INTRODUCTION

Anterior Cruciate Ligament (ACL) tear is one of the most serious knee traumatism occurring during sport activities [3]. Advances in surgical reconstruction and rehabilitation allow patients to return to sport about 6.2 months after surgery [1]. Currently, several parameters could monitor 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 (e.g. the International Knee Documentation Committee (IKDC) subjective knee form) [7]. Objective parameters: stability on X-ray (measure of the anterior translation of the tibia) and muscular recovery that could be estimated by two tests [4].

One using an isokinetic machine giving the value of the peak torque of quadriceps and hamstrings [10]. However, this test determines only quantitative muscular recovery, in term of analytical force of the two main muscles crossing the knee joint and it takes into consideration only a single joint while daily or sport activities are pluri-articular movements.

The second is hop testing [5, 9], 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.

In light of the re-injury risk, ranging from 2.6 to 25% [6, 11, 12], it would be appropriate to complete these tests by an analysis of a pluri-articular dynamic movement such as squat jump. This task is quasi-ballistic, found in many sports and the vertical performance is related to the ability of the subject to generate work during the push-off and to transform this work into energy contributing to jump height [2]. Parameters of this task were well-known and have been often studied in healthy population [2, 8].

Therefore, the aim of this study is to assess kinematic parameters during a squat jump after an ACL reconstruction in order to improve the evaluation procedure of the injured leg.

METHODS

Seven male subjects agreed to participate in this study and provided informed consent. These subjects have all undergone isolated ACL tear and surgical reconstruction with patellar tendon or hamstring grafts. They took part in the experiment from six to nine 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 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.

Landmarks were placed on both sides of the lower limbs, 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. 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 landmarks and angular velocities by deriving with respect to time the joint angles (Figure 1).

Figure 1: Hip (θ_H), Knee (θ_K), Ankle (θ_A) angles and HAT, thigh, shank and foot segments.

The better of the three trials, based on the maximum height reached during flight, was selected for further analysis. The jump height was calculated by the raising of the body mass centre between the standing position and the position at the apex of the jump. The Push-Off Phase (POP) duration corresponded to the time from the start of the movement to the instant when toes left the ground. Wilcoxon paired-test was used for the statistical analysis and significance was set at p<0.05 level.

RESULTS AND DISCUSSION

There was a significant decrease in the jump height between the NIL and IL (30.5%, p=0.031), however there was no difference in the time of the POP. Despite the equivalent POP duration, maximal angular velocities of the knee and ankle were respectively reduced of 44.7% (p=0.015) and 33.7% (p=0.031) for the IL. This can be explained by the more extended position of the knee at the start of the movement (+0.13 rad, p=0.046) (Figure 2) and the more flexed position of the knee (-0.17 rad, p=0.046) and the
ankle (-0.19 rad, p=0.015) (Figure 3) at the take-off for the IL.

**Figure 2:** Average and standard deviation values for the ankle, knee and hip angles at the starting position.

**Figure 3:** Average and standard deviation values for the ankle, knee and hip angles at the takeoff.

Based on these results, jump performance appeared to be still reduced for the IL at 7.5 months after ACL reconstruction. The incapacity of the subject to maintain the initial position and the dynamic limitation of the knee extension at the take-off could be explained by a muscular strength deficit of the quadriceps and a weakness of the dynamic control of the knee. These deficits have a negative influence on the ankle by limiting the plantar flexion of this joint.

**CONCLUSIONS**

This single leg squat jump test highlights 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 post-ligamentoplasty rehabilitation and therefore reduce re-injury risk. These first results are part of a more global study including dynamic and electromyographic analysis.

**REFERENCES**