Reconstruction of the medial patellofemoral ligament (MPFL) can lead to an increased retropatellar force

- dynamic measurements with an industrial robot under muscular loading -

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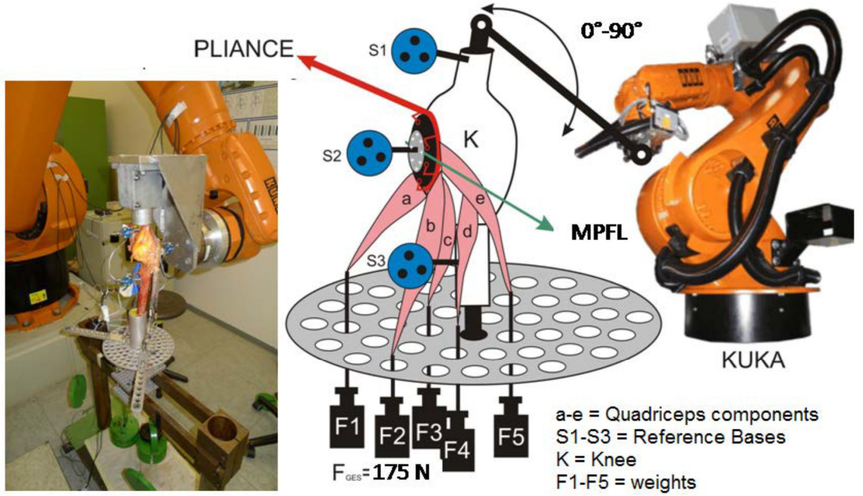
INTRODUCTION

The medial patellofemoral ligament (MPFL) is one of the most important medial structures preventing lateral dislocation or subluxation of the patella [1]. MPFL rupture leads to an altered patellar-tracking and retropatellar pressure distribution which can result in early degeneration and joint replacement. The below described method was developed and evaluated by the authors in 2011 [2] .The goal of this study was to evaluate changes in retropatellar force after surgical reconstruction of the MPFL under simulation of quadriceps muscle loading.

M&M

On nine fresh-frozen cadaveric knees the quadriceps muscle was divided into 5 parts along their anatomic fiber orientation analogous to Farahmand [3]. Muscular loading was achieved by applying weights to each of the fife components in proportion to the cross sectional muscle area. A total of 175 N was connected to the muscles using modified industrial cable connecting systems. A custom made sensor was introduced between the patella and femur [Pliance, Novel / Germany]. The sensor consists of 85 single pressure measuring cells. The robot-control-unit is linked to a force-torque sensor (hybrid method). The force free knee-flexion-path from 0° to 90° was calculated during three “passive path” measurements using this hybrid robotic method. The actual measurements followed with identical parameters.

Figure 1 : Setup



At first, the retropatellar pressure distribution was recorded with intact ligaments (“native”). After cutting the MPFL double bundle MPFL reconstruction was performed and the pressure distribution was obtained again [4]. A CT-scan of the cadaver knees was performed after all tests to calculate the retropatellar 3D surface of the patella. The surface was then divided in 4 quadrants (proximal, distal, medial, lateral) and matched to the corresponding single measuring cells. Minimum, mean and maximum forces were statistically compared for the complete retropatellar surface and the 4 above described areas in each of the two tested conditions (native Patella with intact MPFL and reconstructed MPFL). We followed the hypothesis that MPFL reconstruction can restore native retropatellar pressure distribution.

RESULTS

For the total retropatellar surface and intact MPFL mean force increased during knee flexion from 91.42 N [QL 86.11/ QU 111.00] at 5° flexion to a max. of 159.72 N [QL 40,43/ QU 187,67] at 85° which equals an increase of 75% during flexion. Mean retropatellar force was 141.1 N for ligament stable knees which was significantly increased to 151.7 N after MPFL reconstruction. The physiological retropatellar force could not be restored through MPFL reconstruction. At the lateral patellar facet of native knees was a significantly higher force than the medial facet. Mean force was 95.2 N at the lateral and 43.7 N at the medial facet. Thus 70% of force was measured at the lateral und 30% at the medial facet. At the medial facet native mean retropatellar force was 43.7 N. Through ligament reconstruction mean force decreased 41.51 N. Mean force at the lateral facet was 95.22 N for the MPFL intact knees and 99.41 N after ligament reconstruction which equals a relative increase of 8.7 %. **In conclusion reconstruction of the MPFL could not restore native conditions and even produced significantly higher retropatellar forces. Therefore our above stated hypothesis was rejected.** To our knowledge this is the first experimental data of dynamic retropatellar force measurements on human cadaver knees in which a smooth, force free knee flexion is performed by an industrial robot under muscular quadriceps loading. A possible explanation for this is the applied surgical method which might tend to alter patellar movement and increase retropatellar pressure. Therefore close attention has to be paid to ligament tensioning and anatomical attachment at the origin and insertion of the reconstructed MPFL.

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