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A pilot randomised controlled trial of eccentric exercise to prevent hamstring injuries in community-level Australian Football

B.J. Gabbe[a,*], **R. Branson**[b], **K.L. Bennell**[b]

[a] *Department of Epidemiology and Preventive Medicine, Monash University, Central and Eastern Clinical School, Alfred Hospital, Commercial Road, Melbourne, Vic. 3004, Australia*
[b] *Centre for Health, Exercise and Sports Medicine, School of Physiotherapy, University of Melbourne, Australia*

KEYWORDS
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Summary Hamstring injuries are the most common injury sustained by Australian Football players. Eccentric training has been proposed as a potential preventative strategy. This pilot randomised controlled trial (RCT) evaluated the effectiveness of a pre-season eccentric training program for preventing hamstring injuries at the community level of Australian Football. Seven amateur clubs ($n = 220$ players) were recruited. Players were randomised within clubs to the intervention (eccentric exercise) or control (stretching) groups and randomisation was stratified according to previous history of hamstring injury. Five exercise sessions were completed over a 12-week period, three during the pre-season and two during the first 6 weeks of the season. Compliance was recorded and players were monitored for the season to collect injury and participation data. There was no difference between the control ($n = 106$) or intervention ($n = 114$) groups with respect to baseline characteristics. Only 46.8% of all players completed at least two program sessions. Compliance was poorest for the intervention group. Intention-to-treat analysis suggested that players in the intervention group were not at reduced risk of hamstring injury (RR 1.2, 95% CI: 0.5, 2.8). When only control and intervention group players who participated in at least the first two sessions were analysed, 4.0% of intervention and 13.2% of control group players sustained a hamstring injury (RR 0.3, 95% CI: 0.1, 1.4; $p = 0.098$). The findings suggest that a simple program of eccentric exercise could reduce the incidence of hamstring injuries in Australian Football but widespread implementation of this program is not likely because of poor compliance.

Introduction

Hamstring injuries are the most common muscle strain sustained by athletes and are a frequent occurrence in sports such as Australian Football,

* Corresponding author. Tel.: +61 3 9903 9051; fax: +61 3 9903 0576.
E-mail address: belinda.gabbe@med.monash.edu.au (B.J. Gabbe).

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rugby, soccer, track and field and other sports involving sprinting.[1–4] The rate of recurrence is high, emphasising the need for primary prevention. Despite the relatively high incidence of hamstring injuries in sport, clear methods for prevention have not been identified and the most commonly cited risk factors for hamstring injury are factors such as age, past history and aboriginality, which are not modifiable.[5–8]

Over recent years, eccentric hamstring exercise has been proposed as a preventative measure for hamstring injury[4,9,10] and a growing body of laboratory-based evidence supports this proposition.[10–12] However, only one randomised controlled trial, involving 30 elite soccer players, has been undertaken to determine the effectiveness of eccentric hamstring training for the prevention of hamstring injuries.[4] While this study found a significant protective effect from the eccentric program implemented, the rate of hamstring injuries across both groups was unusually high, with 67% of the control group sustaining a hamstring injury and 20% of the intervention group. This is in contrast to the majority of studies of soccer and other football codes which cite a frequency of 12%—16%.[1,8,13,14] In addition, the program involved the use of specific equipment, limiting the applicability of the program to sub-elite and community levels of sport where resources for the purchase of equipment are low.

The aim of this pilot RCT was to determine the effect of an eccentric hamstring conditioning program on the incidence of hamstring injuries at the community level of Australian Football and to test the methodology employed in preparation for a full trial in the subsequent year.

Methods

Study design and participants

An RCT study design was used. Seven Victorian Amateur Football Association clubs (VAFA) agreed to take part in the pilot phase of this study during 2004. The VAFA is an adult, male Australian football league based in metropolitan Melbourne and VAFA rules prevent payment of players for participation. Participating clubs were from the A (highest level of competition), B, C and D (lowest level of competition) sections of the VAFA.

Players were eligible to participate in the study if they would be playing in either the senior (highest level of participation for the club) or reserve grade teams during the 2004 season, regardless of previous history of hamstring injury or age. However, any player who was injured at the time of recruitment and study commencement and therefore unable to complete the eccentric program was excluded from the study (both control and intervention groups). All players provided written informed consent and the study was granted ethics approval by the University of Melbourne Human Research Ethics Committee. Players were recruited into the study prior to group allocation.

Procedures

Questionnaire

Participating players completed a baseline questionnaire prior to randomisation. The information captured through the questionnaire included age, anthropometric characteristics, playing experience, past history of hamstring injury (previous 12 months), regular playing position and level of competition, and their preferred leg for kicking.

Randomisation

For each club, players were randomised to either the intervention (eccentric hamstring program) or control (basic stretching) groups. Therefore, within each club, approximately half of the participating players would perform the intervention and the remainder would acts as controls. Randomisation was stratified by past history of a hamstring strain to ensure an even spread of players with a past history of injury across the intervention and control groups. Players were randomised according to a computer-generated randomisation list for each club which included blocking in groups of four or six with the order of allocation varying within each block. Players were separated into either the previously-injured or no previous injury group and names entered into the randomisation list spreadsheet. Randomisation was undertaken by the primary author and the group allocation was provided to the study personnel responsible for supervising the program sessions.

Program

The intervention and control groups each underwent a five-session program over a 12-week period. Each of the sessions was supervised by study personnel who completed a participation sheet for each player, including the number of repetitions completed during the session. The first three sessions were undertaken during the final 6 weeks of the pre-season period. These three sessions were 2 weeks apart. The fourth and final sessions were completed over the first 6 weeks of the VAFA season and were 3 weeks apart. Each session was performed at the end of the club's core training

Figure 1 Intervention exercise starting position.

session but prior to their cool-down. After the groups completed their programs, the study players completed the club's scheduled cool-down with the non-participating players. The details of the intervention and control group programs are provided here.

Intervention group. The eccentric exercise program chosen for the trial was that described by Brockett et al.[10] which has been shown to produce a shift in the optimum angle for hamstring torque generation, a change in muscle function hypothesised to prevent hamstring muscle injury.[10] The program involves one exercise performed as 12 sets of six repetitions with 10 s rest between repetitions and rest periods of 2—3 min between sets.[10] The dosage and timing of the program was determined through consultation with two of the authors of the study by Brockett et al.[10] In the current study, a second person was used to stabilise the lower legs for the exercise, rather than the use of a board with straps. Figs. 1—3 illustrate the exercise from

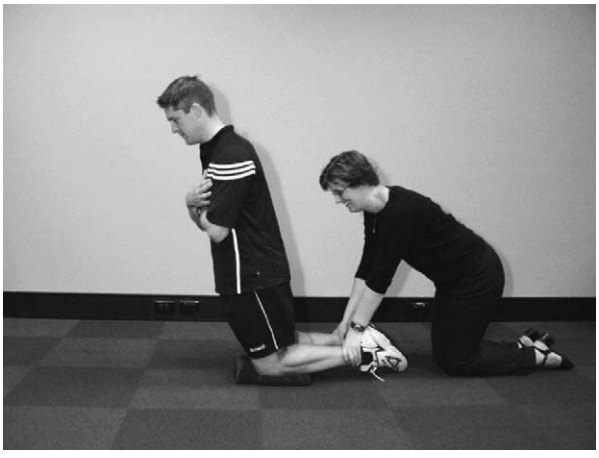

Figure 2 Controlled lowering of the body towards the ground for the intervention exercise.

Figure 3 Finishing position for the intervention exercise.

start to finishing position. From the starting position (Fig. 1), players were instructed to keep their arms crossed in front of their chest and, keeping their back straight and without bending the hips, slowly lower their body against the force of gravity forward towards the floor (Fig. 2). When the player was unable to control the lowering any further, they were able to relax, fall forward and stop their descent with their arms (Fig. 3).

Control group. The control group program involved a group of stretching and range of movement exercise of equivalent duration to the intervention group's program. The exercises included were:

i. gastrocnemius stretch performed in standing;
ii. hip flexor stretch performed in kneeling;
iii. hamstring stretch performed in supine (also called the Active Knee Extension or ''90/90'' stretch);
iv. hamstring stretch performed in sitting; and
v. lumbar spine rotation performed in supine.

Each of these exercises was performed three times on each side as a static stretch held for 30 s. The exception to this was the lumbar spine rotation which was held for 15 s only.

Outcome measures

The outcome of interest was the occurrence of a hamstring injury defined by physical assessment including[15—17]:

i. sudden onset posterior thigh pain;
ii. tenderness on palpation;
iii. with or without pain on stretch of the hamstring muscles; and
iv. with or without pain on contraction of the hamstring muscles.

Players were monitored for hamstring injury throughout the season through regular contact with coaches, club officials and medical staff members. When a hamstring injury occurred, the club physiotherapist completed an injury surveillance form. The physiotherapists were not blinded to the allocation of the players as such. They were provided with a list of participating players but group allocation was excluded. The injury surveillance form, used previously in Australian football studies,[1,8,18] recorded details about the injury such as the date of injury, a description of how the injury occurred and the context of the injury (i.e., training or match play). Club coaching staff was required to record player participation in training sessions and matches.

Data management and analysis

All baseline questionnaires, study session participation and injury data were analysed using SPSS for Windows (version 12.0). Groups were compared using χ^2 tests for categorical variables, and either independent *t*-tests or Mann—Whitney *U* tests for continuous variables, depending on the distribution of the data. χ^2 analysis was used to determine the association between study group and the outcome of hamstring injury. Relative risks, including 95% confidence intervals (95% CI), were also calculated. For all statistical tests, a *p*-value < 0.05 was considered significant.

Results

Two hundred and twenty players consented to participate in 2004. The randomisation process allocated 106 (48.2%) players to the control group and 114 (51.8%) players to the intervention group. Table 1 summarises the profile of players in each study group. There was no difference between the intervention and control groups with respect to age ($z = -0.1$, $p = 0.932$), past history of hamstring strain ($\chi^2_1 = 0.0$, $p = 0.997$), height ($t = 0.4$, df = 203, $p = 0.697$), weight ($t = 0.3$, df = 203, $p = 0.778$) or playing experience ($t = -0.8$, df = 200, $p = 0.932$).

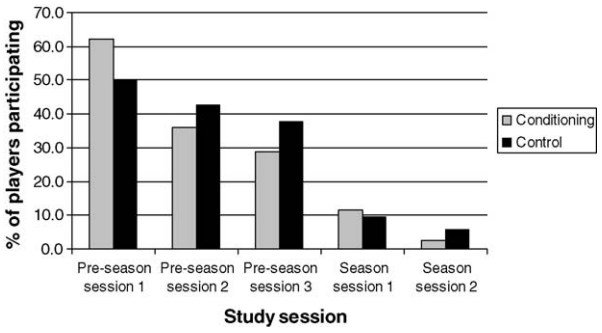

Figure 4 Percentage of players participating in each scheduled study session.

Five study sessions were completed at each participating club. The percentage of players participating in each study session is shown in Fig. 4. Overall, participation in the study sessions was poor. There was a consistent fall in participation as the study progressed which was most noticeable for the intervention group. The participation rate fell 50% for the intervention group from session 1 to session 2. In contrast, the participation in the control group fell just 10% over the same sessions. Participation in the sessions held during the VAFA season was extremely poor with fewer than 10% of players taking part (Fig. 4). Thirty percent ($n = 66$) of players who agreed to participate in the study failed to complete even one session, while 103 (46.8%) completed at least two sessions.

Among the players participating in this study, 18 hamstring injuries were sustained during the 2004 season, equating to 8.2% of players sustaining a hamstring injury during the 2004 season. Intention-to-treat analysis suggests that players in the intervention group were not at reduced risk of hamstring injury (RR 1.2, 95% CI: 0.5, 2.8). However, when only control and intervention group players who participated in at least the first two sessions were analysed, a trend towards a protective effect for the intervention group was noticed (RR 0.3, 95% CI: 0.1, 1.4; $p = 0.098$). Again, there was no dif-

Table 1 Profile of participating community-level Australian football players by study group

Characteristic	Intervention ($n = 114$)	Control ($n = 106$)
Age (years), median (range)	23.4 (18.0—35.0)	23.9 (17.4—36.0)
Playing experience (years), mean (S.D.)	11.8 (6.2)	12.4 (4.9)
Weight (kg), mean (S.D.)	83.3 (8.6)	83.0 (9.5)
Height (cm), mean (S.D.)	183.4 (6.1)	183.1 (7.0)
Past history of a hamstring strain (previous 12 months), % (95% CI)		
No	86.0 (79.6, 92.4)	86.0 (79.4, 92.6)
Yes	14.0 (7.6, 20.4)	14.0 (7.4, 20.6)

ference between the groups with respect to age ($z = -0.8$, $p = 0.425$), height ($z = -1.1$, $p = 0.257$), weight ($z = -1.6$, $p = 0.116$), playing experience ($z = -0.8$, $p = 0.434$) and past history of hamstring injury ($\chi^2_1 = 1.7$, $p = 0.191$). In the ''compliant'' subgroup, only 4.0% of players in the intervention group sustained a hamstring injury compared to 13.2% in the control group.

Discussion

This was the first RCT to test an intervention for the prevention of hamstring injuries in Australian Football and describes the first-year results of a planned 2-year trial. The intervention selected for investigation was a simple and inexpensive eccentric exercise program shown to produce a potentially protective change in muscle function in the laboratory.[10] This first year of the study showed that, in the sub-set of players who completed at least two of the study exercise sessions, the program showed a trend towards protection against hamstring injury, though significance was not reached ($p = 0.098$).

The exact timing and mechanism of hamstring injuries has not been fully established but the majority of injuries occur during sprinting. It is hypothesised that the hamstring muscles are vulnerable to injury when this muscle group acts to slow the momentum of the swinging leg in preparation for ground contact of the stance phase of sprinting, effectively changing from an eccentric to concentric role.[9] Eccentric exercise has long been postulated as a potential method for preventing hamstring injury in athletes[9] and several studies have extended this hypothesis to suggest that being able to generate peak torque at longer length would protect against hamstring injury.[10–12] The session dosage chosen has been demonstrated in the laboratory setting to increase the length significantly at which peak hamstring torque is generated[10] and, through discussions with the authors of the previous study, the full program was developed for evaluation. The majority of the program was scheduled for the preseason and early part of the playing season as the majority of hamstring injuries occur early in the season[1,8] and it was hypothesised that the program would be most effective if started early. While the overall effect of the program appeared to be positive and supports the findings of Askling et al.,[4] there were significant limitations that would prevent the widespread implementation of this program to community-level Australian Football players.

There was a 50% fall in participation from the first to second sessions of the intervention group with many players attending training on the program session nights but not completing the study sessions. There was no clear pattern for non-compliance, with no differences noted between compliant and non-compliant players with respect to age and past history of hamstring injury. The primary reason given by players for the lack of compliance was that the program resulted in delayed onset muscle soreness (DOMS). This soreness is an indicator of muscle fibre damage but it is the response of the muscle to the damage induced by eccentric exercise that is believed to have a protective effect against further damage.[10] The players were made aware of the potential for DOMS and that the soreness was a necessary after-effect of the program. However, the DOMS experienced had a twofold effect. First, it inhibited the players' ability to participate in subsequent club training sessions and, second, players believed that the soreness would increase their risk of hamstring injury. While visual analogue scale (VAS) scores of DOMS were collected at subsequent sessions, the lack of compliance meant that these data were incomplete. Although the median soreness, on a scale of 0—10 (no pain to worst pain imaginable) were low, these scores were only collected for those who attended subsequent sessions. Perhaps players who experienced greater DOMS failed to participate in subsequent sessions. Brockett et al.[10] reported a mean DOMS rating of 5.5 in their study group, indicating that the muscle group was tender to touch but only mildly sore on moving about. It was anticipated that the football players would experience less DOMS than the cohort of Brockett et al.[10] as the football players participate in regular physical activity, while the participants in the laboratory study were all untrained. Nevertheless, the DOMS was clinically significant to Australian Football players and resulted in extremely poor compliance. Whether or not the provision of incentives would have improved compliance is unknown but the question warrants consideration for future studies.

The lack of compliance with the program was compounded by the difficulties of organising an RCT within the structure of a community-level Australian Football competition, an issue noted in another community-level based RCT.[19] The competitive season runs from April to September and players and clubs reconvene for pre-season training in January. Although pre-season training is organised by the clubs, attendance is not compulsory and many players do not begin training until closer to the start of the competitive season, often due to commitments to summer sports such as cricket, and

most do not attend all scheduled sessions. Identifying the time to recruit the optimal number of players with sufficient time to complete the intervention was difficult. When preparing for the pilot trial, it was anticipated that just over 400 participants would be required in the full trial to be able to detect a 60% reduction in the incidence of hamstring injuries with 80% power and accounting for a 20% loss to follow-up. Although 220 players were recruited across the clubs in the 2004 pilot season, 30% of consenting players failed to attend even one study session, suggesting that adjustment for a higher rate of drop-out is necessary for future trials. Nevertheless, the difference between the incidence of injury in the control and intervention groups was larger than anticipated when analysing the group who completed at least 40% of the study sessions and, had all of the players complied to this level, this pilot study fell just 60 players short of having 80% power to show that the difference in incidence of hamstring injury between the control (13%) and the intervention (4%) groups was significant.

In addition to poor compliance, there are three further limitations that warrant discussion. Randomisation within the club, while avoiding the issues related to clustering, creates the potential for contamination (i.e., players from one group participating in the other). As the sessions were attended, supervised and monitored by study personnel, there was no contamination of the study sessions. However, as with all RCT studies, the potential for players to undertake the program of the group to which they were not allocated could not be ignored. Given the low compliance in this study, contamination is unlikely but warrants consideration as a potential cause of the null finding. Secondly, while all clubs agreed to collect exposure data in the form of participation in training and games for participating players, this information was not provided. Therefore, adjustment for exposure in the analyses could not be performed, a significant limitation of the study. Finally, the potential for the control group exercises to impact on the risk of hamstring injury cannot be ignored and, therefore, its suitability as a control regimen could be questioned. Nevertheless, compliance with the control group program was also poor and it is unlikely that the program was able to change flexibility and the risk of hamstring injury due to the spacing and content of the program. A prior prospective cohort study of amateur Australian Football players found that flexibility of the muscle groups included in the stretching program were not predictors of hamstring injury.[8] The incidence of hamstring injuries in the control group (13%) was as expected for any Australian Football cohort and supports the notion that the control group exercises did not influence hamstring injury risk although only pre and post-program testing would have eliminated this possibility.

Conclusion

The results of this pilot year of an RCT in community-level Australian Football suggest that a simple pre-season program might reduce the incidence of hamstring injuries. However, the degree of DOMS generated by the eccentric program limited compliance in the trial and would be a major barrier for a full RCT. Therefore, it was concluded that the program would have little widespread benefit to community-level Australian football and that further development of modified programs which produce less DOMS but still have a beneficial effect on muscle function was needed. An RCT of a modified program, rather than completion of a second year of the planned RCT, is currently underway.

Practical implications

- Hamstring injuries are the most common injury sustained by Australian Football players.
- Eccentric hamstring training programs have been suggested as a method of preventing hamstring injuries.
- This randomised controlled trial of pre-season eccentric program involving 220 community-level Australian Football players showed a trend towards protective against hamstring injuries.
- Poor compliance with the training program was predominantly due to the delayed onset muscle soreness experienced by players in the eccentric program group.
- Development of modified programs which produce less delayed onset muscle soreness but still have a beneficial effect on muscle function is needed and require evaluation in future studies.

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