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COMPARISON BETWEEN DIFFERENT FEMORAL BONE REMODELLING PATTERNS AFTER ACL RECONSTRUCTION IN PATIENTS OVER 40 YEARS OF AGE: TC ANALYSIS

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SUMMARY

The purpose of this study was to evaluate the different behaviors of the femoral bone in patients after anterior cruciate ligament reconstruction. Twenty-two patients undergoing ACL reconstruction either by double semitendinosus and gracilis tendon graft (DTSG), or ligament advanced reinforcement system (LARS) fixed at the femur with two biodegradable pins (RIGID FIX), were evaluated.

In all patients a physical examination was performed and functional outcome scores were obtained at follow up. Instrumental evaluation was performed by multislice CT. The CT scan, which mainly focused on the area of the femoral tunnel, showed an increase in spongy bone out of the socket in the surgery performed with LARS, while in patients treated with DTSG, the bone retained the normal structural characteristics of density of the femoral meta-epiphysis. The CT scan also documented a higher rate of pin biodegradation in reconstruction with LARS. The results analysis showed different patterns of response based on the type of ligament. A bone reaction for mainly mechanical purposes, evidenced by a circumferential fibrous ring, was observed in all patients. Additionally, a bone reaction for biological purposes, characterized by an increase in the spongy tissue associated with a reduction in bone density and a faster reabsorption of pins, was found in patients treated with LARS.

Introduction

Significant advances in anterior cruciate ligament reconstruction have been made over the years. Currently, different fixation techniques are available, including staples, soft-tissue washers, buttons, interference screws and cross-pins. These fixation techniques should withstand early physiological forces and facilitate biological graft incorporation. Numerous studies exist comparing these techniques with regard to their initial fixation strength, biocompatibility, and risk of graft laceration. Advantages of bioabsorbable pins include the ability to perform postoperative imaging without metallic artifacts, excellent mechanical strength and easier revision without the need for hardware removal [1, 2, 3, 4, 5, 6, 7, 8]. The characteristics of the reactive bone tissue generated around the graft vary depending on the type of ligament [9, 10, 11]. Therefore, the aim of the present study was to analyze the structure of the reactive bone after ACL reconstruction with DTSG and LARS, CT was used in order to evaluate how the behavior of the bone differs depending on the type of ligament. We did not consider the patellar tendon because its anchorage is facilitated by the bone-bone interface [12, 13, 14].

Material and Methods

Between April and July 2008, 22 patients underwent arthroscopic ACL reconstruction using different grafts. The patients, 12 women and 10 men, had a mean age of 46 years (range 42 to 55) and occasionally carried out physical activity.

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Reconstruction was performed with hamstring tendons in 10 patients, while we used LARS on the remaining 12 (all over 49 years of age) who required a faster period of recovery because of their profession.
All grafts were fixed with double biodegradable femoral cross pin fixation (Rigid Fix). ACL injuries were confirmed in all patients by physical examination and magnetic resonance imaging. Only 4 ACL injuries without associated lesions were found, while in the other 18 patients the injuries presented were meniscal tears and cartilage lesions. Preoperative and postoperative evaluation was based on the International Knee Documentation Committee (IKDC) criteria. The evaluation for instability was based on KT-2000 arthrometer measurement with maximal manual displacement, the Lachman test and pivot shift test. All patients were examined under general and spinal anesthesia; meniscal injuries and articular cartilage lesions were evaluated, and if necessary, meniscesctomy or meniscal repair and treatment for cartilage lesions (microfracture) were performed. ACL reconstruction was performed in the same way for both groups except for the first phase which included (in patients treated with autologous graft) the removal of hamstring tendons and their adequate preparation. Femoral tunnel placement was carried out at 10 o'clock for the right knee and 14 o'clock for the left knee with a femoral guide through the transtibial tunnel. After creation of the tibial tunnel, a reamer with a diameter 1 to 1,5 mm smaller than the graft diameter was introduced, and the femoral tunnel was drilled to a depth of 30 mm, 1 to 2 mm before the posterior cortex. After confirmation of the insertion location of the Rigid Fix cross pins via tibial tunnel arthroscopy with temporary insertion of a wire, the graft was inserted. Femoral fixation was performed via 2 cross pins, and all graft material was tensioned. All patients immediately began a postoperative rehabilitation program based on a passive range of motion exercises (target: 90° of flexion at 20 days after surgery) and co-contraction with 60° knee flexion. Two days after surgery crutches were used to allow partial weight-bearing. In the following period patients who had undergone hamstring tendons removals received standard rehabilitation treatment [15] while patients treated with LARS resumed their normal activity 30 days after surgery. Instrumental evaluation was performed, in a period between 24 and 36 months after surgery, using a CT scan whit a 1 mm thick multi layered image, through which we studied bone reaction and pin reabsorption. CT scanning, instead of MRI, was selected as the preferred imaging method because of its superiority in evaluating bone quality, pin degradation and bony replacement of the pin tracts. Images were analyzed with the contribution of expert radiologists, who were unaware of the clinical condition of the patients.

Results

The CT scan, which was mainly focused at the level of the femoral tunnel, showed evidence of confinement of the bone sleeve, with the characteristics of tight apposition due to trabecular collapse, with a thin, non-calcificated layer, at the ligament-bone interface. There were no signs of bone growth from the tunnel. Also, at the follow up, 24-36 months after surgery, we were able to perceive the presence of the graft. In reconstructions with LARS the bone structure out of the sleeve showed an increase in spongy bone (Figure 1), while in patients treated with DTSG, bone retained the normal structural characteristics of density of the femoral meta-epiphysis (Figure 2). With regards to the absorption of the fixation devices in PLLA (poly-L-lactic acid) we observed that the biodegradation

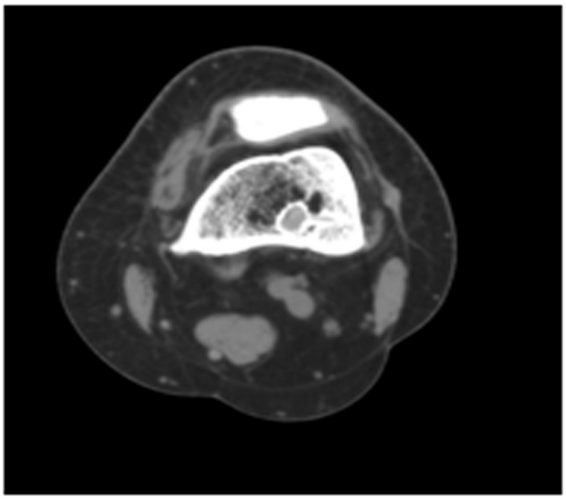

Figure 1: CT coronal section; left distal femur at 2 years after ACL reconstruction with LARS: neoligament surrounded by sclerotic halo and phenomenon of "spongiosizzazione" with bone density reduction.

of the pins located in allografts occurs faster than those located in autologous ligaments as demonstrated by the sagittal sectional images. These show the absence of any sign of the fixation device at follow up, 24 months after surgery (Figure 3a-b).

Discussion

We have detailed two important response patterns of remodelling. A bone reaction for mainly mechanical purposes, evidenced by a circumferential fibrous ring, was observed in ACL reconstruction with both allografts and autografts. This response is useful as a barrier for the anchorage of the new ligament. Additionally, a bone reaction with biological purposes, characterized by an increase in the spongy tissue caused by the synthetic material was found in patients treated with LARS. Indeed, pins pass-

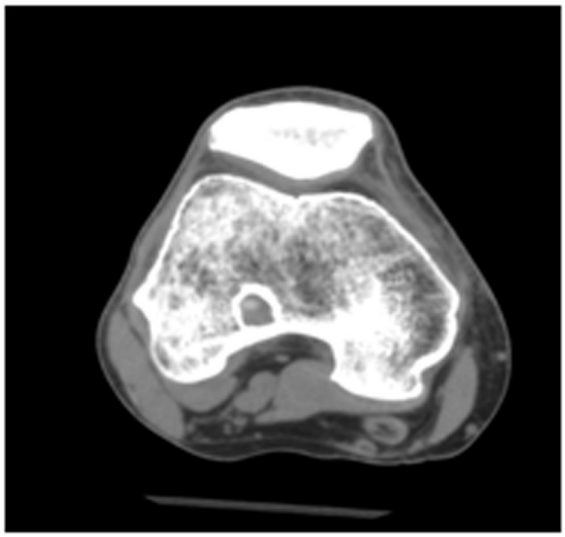

Figure 2: CT coronal section; right distal femur at 2 years after ACL reconstruction with autologus ligament: the sclerotic margin of containment and the preservation of bone density are a valid support for the neo ligament anchorage

Figure 3b: CT sagittal section; femur at 2 years after ACL reconstruction with synthetic ligament: absence of residues of the 2 pins inside the tunnel.

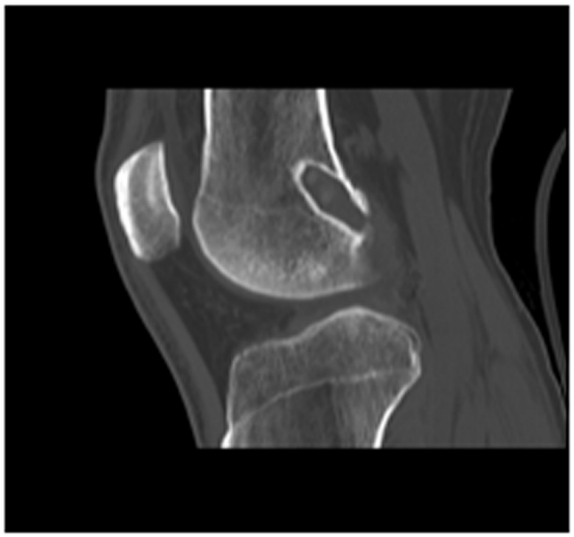

Figure 3a: CT sagittal section; femur at 2 years after ACL reconstruction with autologus ligament: presence of residues of the 2 pins inside the tunnel

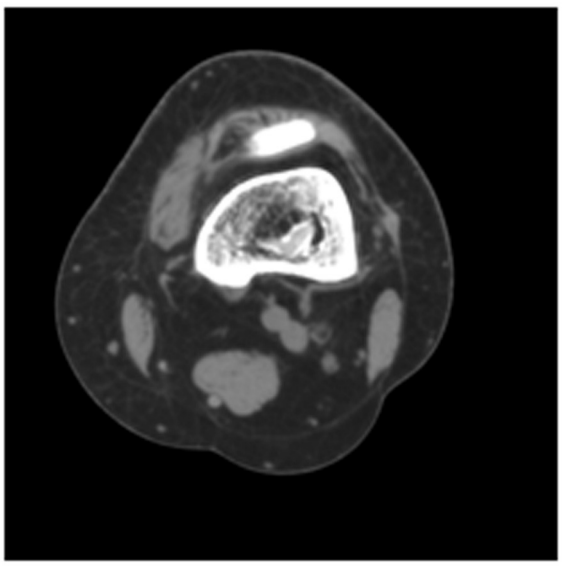

Figure 4: CT coronal section; distal femur at 2 years after ACL reconstruction with synthetic ligament: the phenomenon of "spongiosizzazione" is circumferential to the rib but it prevails on the medial side due to the spin-drag carried by pins

ing through the bone sleeve, carry ligament fibers which promote the expansion of the vascular bed with them. This is the prelude to the phenomenon of "spongiosizzazione" (Figure 4). This condition reduces the bone quality for bone loss and accelerates the absorption of the pins but does not generate areas of osteolysis.

Conclusions

Several structural aspects can be noticed in the newly-formed reactive bone which generates itself in response to the different kinds of ligaments used in LCA reconstruction.

24-36 months after the operation the osseous reabsorption around the synthetic graft determines the presence of an area of low osseous consistency and therefore a fragile area at the fixing point of the ligament.

Consequently, in chosing a synthetic ligament the patient's level of activity, lifestyle and the quality of their bone have to be considered.

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