HANDBALL AND ACL INJURIES OF THE KNEE

– Written by Philippe Landreau, Qatar

INTRODUCTION

Team handball is a sport requiring the most rapid deceleration of cutting, pivoting and jump-landing movements. An anterior cruciate ligament (ACL) tear of the knee in a handball player is a challenging issue, particularly in professional players. In the best-case scenario, it temporarily halts all sporting activity; in the worst scenario, it can compromise an athlete's career.

EPIDEMIOLOGY AND MECHANISMS OF ACL RUPTURE

The majority of acute injuries in handball are isolated to the lower extremity, regardless of age and gender[1,2]. The most serious injuries reported in handball are knee injuries (7 to 27%). ACL injury accounts for up to 40 to 50% of all ligamentous knee injuries.

Injured players report that injuries often occur while performing a cutting movement or on landing from a jump without direct body contact (Figure 1).

Studies which have analysed videos of mechanisms of injury observe[3,4] that ACL injuries in team handball occurred mainly during a non-contact plant and cut movement or when landing from a jump shot. It is usually a plant-and-cut faking movement (to change direction to pass an opponent, for example) or a one-legged landing from a jump shot. In both cases, the mechanism of injury appears to be the same. A consistent pattern is a forceful valgus-external or -internal rotation with the knee set close to extension. It appears that tearing of the ACL occurs at the time when the foot is planted and firmly fixed to the floor. The injured player usually reports that most of the injury occurs in a move performed numerous times previously, but some additional factors may help to explain the injury. Among factors reported are:

- being out of balance,
- being pushed or held by another player,
- trying to evade a collision with an opponent and
- having an unusually wide foot position.

These conditions could contribute to the injury by causing the athlete to plant the foot without adequate preparation, with an unfavourable lower extremity alignment or with inadequate and poor neuromuscular control.

In all these situations, the injuries occurred when the foot was firmly fixed to the floor – it can be assumed that the friction between the shoe and the floor surface can also contribute to the mechanism of injury. It has been shown that the risk of an ACL injury in women is higher on artificial floors (generally having higher friction) than on wooden floors[5].

It has been described that female handball players have approximately a five-fold higher risk of incurring a rupture of the ACL than male players[6]. The reasons for this gender difference are multifactorial and may include anatomical factors such as valgus and decreased notch width index, hormonal differences and altered

Figure 1: Handball player landing on his lower limb.

neuromuscular and biomechanical patterns that help create increased anterior and valgus moments around the knee.

PHYSICAL EXAMINATION AND IMAGING

The first step in any good clinical examination for ACL injury is an appropriate patient history.

It should be possible to establish a definite diagnosis of injury to the cruciate ligament in most cases on comprehensive physical examination.

Standard physical examination of the knee includes testing of anterior/posterior/varus/valgus and rotational joint stability. Anterior stability testing usually employs the use of the Lachman test. The degree of translation is categorised in grades of laxity:

- **Grade I laxity** describes 1 to 5 mm of increased anterior translation.
- **Grade II laxity** is 6 to 10 mm.
- **Grade III laxity** is more than 10 mm of translation when compared with the opposite, uninjured knee.

In addition to the Lachman test, arthrometers have been used to provide objective instrumented laxity measures of ACL laxity[7]. The KT-1000™ (MEDmetric®, USA) is the mostly commonly cited device. In daily practice, I prefer the use of the GeNouRoB® (GNRB)(Figure 2). It allows for a quantitative evaluation of anterior laxity of the knee and can give some information if a partial tear is suspected. The GNRB reports various supplementary advantages compared with other available laximeters[8]. It allows for good control of the investigated limb position in rotation, recording of translation in the absence of hamstring muscles contraction and, in direct comparison with the KT-1000, has a better reproducibility, constant pressure, arthrometry improved accuracy and automated measurements recording. The GNRB can be used for diagnosis of partial and complete ACL tears and during follow-up of reconstructed ACL tears.

The pivot shift test is another important clinical examination manoeuvre to measure instability in the knee secondary to ACL injury. This test is graded on the degree of subluxation of the lateral compartment of the knee:

- **Grade 0** having no detectable shift.
- **Grade I** having the tibia in a smooth glide during reduction.
- **Grade II** having an abrupt reduction.
- **Grade III** having an explosive subluxation.

Currently an ability to objectively evaluate the pivot shift using instrumentation is still being debated.

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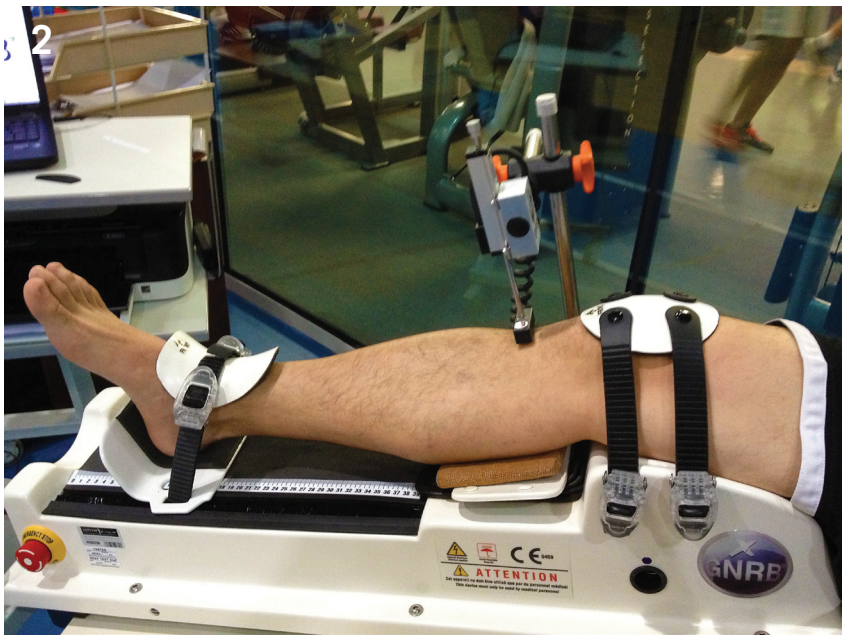

Figure 2: GNRB allows for a quantitative evaluation of anterior laxity of the knee and can give some information if a partial tear is suspected. The GNRB can be used during follow-up of reconstructed ACL tears.

Figure 3: ACL reconstruction with a bone-patellar-tendon graft harvested through two min invasive incisions.

Plain radiographic imaging plays a primary role in the exclusion of other associated injuries in the evaluation of the ACL. Such associated injuries include lateral capsular avulsions (Segond fractures) and tibial eminence avulsion fractures – often seen in younger patients. Plain films can also alert the physician to the presence of loose bodies, combined fractures, degenerative disease and osteophytes in chronic ACL-deficient knees.

MRI is a highly useful tool for confirming the diagnosis of ACL injury. It is highly specific and sensitive and is able to provide information on the other intra-articular structures in the knee as well as evaluating both bundles of the native ACL.

TREATMENT CONSIDERATIONS

Non-operative treatment

In my clinical experience, there is no place for conservative treatment after complete ACL tear in handball players. This is because handball is a highly demanding sport activity with frequent cutting, pivoting and jump-landing situations which need a functional ACL. Therefore we do not recommend conservative treatment in handball players who have sustained a complete ACL tear. A handball player returning to play without surgical ACL reconstruction is at risk for instability episodes – with additional meniscal and cartilage lesions – in the future.

Partial tears

The incidence of partial tears ranges from 10 to 28% of all ACL injuries. Partial ACL tears, often of a single ACL bundle, are now being diagnosed with increasing frequency[9]. A combination of physical examination, arthrometer assessment and MRI findings is helpful in making this diagnosis.

Although the natural history of complete ACL ruptures has been well-defined, patients with partial ACL tears have a less predictable clinical course.

There is no published evidence regarding handball players returning to play after a partial ACL tear that has been treated conservatively. Due to the high constraints of this particular sport, I believe that surgical treatment is recommended. It is possible to perform a single-bundle reconstruction in those patients found to have single-bundle ACL tears (anteromedial or posterolateral bundle) with the remaining bundle being functionally intact. During arthroscopic assessment at the time of surgery, if there is any doubt as to the integrity of the remaining bundle, I prefer to perform a complete ACL reconstruction.

Graft choice

- The **bone-patellar-tendon-bone** (BPTB) autograft has some mechanical and biological properties that are advantageous but there is a higher graft site morbidity and it is less cosmetically satisfactory if the traditional anterior vertical incision is performed.
- The **hamstring** graft offers less donor site morbidity but is slower to incorporate[10]. Quadriceps tendons are thicker, have intermediate morbidity and decrease the operative time but have a worse cosmetic outcome. There are also concerns with the soft-tissue fixation at one end of the graft, with slower incorporation.
- The **patellar tendon allograft** has no donor morbidity, a good initial fixation and decreased operative time. However, costs are higher, the graft may not integrate sufficiently and there is a very slight risk of disease transmission.

In 2014, an autograft of the BPTB complex and hamstring tendon grafts can be considered as the gold standard graft types for ACL reconstruction.

Anterior knee pain after BPTB harvest has been reported to occur in up to 50% of cases but a direct correlation to BPTB harvest is being refuted. The source of this pain may be multifactorial: the incidence of postoperative knee pain has been decreasing in more recent studies because of earlier rehabilitation, avoidance of immobilisation and emphasis on recovery of motion and strength. In our experience, a correct postoperative physiotherapy regimen ensures that a lack of knee extension and anterior knee pain is not frequent after BPTB reconstruction (Figure 3).

Our main concern is one of a slower bone integration of hamstrings when compared to the bone-to-bone integration of the BPTB graft and a subsequent higher risk of re-rupture of the hamstring grafts in these athletes. In addition, the hamstring tendons have a protective effect on the graft. Harvest of two or even only one of these tendons decreases this protection and can affect future graft behaviour. These issues can be a real concern in a sport with high knee mechanical constraints like handball. There is no real consensus about the superiority of BPTB or hamstring grafts for ACL reconstruction. However, the majority of comparative studies include patients with different sports and activity levels. A majority of meta-analysis reports a superiority of laxity control with BPTB and less anterior knee pain with hamstring grafts.

In 2003, Freedman et al performed a large meta-analysis of the available articles published on ACL reconstruction with BPTB vs hamstring grafts[11]. It reported on 1348 patients selected from 21 and 13 studies respectively, involving BPTB or hamstring ACL reconstructions. They found that BPTB ACL reconstruction was associated with a statistically significant decreased rate of failure and laxity and provided patients with a more stable knee. Hamstring ACL reconstruction was found to have a significantly decreased incidence of anterior knee pain and rate of arthrofibrosis requiring manipulation or adhesiolysis.

Yunes and associates performed a more restricted meta-analysis involving only prospective, semi-randomised studies[12]. It consisted of four studies comprising of 424 patients in total. Their findings were similar to those of Freedman in that BPTB reconstruction was found to give a statistically more stable knee with regard to KT-2000 and pivot shift objective testing. Additionally, they found that BPTB had an 18% increased chance of returning to pre-injury levels than HS grafts.

In my opinion, this mild difference between the two grafts can be of importance for a high demanding sport such as handball. For that reason I recommend

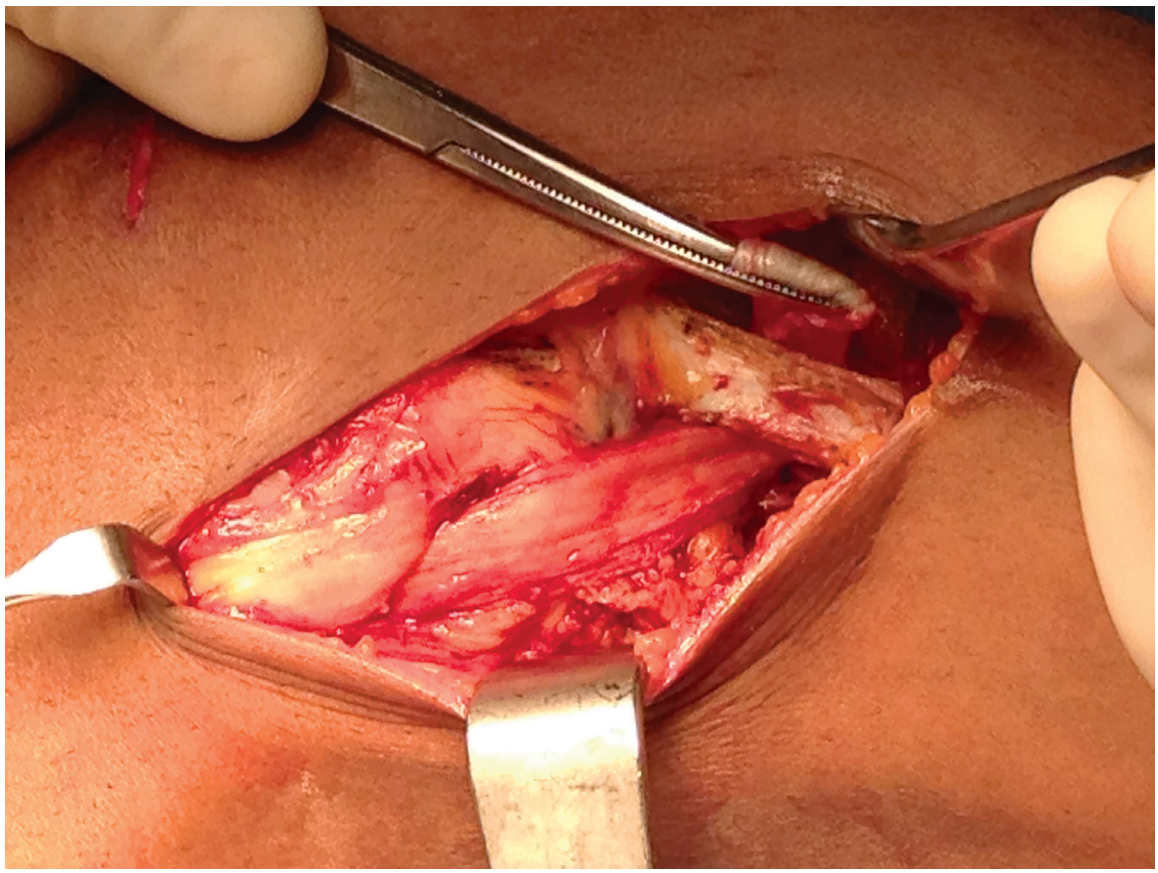

Figure 4: A lateral tenodesis using the ilio-tibial band is performed in addition to the intra-articular ACL graft if the pivot shift is grade III or if there is a knee hyper-laxity.

> ***Before surgical reconstruction patients should have minimal pain and be mentally prepared for the reconstruction and rehabilitation***

the use of BPTB graft in handball players – particularly if professional or playing at a high level. The quality of fixation and bone integration of the graft is more predictable. Furthermore, there is no deleterious effect on the protective hamstring mechanism.

Associated lesions

The medial collateral ligament (MCL) and lateral meniscus are commonly injured concurrently with an ACL tear. Medial meniscal injuries are more common in chronic ACL tears.

Bellabarba et al[13] performed a review of meniscal injuries associated with acute and chronic ACL insufficiency. They found a 41 to 81% incidence of meniscal tears in acute ACL injuries; 56% were lateral tears and 44% were medial tears. In chronic ACL-deficient knees, the rate of associated meniscal injury ranged from 58 to 100%. In this population, medial meniscal tears were more common, representing 70% of all meniscal injuries.

The importance of the meniscus in knee stability, load transmission and prevention of long-term arthrosis has been proved, thus the need for meniscal preservation is essential. Meniscal repairs performed in conjunction with ACL reconstruction have a higher rate of healing. Therefore, we attempt to preserve the meniscus at the time of ACL reconstructive surgery.

Adequate healing of the non-operatively treated MCL in the context of ACL reconstruction has been shown in multiple retrospective studies[14]. Concern exists regarding the risk for arthrofibrosis in the setting of a combined ACL and MCL injured knee in which acute operative treatment is undertaken. We routinely wait until the patient has reached full extension, has achieved flexion to 120° and until the majority of the acute haemarthrosis has resolved.

Double bundle reconstruction

Cadaveric studies have shown that double-bundle reconstruction may restore better joint kinematics but up until now there is no proof that these more complex procedures result in a better clinical outcome than the standard single-bundle procedure[15]. As double-bundle reconstruction is performed using hamstring tendons (as previously discussed) we do not perform double-bundle ACL reconstruction surgery in the handball population.

Lateral tenodesis

The literature reports an 85 to 90% good or excellent result with a high rate of return to sport with conventional techniques of ACL reconstruction. The reasons for the remaining 15% failure rate are multifactorial, including imperfect control of anterior laxity and residual rotational abnormal laxity. Despite the lack of evidence[16] concerning the use of additional lateral tenodesis (lateral extra-articular augmentation), I routinely perform a lateral tenodesis using the ilio-tibial band if the pivot shift is grade III and if there is a hyper-laxity with hyper-extension for high level athletes (Figure 4).

Timing of surgery

There has been ample debate surrounding the ideal timing of ACL reconstruction surgery[17]. Studies have found increased rates of arthrofibrosis from early ACL reconstruction, whereas others have found early reconstruction to be safe. Arthrofibrosis is the most common postoperative complication after ACL reconstruction and a loss of motion (particularly terminal extension) can be more debilitating for the patient than instability. In my own experience, the time interval from ACL injury to reconstruction is not as important as the condition of the knee at the time of surgery. Before reconstruction, the knee should have a full range of motion with minimal effusion, and patients should have minimal pain and be mentally prepared for the reconstruction and for the rehabilitation required after surgery. A preoperative period of physiotherapy is usually performed.

Postoperative rehabilitation

After ACL replacement with a BPTB graft, rehabilitation is absolutely vital. It is clear that immobilisation of the knee, or restricted motion without muscle contraction, leads to undesired outcomes for the ligamentous, articular and muscular structures that

surround the joint[18]. Rehabilitation that incorporates full weight-bearing and early joint motion is beneficial for reducing pain, minimising capsular contraction and decreasing scar formation that can limit joint motion, as well as being beneficial for articular cartilage.

Return to sport and criteria to return to play

Although any unnecessary delay to returning to unrestricted sport activities should be avoided, a premature return to play after surgery is dangerous and can jeopardise the ACL graft[19]. The use of multiple criteria is necessary in determining clearance for a patient to return to full activity, including:

- the return of range of motion,
- muscle strength and balance,
- static stability as measured by GNRB and
- dynamic stability as measured by functional testing.

If the patient has achieved the goals set in rehabilitation, he/she is allowed to return to play 6 months after ACL reconstruction.

CONCLUSION

Team handball is a very demanding sport activity with a high risk of ACL injury. The mechanisms of rupture are mainly non-contact injuries. The female population is more affected by ACL ruptures. The BPBT is an optimal graft for ACL reconstruction and the lateral tenodesis can avoid residual rotational laxity in these athletes. Postoperative rehabilitation is crucial to enable a return to play at the same level and specific criteria must be validated before allowing the player to return to the field.

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