

The influence of rehabilitation factors on recurrence of hamstring injury in elite Australian footballers

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Summary

Using a prospective cohort design, this study examined rehabilitation parameters and recurrence following hamstring injury in fifty-eight elite Australian footballers. The frequency of rehabilitation training appears to be related to the risk of suffering a recurrence of a hamstring strain in the first few weeks of returning to competition.

No player who engaged in hamstring strengthening every 2nd day or less than every 2nd day had a re-injury. Twenty-six percent of players who engaged in a strengthening regime (including eccentric strengthening) more often than every 2nd day (once a day or twice every 3 days) re-injured.

On average, players who ran more often than every 2nd day were 5.7 times more likely to re-injure than players who ran every 2nd day or less. On average, players who performed a hamstring stretching session four or more times a day were 2.3 times more likely to suffer a re-injury to their hamstring than players who stretched 1-3 times a day.

Training consisting of running drills and specific hamstring strengthening should be engaged in every second day, particularly in players thought to be at risk of re-injury. Players should stretch twice a day and engage in three full training sessions before returning to play.

ABSTRACT

Objective: To investigate whether rehabilitation parameters are related to early recurrence of hamstring strain following return to play

Design: Prospective observational study

Setting: Elite level of Australian Football competition

Participants: 59 players who suffered a hamstring strain in 2002 season

Predictors: Rehabilitation parameters assessed via questionnaire completed by club physiotherapist at 2 weeks post injury and on return to competition.

Main outcome measures: Recurrence of hamstring injury within 3 weeks.

Results: Ten players (16%) suffered a recurrence of their hamstring injury. No player who engaged in hamstring strengthening every second day or less frequently sustained a recurrence. Twenty-six percent of players who engaged in strengthening (including eccentric strengthening) more often than every second day re-injured ($p=0.05$). Players who ran more often than every second day had a recurrence rate of 27% and were 5.7 (95% CI 0.8-41.0) times more likely to re-injure than players who ran every second day or less who had a recurrence rate of 4.8% ($p=0.044$). On average, players who performed a hamstring stretching session four or more times a day were 2.3 times more likely to suffer a re-injury to their hamstring than players who stretched 1-3 times a day ($=0.165$). There was no difference between groups who did and did not recur for the number of full training sessions completed prior to returning to competition.

Conclusion: The results suggest that to minimise the risk of recurrence on return to play, hamstring injury rehabilitation consisting of running drills and specific hamstring strengthening should not be engaged in more frequently than every two days.

Key words: hamstring strain, rehabilitation, recurrence, strengthening, stretching

Introduction

In the Australian Football League (AFL), the elite level of competition, hamstring strains are the most common injury, classically occurring when footballers accelerate or run at maximum speed (Orchard and Seward 2002). Hamstring injuries result in lost playing time of up to eight weeks and affect an average of six out of a team's 38 players each season (Orchard and Seward 2002). The rates for recurrence of hamstring strain are also high in this elite sporting population with more than 30% of hamstring strains recurring, despite concentrated rehabilitation and prevention efforts (Orchard and Seward 2002). Thus identifying factors associated with successful return to play following an initial hamstring injury may assist clinicians to reduce the recurrence rate.

A number of factors have been proposed to influence the risk of hamstring recurrence. We have previously shown that hamstring injuries in the biceps femoris are much more likely to recur than those in the medial hamstrings and that past history of hamstring strain in the previous 12 months results in a 20 times greater likelihood of sustaining a recurrence in the first three weeks of returning to play [Warren, 2008 #213]. Rehabilitation parameters have also been implicated as they may influence the quality of muscle healing, risk of hamstring injury recurrence and the overall readiness of the player to return to competition; however these have not been well studied.

While there is no proven effective rehabilitation for hamstring injuries (Orchard and Best 2002), the goals are to achieve the football-specific rehabilitation parameters of flexibility, strength, power, endurance and co-ordination. At the elite level, injured

players usually have daily treatment and rehabilitation sessions with the aim of facilitating an expedient and successful return to play. The standard immediate treatment in the acute phase of a hamstring strain is to minimise bleeding and the inflammatory process (Clanton and Coupe 1998, Kujala, 1987 #36) using rest, ice, compression and elevation (Orava et al. 1997; Clanton and Coupe 1998). Mobilization and strengthening are instituted for better structural organization of the regenerating muscle fibers (Lehto, Duance et al. 1985; Jarvinen and Lehto 1993). Neural mobility is usually addressed to prevent tethering within the scar and at other interfaces. Functional rehabilitation incorporating coordination, skill patterns, power and agility to progress the footballer to highly complex movement patterns and football specific activities are incorporated in rehabilitation (Lephart and T.J. 1995; Sherry and Best 2004). Clubs also employ formal running rehabilitation programs adapted largely from one first outlined by Reid (Reid 1993). This program utilizes increments of pace, acceleration, change of direction and distance with progression according to symptoms and predicted rate of recovery.

The aim of this study was to investigate whether rehabilitation parameters are related to the risk of recurrence in elite Australian football players. This will provide important information that may guide management of players following hamstring muscle injuries.

Methods

This study was part of a prospective cohort design to evaluate clinical and imaging factors related to time to return to play and recurrence following hamstring injury in elite Australian footballers. The methods are described in full elsewhere and other results have been previously published (Warren, 2008 Connell, 2004 #12}. This subsequent study

reports on the relationship between rehabilitation parameters and recurrence in this cohort.

Participants

Players from the Victorian based AFL clubs (n=10 clubs, 380 players) who sustained a hamstring strain as clinically diagnosed by club medical personnel during the 2002 season were invited to participate. The criteria for diagnosis of a hamstring muscle strain were: acute onset of posterior thigh pain, palpable hamstring muscle tenderness; reproduction of the pain on hamstring stretch and; reproduction of pain by resisted contraction of the hamstrings. Players were excluded from the study if they: were unavailable for clinical testing within three days of injury onset; sustained a hamstring injury within six weeks of the end of their playing season as this would preclude adequate return to play follow-up; or had clinical signs and symptoms suggestive of a diagnosis other than a hamstring strain. The study was approved by the Human Research Ethics Committee of The Alfred Hospital. Written informed consent was obtained for all participants.

Procedure

The players underwent their usual rehabilitation program. At 2 weeks post injury and when the player returned to play each player's club physiotherapist completed a questionnaire. The physiotherapist recorded how often the players ran and engaged in hamstring strengthening as part of their rehabilitation program. The number of sessions per day of hamstring stretching was recorded. The information from the 2 questionnaires was correlated and where discrepancies occurred the physiotherapist was contacted to

determine how often the player *mostly* engaged in the rehabilitation parameter in question. The number of full training sessions before returning to play was also recorded.

A hamstring injury was considered a recurrence if the player reported pain in the same hamstring muscle compartment in the same leg which fulfilled the same criteria for a hamstring injury, within three weeks of returning to play. Given that the majority of re-injuries in the AFL occur during the first three weeks (19), completing three matches without recurrence was considered a successful return from injury.

Data management and analysis

The data were analyzed using SPSS (version 11.5) (Chicago, USA). For analysis, a number of variables were converted into categories of more or less frequency. Hamstring stretching was categorized into either engaging in a hamstring stretching session at least four times a day or engaging in a hamstring stretching session less than four times a day. Hamstring strengthening was categorized as performing resistance training, including eccentric strengthening, either at least 2 times every 3 days (once a day or 2 times every 3 days) or every second day or less. Running as part of rehabilitation was categorized as either at least 2 times every 3 days (once a day or 2 times every 3 days) or every second day or less.

Ninety-five percent confidence intervals (CI) were calculated for each proportion to indicate the variability in the observed proportions. Chi-square analyses were used to identify univariate associations between the baseline variables and the outcomes of

interest. Fisher's exact tests were undertaken if these criteria were not met (Bland 1995). Relative risks were calculated where possible. Multivariate tests or adjustment for past history of hamstring strain were not performed given the small sample. The 5% level of significance was taken for the statistical tests.

Results

The mean (range) age of the players was 23.9 (17-33) years while the mean (range) height and weight of the players was 186.4 (174-200) cm and 88.0 (74-107) kg, respectively. The cohort represented 95% of Melbourne based AFL footballers who suffered a hamstring strain that resulted in a missed week of football participation in the study period of 2002 (AFL Injury Database). The time taken to return to competition ranged from one to 8 weeks with a median of 26 days.

Ten players experienced a recurrence of their hamstring injury within the first three weeks of returning to play. Seven of these had a recurrence in the first week of returning to competition, with 2 in the second week and 1 in the third week. In all cases, players were unable to participate in at least three games (range 3-7 games) following the recurrence. Nine of the ten recurrences occurred in the first quarter of the game at an increasing rate as the quarter evolved.

The frequency of hamstring stretching, strengthening and running in the cohort as a whole and in those with and without recurrence is shown in Figures 1A-C. All players undertook hamstring stretching. Almost half engaged in a stretching session twice a day while 24% stretched three times a day and 14% stretched four or more times a day. Hamstring strengthening was performed by most players (92%) with 42% undertaking a

daily session and 31% undertaking two sessions every 3 days. All players participated in a formal running program with 86% percent of players running at least every second day or daily as part of their rehabilitation.

Rehabilitation factors associated with recurrence of hamstring injury

The results are shown in Table 1 and Figures 1 and 2. Sixteen percent of players who stretched 1-3 times per day suffered a recurrence of their hamstring injury (95% CI, 8% to 28.5%). Thirty-eight percent of players who performed a hamstring stretching session 4 or more times a day suffered a recurrence (95% CI, 13.6% to 69.4%) although with the small sample size, this difference did not achieve conventional levels of significance (Fischer's exact test, $P=0.17$). On average, players who performed a hamstring stretching session four or more times a day were 2.3 times (95% CI, 0.8 to 7.0 times) more likely to suffer a re-injury to their hamstring than players who stretched 1-3 times a day.

Twenty-seven percent of the players who engaged in a running program every day or twice every three days suffered a recurrence within three weeks of returning to play (95% CI, 15.4% to 43.0%). In the group of players who engaged in a running program every second day or less than every second day, the proportion of players who had a recurrent strain was only 4.8% (95% CI, 0.9% to 22.7%). The difference in proportions was 22.3% (95% CI, 0.9% to 38.7%) which is statistically significant (Fischer's exact test, $P=0.044$). On average, players who ran more often than every second day were 5.7 times (95%CI, 0.8 to 41.0) more likely to re-injure than players who ran every second day or less frequently.

No player who engaged in hamstring strengthening (including eccentric strengthening) every second day or less than every second day suffered a recurrence. Twenty-six percent of players who engaged in a strengthening regime more often than every second day (once a day or twice every 3 days) re-injured (95% CI, 14.9% to 40.2%). This difference was statistically significant (Fischer's exact test, $P=0.05$).

Both the group that successfully returned to play and the group that re-injured on returning to play participated in an average of 3 full training sessions before returning to play (range 1-5).

Discussion

This study examined the relationship of several rehabilitation parameters to the risk of hamstring recurrence in a cohort of elite level Australian footballers. It showed that a greater frequency of hamstring strengthening and running was associated with a greater likelihood of sustaining a recurrence in the first three weeks following return to play. The frequency of hamstring stretching was not significantly related to the risk of recurrence although a similar trend with increased frequency was noted.

Despite elite club medical and fitness staff normally requiring their hamstring-injured players to train several full pace game simulation training sessions prior to returning to competition, 10 players still suffered a recurrence of injury. These recurrences all occurred in the initial thirty percent of the game with nine of the ten occurring at an increasing rate as the first quarter evolved. This suggests that the intensity and demands

of the game are at a level greater than that achieved at training. It is possible that increasing fatigue as the first quarter evolved led to increasing susceptibility to hamstring strain recurrence. It is also possible that the apprehension and fear of overexerting previously injured muscles that was prohibiting them from exposing themselves to pre-injury levels of exertion was overcome as the first quarter of competition evolved.

Analysis of the hamstring rehabilitation program parameters showed that players who sustained a recurrence of their injury on their return to play generally trained more often than the group that successfully returned to play. In particular, a greater frequency of strengthening and running was associated with an increased risk of re-injuring the hamstring. It appears that the frequency of strengthening and running may influence the quality of muscle healing and risk of hamstring injury recurrence. A logical inference is that there is an optimal quantity and quality of stretching, strengthening and running to be engaged in as part of the rehabilitation process and, in the haste to expedite a player's return to competition, a healing muscle is subjected to an excessive amount of work such that the quality of healing is compromised and risk of recurrence is increased. This parameter of rehabilitation has not been studied previously

The decision of when a player returned to competition was at the discretion of the medical personnel with all players required to complete a number of full training sessions. The risk of hamstring recurrence was not related to how many training sessions a player completed. This suggests that making a player undertake more training sessions before returning to competition will not reduce his risk of hamstring recurrence.

However, this may not necessarily apply to all subgroups such as those with previous history of injury that are known to be at greater risk of recurrence.

The strengths of this study were its high capture of injured athletes (95% of all eligible cases) and its prospective nature. Nevertheless, there are several limitations that warrant mention. First, the rehabilitative practices were obtained via a retrospective questionnaire completed by the club physiotherapist and as such only relatively crude information about the frequency of different training modes was gained. More detailed information about specific training and dosages as well as variations across the rehabilitation phase could have been obtained by using a prospective log-book and other measurement tools such as heart rate monitors. Second, the study involved a young, elite population playing the highest level of Australian Football and results may not necessarily translate to the community level or to hamstring-injured players in other sports. Third, while the cohort was relatively large, the number of hamstring recurrences was small. A larger study with control of other variables such as past history of injury could better examine the association of different rehabilitation parameters and their relationship to successful return to competition.

Conclusion

This study found that the frequency of rehabilitation training was related to the risk of suffering a recurrence of a hamstring strain in the first few weeks of returning to Australian football competition. The clinical implications from the results are that injured players engage in rehabilitation consisting of running and strengthening not more frequently than every second day and stretching sessions not more than twice per day.

Further research is needed to establish whether such changes to rehabilitative practices can reduce hamstring recurrence rates.

Acknowledgements

We acknowledge the Australian Football League for financial support. We also acknowledge the support of the club medical officers and physiotherapists who assisted with participant recruitment and who completed questionnaires.

Dr Belinda Gabbe was supported by a Career Development Award (465103) from the National Health and Medical Research Council of Australia during the preparation of this manuscript.

Competing interests

The authors have no competing interests to declare.

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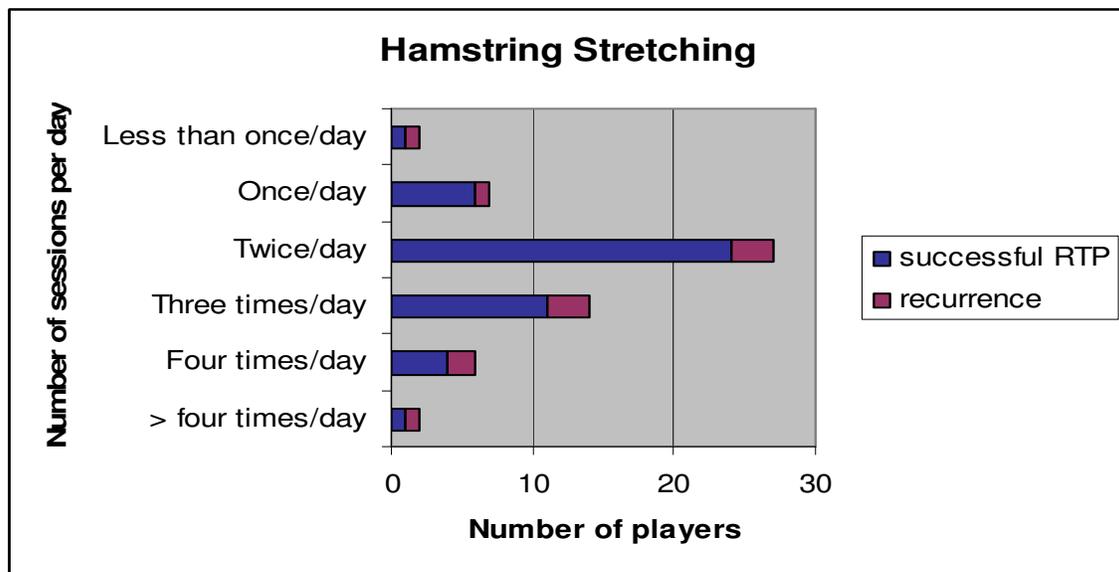
Table 1. Rehabilitation factors associated with recurrence of hamstring injury

Variable		n	% of players sustaining a recurrence (95% CI)	RR (95% CI)	p-value
Hamstring stretching frequency	1-3 times per day	50	16.0 (8, 28.5)		
	≥4 times per day (ref)	8	37.5 (13.6, 69.4)	2.3 (8.0, 28.5)	0.165

Hamstring Running frequency	\leq every 2 nd day	21	4.8 (0.85, 22.7)		
	$>$ every 2 nd day (ref)	37	27.0 (15.4, 43.0)	5.7 (0.8, 41.0)	0.044
Hamstring strengthening frequency	\leq every 2 nd day	15	0 (0, 20.4)		
	$>$ every 2 nd day (ref)	43	25.6 (14.9, 40.2)	Not Applicable*	0.05

**Relative risk was not estimated for frequent hamstring strengthening cohort as no player who engaged in strengthening every second day or less suffered a re-injury.*

Figure 1 A: Frequency of hamstring stretching, B: strengthening and C: running with proportion of hamstring injury recurrence.



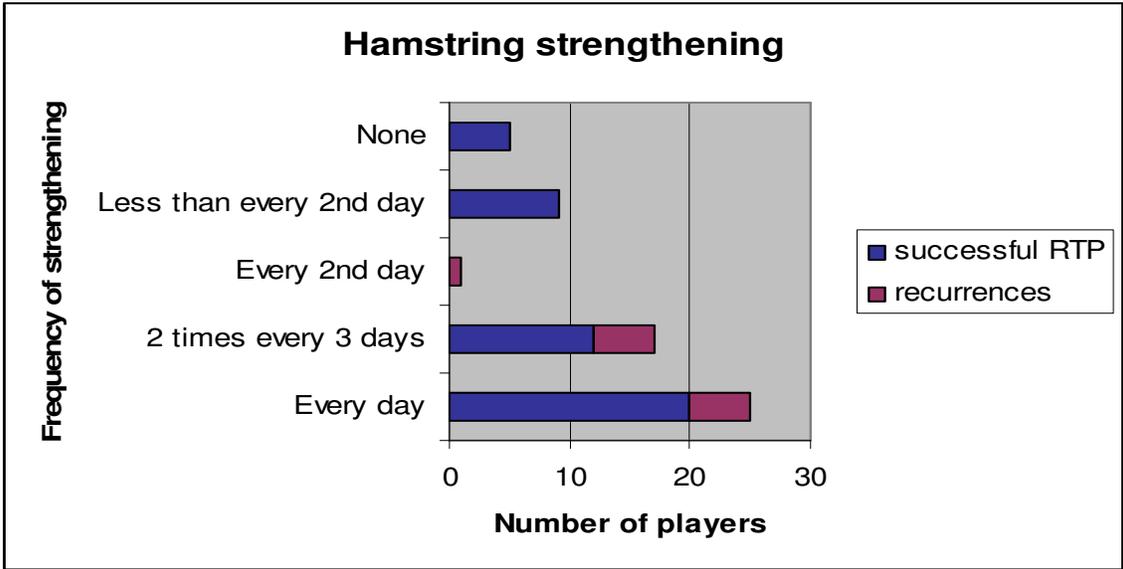
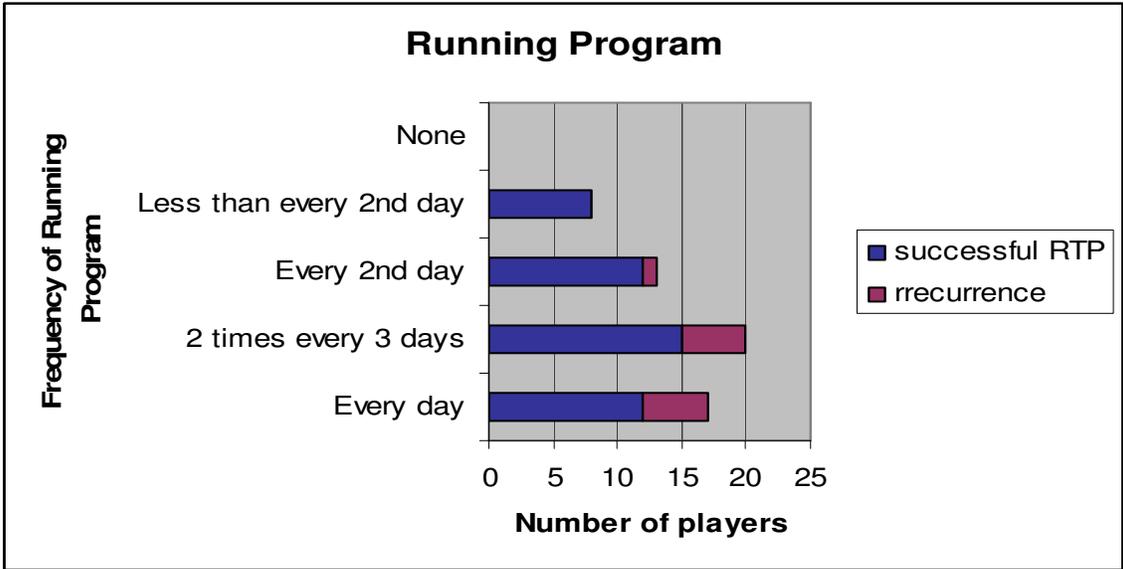


Figure 2. Hamstring rehabilitation parameter proportion of players with recurrent strain

