Anterior cruciate ligament reconstruction using hamstring tendon autograft in young football players

Mohamed A. Radwan, Mohamed S. Mostafa, Tarek A. Elaziz

Department of Orthopedic Surgery, Suez Canal University, Ismailia, Egypt

Correspondence to Mohamed A. Radwan, MD, Department of Orthopedic Surgery, Suez Canal University, Ismailia, Egypt
Tel: +20 122 332 6447;
e-mail: radwanma@yahoo.com

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Background
Anterior cruciate ligament (ACL) injuries in young athletes are becoming more common. Surgical intervention seems to be more satisfactory than conservative treatment by bracing and lifestyle modification.

Aim of the study
This study aimed at evaluation of the functional results of transphyseal ACL reconstruction performed in skeletally immature football players using a four-strand hamstring graft.

Patients and methods
The study was performed between 2004 and 2009 in Suez Canal University Hospital. Twenty-two young football players were included. All patients included were boys younger than 17 years of age with radiographic evidence of open physis. All patients underwent preoperative and postoperative clinical and radiologic assessment, and were rated preoperatively and postoperatively on the basis of the Lysholm score.

Results
There were significant differences between the preoperative and postoperative Lysholm scores. During the end of the follow-up period, none of the patients scored fair or poor. At final follow-up visit, 20 patients (91%) were negative for the anterior drawer test. Only two patients (9%) had persistent mild knee swelling until the sixth month postoperatively, and this improved at the end of follow-up. Neither growth disturbance nor limb length discrepancy was detected at final follow-up visit. All patients returned to play football.

Conclusion
The results of this study concluded that early reconstruction of ACL using a four-strand hamstring autograft is an effective and safe procedure in skeletally immature football players with rupture ACL.

Keywords:
anterior cruciate ligament, hamstring tendon, young football players

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Introduction

The incidence of anterior cruciate ligament (ACL) injuries in skeletally immature athletes has rapidly increased over the last decades. Rupture of ACL compromises the stability of the knee in individuals who are active, resulting in chronic instability, recurrent episodes of giving way, and associated intra-articular injuries [1].

These injuries present a challenge for surgeons, particularly physeal damage with reaming of tunnels. Activity reduction and bracing may be all that is necessary until maturation of the epiphysis. In immature athletes, activity modification cannot be performed.

The outcome is better in patients treated by surgical reconstruction of ACL than those managed conservatively. Therefore, it is necessary to reproduce the intra-articular anatomy and function of ACL to best restore normal knee joint kinematics and stability [2].

Reconstruction of ACL in skeletally immature patients is an established operation to avoid degenerative meniscal tears and subsequent degenerative changes in the knee after that [3–6].

In growing patients, soft tissue graft is preferred to a bone patellar tendon bone graft, as it poses less risk to the growth plate. A four-strand hamstring graft using a transphyseal technique has become more popular than a physeal-sparing operation.

Return to complete athletic activity should be expected with no deformity and growth disturbance, when using transphyseal technique and hamstring tendons.

Physeal-sparing surgical procedures as a means of minimizing the risk of growth disturbances are technically demanding, and efficiency of these reconstruction procedures on chronic laxity and pivot shift has been poorly investigated [7–12]. Some authors recommended adult-like ACL reconstructions, but these series are not large

enough to establish the outcome of the adult-like procedures [4,13,14].

This study aimed at evaluating the functional results of transphyseal technique using four-strand hamstring tendons graft and at identifying any deformity or limb length discrepancy after using this technique.

Patients and methods

This study was performed at Suez Canal University Hospital during the period between 2004 and 2009. Inclusion criteria were football players who were younger than 17 years of age and radiographic evidence of open physes without any avulsion or fractures near the knee joint.

Twenty-two knees of 22 male patients were included in this study.

All patients had complete ACL disruption proven by clinical examination and MRI.

Routine anteroposterior and lateral views were examined to exclude avulsion fracture of the ACL attachment sites and other pathology.

The mean age at the time of surgery was 15.4 years (14–17 years). The delay between injury and reconstruction ranged from 2 to 6 weeks, with a mean of 3.4 weeks.

Preoperative MRI revealed that four patients (18%) were diagnosed to have a torn medial meniscus in addition to their ACL injuries: a torn medial meniscus in two patients (9%); a torn lateral meniscus in one patient (4.5%); both menisci torn in one patient (4.5%). No tear was detected in 18 patients (82%).

All patients included in the study were followed up until the age of skeletal maturity. The follow-up period for clinical and functional assessment was 2 years for all patients and until the age of skeletal maturity for detecting growth disturbance and limb length discrepancy.

Preoperative and postoperative range of motion, ligamentous laxity tests, thigh circumference measurement, limb length discrepancy, and the Lysholm score [15] of the knee were reported.

Surgical procedure

Under general or spinal anesthesia with the use of a pneumatic tourniquet, an arthroscopic examination was initiated followed by removal of the ACL remnants. Notchplasty was accomplished. Partial meniscectomy for all torn menisci was preformed. Dissection, transection, and preparation of the hamstring tendons were carried out. The diameter of the graft ranged from 6 to 8 mm, with an average of 7 mm.

A tibial aimer at 55° was used for the placement of tibial tunnel guide wire, whereas the femoral aimer was placed at an anatomic position; however, the level of offset was higher than that used in adults to avoid drilling the perichondral ring. The femoral fixation was by the transfix technique (Arthrex). An interference screw 1 mm larger than the tibial tunnel diameter was used for tibial fixation [16].

Weight bearing was allowed on the operated leg using crutches for the first week after surgery, and postoperative rehabilitation was initiated on the second day after surgery aiming at a full range of movement.

Follow-up assessment

Subjective and objective methods to evaluate the postoperative knee function were used in this study. The follow-up assessment included measuring of swelling, range of motion, and thigh circumference. Ligament laxity tests including the Lachman, anterior drawer, and pivot shift tests were performed. The Lysholm score of the knee was recorded during different follow-up visits. Radiologic assessment of growth disturbance and measuring the length of both limbs to detect any discrepancy were carried out during final follow-up visit. The ability to return to play football was evaluated subjectively during training and competitive games.

Results

Using the Lysholm score, the preoperative and postoperative points of 22 patients were compared. The preoperative Lysholm score ranged between 46 and 76 points, with an average of 60.6 points. The 6-month postoperative Lyshlom score ranged between 77 and 91 points, with an average of 84.8 points. One and a half years postoperatively, the average score was 88.6 points, whereas at the end of the follow-up the average was 92.8 points (Table 1).

At the end of clinical follow-up, 18 patients (82%) scored excellent (>90 points) and four patients (18%) scored good (77–90 points) (Fig. 1). None of the patients scored fair or poor.

On comparison, the preoperative scores were fair in five patients (23%) and poor in 17 patients (77%). There was statistically significant differences ($P < 0.01$) between the preoperative and postoperative Lysholm scores (Fig. 1).

The objective assessment of the operated knees showed a significant improvement of the ligamentous laxity and stability. At the end of follow-up, 21 patients (95.5%) had negative anterior drawer test; at the same time, all patients had negative pivot shift test and 20 patients (91%) had negative Lachman test (Table 2).

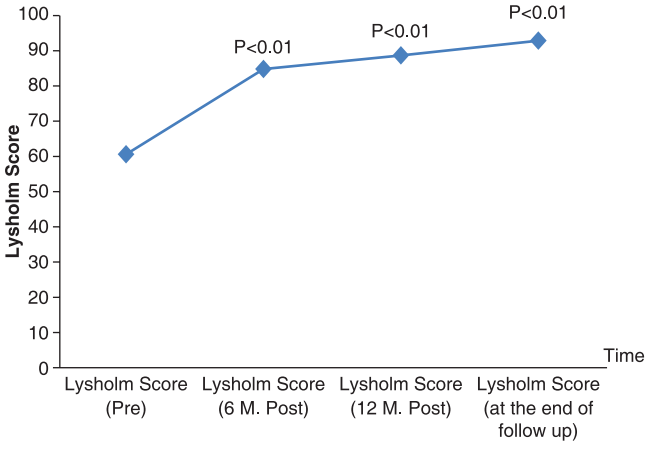
Two patients (9%) complained of significant knee pain during the first 6 months postoperatively that improved at the end of their follow-up. Thirteen patients (59%) had knee swelling preoperatively, and two patients (9%) had persistent mild knee swelling until the sixth month postoperatively, which resolved completely by the end of follow-up. These results reflected statistically significant differences in knee pain and swelling.

The ranges of active movement of the operated knees improved throughout the follow-up period. At the end of the follow-up period, all patients had a flexion range of up to 135° without any loss of extension (Table 3).

No growth disturbance or limb length discrepancies were clinically detected at final follow-up visit.

During the end of the follow-up period, all young football players included in the study returned to their ordinary activities. Twenty patients accomplished their rehabilitation program and returned to the usual football training and competitive games with their peers at the sixth month postoperatively. Two patients continued their rehabilitation program and returned to play at the ninth month postoperatively. The postoperative MRI assessment showed no rerupture (Fig. 2).

Figure 1



Curve of the average Lysholm scores preoperatively and postoperatively.

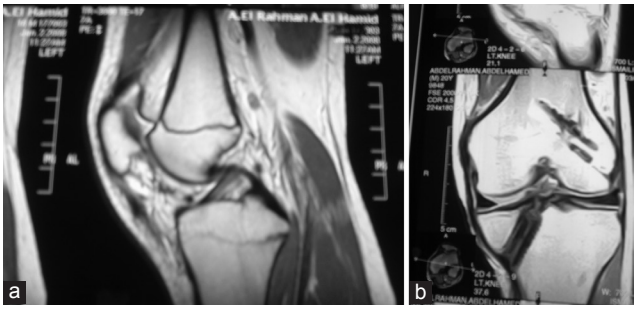
Discussion

Over the last two decades, complete midsubstance tears of ACL in skeletally immature football players have been reported with increased frequency. This increase is probably secondary to increased clinical suspicion, improved radiographic imaging, and an increase in participation in high-demand ACL sports (football) at an earlier age [17].

Kannus and Jarvinen [18] studied 32 patients with ACL injuries during adolescence and concluded that nonoperative treatment for complete ACL injuries was not acceptable because of chronic instability, continuous symptoms, and post-traumatic osteoarthritis. These findings and the results of other studies [19,20] support the conclusion of this study that transphyseal drilling with soft tissue grafting across open growth plates is a safe and effective operation.

Simonian *et al.* [21] and Stadelmaier *et al.* [22] recommended transphyseal tibial and femoral drill holes in skeletally immature knees with ACL tears. They believe that the use of centrally placed tunnels and soft tissue grafts minimizes the risk of physeal closure. In this study, good functional results were obtained in all patients. All patients resumed their previous active lifestyles and sport level. The stability outcome obtained in this study was comparable with those achieved in a

Figure 2



Preoperative (a) and postoperative (b) MRI.

Table 1 Average Lysholm scores at different stages preoperatively and postoperatively [15]

Lysholm score	Minimum	Maximum	Mean	SD	*P* value
Preoperative	46	76	60.6	8.0712	–
6 months postoperative	77	90	84.8	4.8023	<0.01**
1 year postoperative	80	95	88.6667	4.7002	<0.01**
Last follow-up clinical assessment	84	100	92.8333	4.5794	<0.01**

**Statistically significant differences between preoperative and each of the postoperative measurements at 0.01 level.

Table 2 Results of objective assessment at preoperative and postoperative follow-up visits

Objective assessment	Preoperative [*N* (%)]	Postoperative (at the end of follow-up) [*N* (%)]	*P* value
Anterior drawer test			<0.01**
–	0	21 (95.5)	
+	1 (4.5)	1 (4.5)	
++	1 (4.5)	0	
+++	20 (91.0)	0	
Pivot shift test			<0.01**
–	0	22 (100.0)	
+	2 (9)	0	
++	20 (91)	0	
Lachman test			<0.01**
–	0	20 (91)	
+	0	2 (9)	
++	3 (14)	0	
+++	19 (86)	0	

**Statistically significant differences between preoperative and postoperative measurements at 0.01 level.

Table 3 Range of motion during different periods postoperatively

	Time [*N* (%)]		
Degrees of flexion	6 weeks	6 months	At the end of follow-up
120	18 (82)	2 (9)	–
130	4 (18)	20 (91)	–
≥135	–	–	22 (100)

study conducted by Meller *et al.* [23]. Objective and subjective evaluation of patients at different sessions postoperatively (the Lysholm scores, anterior drawer test, pivot shift test, and Lachman test) support the efficacy and safety of this technique in treating young footballers with ACL tear.

This corresponds with the results in recent literatures [4,5,9,10] and might be the treatment of choice in immature patients.

During follow-up assessment, the players returned their normal ranges of movement and all of them returned to participate in training and to play competitive football games.

The complication rate was minimal and transit including knee swelling and limitation of movement that improved by time and did not compromise the ability to regain normal sport activities. The complication rate in this study matched with the results of similar studies [21–23]. There were no postoperative growth deformity and limb length discrepancy, which is comparable with that found in the study by Courvoisier *et al.* [24], indicating the safety of this technique in treating young players with ACL tear.

Conclusion

This study confirmed that operative reconstruction of ACL tears before epiphyseal closure using four-strand hamstring autograft is a satisfactory and safe procedure in skeletally immature football players.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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