Return to sport after anterior cruciate ligament reconstruction in professional soccer players

S. Zaffagnini, A. Grassi, G.M. Marcheggiani Muccioli, K. Tsapralis, M. Ricci, L. Bragonzoni, S. Della Villa, M. Marcacci

II Clinica Ortopedica e Laboratorio di Biomeccanica ed Innovazione Tecnologica, Istituto Ortopedico Rizzoli, Bologna, Italy
Isokinetic FIFA Medical Centre of Excellence, Bologna, Italy

ABSTRACT

Background: To investigate time to return to sport and rate of professional sport activity in a homogenous group of competitive soccer players 4 years after anterior cruciate ligament (ACL) reconstruction and rehabilitation.

Methods: Twenty-one male professional soccer players (mean age 22.9 ± 5.4 years) underwent non-anatomical double-bundle autologous hamstring ACL reconstruction and followed the same rehabilitative protocol. Clinical evaluation was performed preoperatively and at 3, 6 and 12-month follow-up. Data regarding return to train and official match, sport activity, complications and revision surgeries were collected at 4-year follow-up.

Results: Laxity test (KT-2000) and total KOOS mean score resulted in a significant improvement from the preoperative status to the 12-month follow-up (p < 0.0001). The KOOS mean value showed a significant progressive improvement from the preoperative status to 6-month follow-up (p = 0.0010) as well, while values collected at 6 and 12-month follow-up were comparable (p = 0.2349). Returned to official matches 186 ± 53 days after surgery. After 12 months, 95% came back to the same activity level performed before injury. Four years after ACL reconstruction, 15 patients (71%) were still playing competitive soccer. One patient (5%) underwent ACL failure and subsequent revision.

Conclusions: The ACL reconstruction with the presented technique followed by patient-tailored rehabilitation, allowed 95% and 62% professional male soccer players to return to the same sport activity 1 year and 4 years after surgery respectively. However, 71% were still able to play competitive soccer at final follow-up. Clinical scores were restored after 6 months.

Level of evidence: IV, case series.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

The time to return to play and the ability to continue sport activity with time are two important outcomes after anterior cruciate ligament (ACL) reconstruction, especially in young sportmen. Nevertheless no consensus is available regarding the optimal rehabilitation length [1] and the return to play definition [2]. These issues are more controversial when considering the outcomes related to single sports. In 2011 a systematic review by Warner et al. [3], evaluating sport-specific outcomes after ACL reconstruction, reported only three studies presenting the results in soccer players [4–6]. The authors concluded that “identifying sport-specific differences in ACL reconstruction outcomes in athletes could lead to more effective rehabilitation programs for all these athletes after surgery” and it will “provide orthopedic surgeons the ability to accurately inform patients about what they should plan to expect after surgery in terms of performance level and timing of return to sport” [3], thus underlying the need for further sport specific studies. Furthermore, different interpretations have been attributed to the “return to sport” outcome, ranging from return to perform sport-specific gestures, restore pre-injury activity level, return to train or return to official match. Often, the precise definition is not even reported.

The main objective of this study was to report the time to return to sport after ACL reconstruction in a homogenous group of competitive football players treated with the same surgical technique and rehabilitative programme and the rate of sport activity four years after the surgery.
2. Material and method

Between January and June 2009 all the patients satisfying the following inclusion criteria were enrolled in the study:

- ACL lesion; and
- male professional soccer player, involved in competitive sport activity more than 4 days per week on regular bases and attending the main divisions of Italian Soccer League.

Exclusion criteria were:

- posterior cruciate ligament (PCL) lesion;
- grade III medial collateral ligament (MCL) lesion;
- lateral collateral ligament (LCL) lesion;
- unstable contralateral knee; and
- systemic or local infection; and
- lower limb malignment requiring surgery.

Among the overall 29 patients, 21 were considered eligible for this study. All of them underwent ACL reconstruction by two senior surgeons (X.X. and X.X.) and subsequently started a patient-specific rehabilitation protocol at the same center.

2.1. Surgical technique

ACL reconstruction was performed in all patients according to the non-anatomical double-bundle technique described by Marcacci et al. [7], with modifications introduced by Zaffagnini et al. [8]. The technique is well described in the publications cited above, what follows is a brief summary of the most important surgical steps.

Autologous semitendinosus and gracilis tendons (ST/G) from the ipsilateral limb were harvested maintaining tibial insertion.

One single tibial tunnel was performed starting close to the MCL epicondyle, 5 mm from the lateral bundle insertion, directed above the end of the lateral femoral footprint. One femoral tunnel was performed from the medial portal with an exit point on the posteromedial aspect of the native ACL footprint. One femoral tunnel was performed from the medial portal with the knee flexed to approximately 120°, from anatomical posterolateral bundle insertion, directed above the end of the lateral femoral epicondyle, 5 mm from the “over-the-top” position. After a lateral incision, the tendons were passed “over-the-top”, than from outside in the femoral tunnel and back again in the tibial tunnel to obtain a double-bundle reconstruction. The graft was tensioned, the knee cycled, and the anteromedial and posterolateral bundle fixed at 90° and 15° with metal staples.

2.2. Rehabilitation protocol

No brace was used. After the first clinical examination after surgery, performed approximately at week one, patients started gym and pool sessions, aimed to improve pain, swelling, range of motion (ROM), proprioception, strength and aerobic fitness. Early sport-specific exercises designed for football players were performed as well.

The final phases of rehabilitation were performed on a soccer synthetic or grass field, under the supervision of an experienced athletic trainer. This phase is referred as “on-field rehabilitation” (OFR) [2].OF R was allowed if the patient presented no knee laxity, no giving-way episodes during previous phases, minimal pain, minimal effusion, complete ROM, isokinetic maximal peak torque deficit <20% between limbs.

![KOOS Score](image)

Fig. 1. The curve reports the KOOS values along the different follow-up evaluations.
Four years after the ACL reconstruction all patients were reviewed, and data regarding sport activity, new injuries and revision surgeries were collected. Particularly, all the patients were questioned if they were still able to play soccer, and in case of negative response, the causes were investigated.

Regarding rehabilitative protocol, number of sessions performed in gym, pool and play-field was recorded. The total length of rehabilitative program was considered from the first day of rehabilitation to the end of rehabilitative sessions and return to training with the own team. The gap between surgery and the beginning of rehabilitation was recorded as well. The time to return to on-field training, to training with team and to official match was collected starting from surgery.

2.4. Statistical analysis

The statistical analysis was performed using Analyse-it-2.00 (Analyse-it Software, Ldt, Leeds, UK). Statistical comparison between the preoperative and follow-up parametric scores was performed using paired Student’s t-test, while unpaired Student’s t-test was used to compare parametric variables between subgroups. The population study was tested for normal distribution before t-test was applied. Differences between multiple scores were performed using the 1-way ANOVA test. Correlation analysis was performed using Spearman test. The life table survival analysis was used to evaluate cumulative rates of returning to on field rehabilitation, train, and official match. The level of significance was set at p < 0.05. Results are expressed using mean values ± standard deviation (SD) for parametric values and median ± interquartile range (IQR) for non-parametric values.

2.5. Ethics

Approval of the study was obtained from the institutional review board. Informed consent complied with European Union laws and was signed by the patient before enrolment.

3. Results

All patients (100%) were available for on-going clinical evaluations and at the 4-year follow-up. The mean age at time of surgery was 22.9 ± 5.4 (Table 1). Four patients (19%) had a history of medial or lateral partial meniscectomy on the interested knee and three (15%) of contralateral ACL reconstruction, while 12 patients (57%) underwent at least one concurrent procedure combined to ACL reconstruction (Table 2).

The statistical analysis was performed using Analyse-it-2.00 (Analyse-it Software, Ldt, Leeds, UK). Statistical comparison between the preoperative and follow-up parametric scores was performed using paired Student’s t-test, while unpaired Student’s t-test was used to compare parametric variables between subgroups. The population study was tested for normal distribution before t-test was applied. Differences between multiple scores were performed using the 1-way ANOVA test. Correlation analysis was performed using Spearman test. The life table survival analysis was used to evaluate cumulative rates of returning to on field rehabilitation, train, and official match. The level of significance was set at p < 0.05. Results are expressed using mean values ± standard deviation (SD) for parametric values and median ± interquartile range (IQR) for non-parametric values.

Approval of the study was obtained from the institutional review board. Informed consent complied with European Union laws and was signed by the patient before enrolment.

Table 4

<table>
<thead>
<tr>
<th>Time</th>
<th>From surgery to on-field rehabilitation</th>
<th>From surgery to training with team</th>
<th>From surgery to first match</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio</td>
<td>CI (95%)</td>
<td>Ratio</td>
</tr>
<tr>
<td>Mean value (days)</td>
<td>85</td>
<td>(0.000—0.139)</td>
<td>169</td>
</tr>
<tr>
<td>2 months</td>
<td>0.048</td>
<td>(0.000—0.097)</td>
<td>0.000</td>
</tr>
<tr>
<td>4 months</td>
<td>0.810</td>
<td>(0.000—0.100)</td>
<td>0.095</td>
</tr>
<tr>
<td>5 months</td>
<td>0.952</td>
<td>(0.000—0.100)</td>
<td>0.467</td>
</tr>
<tr>
<td>6 months</td>
<td>1.000</td>
<td>(0.000—0.100)</td>
<td>0.762</td>
</tr>
<tr>
<td>7 months</td>
<td>1.000</td>
<td>(0.000—0.100)</td>
<td>0.810</td>
</tr>
<tr>
<td>8 months</td>
<td>1.000</td>
<td>(0.000—0.100)</td>
<td>0.952</td>
</tr>
</tbody>
</table>

Fig. 2. The curves report the trend of the various KOOS subscales at different follow-up evaluations. Means ± standard deviations are reported as well.

measured with isokinetic dynamometers (Genu3 Easytech, Florence, Italy) and the ability to run on the treadmill at 8 km/h for more than 10 min [9]. Each OFR session lasted 90 min, 2 to 5 days a week; the progression of each type of exercises followed principles of strength training, conditioning and increased functional demand with respect to musculoskeletal and neuromechanical components involved in the recovery process.

OFR for football players was divided in five phases, and the progression occurred only when exercises of each phase were comfortable, coordinated, tolerable, and without swelling or decreased ROM.

On-going knee examinations were performed at the beginning of rehabilitation and every 2 to 4 weeks during the whole rehabilitative period, in order to detect knee malfunctions and monitor the progression through rehabilitative protocol.

2.3. Follow-up evaluation

All patients underwent preoperative clinical and radiographic evaluation, with bilateral antero-posterior weight-bearing and a lateral view in 30° of flexion of the involved knee. A pre-operative MRI was performed to evaluate ligaments, menisci and cartilage status.

Clinical objective evaluation was performed preoperatively and 12 months after surgery by two independent orthopedic surgeons who did not take part in the surgery, using the objective a KT-2000™ arthrometer (MedMetric, San Diego, CA, USA) for laxity measurements.

Patients were clinically evaluated preoperatively and at 3, 6 and 12 months after surgery by means of the Knee injury and Osteoarthritis recovery process.

The life table survival analysis was used to evaluate cumulative rates of returning to on field rehabilitation, train, and official match. The level of significance was set at p < 0.05. Results are expressed using mean values ± standard deviation (SD) for parametric values and median ± interquartile range (IQR) for non-parametric values.

Approval of the study was obtained from the institutional review board. Informed consent complied with European Union laws and was signed by the patient before enrolment.

3. Results

All patients (100%) were available for on-going clinical evaluations and at the 4-year follow-up. The mean age at time of surgery was 22.9 ± 5.4 (Table 1). Four patients (19%) had a history of medial or lateral partial meniscectomy on the interested knee and three (15%) of contralateral ACL reconstruction, while 12 patients (57%) underwent at least one concurrent procedure combined to ACL reconstruction (Table 2).

The side-to-side difference in manual maximum displacement test performed with a KT-2000™ arthrometer revealed a significant difference between the pre-operative and the 12-month follow-up status (7.4 ± 0.9 mm vs. 1.4 ± 1.9 mm; p < 0.0001).

The total KOOS scores resulted in a significant improvement from the preoperative status to the 12-months follow-up (Table 3). The mean value showed a progressive improvement from the preoperative status to 3 months (p = 0.0003) and from 3 to 6 months (p = 0.0010) as well, while the values collected at 6 and 12 months were comparable (p = 0.2349) (Fig. 1). Therefore the KOOS score reached the plateau level since 6 months after surgery. A similar behavior was recorded for all the KOOS subscales. At pre-operative status, Sport/Rec and QOL subscales were significantly lower (p = 0.0036) compared to the other subscales, although at 3, 6 and 12 month follow-up evaluations they were similar (Fig. 2), thus showing a higher improvement. No significant differences in...
clinical scores were found between patients with isolated or combined ACL reconstruction, or between patients with intact or deficient meniscus.

After 12 months from the ACL reconstruction, all patients except one (95%) returned to the same professional sporting level performed before injury. This patient was able to return to play competitive soccer, but in a lower division.

Regarding the details of rehabilitative protocol, the mean duration was 157 ± 49 days, and the mean number of rehabilitative sessions was 73 (56–109). Return to official match was recorded 186 ± 53 days after surgery. The ratio was 0.046 at 4 months, 0.190 at 5 months, 0.429 at 6 months and 0.619 at 7 months. Regarding return to train with team, at 6 months most of the patients (rate 0.762) achieved the goal yet

0.190 at 5 months, 0.429 at 6 months and 0.619 at 7 months. Regarding return to train with team, at 6 months most of the patients (rate 0.762) achieved the goal yet

At the final review four years after ACL reconstruction, 15 patients (71%) were still playing soccer, 13 (62%) at the same injury professional division, and two (9%) in a lower division compared to the pre-injury status, due to issues not related to knee performance. Of the six patients that abandoned their soccer career, the main reason was related not to knee status but to personal issues (Table 5). Furthermore the age at final follow-up of retired athletes were significantly higher compared to active players (30.4 ± 7.2 vs 25.5 ± 4.0; p = 0.0311). Despite this, all the retired players were still involved in non-contact light sport activities (jogging, swimming and gym) at the final follow-up.

4. Discussion

In the present study the outcomes of a homogenous group of male professional soccer players, who underwent ACL reconstruction with the same technique and rehabilitative protocol, are presented using a validated clinical score and precise definition of “return to sport”. Regarding the latter outcome, a 2011 meta-analysis of Arden et al. [10] reported 7.3 (range 2–24) months as the mean time needed to return to sport in general population, even though different end-points were used. Few studies evaluated this outcome specifically in soccer players. Data regarding 55 male soccer players extrapolated from the Multicenter Orthopaedic Outcomes Network (MOON) database, mainly treated with BPTB autograft, reported a mean time to return to play of 10.2 ± 7.3 months, although the outcome was not clearly defined. In a retrospective report of 36 Professional First Italian Division players who underwent ACL reconstruction using different surgical techniques, the mean time to return to official match was 231 ± 134 (range 77–791) days [11]. The analysis of UEFA elite male soccer players showed a mean time to return to official match of 224 ± 75 days for 43 European players and 252 ± 80 days for 20 Swedish players [6]. The latter study reported also the “return to train” outcome, which was respectively 201 ± 68 and 203 ± 70 days for the two groups. The present study, reporting a mean return to train of 169 ± 49 days and a mean return to official match of 186 ± 52 days, seemed to show a slightly shorter recovery compared to sport-specific case series. This finding is also strengthened by the evidence of full recovery of the KOOS at 6 months follow-up yet. Furthermore return to official match is reported already between the 3rd and 4th month in several athletes, with almost 43% reaching the target at the 6th month, compared to 24% and 32% for European and Swedish players respectively. This finding could be explained by the athlete-tailored rehabilitation program, combined to an effective double-bundle surgical technique [8,12]. In the soccer players’ case series [6,11,13] the impact of single or double-bundle techniques was not evaluated, while, regarding graft choice, no difference was reported between the hamstrings and BPTB. Regarding the rehabilitative program, the presented method based on functional goals instead of temporal criteria, allows the player to progress to the rehabilitation phases on the basis of individual responses, leading to different times in the achievement of final goals and with a different number of sessions [9]. Furthermore the on-field-rehabilitation designed with sport-specific gestures is presumed to facilitate the reduction of fear of relapse, which has been reported to be a not negligible issue after ACL reconstruction [14]. These features could have contributed to faster recovery compared to the other case series; nevertheless, it should be taken into account that return to match could be influenced by several non-medical factors, e.g. coach selection, off-season holidays or transfer.

The other primary outcome of ACL reconstruction is the rate of return to sport at short–medium term. The same meta-analysis of Arden et al. [10] reported a pooled return to sport rate of 82%, while 63% at pre-injury level; furthermore only 44% returned to competitive sport. This meta-analysis however evaluated general population, with different sports, activity level, demographic characteristics, and follow-up. In particular higher return to sport rates are found in the studies with less than a 2-year follow-up, suggesting that while athletes initially return to higher-level sport participation postoperatively, this participation is not maintained in the long term.

Similar trend, but with different rates was described for soccer players. Return to play was reported as 94% in elite players at 10 months [6], 76% and 38% at 1 and 7.2 years respectively in the MOON database [13], and 26% at 7 years in the Roos et al. report [4]. In the present study the rates of return to soccer were 100% and 71% at 1 year and 4 years respectively; the rates decreased to 95% and 62% if the return to professional soccer level is considered [4]. The rate is more similar to the high-motivated elite European players, rather than the heterogeneous soccer players of the MOON cohort. Considering the athletes that abandoned their sport career, it is noteworthy how in the present study the main reasons were personal issues, aging and other medical problems; furthermore the retired athletes were significantly older compared to the still active ones, and this could have played a role in their decision to stop sport activity. In fact only one patient abandoned soccer because of an operated knee. However, it is plausible that the injury itself could have played a major role in the change of the patient’s lifestyle, determining career abandonment probably due to the impossibility of maintaining or improving the prospective of a prolific soccer career. Nevertheless, all the retired players were still involved in non-contact light sport activities (jogging, swimming and gym). Regarding graft rupture and revision surgery, the reported 3% rate in the MOON cohort does not differ substantially from the 5% reported in the present study [13].

Table 5 Details of sport activity at 4-year follow-up are presented as number of patients and percentages.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Still playing soccer</td>
<td>15 (71%)</td>
</tr>
<tr>
<td>Same level</td>
<td>13 (62%)</td>
</tr>
<tr>
<td>Lower level</td>
<td>2 (9%)</td>
</tr>
<tr>
<td>Suspended soccer activity</td>
<td>6 (29%)</td>
</tr>
<tr>
<td>Problems related to the involved knee</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Other physical problems</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Career end (due to age)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Personal reasons</td>
<td>3 (14%)</td>
</tr>
</tbody>
</table>
When considering the patients’ characteristics, the age at surgery of the present study (22.9 years) does not differ substantially from what was reported by other authors (22.9–26.2 years) [6] and the KOOS values were similar to those reported in the Scandinavian ACL Registry [15] at pre-operative status but higher at 1 year, probably due to the high level sport practice with respect to the Scandinavian ACL Registry. Globally, the outcomes at short–mid term obtained with the presented original technique are encouraging, despite the high rate of previous or concurrent meniscectomies, that is a well known risk factor for bad outcomes and knee osteoarthritis [16].

This study has several limitations. Primarily the sample size is small, although the other series reported similar number of patients, and the follow-up could not be long enough to detect further failures and inability to continue sport activity. Secondly, the high percentage of previous or concurrent meniscectomies could have biased the results, but in clinical practice coupled ACL and meniscal lesions, particularly in high impact sports athletes, are a very common event so the presented case series is more resembling to sports athlete population. Lastly, the lack of radiographic control does not allow detecting eventual osteoarthritis degeneration, and 4 years could not probably be sufficient to produce degenerative changes is such young population.

5. Conclusions

The ACL reconstruction with non-anatomical double-bundle hamstring technique, combined with a patient-tailored target-based rehabilitation, allowed 95% and 62% of professional male soccer players to return to the same professional sport activity 1 year and 4 years after surgery respectively. However, overall, 71% were still able to play competitive soccer at any level at final follow-up. The clinical scores were restored to pre-injury status since 6 months, while return to play in official match was reported 186 ± 52 days after surgery. Failure of ACL reconstruction and subsequent revision surgery were reported in one patient (5%).

Conflict of interest

The authors declare no personal or financial conflict of interests during the study execution and manuscript preparation.

Acknowledgment

The authors are grateful to Costanza Musiani, MD and Giada Lullini, MD for their support.

References
