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Richard B. Caspari Award First Place Winner

Biomechanical Contact Properties of Rotator Cuff Repairs During Passive Arm Movement: Perilously Low Levels Occur with Single Versus Double-row Repairs

Mark David Haber, AUSTRALIA

Introduction:
Significant rates of re-tear occur following rotator cuff repair (open or arthroscopic) especially when the repair is under some tension. This may in part be due to inadequate tendon-to-bone (TTB) contact pressure during the initial healing phase when mobilization has commenced.
Awareness of the poor TTB contact properties with single row repairs (SRR) has resulted in significant studies in improving contact area and pressure with double row repairs including transosseous-equivalent repairs (TOE).
Nevertheless there have been very few studies looking at these properties in a dynamic fashion, simulating what happens in the early postoperative period before any healing have occurred.
A particular concern has been with repairs which utilize a tension-band effect to achieve TTB contact. With early abduction, it was postulated that lift-off could occur with complete loss of TTB contact which would significantly compromise the ability of the tendon to heal.

Materials and methods:
Simulated rotator cuff tears were created in the supraspinatus tendon of six fresh cadaveric human shoulders. A SRR was then performed using the Opus Magnum arthroscopic instrumentation creating 2 horizontal mattress sutures in accordance with manufacturers specifications. An I-Scan 6900 electronic pressure-sensor (Tekscan, Boston, MA) was placed between the supraspinatus tendon and bone and the sutures were tensioned with the shoulder in 0 degrees abduction. The arm was then rested for 300secs (relaxation) before being passively moved twice through a set range-of-motion (0-90-0 degrees abduction, 0-45-0 external and 0-45-0 internal rotation) and finally returned to neutral. The contact force, pressure and area were recorded throughout each movement. The procedure was then repeated using a TOE technique with two parallel sutures (TOE-P) and TOE with a cross over suture pattern (TOE-C). Data were analyzed by ANOVA using SPSS.

Results:
TOE parallel and cross-over repairs demonstrated no significant change in mean TTB contact pressure, force and area during abduction, external rotation and return to neutral when compared to the 300sec relaxation state. TOE-C demonstrated a higher contact force on internal rotation (+53%). The SRR demonstrated a significant drop in contact force on abduction (-63%), and return to neutral (-43%) and a trend on external rotation (-34%). SRR exhibited no change on internal rotation.

Discussion:
Consistent TTB contact during the healing phase is thought to be vital. There have been very few biomechanical studies with which to base the postoperative rehabilitation.
The electronic pressure sensor is a useful instrument for determining changes in TTB contact properties dynamically allowing the monitoring of changes when the arm is moved, simulating the postoperative rehabilitation.
We showed a significant decrease in contact force and pressure with SRR during abduction and on return to neutral compared to the TOE repairs which remains unaltered. This is an important consideration when determining postoperative rehabilitation protocols.
These findings justify the need to discourage abduction post SRR until some healing has occurred. On the other hand, with TOE technique, it appears safe to commence early passive motion.