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Original article

Opening the medial tibiofemoral compartment by pie-crusting the superficial medial collateral ligament at its tibial insertion: A cadaver study

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ABSTRACT

Background: Arthroscopic treatment of tears in the middle and posterior parts of the medial meniscus can be difficult when the medial tibiofemoral compartment is tight. Passage of the instruments may damage the cartilage. The primary objective of this cadaver study was to perform an arthroscopic evaluation of medial tibiofemoral compartment opening after pie-crusting release (PCR) of the superficial medial collateral ligament (sMCL) at its distal insertion on the tibia. The secondary objective was to describe the anatomic relationships at the site of PCR (saphenous nerve, medial saphenous vein).
Material and method: We studied 10 cadaver knees with no history of invasive procedures. The femur was held in a vise with the knee flexed at 45°, and the medial aspect of the knee was dissected. PCR of the sMCL was performed under arthroscopic vision, in the anteroposterior direction, at the distal tibial insertion of the sMCL, along the lower edge of the tibial insertion of the semi-tendinosus tendon. Continuous 300-N valgus stress was applied to the ankle. Opening of the medial tibiofemoral compartment was measured arthroscopically using graduated palpation hooks after sequential PCR of the sMCL.
Results: The compartment opened by 1 mm after release of the anterior third, 2.3 mm after release of the anterior two-thirds, and 3.9 mm after subtotal release. A femoral fracture occurred in 1 case, after completion of all measurements. Both the saphenous nerve and the medial saphenous vein were located at a distance from the PCR site in all 10 knees.
Discussion: PCR of the sMCL is chiefly described as a ligament-balancing method during total knee arthroplasty. This procedure is usually performed at the joint line, where it opens the compartment by 4–6 mm at the most, with some degree of unpredictability. PCR of the sMCL at its distal tibial insertion provides gradual opening of the compartment, to a maximum value similar to that obtained with PCR at the joint space. The lower edge of the semi-tendinosus tendon is a valuable landmark for PCR of the distal sMCL.

1. Introduction

Arthroscopic treatment of tears in the middle and posterior segments of the medial meniscus can be difficult in knees with a tight medial tibiofemoral compartment. Passage of the instruments can damage the medial femoral and tibial cartilage [1,2]. Fakioglu et al., Atoun et al., and Park et al. [3–5] suggested pie-crusting release (PCR) of the superficial (Fig. 1) or deep medial collateral ligament (MCL) to open the medial tibiofemoral compartment. In PCR, multiple stab incisions are performed in a ligament or tendon to achieve its gradual elongation.

PCR of the MCL is usually described as a procedure performed at the joint line to elongate the superficial and/or deep portions of the ligament. The superficial MCL (sMCL) has two tibial attachment sites: one is proximal, anterior to the anterior tibial expansion of the semi-membranosus tendon; and the other is distal, below the gracilis and semi-tendinosus tendons, about 6 cm distal to the joint line [6,7].

The MCL is the main primary knee stabiliser when valgus stress is applied to the joint. Grood et al. [8] reported that the sMCL supplied 50% to 80% of the resistance to valgus stress. Resistance of the sMCL increases with the degree of knee flexion (57.4% at 5° vs. 78.2% at 25°).

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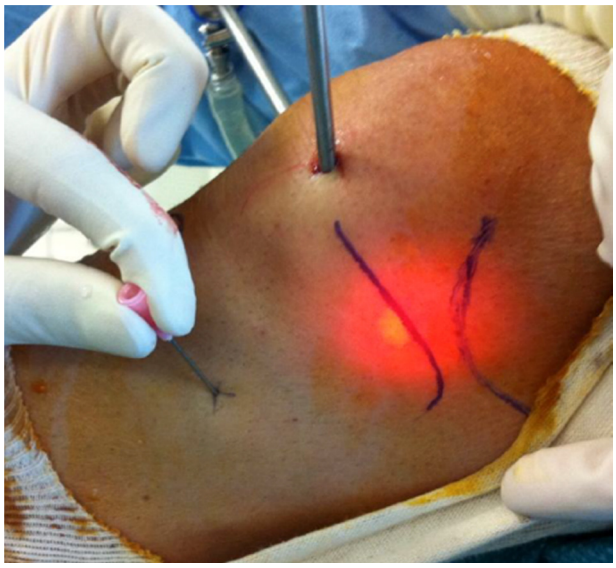

Fig. 1. Pie-crusting release of the superficial medial collateral ligament (sMCL) at its distal tibial insertion. Medial view of a left knee. Release was performed using an 18G needle.

The primary objective of this anatomic study was to evaluate the efficacy of sequential anterior-to-posterior PCR of the sMCL at its distal tibial insertion. We measured the opening of the medial tibiofemoral compartment under arthroscopic vision. Our secondary objective was to describe the anatomic relationships of the PCR site to evaluate the risk of injury to vessels and nerves.

We hypothesised that PCR of the sMCL at its distal tibial insertion allowed customised opening of the medial tibiofemoral compartment.

2. Material and method

We studied 10 cadaver knees that had been embalmed (in a mixture of chloral hydrate, glycerol, potassium nitrate, phenol, alcohol, and formaldehyde) then stored at 4 °C. We used the entire lower limb cut at mid-thigh. There were 6 right knees and 4 left knees. Mean age at death was 77 years (range, 71–85 years) and mean height was 168 cm (range, 155–179 cm). Eligibility criteria were absence of invasive procedures on the knee, full knee extension, and knee flexion greater than 120°.

The medial aspect of each knee was dissected to identify the branches of the saphenous nerve, the great saphenous vein, the MCL with its superficial and deep portions, and the tendons of the gracilis and semi-tendinosus muscles (Fig. 2).

After positioning the femur in a vise (Fig. 3), arthroscopy was performed using the standard anteromedial and anterolateral portals.

The cartilage was assessed according to the ICRS classification [9]. Knees with stage 4 osteoarthritis were excluded to avoid measurement bias related to laxity due to bone wear or ligament distension. Maximal opening of the medial tibiofemoral compartment was measured in millimeters with the knee flexed at 45° and application to the ankle of a 300-N valgus stress via a dynamometer, 300 N being the maximal force used to assess knee laxity by stress radiography.

Sequential PCR of the sMCL was then performed at the distal tibial insertion, under arthroscopic vision, after removal of the

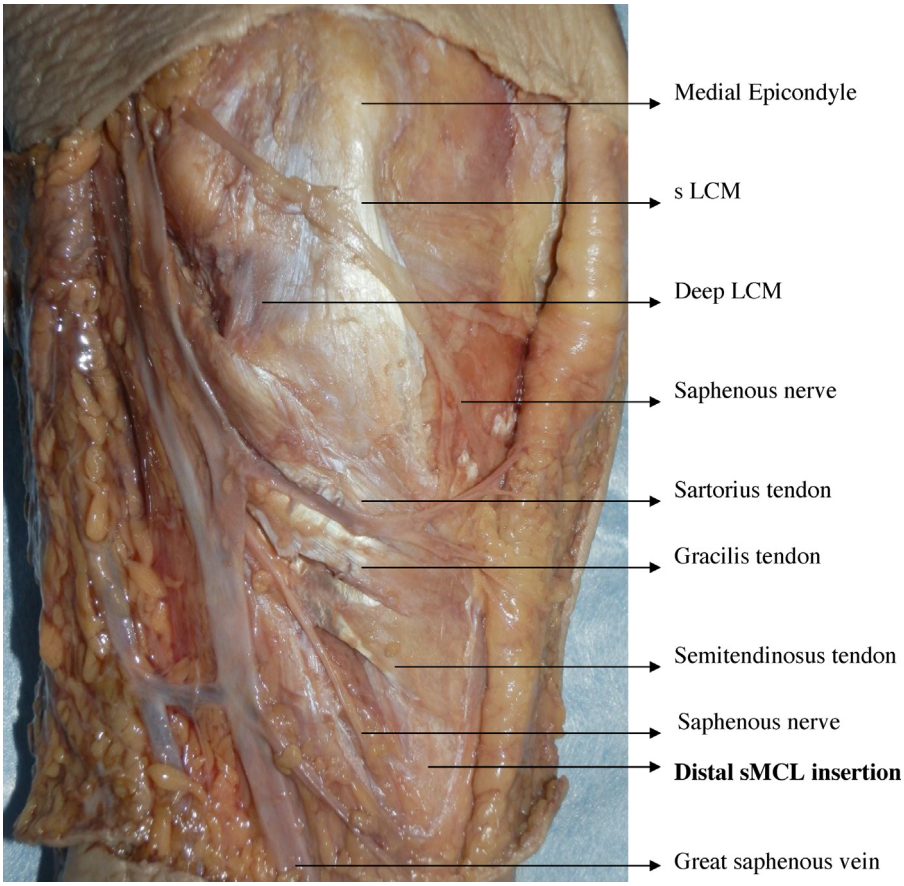

Fig. 2. Dissection of the medial aspect of a left knee. The anterior aspect is on the right and the proximal end at the top.