Mechanical interactions between synergists in physiological conditions and

following tenotomy in the cat

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BACKGROUND It has been shown that muscle fiber force can be transmitted via connective tissues surrounding the muscle and that this is affected by changes in muscle relative position
[e.g. 1, 2]. However, the extent of such myofascial force transmission for normal muscle *in vivo* is still unclear. Myofascial pathways may also serve to transmit force in conditions of muscle or connective tissue injury. Therefore, the purpose of the present study was to assess the mechanical interactions between the one-joint soleus muscle (SO) and its two-joint synergists in physiological muscle lengths and relative positions as well as following tenotomy. METHODS Deeply anesthetized cats (n = 7, 2.8-4.6 Kg) were mounted in a rigid frame with the left foot secured to a 6 degree-of-freedom load cell (JR3) coupled to a robotic arm (Staubli). The load cell was used to calculate ankle moments exerted in the sagital plane. The robotic arm was used to impose isolated rotations of the knee joint yet keep the ankle angle fixed. The SO nerve bundle was isolated, but all nerves to its synergists and antagonists were cut. Ankle moment at the ankle upon tetanic activation of soleus muscle was measured for various knee angles (70-140°), changing the length of the two-joint gastrocnemius (GAS) and plantaris (PL) muscles. Ankle angle and thus SO length was kept constant. In addition, ankle moment was assessed after cutting the distal SO tendon (tenotomy), which prevented any myotendinous force transmission to its insertion. Connective tissues at the muscle belly level were minimally disrupted. RESULTS SO ankle moment was not significantly affected by changes in knee angle, despite the fact that this involved substantial changes in length and relative position of GAS and PL. After tenotomy, SO muscle shortened to a much greater extent during contraction than in the intact case, which resulted in a major position shift relative to its synergists. Consequently, SO ankle moment decreased (by ~60%) but did not drop to zero. CONCLUSIONS The present results indicate that in physiological conditions of the ankle plantar flexors, SO force is predominantly transmitted to bone via its tendons. This suggests that in the intact cat SO muscle acts as an independent actuator. However, strong mechanical connections between SO and synergistic muscles exist. Such intermuscular connective tissues may bear muscle forces after traumatic events in muscle or tendon.

REFERENCES

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