Neer Award 2007: Reversion of structural muscle changes caused by chronic rotator cuff tears using continuous musculotendinous traction. An experimental study in sheep


HYPOTHESIS
Chronic rotator cuff tears are associated with irreversible architectural muscle changes and a high rate of repair failure. The changes observed in man and their irreversibility with a single stage repair can be reproduced in sheep. It was the purpose of this experiment to test the hypothesis that slow, continuous elongation of a retracted musculotendinous unit allows reversal of the currently irreversible structural muscle changes.

MATERIALS AND METHODS
The infraspinatus tendon of 12 sheep was released using a greater tuberosity osteotomy and allowed to retract for 4 months. Then, a new device was mounted on the scapular spine and used to extend the infraspinatus musculotendinous unit transcutaneously by 1 mm per day. Thereafter, the tendon was repaired back to the greater tuberosity. We assessed the muscular architecture using magnetic resonance imaging, macroscopic dissection, histology, and electron microscopy. Fatty infiltration (in Hounsfield units 1/4 HU) and muscular cross-sectional area (in % of the control side) were monitored with computed tomography at tendon release, initiation of elongation, repair, and at sacrifice.

RESULTS
Sixteen weeks after tendon release, the mean tendon retraction was 29 +/- 6 mm (14% of original length, P = .008). In 8 sheep, elongation was achieved as planned (group I), but in 4, the elongation failed technically (group II). The mean traction time was 24 +/- 6 days with a mean traction distance of 19 +/- 4 mm. At sacrifice, the mean pennation angle in the infraspinatus of group I was not different from the control side (29.8 degrees +/- 7.5 degrees vs. 30 degrees +/- 6 degrees, P = .575). In group II, the pennation angle had increased from 30 degrees +/- 6 degrees to 55 degrees +/- 14 degrees (P = .035). There was no fatty infiltration at the time of tendon release. After retraction, there was a significant increase in fatty infiltration of the infraspinatus muscle and a decrease of its cross-sectional area to 57% of the
contralateral side (P = .0001). During traction, the degree of fatty infiltration remained unchanged (36 HU to 38 HU, P = .381), and atrophy improved to a muscle square area of 78% of the contralateral side (P = .0001) in group I. In group II, an increase of fatty infiltration was measured from 36 HU to 28 HU; however, this increase was not significant (P = .144). Atrophy did not change in group II (57-55%, P = .946). At sacrifice, the remaining muscle mass was 64% in group I and 46% in group II (P = .019).

DISCUSSION
Our preliminary results document, that continuous elongation of a retracted, fatty infiltrated and atrophied musculotendinous unit is technically feasible.

CONCLUSION
In the sheep, continuous elongation can lead to restoration of normal muscle architecture, to partial reversal of muscle atrophy, and to arrest of the progression of fatty infiltration.

LEVEL OF EVIDENCE
Basic science level 2; Prospective comparative therapeutic study.