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Comment on "Quadriceps Protects the Anterior Cruciate Ligament"

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Discussion

Comment on "Quadriceps protects the anterior cruciate ligament"

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In a recent paper in this journal it was claimed that contraction of the quadriceps muscle protects the anterior cruciate ligament (ACL) [3]. This is contrary to the common understanding that quadriceps contraction at small flexion angles causes an increase in ACL loading [6,7,9]. I applaud the courage of the author to challenge existing views, and indeed there are recent indications that those views have been overly simplistic [1,8,9]. However, the methods employed in [3] are seriously flawed, and application of these findings in a rehabilitation program may be harmful to patients.

The first flaw is caused by the statement that the quadriceps acts superiorly on the tibia during an open chain exercise because the tibia is moving, and that the quadriceps acts inferiorly on the femur during a closed chain exercise because the tibia is constrained. In fact, both forces (action and reaction force) always exist at the same time. When *all* forces are shown, effectively combining Figs. 1 and 2 of [3], there is no difference between closed chain and open chain exercise. The different movement of muscle fibers, as seen using ultrasound imaging [3], may have been due to a larger range of motion or a lower resistance during the open chain exercise. Neither range of motion or resistance appeared to have been controlled in the experiment [3]. Tendon and aponeurosis tissue is stiffer under large load, possibly resulting in smaller motion of muscle fibers relative to the bone.

The second flaw is that the force in the patellofemoral joint was not considered in Fig. 2 of [3]. When considering whether the femur is being pulled anteriorly or posteriorly by the quadriceps, it is important to include *all* effects of the quadriceps on the femur, including the forces transmitted through the patella. It is then easily seen that the resultant of all forces acting on the femur (Q_1, Q_2, and Q_3 in Fig. 1) is directed posteriorly. Hence, quadriceps activation pushes the femur posteriorly relative to the tibia and increases the strain in the ACL, which is exactly the same result that was obtained by Fig. 1 in [3].

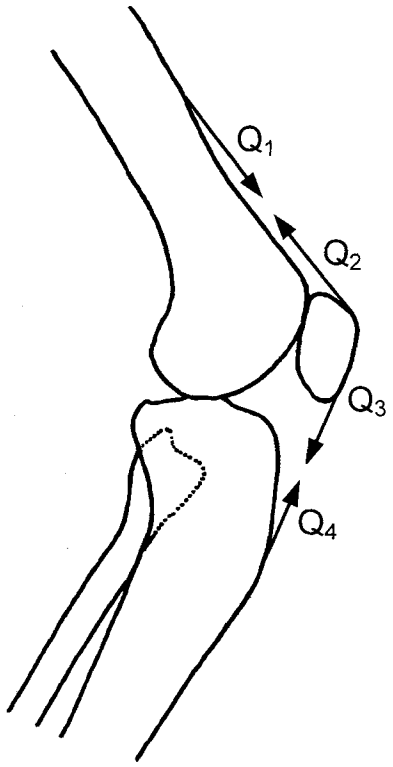

Fig. 1. Forces in the quadriceps and patella tendon. Forces Q_1, Q_2 and Q_3 are transmitted to the femur. Force vectors Q_1 and Q_2 are equal and opposite, and cancel each other out when considering their resultant action on the femur. The resultant force on the femur due to quadriceps contraction is therefore equal to Q_3, which is equal and opposite to Q_4, the force acting on the tibia. Adapted from [3].

Nevertheless, it is important to know that there is some evidence that the ACL is protected and safe during closed chain exercise [2,4,5]. This can be explained mainly by the fact that closed chain exercise is a multijoint task in which the hamstrings tend to have a higher level of activation because they contribute to hip extension [4]. The magnitude of this protective effect will depend on the patient's muscle coordination. A secondary

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consideration is that the force vector orientation of the external resistance may be different for both types of exercise. Both effects will diminish the loading of the ACL that is caused by quadriceps contraction.

It is also important to stress that increased compressive force in the knee, due to either weightbearing or muscle contraction, can potentially be protective. Such compression may increase or decrease the load in the ACL, depending on the slope of the tibial plateau [8,9]. Aune et al. [1] showed a protective effect of joint compression due to quadriceps contraction, but this was in a dissected joint where frictional properties of cartilage may have contributed to the anterior stability.

In conclusion, the results presented in [3] were obtained with a flawed method, and the conclusion that quadriceps contraction protects the ACL during closed chain exercise is incorrect and potentially harmful to patients.

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