BMJ Open Sport & Exercise Medicine

Effect of Holmich protocol exercise therapy on long-standing adductor-related groin pain in athletes: an objective evaluation

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To cite: Yousefzadeh A, Shadmehr A, Olyaei GR, *et al*. Effect of Holmich protocol exercise therapy on long-standing adductor-related groin pain in athletes: an objective evaluation. *BMJ Open Sport & Exercise Medicine* 2018;**4**:e000343. doi:10.1136/bmjsem-2018-000343

Accepted 23 May 2018

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ABSTRACT

Aim To objectively evaluate the effect of Holmich protocol-based exercise therapy on long-standing adductor-related groin pain (LSAGP).

Methods We reproduced the Holmich protocol of exercise therapy and objectively evaluated its effect on 17 male athletes (mean age, 25.07±4.96 years) suffering from LSAGP, of whom 14 participants completed the 10 weeks treatment period. The study was designed as a single-blinded, before-and-after clinical trial. Main outcome measures included pain, functional ability, hip range of motion (ROM), hip abductor and adductor muscle strength, and successful return to sports activity.

Results Eleven athletes (78.57%) returned to their sports activities in a mean time of 14.2 weeks (range, 10-20 weeks). Visual analogue scale pain score, hip abductor and adductor muscles strength, and function scores improved significantly. Although hip abduction ROM did not show any significant changes (p = 0.609), the extent of progress in the hip internal rotation ROM was significant (p = 0.001). The ratio of hip adduction to abduction strength did not change significantly (p = 0.309 for the isometric and p = 0.957 for the eccentric ratio).

Conclusions Exercise therapy according to the Holmich programme may be an effective treatment for LSAGP. However, more emphasis should be paid to the hip adductor muscles' eccentric strength.

Trial registration number IRCT2016080829269N1.

Summary

- Exercise therapy based on the Holmich protocol may be an effective treatment for long-standing adductor-related groin pain.
- We need more emphasis on eccentric strength of hip adductors in our treatment protocol.
- Future studies should also include assessment of hip muscles' strength.

INTRODUCTION

Groin pain arising from sports injuries is widespread, especially among those who participate in sports that involve repetitive rotational movements such as kicking and turning as in soccer.[1] This type of injury is the fourth most common sports injury, with soccer players suffering from long-term symptoms and frequent relapses.[2–4] The injury rate is 1.015–1.133 per 1000 hours of play, which is equivalent to 11%–16% of all football injuries.[2 3] The prognosis for exercise-related groin pain is not clear. Injured athletes may be forced to wait a long time before returning to sports activity free of restriction.[5–7]

It is known that adductor-related groin injuries are the most common cause of groin injury, accounting for 69% of groin injuries in football and 58% across all forms of sport.[4 8] Adductor-related groin pain is often treated without surgery. Among different conservative approaches, it appears that exercise therapy (ET) is more effective than other conservative treatment methods such as electrotherapy, manual therapy or steroid injections.[7 9] Unfortunately, however, many important factors including frequency, duration and the exact amount of resistance or perceived exertion to be used in the ET protocols have not been carefully recorded in clinical trials.[9] To our best knowledge, the randomised clinical trial carried out by Holmich *et al*[7] in 1999 still offers the best evidence for the effectiveness of exercise as a prescription for the treatment of adductor-related groin pain.[6 7 9] Holmich *et al*[7] collated the results of ET (based on isometric and isotonic strengthening of the hip abductor/adductor and the abdominal muscles) with results from physiotherapy including passive modalities (transverse friction massage, laser therapy, transcutaneous electrical nerve stimulation and stretching). They evaluated successful treatment (based on pain measures), patients' subjective global assessments and their return to sport without groin pain at the same level as before the injury.[6 7] 'Successful treatment' as described in their study is an unfeasible

Box 1 Inclusion and exclusion criteria

Inclusion criteria: Male; age 18-–35 years; desire to return to the former level of sports activity; groin pain for at least 2 months; pain at palpation of the adductor tendons or the insertion of the pubic bone or both; groin pain during active adduction against resistance (squeeze test); pain during adduction against resistance had to be less than six*, based on the visual analogue scale (VAS).
In addition, at least two of the following criteria had to be present: a clear history of groin pain and stiffness in the morning, cough-induced or sneeze-induced groin pain, nocturnal groin pain or radiological evidence demonstrating osteitis pubis or pain at the symphysis pubis due to palpation.
Exclusion criteria: Femoral or inguinal hernia; chronic urinary tract disorder or prostatitis; disease, fracture of the pelvis or the lower limbs inhibiting the participant from completing the treatment plan; entrapment of the genitofemoral or back pain felt between T10 and L5 levels and consisting of the facet joints; virulent ilioinguinal nerve; inability to follow the active physical training plan; use of non-steroidal anti-inflammatory drugs during the study; participation in principled strength training of the hip adductors for more than once a week in the 6 months prior to the study.

*In our pilot study, the patients who had a pain score of >6 on the VAS during active adduction against resistance could not perform functional tests; therefore, we considered this level of pain as the highest level to participate in the study.

and non-validated measure for evaluating outcome;[6 7] on the other hand, the published results by Holmich *et al*[7] are related to the follow-up performed at 4 months after the end of treatment. Therefore, there is no information about the flow of alterations in pain and functional ability during this follow-up period.

In the current study, we reproduced Holmich *et al*'s[7] research to treat long-standing adductor-related groin pain (LSAGP) and analysed the short-term flow of alterations in pain and functional ability. Furthermore, as limited range of hip abduction and hip internal rotation and decreased hip adductor strength (absolute and comparative to the hip abductors) are considered potential risk factors for groin injury,[10–12] we also measured these variables as our outcomes.

The purpose of this study was to obtain an objective evaluation of the effect of ET based on the Holmich protocol in LSAGP.

MATERIALS AND METHODS

Subjects

Athletes were referred to a sports injury physiotherapy clinic by physicians and physiotherapists. Some of the participants were also recruited to the clinic through announcements in sport clubs and posters in sport facilities. A total of 22 athletes applied for the interview and examination, of whom 17 subjects were included in the study and gave informed consent. Inclusion and exclusion criteria are shown in box 1.[7]

Design

The study was single-blinded before and after the clinical trial. The assessor physiotherapist was not involved in the treatment and remained unaware of the treatment plan.

Treatment

The treatment consisted of ET protocol suggested by Holmich *et al*[7] and was started under the supervision of a trained sport physiotherapist who ensured that the exercise was carried out correctly and adhered to the original protocol. No treatment other than ET was applied. Although the ET protocol exactly mirrored the randomised clinical trial of Holmich *et al*,[7] details such as the perceived resistance or weights (in exercise 3 in module 2) and the rest period between the exercise sets and repetitions, which were not defined in the Holmich study, were explained here for the athletes' benefit (tables 1 and 2). Exercise 6 in module 2 is shown in figure 1.

Treatment was administered three times a week (on even or odd days). The duration of each session was about 90 min for module 1 (first two weeks) and 120 min for module 2 (from the third week). From the third

Table 1 Holmich protocol: module 1—first two weeks

Exercise	Amount	Rest period
1 Ssometric adduction against soccer ball located between feet in supine position	10 repetitions of 30 s	30 s rest after each repetition
2 Abdominal sit-ups both in straight and oblique directions	5 series of 10 repetitions	1 min rest after 10 repetitions
3 Isometric adduction against soccer ball located between knees in supine position	10 repetitions of 30 s	30 s rest after each repetition
4 Compound abdominal sit-ups and hip flexion beginning from supine position and with soccer ball between knees (folding knife exercise)	5 series of 10 repetitions	1 min rest after 10 consecutive repetitions
5 Balance exercise on wobble board	5 min	
6 One-foot exercise on sliding board with parallel feet as well as with 90° angle between feet	5 sets of 1 min (almost 22–25 repetitions per min) continuous work with each leg and in both positions	1 min rest after each set

Table 2 Holmich protocol: module 2—from third week

Exercise	Amount (all performed twice)	Rest period
1 Leg abduction and adduction exercise carried out in side lying	5 series of 10 repetitions of each exercise	1 min rest after one set of 10 repetitions of each exercise
2 Low-back extension exercise prone on the end of bench	5 series of 10 repetitions	1 min rest after 10 consecutive repetitions
3 One-leg weight pulling abduction/adduction standing*	5 series of 10 repetitions for each leg	1 min rest after one set of 10 repetitions of each exercise
4 Abdominal sit-ups both in straight and in oblique direction	5 series of 10 repetitions	1 min rest after 10 consecutive repetitions
5 One-leg coordination exercise with flexing and extending knee and swinging arms in same rhythm (cross-country skiing on one leg)	5 series of 10 repetitions for each leg	1 min rest after one set for each leg
6 Training in sideways motion on a 'Fitter'	5 min	
7 Balance exercise on wobble board	5 min	
8 Ikating motions on sliding board	5 sets of 1 min rest after each set continuous work	1 min rest after each set

*For one-leg weight-pulling abduction/adduction, the perceived resistance was determined by the physiotherapist at the baseline, which was the maximum weight that could be handled by the subject without pain for 10 repetitions. This weight was increased by the physiotherapist every week of treatment.

week, the athletes were asked to perform exercises from module 1 every other day, between the treatment sessions. Although adductor muscle stretching was forbidden, participants were allowed to stretch other muscles when needed, but after the treatment session.

During the treatment course and before the final evaluation, no athletic activity was permitted. The participants were allowed to ride a bicycle, on the condition that it was pain free. From the sixth week of treatment, participants were allowed to run slowly on a soccer pitch, only so long as it did not produce groin pain.

As the duration of treatment in the Holmich study was between 8 and 12 weeks, we selected an average 10 weeks as the minimum treatment duration for our study.

Figure 1 Training in sideways motion on a 'Fitter'.

However, participants were allowed to continue their treatment for up to 12 weeks, if needed. At the end of the treatment period, a written programme was also given to the participants regarding their sports rehabilitation. After the 10th week, we placed a weekly telephone follow-up call to each participant enquiring whether they had returned to sports activity. In addition, there was a final follow-up appointment 20 weeks after the baseline for all participants during which they completed a fresh questionnaire regarding their symptoms.

Outcome measurements

The subjects were evaluated by a trained single-blinded physiotherapist before treatment and 10 weeks after the treatment commenced.

Hip muscle strength (abductor/adductor)

Our muscle strength test set-up consisted of a hand-held dynamometer (Powertrack II Commander JTECH Medical, Salt Lake City, Utah, USA) and an examination table. Application of the hand-held dynamometer has been shown to be a valid procedure for muscle strength measurement.[13] The main outcomes for muscle strength were maximal isometric hip adduction (IHAD), maximal isometric hip abduction (IHAB), maximal eccentric hip adduction (EHAD), maximal eccentric hip abduction (EHAB) and maximal IHAD/IHAB and EHAD/EHAB ratios.

The strength measurement methods we used have been described in detail in earlier studies.[10 14 15] According to Thorborg *et al*,[15] IHAD and IHAB were measured with subjects in the supine position (applying a make test), while EHAD and EHAB were measured with subjects lying on their sides (applying a break test).[14] We carried out measurements for the affected lower limb. Using leg

length and bodyweight, all the force values were shown as Newton-metres per kilo of bodyweight.[15] The methods used for application of the hand-held dynamometer in this study have been previously shown to have interday and intratester reliability, with no systematic test–retest bias.[10 15 16]

Pain

Pain was assessed and recorded based on the visual analogue scale (VAS) in the following two situations: (i) pain during the hip adduction against resistance (squeeze test) and (ii) pain during functional tests (the average earned from the three functional tests).

Hip range of motion (ROM): abduction and internal rotation

We performed the measurements for passive abduction ROM based on the details described in previous studies.[10] We also performed the measurements for passive internal rotation ROM according to the method used in previous studies.[17] All the measurements in this part were single and for the affected limb.

Functional ability

The subjects passed the three functional tests on a soccer pitch. In this study, we used the T-TEST,[18 19] Edgren Side-Step Test (ESST)[19] and the Triple Hop Test for Distance (THT)[20 21] to objectively assess the effect of our intervention from the functional point of view. These functional tests are known to be reliable and valid measures for the evaluation of multiple agility ingredients (unidirectional, bidirectional and multidirectional movements), leg speed and power.[19 20 22 23]

Statistical analysis

This study used a double data entry process. The statistician was blinded to the treatment plan and outcomes until the analysis was completed. We used SPSS Statistics V.24 (IBM) for the data analysis. A Kolmogorov-Smirnov test indicated that dependent variables had normal distribution. A paired samples t-test was used to determine whether there were any significant differences between the before and after values of the dependent variables.

RESULTS

Of the 17 included athletes, 3 withdrew during the study. One athlete dropped out because he developed groin pain and did not want to continue the treatment, one athlete could not get enough time off from work to complete the treatment and one athlete was lost to follow-up. Fourteen athletes completed the programme. Baseline characteristics are presented in table 3.

According to the regular weekly follow-ups and the final follow-up 20 weeks after the baseline, 11 athletes (78.57%) returned to their former level of sports activity with no symptoms of groin pain. The mean time for recovery was 14.2 weeks from the baseline (range, 10–20 weeks). Three participants failed to return to their previous level of sports activity and had some residual symptoms. However, they confirmed some improvement compared with the situation before treatment and decided to continue in another field of sport.

Table 3 Baseline characteristics of the participants (n=14)

Age (years)	25.07 (SD 4.96)
Height (m)	1.79 (SD 0.03)
Preferred limb	Right=11, left=3
Level of athletic activity	Elite (>5 times per week)=3 Subelite (3 or 4 times per week)=11
Location of injury	Right=6, left=8
Duration of symptoms (months)	24.07 (SD=24.09)
Pain (VAS) on squeeze test (no pain=0, maximum pain=10)	5.14 (SD 0.66)
Pain (VAS) during functional tests	5.29 (SD 0.61)

VAS, visual analogue scale.

Measurements were made at baseline (before) and 10 weeks after the start of treatment (after). The details are described in the following sections.

VAS for pain

At the end of the 10th week of treatment, there were significant improvements on VAS pain scores for the squeeze test (5.14±0.66 vs 1.64±1.15, before and after treatment, respectively; p=0.0001). The VAS pain scores during the functional tests (ESST, THT and T-TEST) also improved significantly (5.29±0.61 vs 1.93±1.07, before and after treatment, respectively; p=0.0001) (table 4).

Hip ROM (abduction/internal rotation)

Changes to the mean hip abduction ROM in the affected limbs were not significant (p=0.609). However, the difference between mean hip internal rotation before and after treatment in the affected limbs was significant (p=0.001) (table 4).

Hip adductor and abductor muscle strength

The mean maximum IHAD (p=0.0001), maximum IHAB (p=0.0001), maximum EHAD (p=0.0001) and maximum EHAB strength (p=0.02) showed significant improvements ((table 4).

The ratio of mean maximum isometric and EHAD to abduction strength showed no significant improvements (p=0.309 and 0.957, respectively) after 10 weeks of treatment compared with the baseline (table 4).

Table 4 shows the percentage gain in muscle strength with treatment (the percentage gain in this study is equal to the difference between the before and after values, divided by the before value and multiplied by 100).

Table 4 Dependent variables: 'before' and 'after' values and significance level after paired samples t-test

Dependent variable	Before	After	Percentage gain In muscle strength	Paired samples test sig. (two-tailed)
VAS pain score (squeeze test)	5.14 (0.66)	1.64 (1.15)		0.0001
VAS pain score (during function)	5.29 (0.61)	1.93 (1.07)		0.0001
Hip ROM abduction (°)	42.93 (3.60)	43.14 (3.57)		0.609
Hip ROM internal rotation (°)	22.50 (7.94)	23.57 (8.00)		0.001
Isometric adduction (N.m/kg)	1.31 (0.35)	1.65 (0.37)	26.15	0.0001
Isometric abduction (N.m/kg)	1.49 (0.26)	1.80 (0.29)	20.77	0.0001
Eccentric adduction (N.m/kg)	1.87 (0.52)	2.02 (0.57)	7.75	0.0001
Eccentric abduction (N.m/kg)	2.43 (0.42)	2.64 (0.54)	8.54	0.02
Ratio of isometric hip adduction to abduction	0.87 (0.17)	0.91 (0.14)		0.309
Ratio of eccentric hip adduction to abduction	0.77 (0.18)	0.77 (0.17)		0.957
T-TEST (s)	11.26 (0.83)	10.15 (0.64)		0.0001
ESST (m)	23.14 (2.98)	27.36 (3.34)		0.0001
THT (m)	5.22 (0.67)	5.76 (0.69)		0.0001

'after', 10 weeks after the start of treatment; 'before', baseline; ESST, Edgren Side-Step Test; ROM, range of motion; THT, Triple Hop Test for Distance; VAS, visual analogue scale.

Functional tests

T-TEST agility measures improved significantly after treatment (p=0.0001). Significant improvements were also visible for THT and ESST functionality (p=0.0001 and 0.0001, respectively) (table 4).

DISCUSSION

In this study, we objectively evaluated the effect of ET on LSAGP by reproducing the Holmich protocol in a before-and-after clinical trial. Our findings show that this programme of ET, which concentrates on the strength and coordination of the muscles affecting the pelvic girdle, significantly improved the primary outcomes for pain, muscle strength and functional ability after 10 weeks of treatment.

Pain

VAS pain scores on squeeze tests and during functional tests showed a significant decrease (from 5.14 to 1.64 on the squeeze test and from 5.29 to 1.93 during functional tests). These results were similar to those obtained by Weir *et al*,[5] who compared the effect of ET (based on the Holmich protocol) with manual therapy on two groups of athletes with LSAGP (n=22 and 26, respectively). In their study, the VAS scores during sport activities improved from 58.5 before treatment to 21.0 (VAS 100=maximum pain) after 16 weeks in the ET group. Our results were obtained in a shorter time frame of 10 weeks.

Return to sports activities

In the present study, 78.57% of the participants who completed the treatment programme were able to return to sports activities at their former level with no groin pain after the mean time of 14.2 weeks. In the study by Weir *et al*,[5] also based on the Holmich protocol, 55% of the participants in the ET group returned to sports activities at their previous level after the mean time of 17.3 weeks. In the original study by Holmich *et al*,[7] 79% of athletes in the active training group returned to their former level of sports activities with no symptoms of groin pain after a mean duration of 18.5 weeks. Although we followed a similar programme, our results were better than both these studies: compared with the study by Holmich *et al*,[7] we obtained similar rate of return to sports activities but in a shorter time frame of 14.2 weeks. This difference may be attributable to the lower age of the participants in our study. The median age of the participants included in the study by Holmich *et al*[7] was 30 (20–50) years, and the mean age of the subjects included in the study by Weir *et al*[5] was 27.4 (18–50) years, whereas the mean age for the athletes in the current study was 25.07 (18–35) years. Although the participants in the current study were in the similar age group, their mean age was somewhat lower.

In this study, treatment exercises were performed under the supervision of a sports physiotherapist, with three to four athletes in each session supervised by one physiotherapist. In the study by Weir *et al*,[5] the subjects were told how to do the exercises by a physiotherapist on three separate occasions, but the participants were not supervised while attempting the exercises. The difference in the findings may be the result of this supervision.

Holmich *et al*[7] did not explain details such as the perceived resistance in weight-pulling adduction–abduction, increment in the order of resistance and rest time between exercise sets. In the current study, these details were defined and controlled by the physiotherapist. In addition, the physiotherapist was responsible for determining the resistance on weight-pulling adduction/abduction for each participant not only at the beginning of treatment but also at the end of each week. This may also help to explain the difference in the results.

Hip ROM

There was no noticeable change in the affected hip joint abduction ROM at the end of the treatment (p=0.609) in contrast to the findings reported by Holmich *et al*[7] This difference can be explained by the fact that most of the participants in the current study had not stopped their sports activity, but had just reduced it before taking part in the study. In addition, they were not allowed to stretch their adductors during the treatment. In contrast, most of the subjects in the Active Training Programme group in the Holmich *et al* study[7] had stopped their sport activities at the baseline. The overall flexibility of the subjects at the study baseline may have impacted the results.

The ROM of internal rotation of the affected hip joint increased significantly (p=0.001). As the decreased range of hip internal rotation has been suggested as a potential risk factor for groin injuries,[17] this result could be an advantage for this study and the Holmich protocol. It should be mentioned that although the increase in the ROM of the hip internal rotation is statistically significant, the mean value of the changes is almost 1° that may be clinically insignificant or even may be related to error of measurements.

Hip adductor and abductor muscle strength

Maximum IHAD and abduction strength improved significantly in the affected limb by 26.15% (p=0.0001) and 20.77% (p=0.0001), respectively. Maximum EHAD and abduction strength also improved significantly in the affected limb by 7.75% (p=0.0001) and 8.54% (p=0.02), respectively. The significant difference between percentage gain in isometric and eccentric strength (table 4) reminds us that we may need to pay more attention to strengthening EHAD and abduction, especially for the adductors in our treatment plan.

The ratio of isometric and eccentric adduction strength to abduction strength did not change significantly (p=0.309 and 0.957, respectively). The affected limb ratio of eccentric adduction to abduction strength was 0.77 after the treatment. Tyler *et al*[10] reported that an athlete was 17 times more likely to suffer an adductor strain (in professional ice hockey players) if the ratio of adduction to abduction strength was <80%. Of note, they evaluated eccentric strength to reach this conclusion.[10] Achieving a hip adduction to abduction ratio of >90% before returning to sports after an adductor injury has also been recommended.[14] These points again remind us of the need for more emphasis on eccentric exercises in our treatment protocol.

Functional tests

Functional test scores improved significantly at the 10th week of the treatment programme compared with baseline (p=0.0001). As functional test scores have not been evaluated in similar studies, we can only compare these values with those of similar studies in the future.

Although the mean duration of symptoms in our participants was 24.07 months (at the baseline), lack of a control group is considered a limitation for this study. The low number of participants is also another limitation for the current study.

CONCLUSION

The results of the present study objectively show that ET based on the Holmich protocol may be an effective treatment for LSAGP. However, more emphasis may be required on the eccentric strength of hip adductors and abductors. Future studies should be designed with a greater concentration on strengthening EHAD and abduction, especially for the hip adductors. They should also include hip muscle strength assessment to discover more effective treatment methods and shorten rehabilitation times for returning to sports activities.

Acknowledgements This study was performed as a part of physiotherapy PhD thesis under supervision and financial support at the School of Rehabilitation, Tehran University of Medical Sciences.

Contributors All authors have seen and agree with the contents of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent Not required.

Ethics approval Ethics Committee of Tehran University of Medical Sciences.

Provenance and peer review Not commissioned; externally peer reviewed.

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