A pilot study of the eccentric decline squat in the management of painful chronic patellar tendinopathy

C R Purdam, P Johnsson, H Alfredson, R Lorentzon, J L Cook, K M Khan

MATERIALS AND METHODS

Subjects
Subjects referred to a university sports medicine clinic with the diagnosis of patellar tendinopathy were recruited to the study. All were examined by one orthopaedic surgeon (HA). The inclusion criteria were:

- pain in the proximal patellar tendon with increased load
- tenderness to palpation
- imaging changes at the proximal attachment of the tendon to the patella (ultrasonography or magnetic resonance imaging)
- having rested for more than three months without effect on the tendon pain

All patients had been treated with non-steroidal anti-inflammatory drugs. One subject had had hydrocortisone injected as part of conservative treatment. Ethics approval was obtained from the University of Umeå, Sweden and all subjects provided informed consent.

Intervention
Subjects in this pilot study were not randomised because of the later development and inclusion of the decline exercise technique. Thus, the first nine consecutive subjects presenting for evaluation and agreeing to participate in the study were prescribed eccentric squats with the ankle joint in a standard position (fig 1). The next eight subjects were prescribed eccentric squats on a 25° decline board (fig 2).

Both groups undertook an exercise programme twice daily, consisting of three sets of 15 repetitions on a single leg, for 12 weeks. Those subjects with bilateral tendinopathy completed the programme separately for each leg. Subjects were instructed to complete the exercises with the trunk upright. Both groups were instructed to perform the exercise by slowly flexing the knee to 90° of flexion, and, as far as possible, to perform eccentric loading of the quadriceps muscles only and to return to the starting position using the non-injured side.
If they had bilateral tendinopathy, the arms and both legs were used to return to the starting position.

Subjects were asked to increase the load with weights in a backpack once the exercise could be completed without pain. Load was increased so that exercises were always performed with some pain or discomfort.

Subjects were not allowed to continue their competitive sporting activity during the first eight weeks of the trial period. After four weeks of the eccentric training regimen, they were allowed to complement it with slow jogging on flat ground, cycling, and water activities, if these could be performed without sharp pain in the patellar tendon. After eight weeks the patients were allowed to gradually return to previous activity.

**Outcome measures**

Visual analogue scale (100 point) (VAS) scores were recorded at baseline and at completion of the 12 weeks, to record the amount of pain during patellar tendon loading activity—that is, volleyball players during volleyball, soccer players during soccer, etc.

A further follow up was conducted at 15 months in the decline squat group of all tendons not managed surgically.

**Table 1** Anthropometric and symptomatic data of the standard and decline squat groups

<table>
<thead>
<tr>
<th>Standard squat</th>
<th>Decline squat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/Female (n)</td>
<td>8/1</td>
</tr>
<tr>
<td>No of tendons</td>
<td>10</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>22</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77.4 (7.4)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>181.6 (5.6)</td>
</tr>
<tr>
<td>Unilateral/bilateral</td>
<td>8/1</td>
</tr>
<tr>
<td>Duration of symptoms (months)</td>
<td>14.1 (6.6)</td>
</tr>
</tbody>
</table>

Where applicable, values are mean (SD).

**Table 2** Sports played by the subjects in the standard and decline squat groups

<table>
<thead>
<tr>
<th>Normal squat (n = 9)</th>
<th>Decline squat (n = 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floorball</td>
<td>4</td>
</tr>
<tr>
<td>Soccer</td>
<td>2</td>
</tr>
<tr>
<td>Ice hockey</td>
<td>1</td>
</tr>
<tr>
<td>Running</td>
<td>0</td>
</tr>
<tr>
<td>High jump</td>
<td>1</td>
</tr>
<tr>
<td>Volleyball</td>
<td>0</td>
</tr>
<tr>
<td>Skiing</td>
<td>1</td>
</tr>
</tbody>
</table>

Patient ability to return to previous (pre-injury) activity level was also recorded.

**Statistical analysis**

Subject characteristics of both groups were tabulated using descriptive statistics. VAS scores recorded before and after the eccentric programme were analysed for each group using a Wilcoxon matched pairs test (Statistica Release 6, 2002; Statsoft Inc). Two tailed significance was set at p<0.05. Because of limitations in study design, no between group comparison was performed.

**RESULTS**

**Subjects**

Seventeen subjects completed the intervention. At baseline, there were no significant differences in height, weight, and duration of symptoms between groups (table 1). All subjects were competitive in a range of sports before presentation (table 2).

**Visual analogue scale**

Table 3 shows descriptive results. There was a significant (p = 0.004) decrease in the amount of pain during activity (mean VAS score reduced from 74.2 to 28.5) in the decline squat group, between the measurements before and after the 12 week eccentric training regimen. No significant change was found in the standard squat group for the same period of training (mean VAS scores 79.0 at baseline and 72.3 at 12 weeks, p = 0.144).

**Return to activity**

Six subjects (nine tendons) in the decline group had returned to pre-injury activity levels in their sports. The remaining subjects had not been able to return to their previous activity level and were referred for surgical treatment. In the standard squat group, only one subject (one tendon) had been able to return to previous activity level. The remaining eight subjects (nine tendons) were also referred for surgical treatment.
and contains low numbers.

be clearly recognised that, by its nature, it is non-randomised
treatment of painful patellar tendinopathy. However, it must
eccentric exercise performed as a decline squat in the
tendons. We and others have also noted this in our clinical
Few studies have investigated the effect of conservative

DISCUSSION

The nine tendons in the decline group above were followed
up at 15 months. Four of the six subjects (five of nine
tendons) described in the decline group above were still
active at pre-injury levels. One subject (two tendons)
reported no symptoms in his patellar tendons, yet was
unable to continue his sport because of the development of
bilateral patellofemoral pain syndrome after jump training.
Colour Doppler ultrasonography of the patellar tendons
showed them to be normal. A further subject (two tendons)
had a relapse of significant patellar tendon pain (mean VAS
score 68) and had tried an alternative treatment within the
follow up period. Colour Doppler ultrasonography in this case
showed changes consistent with patellar tendinopathy.
The overall mean (SD) of the VAS scores at 15 months for
the five remaining tendons in the decline group was 26.2
(25.4).

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The overall mean (SD) of the VAS scores at 15 months for
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DISCUSSION

Few studies have investigated the effect of conservative
treatment on patellar tendinopathy. Curwin and Stanish
noted that patellar tendinitis responded less well to their
eccentric programme than intervention in several other
tendons. We and others have also noted this in our clinical
practices. Thus, we sought modes by which eccentric exercise
may have greater efficacy when applied to patellar tendino-
thropy. This pilot study is the first report of the effect of
eccentric exercise performed as a decline squat in the
treatment of painful patellar tendinopathy. However, it must
be clearly recognised that, by its nature, it is non-randomised
and contains low numbers.

In this study, subjects performing the eccentric squat on
the decline board showed good clinical results, with a
decreased amount of pain during activity (VAS score) and a
return to previous activity level. Most subjects who
performed the standard squat had unsatisfactory clinical
results over the 12 week treatment period. We speculate that
the effectiveness of the decline squat may be the result of the
decline board reducing calf muscle tension, allowing better
isolation of the knee extensor mechanism.

We consider that from the results of this small pilot study,
further clinical studies are warranted to test the efficacy of
the exercise. Such studies should use larger numbers, a
randomised study design, and more specific outcome
measures such as the VISA. A similar follow up period
would also be appropriate to better capture the effect of these
exercise programmes on sustained return to sporting activity.
Biomechanical studies comparing the relative loads on the
knee extensor mechanism with a standard and decline squat
would also be of benefit.

Limitations of this study

This study did not use a randomised design, as subjects who
presented first were given squat exercise without a decline
board, because at that time the decline squat had not been
developed. However, we were cautious not to change any
other aspects of the study design for the decline board
intervention. The subject numbers of the study are small,
particularly at the 15 month follow up. Outcome measures
should be extended to include a more specific outcome
measure such as the VISA scoring system developed
specifically for patellar tendinopathy.

CONCLUSION

The results of this pilot study indicate that an eccentric
exercise programme using the decline squat may have
promise for subjects with chronically painful patellar
tendinopathy. However, as the number of patients included
was small, the data should be interpreted cautiously.
Randomised studies comparing different models of squat
exercise are needed.

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doi: 10.1136/bjsm.2003.000053

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