INTRODUCTION  Well over one hundred operative treatments of chronic lateral instability of the patella have been reported [1]. These techniques can be divided into two groups: the first group seeks to change the direction of the extensor mechanism in order to medialize the extending force vector of the quadriceps muscle, i.e. by a distal anteromedialization of the tibial tuberosity or a proximal realignment of the extensor mechanism; the second seeks to reconstruct the medial soft tissue structures, i.e. the medial patellofemoral ligament (MPL), using auto- or allografts. In biomechanical studies, the medial patellofemoral ligament has been found to be the most important medial soft tissue restraint in preventing lateral dislocation of the patella [2,3]. The goal of this study was therefore to measure changes in patellofemoral kinematics in the physiologic, MPL deficient knee, after medial transfer of the tibial tuberosity, after proximal realignment as well as after reconstruction of the MPL.

METHODS  Eight fresh frozen right knee specimens (mean age 62, range 52-75 years) were mounted in a specially designed knee simulator in which isokinetic flexion-extension motions under physiologic loading were simulated (Fig. 1). Extension cycles were simulated from 120° flexion to full knee extension with an extension moment of 31 Nm. Movement of the patella relative to the femur was measured using an ultrasound based 3D motion analysis system (Zebris CMS-100®, Isny, Germany). During the first test cycles, patellar movement under intact knee conditions were measured: the intact knee was extended while a constant 100 N laterally oriented force was applied by means of a steel cable attached to the lateral aspect of the patella. Subsequently, patellar movement was again measured after: (1) after transecting the MPL (deficient knee), (2) performing a 10 mm medialization of the tibial tuberosity, (3) after reconstruction of the transected MPL using a semitendinosus autograft and (4) after proximal realignment of the extensor mechanism.

RESULTS  The patella of the intact knee moved along a medial path with a maximum attained position of 8.8 mm at 25° of knee flexion (Fig. 2). The patella of the deficient knee moved up to 4.6 mm (p=0.04) in the medial direction at maximal extension at 30° of knee flexion. After medial transfer of the tibial tuberosity patellar movement reached a maximum medial position of 12.8 mm (p=0.04) at 22° of knee flexion with the laterally oriented force (Fig. 1). With a reconstructed MPL, the patella attained a maximum medial position 14.8 mm (p=0.04) at 24° of knee flexion with the subluxation force. Following proximal realignment, the patella moved on a medial, but significant (p=0.03) different path up to 13.8 mm medially at 30° of knee flexion. In addition, following medialization of the tibial tuberosity and proximal realignment, the center of the patella was significantly (p=0.03) more internally rotated (tilted) than the physiologic patella, whereas after reconstruction of the MPL patellar tilt similar to intact knee conditions was observed (p=0.40) (Fig. 3).

DISCUSSION  The experiments performed in this study enabled the dynamic measurement of patellar movement under nearly physiologic conditions and loadings. The application of a laterally oriented force of 100 N resulted in a more lateral positioning of the patella. In the deficient knees, with a transected MPL, substantial differences in patellar path compared to physiologic were observed: the patella moved along a significantly more lateral path than physiologic. The shape of the movement curves after the stabilizing procedures resulted in a medialization relative to physiologic [3]. With the reconstructed medial patellofemoral ligament, the patella moved along the most medially oriented path with physiologic tilting. The results suggest that a semitendinosus autograft can provide sufficient stabilization to prevent lateral displacement or subluxation with physiologic patellar tilt.

LITERATURE  