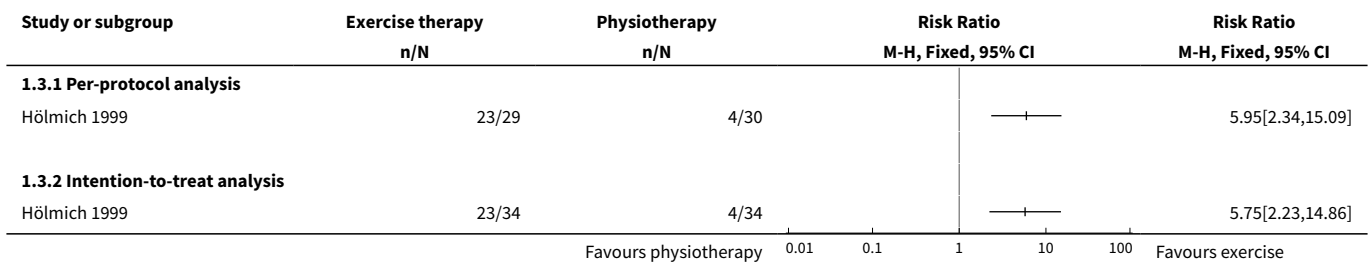
Analysis 1.1. Comparison 1 Exercise therapy versus conventional physiotherapy, Outcome 1 'Successful treatment'!



Analysis 1.2. Comparison 1 Exercise therapy versus conventional physiotherapy, Outcome 2 Patients' subjective global assessment (better or much better).



Analysis 1.3. Comparison 1 Exercise therapy versus conventional physiotherapy, Outcome 3 Return to sports.



Comparison 2. Multi-modal treatment versus exercise therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 'Successful treatment'	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 Per-protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Maximum pain during sports	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3 Return to sports	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.1 Per protocol analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3.2 Intention-to-treat analysis	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4 Time to return to sports (weeks)	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Analysis 2.1. Comparison 2 Multi-modal treatment versus exercise therapy, Outcome 1 'Successful treatment'.

Study or subgroup	Multi-modal treatment n/N	Exercise therapy n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
2.1.1 Per-protocol analysis				
Weir 2011	14/26	12/22		0.99[0.59,1.66]
2.1.2 Intention-to-treat analysis				
Weir 2011	14/29	12/25		1.01[0.58,1.75]

Favours exercise 0.01 0.1 1 10 100 Favours multi-modal

Analysis 2.2. Comparison 2 Multi-modal treatment versus exercise therapy, Outcome 2 Maximum pain during sports.

Study or subgroup	Multi-modal		Exercise therapy		Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)		
Weir 2011	13	36.1 (30.1)	12	21 (27)		15.1[-7.29,37.49]

Favours multi-modal -100 -50 0 50 100 Favours exercise

Analysis 2.3. Comparison 2 Multi-modal treatment versus exercise therapy, Outcome 3 Return to sports.

Study or subgroup	Multi-modal treatment n/N	Exercise therapy n/N	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
2.3.1 Per protocol analysis				
Weir 2011	13/26	12/22		0.92[0.53,1.58]
2.3.2 Intention-to-treat analysis				
Weir 2011	13/29	12/25		0.93[0.53,1.66]

Favours exercise 0.5 0.7 1 1.5 2 Favours multi-modal

Analysis 2.4. Comparison 2 Multi-modal treatment versus exercise therapy, Outcome 4 Time to return to sports (weeks).

Study or subgroup	Multi-modal treatment		Exercise therapy		Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)		
Weir 2011	13	12.8 (6)	12	17.3 (4.4)		-4.5[-8.6,-0.4]

Favours multi-modal -10 -5 0 5 10 Favours exercise

APPENDICES

Appendix 1. Search strategies

Cochrane Central Register of Controlled Trials (Wiley Online Library)

- #1 MeSH descriptor Groin, this term only (81)
- #2 MeSH descriptor Pubic Symphysis, this term only (10)
- #3 MeSH descriptor Pubic Bone, this term only (6)
- #4 (groin):ti,ab,kw (378)
- #5 (pubic bone*):ti,ab,kw (22)
- #6 (#1 OR #2 OR #3 OR #4 OR #5) (404)
- #7 MeSH descriptor Pain, this term only (8804)
- #8 MeSH descriptor Abdominal Pain, this term only (506)
- #9 MeSH descriptor Pelvic Pain, this term only (243)
- #10 MeSH descriptor Tendon Injuries explode all trees (322)
- #11 MeSH descriptor Osteitis, this term only (23)
- #12 MeSH descriptor Athletic Injuries, this term only (405)
- #13 MeSH descriptor Soccer, this term only (199)
- #14 (tend?nopath* or tend?nitis or pain):ti,ab,kw (53373)
- #15 (#7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14) (53906)
- #16 (#6 AND #15) (150)
- #17 (symphysis syndrome):ti,ab,kw (1)
- #18 (osteitis pubis):ti,ab,kw (1)
- #19 (pubalgia):ti,ab,kw (1)
- #20 (adductor tend?nopath*):ti,ab,kw (0)
- #21 (adductor tend?nitis):ti,ab,kw (0)
- #22 (adductor strain):ti,ab,kw (2)
- #23 (gracilis syndrome):ti,ab,kw (0)
- #24 (sport* hernia):ti,ab,kw (5)
- #25 (#17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24) (10)
- #26 (#16 OR #25) (142)

MEDLINE (Ovid web)

- 1 Groin/ (2773)
- 2 Pubic Symphysis/ or Pubic Bone/ (2623)
- 3 groin.tw. (6861)
- 4 "pubic bone*".tw. (606)
- 5 or/1-4 (11076)
- 6 Pain/ or Abdominal Pain/ or Pelvic Pain/ (120886)
- 7 exp Tendon Injuries/ (12307)
- 8 Osteitis/ (2440)
- 9 Athletic Injuries/ (18407)
- 10 Soccer/ (3264)
- 11 (tend#nopath* or tend#nitis or pain).tw. (341832)
- 12 or/6-11 (408910)
- 13 and/5,12 (2110)
- 14 symphysis syndrome.tw. (3)
- 15 osteitis pubis.tw. (213)
- 16 pubalgia.tw. (32)
- 17 adductor tend#nopathy.tw. (5)
- 18 adductor tend#nitis.tw. (8)
- 19 adductor strain.tw. (10)
- 20 gracilis syndrome.tw. (5)
- 21 "sport* hernia".tw. (59)
- 22 or/14-21 (299)
- 23 or/13,22 (2187)
- 24 Randomized controlled trial.pt. (323396)
- 25 Controlled clinical trial.pt. (84105)
- 26 randomized.ab. (239614)
- 27 placebo.ab. (135172)

- 28 Drug therapy.fs. (1521264)
- 29 randomly.ab. (175370)
- 30 trial.ab. (248379)
- 31 groups.ab. (1150633)
- 32 or/24-31 (2907256)
- 33 exp Animals/ not Humans.sh. (3724073)
- 34 32 not 33 (2480665)
- 35 and/23,34 (405)

EMBASE (Ovid web)

- 1 Inguinal Region/ (5380)
- 2 Pubic Bone/ or Pubis Symphysis/ (3429)
- 3 groin.tw. (7962)
- 4 "pubic bone*.tw. (699)
- 5 or/1-4 (14399)
- 6 Abdominal Pain/ or Lower Abdominal Pain/ or Pain/ or Inguinal Pain/ (212286)
- 7 Tendon Injury/ or Tendinitis/ (10901)
- 8 Osteitis/ (2879)
- 9 Sport Injury/ (21112)
- 10 Football/ or Athlete/ (26141)
- 11 (tend#nopath* or tend#nitis or pain).tw. (419742)
- 12 or/6-11 (552961)
- 13 and/5,12 (2923)
- 14 symphysis syndrome.tw. (2)
- 15 Osteitis Pubis/ (40)
- 16 osteitis pubis.tw. (231)
- 17 Pubalgia/ (11)
- 18 pubalgia.tw. (60)
- 19 adductor tend#nopathy.tw. (4)
- 20 adductor tend#nitis.tw. (8)
- 21 adductor strain.tw. (11)
- 22 gracilis syndrome.tw. (5)
- 23 Sportmen Groin/ (1)
- 24 "sport* hernia".tw. (67)
- 25 Pubic Bone Stress Injury/ (3)
- 26 or/14-25 (351)
- 27 or/13,26 (3031)
- 28 Randomized Controlled Trial/ (293827)
- 29 Clinical Trial/ (821915)
- 30 Controlled Clinical Trial/ (173310)
- 31 Randomization/ (55111)
- 32 Single Blind Procedure/ (14524)
- 33 Double Blind Procedure/ (101992)
- 34 Crossover Procedure/ (31323)
- 35 Placebo/ (188741)
- 36 Prospective Study/ (177986)
- 37 ((clinical or controlled or comparative or placebo or prospective\$ or randomi#ed) adj3 (trial or study)).tw. (574290)
- 38 (random\$ adj7 (allocat\$ or allot\$ or assign\$ or basis\$ or divid\$ or order\$)).tw. (139798)
- 39 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj7 (blind\$ or mask\$)).tw. (134349)
- 40 (cross?over\$ or (cross adj1 over\$)).tw. (57449)
- 41 ((allocat\$ or allot\$ or assign\$ or divid\$) adj3 (condition\$ or experiment\$ or intervention\$ or treatment\$ or therap\$ or control\$ or group\$)).tw. (174957)
- 42 RCT.tw. (8137)
- 43 or/28-42 (1557082)
- 44 Case Study/ or Abstract Report/ or Letter/ (815439)
- 45 43 not 44 (1523124)
- 46 and/27,45 (466)

LILACS (Bireme)

(Mh Groin or Tw Groin OR Tw Ingle OR Tw Virilha OR Mh Pubic Bone OR Tw Pubic Bone OR Tw Hueso Púxico OR Tw Osso Púxico OR Mh Pubic Symphysis OR Tw Pubic Symphysis OR Tw Sínfisis Pubiana OR Tw Sínfise Pubiana) [Words] (168)

and

(Mh Pain OR Tw Pain OR Tw Dolor OR Dor OR Mh Abdominal Pain OR Tw Abdominal Pain OR Tw Dolor Abdominal OR Tw Dor Abdominal OR Mh Tendon Injuries OR Tw Tendon Injur\$ OR Tw Traumatismos de los Tendones OR Tw Traumatismos dos Tendões OR Mh Tendinopathy OR Tw Tendinopathy OR Tw Tendonopathy OR Tw Tendinitis OR Tw Tendonitis OR Tw Tendinopatía OR Tw Tendinopatía Mh Osteitis OR Tw Osteitis Tw Osteítis OR Tw Osteíte OR Mh Athletic Injuries OR Tw Athletic Injur\$ Tw Traumatismos en Atletas OR Tw Traumatismos em Atletas OR Tw pubalgia) [Words] (20178)

and

((Pt randomized controlled trial OR Pt controlled clinical trial OR Mh randomized controlled trials OR Mh random allocation OR Mh double-blind method OR Mh single-blind method) AND NOT (Ct animals AND NOT (Ct human and Ct animal)) OR (Pt clinical trial OR Ex E05.318.760.535\$ OR (Tw clin\$ AND (Tw trial\$ OR Tw ensa\$ OR Tw estud\$ OR Tw experim\$ OR Tw investiga\$)) OR ((Tw singl\$ OR Tw simple \$ OR Tw doubl\$ OR Tw doble\$ OR Tw duplo\$ OR Tw trebl\$ OR Tw trip\$) AND (Tw blind\$ OR Tw cego\$ OR Tw ciego\$ OR Tw mask\$ OR Tw mascar\$)) OR Mh placebos OR Tw placebo\$ OR (Tw random\$ OR Tw randon\$ OR Tw casual\$ OR Tw acaso\$ OR Tw azar OR Tw aleator\$) OR Mh research design) AND NOT (Ct animals AND NOT (Ct human and Ct animals)) OR (Ct comparative study OR Ex E05.337\$ OR Mh follow-up studies OR Mh prospective studies OR Tw control\$ OR Tw prospectiv\$ OR Tw volunt\$ OR Tw volunteer\$) AND NOT (Ct animals AND NOT (Ct human and Ct animals))) [Words] (174402)

SPORTDiscus (EBSCO)

(Groin OR pubic bone OR pubic symphysis) (1104)

and

(pain OR abdominal pain OR osteitis OR tendon injuries OR tendinopathy) (34501)

CINAHL (EBSCO)

((MH "Groin") OR (MH "Pubic Symphysis") OR (MH "Pubic Bone")) (603)

AND

((MH "Pain") OR (MH "Abdominal Pain") OR (MH "Pelvic Pain") OR (MH "Tendon Injuries") OR (MH "Osteitis") OR (MH "Athletic Injuries") OR (MH "Soccer Injuries")) OR ("adductor strain" OR "adductor tendinopathy" OR "adductor tendinitis" OR "pubalgia" OR "gracilis syndrome" OR "sport hernia" OR "osteitis pubis" OR "symphysis syndrome")) (15)

AND

(Randomized Controlled Trial OR Controlled Clinical Trial OR randomized OR placebo OR Drug Therapy OR randomly OR Trial OR groups) (363692)

PEDro

groin AND pain (9)

OTseeker

groin OR pubic bone OR pubic symphysis (1)

Current Controlled Trial

groin AND pain (87)

CONTRIBUTIONS OF AUTHORS

Co-ordinating the review: MOA

Screening search results: MOA, RBA, BNGS

Undertaking manual searches: MOA, BNGS

Organizing retrieval of papers: MOA, MSP

Screening retrieved papers against inclusion criteria: MOA, ANA, MSP

Appraising quality of papers: MOA, RBA, BNGS

Abstracting data from papers: MOA, RBA, BNGS, MSP, ANA

Writing to authors of papers for additional information: MOA

Providing additional data about papers: MOA, MSP

Obtaining and screening data on unpublished studies: MOA, MSP

Data management for the review: MOA, RBA, BNGS

Entering data into Review Manager (RevMan): MOA, RBA, BNGS

RevMan statistical data: MOA, RBA

Interpretation of data: MOA, RBA, BNGS, MSP, ANA

Statistical inferences: MOA, RBA

Writing the review: MOA, BNGS, RBA, MSP, ANA

Responsible for reading and checking review before submission: MA, RBA, BNGS, MSP, ANA

Matheus O Almeida is the guarantor of the review.

DECLARATIONS OF INTEREST

None known.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Type of outcome measures

The outcome 'successful treatment' was not planned in the protocol of this review, but it was assessed in both included studies. We considered it as a primary outcome in the review since pain (an outcome previously planned in the protocol) was one of the main points to classify the patients objectively.

'Maximum pain during sports' was another primary outcome included in the review that was not planned in the protocol. In the protocol, we planned to evaluate pain at rest, on palpation and during physical activity, but different forms of pain intensity were not listed. Therefore we added the phrase 'regardless of the intensity' to cover outcomes that approach different characteristics of the same aspect (pain), such as maximum pain during sports.

INDEX TERMS

Medical Subject Headings (MeSH)

*Exercise; Athletic Injuries [*therapy]; Electric Stimulation Therapy; Exercise Therapy [*methods]; Groin; Ligaments; Massage; Muscle Stretching Exercises; Musculoskeletal Pain [etiology] [*therapy]; Pain Measurement; Randomized Controlled Trials as Topic

MeSH check words

Female; Humans; Male