ANALYSIS OF SINGLE LEG LANDING AFTER ACL RECONSTRUCTION

INTRODUCTION
Anterior Cruciate Ligament (ACL) tear is one of the most serious knee traumatism [2]. 92% of non-contact ACL tears occur during a landing or a deceleration [1] when the knee is flexed and the quadriceps contracts eccentrically, leading to a significant increase on the ACL load. The usual treatment is surgical reconstruction followed by a long period rehabilitation. Currently, several parameters allow monitoring the post-operative recovery. Clinical parameters: oedema, pain, mobility (range of motion of the knee joint) and stability (e.g. the Lachman test). Subjective parameter: the International Knee Documentation Committee (IKDC) subjective knee form [6]. Objective parameters: stability on X-ray (measure of the anterior translation of the tibia) and muscular recovery that could be estimated by two tests [3]. One using an isokinetic machine giving the value of the peak torque of quadriceps and hamstrings [8]. However, this test only determines quantitative muscular recovery, in term of concentric analytical force of the quadriceps and it only takes into consideration a single joint while daily or sports activities are pluri-articular movements. The second is hop testing [4, 7], using single leg vertical and/or long jumps. This test could point out a deficit of performance between both legs without identifying the deficit parameters of the landing. In light of the re-injury risk, ranging from 2.6 to 25% [5, 9, 10], it would be appropriate to complete these tests by an analysis of a squat jump landing. Squat jump is a dynamic movement, pluri-articular, quasi-ballistic and found in many sports. It is a standardized movement that allows an accurate study of the landing. Therefore, the aim of this study was to assess the landing after ACL reconstruction in terms of dynamic and kinematic analysis.

METHODS
7 male subjects participated in this study. These subjects had all undergone isolated ACL tear and surgical reconstruction with patellar tendon or hamstring grafts. They took part in the experiment from six to seven months after surgery when they were clinically identified as able to return to sport activities. A warm-up session and a few training jumps were realised in order to familiarize the subjects with the task and to minimize possible bias. Subsequently, each subject performed six maximal squat jumps (three on each leg, Injured Leg (IL) and Non-Injured Leg (NIL)). They were asked to jump as high as possible without downward movement while keeping their hands on their hips, to land on the same leg and to stabilize with the knee flexed before standing up. Landmarks were placed on both sides, on the fifth metatarsophalangeal, lateral malleolus, lateral femoral condyle, great trochanter and acromion during the test. Subjects were filmed in the sagittal plane with a 100Hz camcorder and a force plate measured the ground vertical reaction force. A four rigid segments model (foot, shank, thigh and upper body, i.e. head, arms and trunk; HAT) was obtained from the digitalization of the landmarks’ centre. Joint angles (hip, knee and ankle) were calculated from the absolute coordinates of the landmark (Figure 1).

The jump height was calculated by the vertical difference of the body mass centre between the standing position and the position at the apex of the jump. The landing phase started when the toes touched the floor and lasted until the three joints had reached their maximal flexion angle. Peak Impact Force (PIF) corresponded to the maximal value of the ground vertical reaction force and the Rate of Force Development (RFD) was defined as the ratio of PIF/Time to reach it.

An innovative statistical technique was used both to point out the leg effect and to avoid a possible confounding with the jump height effect. First, for every subject, the jump height effect was decomposed into two parts: a mean jump height effect and a difference effect in jump height (based on the two leg values). These two covariables were employed in a repeated measures ANOVA in interaction with the direct leg effect. An ascending algorithm was used to select the statistically significant (p<0.05) within-subjects variables among (a) the leg effect, (b) the mean jump effect, (c) the difference effect.

RESULTS AND DISCUSSION
There was no difference in dynamic values (PIF and RFD) between the IL and NIL and the landing phase lasted the same time (p=0.56). For the kinematic parameters, there was no difference between legs in the initial positions at landing of the three joints (hip: p=0.90, knee: p=0.98, ankle:
p=0.63), but a marginally significant difference for the range of motion of the hip (p=0.08) and the ankle (p=0.08) can be noticed. The leg effect of the range of motion of the knee was significant (p=0.03) with a value of 0.49 rad for the IL versus 0.69 rad for the NIL. However, this significance disappeared when the jump height was taken into consideration (p=0.62).

Compared to the NIL, maximal flexion values of the knee and the ankle of the IL were significantly reduced of 0.21 rad (p=0.03) and 0.10 rad (p<0.001) respectively.

Figure 1: Maximal flexion values of the hip, knee and ankle joints, at landing.

From a kinematical approach, the landing quality appeared to be altered 6 months after ACL reconstruction. Indeed, the maximal flexion of the injured knee was reduced. It may be due to the weakness of the quadriceps and/or a lack of dynamic control of the knee. This would have a negative influence on the ankle, by limiting the dorsal flexion.

CONCLUSIONS

This single leg squat jump test highlighted dynamic deficits at 6 months after ACL reconstruction. These findings complete those tests usually done by medical profession by providing additional information in order to improve rehabilitation post-ligamentoplasty. These first results are part of a more global study including a larger population as well as dynamic and electromyographic analysis.

REFERENCES