Hamstring Structural Injury in Futsal Players: The Effect of Active Range of Motion (AROM) Deficit on Rehabilitation Period

L. Smirnova¹, A. Derinov², I. Glazkova³

¹ Department of Dermatology and Venereology, Sechenov First Moscow State Medical University, Moscow, Russian Federation
² Department of Surgery, Sechenov First Moscow State Medical University, Moscow, Russian Federation
³ Department of Pharmacy, Sechenov First Moscow State Medical University, Moscow, Russian Federation

INTRODUCTION
Active sports, in particular football, are characterized by an increased traumatic risk. The most common type of sustained injuries occurring in sports are the muscle injuries, their frequency varying from 25 to 50% of all cases (1-5).

Almost all muscle injuries (95% according to Hallen and Ekstrand (4)) can be divided in four groups: hamstring injury, adductor injury, quadriceps injury, and the calf muscle injury. Among the above groups, hamstring injuries are the most common type, presenting a third of all cases. Overall, the number of hamstring injuries varies depending on the
Injury severity can significantly impact the subsequent risk of repeated injuries. Other studies have examined the effect of initial injury severity on the recovery rate measure. Furthermore, this indicator serves as an objective and accurate measure. Other studies have investigated the correlation between AROM deficiency and the time to full recovery in Greek elite athletes. The authors showed that the active range of motion deficit after hamstring injury correlates with rehabilitation time in futsal players. The purpose of this study was to investigate cases of hamstring injury in futsal players and find a significant association between the active ROM deficit and the rehabilitation period.

METHODS

Participants and acceptance criteria

A total of 200 male futsal players with first-time hamstring injuries were admitted into the study (age range, 18–23 years) between January 2010 and December 2016. No patients required surgical intervention. Exclusion criteria were comitant bilateral or asynchronous hamstring strain (with chronic tendonitis); confirmed or suspected previous hamstring injury; extrinsic injury to the posterior thigh; pain at the palpation of the proximal hamstring tendon-bone junction; non-structural hamstring injury; proximal hamstring tendon tear, and grade IV injury according to Maffulli et al. (15). The ultrasound showed no anatomical lesions in 74 patients (grade 0 according to Peetrons (12)). Thereby, only 126 futsal players were included for further research. The control group included 100 men of the same age who had never experienced a hamstring muscle injury.

Clinical assessment

All athletes underwent an examination by a sport medicine doctor. A traumatologist was only involved in the most severe cases. All athletes had the following: a) local pain...
on palpation, and b) pain with resisted movements (e.g. hip extension, knee flexion). Athletes were managed with the PRICE protocol (Protect, Rest, Ice, Compression, and Elevation). Ice was applied for 15 minutes every hour for the first 6 hours after the injury and initial evaluation, and then every 3 hours. The thigh was protected and compressed using a compressive elastic bandage and was kept elevated. No motion was allowed for the first 6 hours and isometric exercises were encouraged for all the periarticular muscles of the hip and knee thereafter.

Clinical evaluation conducted 2 days after the injury included the following: a) inspection for bruising, b) ability to walk on level ground without pain, c) palpation of the hamstring with the athlete prone and knee extended (for presence or absence of tenderness), d) provocation of pain on isometric hamstring contraction, e) provocation of pain on passive movements (hip flexion with the knee extended and athletes supine), and f) AROM testing under the Askling protocol (23, 24). These parameters are important for both obtaining accurate data on injury severity and predicting the length of the recovery period.

Athletes enrolled in the study underwent clinical and ultrasound examinations. The study and control groups were exposed to the same AROM assessment procedures.

Protocol processing
The athlete was positioned supine with both hip and knee flexed to 90 degrees (figure 1 A). The unaffected leg was placed flat on the couch with the knee fully extended and maintained in this position throughout the test. The athlete was then instructed to actively extend the knee through the full available ROM until firm resistance was felt (figure 1 B). Meanwhile the hip was maintained at 90 degrees of flexion. The degree angle was measured by a double-arm 30 cm clear plastic inclinometer. The inclinometer was aligned along the femur with the reference point at the greater trochanter of the femur. All measurements were done in triplicate by the same physician in order to reduce examiner bias. The rehabilitation time is expressed as an interval from the trauma event to pre-injury sports activity (return to play). The difference in AROM data between the injured and uninjured leg was expressed as an AROM deficit.

Rehabilitation protocol
Injured athletes were supervised by experienced physiotherapists and traumatologists. The rehabilitation process was divided into 4 phases:
- traumatic or acute phase. Normalization of gait, involved the use of strapping and/or crutches;
- rehabilitation or strength phase. Regaining of pain-free ROM, starting with concentric training and progressing to eccentric training;
- functional phase. Application of limited loading and return to full activities under the supervision of a doctor or according to recommendations;
- full recovery phase. Return to full sport activities.

Follow-up
The athletes were followed weekly in the clinic during the rehabilitation program. The clinical follow-up period lasted until the athlete returned to pain-free full sports activity. All

Figure 1. (A) Positioning of the inclinometer; (B) Active knee extension testing technique.
athletes were exposed to additional remote monitoring by telephone. Telephone contacts with the athletes and their coaches were held at 3, 6, 12, 18 and 24 months after injury.

Statistical analysis
Pearson correlation was used to find correlation between the return to full athletic activity (4th phase) and AROM findings. Statistical data were processed using the 1-way analysis of variance, the Chi-Square ($\chi^2$) test and regression analysis. The significance level (t-test) was set at $p < 0.05$. Statistical processing was performed with the Past v. 3.0 software.

RESULTS
Among 126 (63%) athletes with sonographic abnormalities, 101 or 80% had injuries to the biceps femoris muscle. Musculotendinous Junction (MTJ), proximal or distal, was involved in 91% of injuries or in 115 athletes. None of the athletes had more than one injured muscle. Characteristics of muscle injuries in 126 athletes with abnormal ultrasound findings are presented in Table I.

Ultrasound scans revealed grade I injuries (according to Peetrons (12)) in almost half of the participants (62 or 49.2%), and grade II injuries in 64 (50.8%) athletes.

Table I. Muscle injury characteristics in 126 athletes with abnormal findings documented by Ultrasound Imaging.

<table>
<thead>
<tr>
<th>Injured area, muscle and ligaments</th>
<th>Number of athletes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps femoris</td>
<td>80.0</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>9.0</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>11.0</td>
</tr>
<tr>
<td>Proximal musculotendinous junction (MTJ)</td>
<td>38.7</td>
</tr>
<tr>
<td>Distal musculotendinous junction (MTJ)</td>
<td>52.3</td>
</tr>
<tr>
<td>Intramuscular tendon</td>
<td>40.1</td>
</tr>
<tr>
<td>Myofascial injury</td>
<td>9.8</td>
</tr>
<tr>
<td>Hematoma</td>
<td>17.8</td>
</tr>
</tbody>
</table>

The mean AROM of the injured leg in the study group was $56.12 \pm 6.9$ degrees (range, 11-90 degrees; $p < 0.05$). For asymptomatic side, it was $68.9 \pm 5.4$ degrees (range, 40-91 degrees; $p < 0.05$). The mean AROM deficit in the study group was $12.8 \pm 6.8$ degrees. In the control group, the mean AROM indicated similarly to uninjured side of examined athletes, $67.9 \pm 6.5$ degrees at the range 42 to 93 degrees. There were no significant differences in AROM values between the uninjured side of the athletes and the control individuals ($p < 0.697$). However, there was a significant difference ($p < 0.001$) between the injured legs of athletes in the study groups and controls.

The majority of athletes in the study group (70 or 55.5%) had an AROM deficit of less than 15 degrees. Their average recovery period ranged from three weeks to a month. Forty-four athletes, or 35%, had an AROM deficit of 15 to 25 degrees. For them, this took slightly more than a month. Twelve of 126 athletes, or 9.5%, experienced an AROM deficit of 25 to 35 degrees and it took them more than 2.5 months to recover (Table II). The average number of days lost from futsal training was 29 days ± 3.9, ranging from seven up to 80 days. Hamstring strains were categorized into five grades based on the AROM deficit: grade 0 – AROM deficiency is absent, grade I – less than 15°, grade II – 16° to 25°, grade III – 26° to 35°, grade IV – over 35°.

AROM deficit grades I and II correlate with grade I ultrasound according to Peetrons (12) ($r=0.86$), with first degree injuries according to Askling (9) ($r=0.82$), and with type 3A injuries according to the comprehensive muscle injury classification (14, 15) ($r=0.88$). AROM deficit grade III correlates with grade II ultrasound, second degree injuries, and type 3B injuries ($r=0.92$, $r=0.84$, and $r=0.85$, respectively).

DISCUSSION
The study shows a connection between AROM deficit and time to full recovery. The larger the AROM deficit, the longer the rehabilitation. With an AROM deficit of less than 15 degrees (grade I according to the present grading system), the recovery period was 3 to 4 weeks. For athletes with the AROM deficit of 15 to 25 degrees, this took slightly longer than a month. Athletes with the AROM deficit of > 25 degrees reached full recovery by the end of
2 months. AROM deficit also correlated with the percentage of muscles involved in the injury. The results of the hamstring injury classification based on ultrasound imaging (12) largely coincided with the AROM deficit-based classification, excluding cases with the boundary percentage of muscles involved.

Clinical and ultrasound examinations were performed 48 hours after injury. In the acute setting, immediately after the injury, significant pain and disability are present. For this reason, attempts to accurately determine the athlete’s ROM on the injured side would be unreliable (25).

In this study, the majority of athletes with hamstring injuries under consideration recovered their active ROM and returned to full activity in the span of 3 to 5 weeks. Rarely (1 in 10 cases), the recovery time exceeded 10 weeks. Athletes with the worst recovery prognosis can be identified early, as their ROM deficit is more than 25 degrees.

Studies using MRI (26) or ultrasound scanning (18, 24) showed that athletes with normal imaging returned to competition significantly faster, but there was no correlation between the presence of hematoma and the length of the rehabilitation period (18).

Other authors, however, found that fluid or hemorrhagic collections, cross-sectional involvement more than 50%, and distal musculotendinous injury were associated with longer rehabilitation (27).

The predominance of biceps femoris injuries in the study group is consistent with other reports (1, 18, 28-31). The incidence of semitendinosus and semimembranosus muscles in this study was 9% and 11%, respectively. These indicators vary in different studies (2, 18, 28, 32-34), which suggests the existence of differences in the injury patterns between sports (35-37).

This and several other studies show that injuries occur mainly at the musculotendinous junctions (35-40). Recent studies tend to differentiate injuries at the proximal and distal MTJ, as the proximal case takes more time to heal (39).

This study has several limitations. First, the research only addressed structural hamstring injuries, whereas unclear and severe cases requiring surgical treatment were excluded. The reason behind this decision is that unclear and severe situations require a different rehabilitation program. Furthermore, these cases are less informative in respect of the AROM deficit. Second, this study did not use the MRI method. Third, the study population included only the local-level futsal players and thus highlighted no injury characteristics in different sporting populations. Fourth, the athlete’s behavior was unknown and could be the subject of future research.

CONCLUSIONS

This study sheds light upon the relationship between AROM deficit and time to full recovery. According the study sample, the prognosis of patients with the AROM deficit < 15 degrees was 3 to 4 weeks. Patients the AROM deficit between 15 and 25 degrees were projected to return to play in the span of one month. The average recovery time for athletes with the AROM deficit between 26 and 35 degrees was 2 months at its minimum. The AROM deficit may be considered an indicator that permits an objective prediction of time to full recovery for futsal-related hamstring injuries. Clinical evaluation has proven to be an adequate tool in recovery prognosis. Ultrasound imaging may be good for athletes having an excessive reduction in AROM, a hematoma or complete rupture of the muscle.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

REFERENCES


Hamstring Structural Injury in Futsal Players