Effects of cell-to-collagen ratio in stem cell-seeded constructs for Achilles tendon repair

Reference List


Abstract: The objective of the present study was to test the hypotheses that implantation of cell-seeded constructs in a rabbit Achilles tendon defect model would 1) improve repair biomechanics and matrix organization and 2) result in higher failure forces than measured in vivo forces in normal rabbit Achilles tendon (AT) during an inclined hopping activity. Autogenous tissue-engineered constructs were fabricated in culture between posts in the wells of silicone dishes at four cell-to-collagen ratios by seeding mesenchymal stem cells (MSC) from 18 adult rabbits at each of two seeding densities (0.1 x 10(6) and 1 x 10(6) cell/mL) in each of two collagen concentrations (1.3 and 2.6 mg/mL). After 5 days of contraction, constructs having the two highest ratios (0.4 and 0.8 M/mg) were damaged by excessive cell traction forces and could not be used in subsequent in vivo studies. Constructs at the lower ratios (0.04 and 0.08 M/mg) were implanted in bilateral, 2 cm long gap defects in the rabbit's lateral Achilles tendon. At 12 weeks after surgery, both repair tissues were isolated and either failed in tension (n = 13) to determine their biomechanical properties or submitted for histological analysis (n = 5). No significant differences were observed in any structural or mechanical properties or in histological appearance between the two repair conditions. However, the average maximum force and maximum stress of these repairs achieved 50 and 85% of corresponding values for the normal AT and exceeded the largest peak in vivo forces (19% of failure) previously recorded in the rabbit AT. Average stiffness and modulus were 60 and 85% of normal values, respectively. New constructs with lower cell densities and higher scaffold stiffness that do not excessively contract and tear in culture and that further improve the repair stiffness needed to withstand various levels of expected in vivo loading are currently being investigated.