Adjustable mechanical stability of the balanced tibiofemoral joint in flexion/extension: a novel measuring method in vitro

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Abstract: A number of muscles which pull over the tibiofemoral joint (possessing maximally four kinematic degrees of freedom) is larger than necessary in order to produce static equilibria in the physiologic positions of the tibiofemoral joint. Consequently, it should be possible to balance the knee in any arbitrary position by a set of combinations of isotonic muscular forces. The corresponding equilibria of the same flexional status should be differentiated by their degree of stability. Here, we describe a novel method which allows measuring the isotonic stability in flexion/extension in vitro for examining the above theses derived theoretically. By in vitro experiments we could show for the first lime that not only a) the same position in flexion can be held in differing static equilibria by correspondingly differing combinations of muscular forces, but also b) the varying degree of stability ranges from stable and indifferent to unstable. These features were related a) to rotations of the resultant muscular force in the main functional plane and b) to translations of its force line in parallel to this plane in the direction of abduction/adduction. By that we are able to present a hypothesis of how nature deals with an apparent antagonism of mechanically stable posture and mechanical instability of the joint demanded in the case of fast motion.
Key words: tibiofemoral joint, mechanical stability, flexion/extension, torque, muscular forces