INTRODUCTION
The biomechanical function of ACL reconstruction with quadruple-loop semitendinosus and gracilis tendon graft and bone-patellar-tendon-bone graft was evaluated in a cadaveric study and the results showed that these ACL reconstruction procedure were successful in limiting anterior tibial translation in response to an anterior tibial load but were insufficient to control a combined rotatory load of internal and valgus torque. Moreover with the use of hamstrings, the long-term results have shown that 11% to 30% of the patients had unsatisfying long-term results, especially regarding the control of rotatory stability with a glide or a positive pivot shift test post operatively. One possible cause of these condition could be that current single bundle procedures cannot realistically reproduce the complex anatomy of the ACL, especially the different function of its anteromedial (AM) and posterolateral (PL) bundle. Because most ACL reconstruction procedures have focused only on replacing the anteromedial bundle, the other functional bundle, the posterolateral, has not received sufficient attention. A recent study on cadaveric knees by Yagi et al showed that anatomic reconstruction of ACL with double bundle gracilis and semitendinosus tendons graft may better reproduce biomechanical outcome, especially during rotatory loads.

The hypothesis of our study is that the addition of the PL bundle to the AM bundle, in an “in vivo” double bundle computer assisted ACL reconstruction, is actually able to reduce the internal rotation of the tibia at 30° degrees of knee flexion, minimizing the pivot shift phenomenon. Computer assisted ACL reconstruction has been used because, beside being useful in increasing the precision of the surgical procedure (tunnel placement) it could be very effective in evaluating the global performance of the reconstructed knee, calculating very accurately the anteroposterior displacement, the internal and external rotation of the tibia with respect to the femur in three dimensional planes of the joint motion.

METHODS
In April and May 2006 ten consecutive ACL reconstruction procedures were performed in our Hospital with double bundle gracilis and semitendinosus tendons graft using the 2.0 OrthoPilot ACL navigation system (B.Braun-Aesculap, Tuttingen, Germany). The average age of patients at the time of surgery was 27.8 years (range 17-40). There were nine men and one woman with a story of chronic ACL deficient knee. ACL reconstruction and navigation were performed by the same Senior Author using a double incision endoscopic technique. The diameter of these grafts were measured with a sizing system and were a mean of 7.3 mm±0.8 mm (6.8-8.5 mm) for the semitendinosus used for the AM bundle and 6.1 mm±0.6 mm (5.6-5.5 mm) for the gracilis tendon used for the PL bundle. The tibial and femoral tunnels were made under arthroscopic control. The femoral tunnels were made with an out-in technique. The navigation system was used only for AM bundle placement. The AM tunnel diameter was 7 or 8 mm and the PL tunnel diameter was 5 or 6 mm depending on the tendons diameter. The bundles were fixed on the femur using two Swing.Bridge devices (Citieffe, Bologna, Italy) and on the tibia by using two soft tissues metallic interference screws (Athrex, Neaples, Florida). The length of the screws was 35 mm and the diameter one mm greater than the tunnel diameter. Using the navigation system as reference, the double-looped semitendinosus tendon replicating the AM bundle was fixed first with the knee at 60° of flexion. Then the gracilis tendon replicating the PL bundle was fixed to the tibia with the knee at 15° of flexion as suggested by Yagi et al.

The navigation system assisted the surgeon to orientate the tunnels and moreover allows to precisely calculate anterior, internal and external tibial translation.

Maximum manual A-P displacement at 30° of flexion, as well as maximum internal and external rotation of the knee were evaluated before surgery and after single (AM) and double (AM+PL) bundle reconstruction.

The values of AP tibial displacement and internal and external rotation of the tibia after AM bundle reconstruction and after AM+PL bundles reconstruction were compared using the paired T-test.

RESULTS:
Before ACL reconstruction the mean manual maximum AP tibial was 17.2±2.6 mm; the mean manual maximum internal rotation of the tibia was: 19.8±3.3 mm and the mean manual maximum external rotation of the tibia was: 16.8±2.5 mm.

After AM bundle reconstruction the mean manual maximum AP tibial was 6.1±1.7 mm; the mean manual maximum internal rotation of the tibia was: 17.0±2.5 mm and the mean manual maximum external rotation of the tibia was: 16.3±4.3 mm.

After AM+PL bundles reconstruction the mean manual maximum AP tibial was 5.3±1.7 mm; the mean manual maximum internal rotation of the tibia was: 16.2±4.2 mm and the mean manual maximum external rotation of the tibia was: 14.6±2.2 mm.

There was no statistically significant difference in the tibial internal and external rotation at 30° after single bundle (AM) and double bundle (AM+PL) reconstruction.

DISCUSSION:
In this study the effectiveness of the PL bundle in controlling the internal rotation of the tibia, responsible of rotational instability of the knee, was evaluated in “in vivo” ACL reconstruction. Our method allowed us to obtain the experimental data by using the same specimen thus minimizing the interspecimen variation and increasing the statistical power. Moreover the navigator system allowed us to obtain “in vivo” the real and correct value of AP displacement and internal and external rotation of the tibia before and after reconstruction.

The first limitation of this study is the limited number of patients, which is however sufficient for a T-test statistical analysis. The second limitation is that the tibial displacement values were calculated only at 30 degrees of knee flexion, but this degree of flexion of the knee well simulate clinical situations such as the Lachman and the pivot-shift tests. Moreover, according to previous studies, 30° of flexion seems to be the position at which maximum internal rotation of the knee can be correctly evaluated.

Yagi et al demonstrated in an in vitro model, that the double bundle reconstruction better reproduce the biomechanic of the knee, especially during rotatory loads. They calculated the kinematics and the in situ forces in ten cadaveric knees in two conditions: anterior tibial load and combined rotatory load of internal and valgus tibial torque. Our results seems not in agreement with the findings of Yagi et al., who used cadaveric models, in which they resected only the ACL, producing a truly isolate ACL tear. Although in our series we excluded patients with severe associated ligamentous tears, it is well known that ACL tear are frequently associated with mild tears of anterolateral capsular ligament without or with bony avulsion (Segond fracture). Moreover, in chronic ACL insufficiencies, a progressive stretching of secondary restraints in the lateral aspect of the knee, often occurs.

Moreover Yagi et al evaluated only the in situ forces on AM and PL bundles while we focused to the internal rotation of the tibia which can contribute to the clinical rotatory instability of the knee.

Our results were similar to those of Ishibashi et al that used the same navigation system to assess their technique for double-bundle ACL reconstruction in 32 patients evaluating AP displacement and total rotation of the tibia (internal/external) before reconstruction and after AM bundle fixation, PL bundle fixation and double bundle ACL reconstruction at 15°,30°,45°,60°,75° and 90° of flexion. They found no differences in the total range of tibial rotation after AM and PL bundle reconstruction at more than 30° of flexion. Moreover preliminary clinical reports about double bundle ACL reconstruction that have not shown a significative difference in knee rotatory stability, evaluated by pivot-shift test, between the single and double-bundle technique.

In conclusion our hypothesis that the addition of the PL bundle to the AM bundle is actually able to reduce the internal rotation of the tibia at 30° degrees of knee flexion, minimizing the pivot shift phenomenon, on the basis of our study has not been confirmed.

Therefore the ability of the double bundle ACL reconstruction to better control the rotatory instability of he knee should be questioned.