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Functional outcome following reconstruction in chronic multiple ligament deficient knees

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Abstract Multiligament knee injuries are rare but potentially limb-threatening conditions. In this study we aim to evaluate the mid- and long-term functional outcome of patients who underwent arthroscopically assisted multiple ligament reconstruction for chronic multiple knee ligament deficiency. Thirty-five patients (27 males and 8 females) with an average age of 35.1 years (range: 17–60) were included in this study. Follow-up ranged from 12 to 124 months (average: 40.3). On final follow-up patients had a mean loss of extension of 3.1°, while flexion ranged from 95° to 135° (average: 118.4°). The functional outcome according to Clancy's criteria was excellent in 7 patients (20%), good in 14 (40%), fair in 11 (31.4%), while 3 reconstructions resulted in failure (8.6%). Patients scored an average of 4.03 (range: 1–9) in their Tegner Activity Scale, while their score in Activities of Daily Living Scale of the Knee Outcome Survey ranged from 25 to 98 with an average of 72.7. Sixteen patients returned to sporting activities and all but three returned to work. Early operative treatment of multiple ligament injuries is preferable, as it may allow for anatomic repair instead of reconstruction of ligamentous structures. This study demonstrates though, that even if acute reconstruction has not or could not be performed, reconstruction in chronic multiple ligament deficient knees should be attempted. Although this complex and technically demanding procedure rarely results in a "normal" knee, it offers in most cases very satisfactory stability and a significant improvement in knee function.

Keywords Multiple ligament reconstruction · Knee · Arthroscopy

Introduction

Multiple ligament knee injuries are rare but very serious injuries that can be further compounded by neurovascular complications [13,22,25,29,37]. These complex injuries are usually the result of high velocity trauma such as road traffic accidents or fall from a substantial height, but can also occur during sporting activities [3,14,22,29]. Classically knee dislocation has been defined as radiologically or clinically verified complete loss of tibiofemoral articulation. This definition has been expanded to include cases of grossly unstable knees with at least two of the four major knee ligaments injured. It is thought that such an injury combination results in significant albeit possibly only momentary joint dislocation [3,21,31,37].

The purpose of this study is to evaluate the mid- and long-term functional outcome of patients who underwent arthroscopically assisted multiple ligament reconstruction for chronic multiple knee ligament deficiency.

Patients and methods

From January 1994 to August 2003, 37 patients underwent arthroscopic or arthroscopically assisted multiple ligament reconstruction in our hospital. One patient was lost to follow-up and one died 1 year post-operatively of unrelated reasons. Therefore 35 patients (27 males and 8 females) with an average age of 35.1 years (range: 17–60) were included in this study (Table 1). Due to the fact that our institution is a tertiary referral centre for elective and reconstructive surgery with no trauma service in place, most of the ligament reconstructions included in this study were delayed. Therefore, only 6 of the above patients underwent early repair (within 3 weeks from initial injury), while the remaining 29 underwent multiple ligament reconstruction at an average of 2.7 years (range: 6 months–12 years) following their initial knee injury. Sixteen patients sustained a multiple ligament injury as a result of a road traffic accident, 14 following a sporting injury and 5 as a result of a fall from a height (Table 1).

Twelve of those patients (34.3%) were polytrauma patients initially treated in their local trauma centre having sustained, other than a complex knee injury, abdominal and/or further musculoskeletal injuries, including one tibial plateau fracture that was treated conservatively with cast immobilisation. Two patients had a concomitant popliteal artery injury that necessitated urgent surgical intervention in the trauma centre where they were initially treated. Peroneal nerve palsy at the time of initial presentation was recorded in three patients; in two cases it had fully resolved within 6 months, while in the third patient only partial motor and sensory recovery occurred. Ten patients (28.6%) had already undergone some surgery for ligament deficiency prior to their referral to our institution. Standard AP and lateral X-rays as well as an MRI scan was performed in all cases preoperatively, while stress views under image intensifier were obtained only in a small number of patients.

Table 1 Population, cause and type of injury

Population
35 patients (27 male, 8 female)
Age: 35.1 years (Range: 17–60 years)
Follow-up: 40.3 months (12–124 months)

Cause
RTA: 16
Sporting injury: 14
Fall from height: 5

Type of injury
ACL/PCL/LCL/PLC: 3
ACL/PCL/MCL/PLC: 1
ACL/PCL/MCL: 2
ACL/PCL/PLC: 9
ACL/LCL/PLC: 2
PCL/MCL/PLC: 1
PCL/LCL/PLC: 4
ACL/PCL: 3
ACL/MCL: 1
PCL/MCL: 2
PCL/PLC: 7

In 28 cases the procedure was carried out in one stage, while in a further seven cases it was carried out in two stages, due to the complexity of the procedure and limitations in tourniquet time. Following examination under anaesthetic and arthroscopic assessment of the joint, hamstring tendons were harvested from the ipsilateral or both knees. The PCL was reconstructed with a four-strand hamstrings graft and a double tunnel technique, while for the ACL a four-strand hamstring graft or BPTB was used (Fig. 1a,b). A figure-of-eight Larson technique with a two-strand hamstring graft was used for posterolateral corner reconstruction, while the collaterals were reattached if the patient was treated early enough and they were found avulsed from their insertion, or alternatively reconstructed with synthetic ligaments if the procedure was carried out at a later stage. Allograft or synthetic graft was used for PCL, ACL or PLC when autografts were previously used. All procedures were carried out by the two senior authors (DJAL and MAG), while patients were reviewed by the other two authors (DK and IB).

In patients who underwent PCL reconstruction, post-operative long-leg brace immobilisation in extension was undertaken for 4–6 weeks, followed by a graduated physiotherapy regime in order to regain ROM, muscle power and proprioception.

Patients were followed for a period of 12 to 124 months (average: 40.3). Range of movement and ligament stability were evaluated with physical examination. Knee function was assessed using the Tegner activity scale, the Activities of Daily Living Scale of the Knee Outcome Survey and Clancy's criteria [5,18,24] (Table 2).

Results

Patients were hospitalised for an average period of 6.4 days (ranging from 2 to 34 days in a polytrauma patient). On final follow-up patients had a mean loss of extension of 3.1° (range: 0°–10°), while flexion ranged from 95° to 135° (average: 118.4°). PCL stability was assessed with the posterior drawer test and proximal tibial step-off; out of the 32 knees where a PCL reconstruction was performed 6 were normal on clinical evaluation, while 23 had grade 1 posterior instability and 3 had grade 2/3 posterior instability accompanied by hyperextension. The ACL was assessed with the Lachman test, which was negative in 17/21 knees, while in 4 knees some laxity remained, but a firm end-point was recorded. Posterolateral corner stability was assessed with the ''dial'' test in 30° of flexion, which was

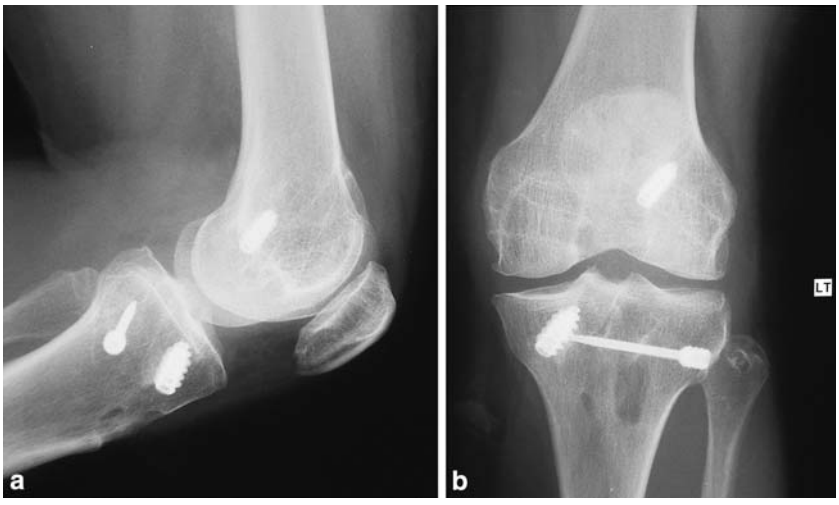

Fig 1 **a** Anteroposterior radiograph of patient 16 months post combined ACL, PCL and PLC reconstruction. **b** Lateral radiograph of patient 16 months post combined ACL, PCL and PLC reconstruction

positive (more than 15° of difference) in 5 out of 27 knees where the posterolateral corner was reconstructed. Collateral ligament stability was tested with varus/valgus testing in 15° of flexion: the LCL and MCL were found to have grade 2/3 instability in four out of nine and two out of seven knees respectively.

The functional outcome according to Clancy's criteria was excellent in 7 patients (20%), good in 14 (40%), fair in 11 (31.4%), while 3 reconstructions resulted in failure (8.6%). Patients scored an average of 4.03 (range: 1–9) in their Tegner Activity Scale, while their score in Activities of Daily Living Scale of the Knee Outcome Survey ranged from 25 to 98 with an average of 72.7. Sixteen patients returned to sporting activities, ranging from regular weekly jogging to playing football in competitive level, and all but three returned to work, although sometimes in lighter duties. No correlation was found between the functional outcome and the type of injury, both regarding the number and type of ligaments injured and the initial cause of injury.

Post-operative complications included partial peroneal nerve palsy in two cases and superficial wound infection in a further three cases; this subsided completely following wound drainage and antibiotics.

One 60-year-old patient who underwent multiple ligament reconstruction for a combined ACL / PCL / MCL / PLC injury and had already early osteoarthritic changes at the time of reconstruction surgery, had a constrained total knee replacement 4 years later. A further four patients underwent revision ligament surgery due to ACL graft failure in two cases and PLC/LCL graft failure in a further two cases. In two out of those four patients graft failure occurred following further trauma. Revision was carried out with synthetic graft in all four cases. One patient with persistent, symptomatic LCL laxity resulting in varus thrust has undergone a high tibial osteotomy and another is planned for the above procedure. Painful hardware was removed as a day-case procedure in eight cases, while a second look arthroscopy and partial lateral meniscectomy was performed in two patients. A further three patients had to undergo manipulation under anaesthesia and arthroscopic arthrolysis for persistent post-operative joint stiffness. This was fully resolved following manipulation and arthrolysis in all three cases.

Table 2 Clancy's functional criteria

Excellent: Full return to sports or manual labour with no or rare pain. No instability, no ligamentous laxity.
Good: Full return to sports or manual labour with occasional pain on exertion. No instability, ligamentous laxity $\leq +1$.
Fair: Significant but not disabling pain on exertion, but not on daily activities. No instability, ligamentous laxity $\leq +1$.
Failure: Return of episodes of instability. Pain on daily activities. Ligamentous laxity $\geq +2$.

Discussion

Multiligament knee injuries are uncommon but potentially limb-threatening conditions that can be compounded by vascular and nerve injuries at an incidence of as high as 40% [3,6,10,29]. They result in multidirectional knee instability, significantly compromising knee function. They are usually caused by high-velocity injuries such as road traffic accidents or fall from a substantial height, but can also occur during low-velocity sporting activities, as a result of severe twisting forces applied to a trapped lower limb [31,33]. Knee dislocations though have also been described without cruciate injury, as are the so-called ultra-low-velocity dislocations, an entity recently recognised in morbidly obese patients [2,13].

The MRI-scan is a very useful tool in assessing the damage to the supporting structures of the knee following dislocation, but has been demonstrated to be more accurate in acute than in chronic injuries, where especially the PCL can be shown to be continuous, although it might be attenuated and functionally insufficient [6,28,30–32,36]. There is mainly radiological evidence that especially MCL and PCL tears may, to a certain extent, heal, but it has been strongly suggested that reconstruction of all injured ligaments leads to far superior functional results than conservative management of such injuries [11,22,38]. The current trend in the management of these complex injuries is to repair or reconstruct all injured structures, in an effort to restore satisfactory ligament stability and knee function and at the same time prevent further damage in the knee joint resulting from joint instability [1,4–9,12,14,19,21,23,38].

The timing of surgery is still a debatable issue. Recent reports suggest that acute repair or reconstruction in multiple ligament deficient knees leads to better functional results although most authors favour delaying surgery for 2–3 weeks to allow for capsular sealing and subsidence of soft tissue swelling [6,8,9,34,39]. Early reconstruction though is thought to increase the risk for post-operative arthrofibrosis [14,21].

Another contentious issue regarding multiple ligament reconstruction is the post-operative rehabilitation regime to be followed. As suggested previously, this complex reconstruction procedure aims to achieve satisfactory ligamentous stability and at the same time satisfactory function. Aggressive rehabilitation regimes including early passive and active mobilisation and range of movement exercises have been proposed in an effort to improve and accelerate functional recovery [7,20,21,26,27,33]. Gravity as well as contraction of the hamstring muscles during the early healing period can have a posterior drawer effect and therefore potentially lead to PCL graft stretching through tibial shear forces [17,21,26,27]. That is the reason why a number of authors adopt a more conservative rehabilitation protocol, protecting the PCL reconstruction by bracing the knee in extension and delaying active and passive flexion–extension exercises for 4–6 weeks [5,6,8,9,11]. Stannard et al. [35] on the other hand advocate a more active early rehabilitation regime, but try at the same time to protect the ligament reconstruction from undue stress with the use of a specially designed external fixation device.

The use of allografts rather than autografts has been advocated by some authors in patients undergoing multiple ligament reconstruction, in an effort to reduce additional surgical morbidity in the region as well as the risk for arthrofibrosis [14,15]. Allografts on the other hand have been associated with significantly slower incorporation compared with autogenous graft material [15,21,23].

In this series the greatest number of reconstructions was performed in knees with chronic multiple ligament deficiency; this was the result of the referral pattern in our institution, which comprises mainly of tertiary referrals. Therefore most reconstructions were performed from 6 months to many years after the initial injury, often after other failed reconstructions of some of the injured ligaments. Autografts have been preferred to allografts and synthetic grafts whenever possible, because they allow for better and faster graft incorporation [15,21,23].

The rehabilitation regime followed was somewhat conservative during the first 4–6 weeks, during which the leg was immobilised in extension in a long leg brace, in an effort to protect the graft from stretching during the early healing period and to allow for better graft incorporation. Range of movement was slow to return in a few cases, but manipulation and arthrolysis were required in only three cases and the overall final range of movement achieved was very satisfactory and is comparable to the results reported in other studies [16,22,26,27,34,35]. On the other hand clinically significant residual PCL laxity or failure has only been a problem in 3/32 cases (9.4%) in our series and favourably compares with the figures stated in other series [1,7,11,14,21,26,27]. We feel that a potentially slow recovery of satisfactory range of movement is a small price to pay in order to avoid graft attenuation leading to residual laxity that may compromise function.

Recent literature suggests that early operative treatment of multiple ligament injuries is preferable, as it may allow for anatomic repair instead of reconstruction of especially the collaterals and the posterolateral corner [14,21]. In this series, multiple ligament reconstruction in chronic multiple ligament deficient knees offered an overall satisfactory clinical outcome in the greatest majority of patients, allowing them to resume their day-to-day activities and often return to sports. Pain on exertion though remained a problem in a considerable number of our patients.

In conclusion, this study demonstrates that even if acute reconstruction has not or could not be performed chronic reconstruction should be attempted in an effort to prevent further damage in the knee joint resulting from persistent joint instability. Arthroscopically assisted multiple ligament reconstruction in chronically unstable knees is a complex and technically demanding procedure. Although it rarely results in a ''normal'' knee, it offers in most cases very satisfactory stability and a significant improvement in knee function.

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