EFFECT OF THREAD PROFILE AND GEOMETRY ON MECHANICAL PROPERTIES OF INTERFERENCE SCREWS

David B. Spenciner PE, ScM, MBA and James J. Mahoney, Jr. BS, Raynham, MA

BACKGROUND
Interference screws for fixation of soft tissue grafts to bone have converged on relatively similar designs with small differences in length, diameter, taper, thread profile and interface with the inserter. The influence of thread profile and taper has been studied, with no differences in maximum pull-out load and stiffness between various thread designs with similar pitches (the distance between individual threads). However, the effect of thread pitch seems to have a more complex effect on pull-out load, since larger thread pitch screws (increased space between individual threads) have been reported to decrease the bone stress in cortical bone, but increase the bone stress in cancellous bone.

Our goal, therefore, was to compare the mechanical properties of several common interference screws to assess whether a quick-starting, increased pitch thread pattern was superior to traditional low-pitch patterns.

METHODS
Using 20 PCF polyurethane foam blocks and nylon cord, five samples each of various 7 mm x 23 mm biocomposite interference screws were evaluated: MILAGRO® ADVANCE Interference Screw System, MILAGRO BIOCRYL RAPIDE™ Biocomposite Material System, and Arthrex® Biocomposite™. MILAGRO ADVANCE System utilizes a higher thread pitch while the other two screws have more conventional threads. Both types of MILAGRO Screws are manufactured from the same material (BIOCRYL RAPIDE Biocomposite Material). In all cases, a 7 mm graft was used with a 7 mm tunnel. The axial load required to engage the threads was measured during screw insertion.

Then the foam blocks were connected to a servohydraulic load frame and the grafts were pulled in line with the bone tunnel at 60 mm/min. The maximum fixation strength was recorded and summary statistics performed on all of the data. A one-way analysis of variance (ANOVA) was used to compare data among the test groups and the level of significance was set to 95% a priori.

RESULTS
The average (± one standard deviation) axial insertion load for MILAGRO ADVANCE Screw System was 31.8 ± 7.4 N (Figure 1). This value was statistically significantly lower (p<0.001) than the average loads for MILAGRO BR (150.2 ± 27.6 N) and Biocomposite™ System (187.3 ± 24.1 N). For maximum fixation strength, the average for MILAGRO ADVANCE System was 926.1 ± 79.2 N (Figure 2). This value was statistically significantly higher (p<0.001) than the average strength for MILAGRO BR (728.7 ± 32.2 N) and Biocomposite System (630.4 ± 41.0 N). In visually inspecting the tested screws, it was found that the threads for MILAGRO ADVANCE System suffered less damage than either MILAGRO BR or Biocomposite System (Figure 3).

Figure 1: Average Axial Insertion Load for MILAGRO ADVANCE System (MA) in gold, MILAGRO BR System (MBR) in dark blue, and Biocomposite (BC) System in light blue. Asterisks signify statistically significant differences.
CONCLUSION
At least for these benchtop tests, the high-pitch thread pattern of MILAGRO ADVANCE System offered multiple advantages over traditional screws: lower axial insertion load, higher maximum strength and less damage to the threads. The mechanism of action appears to be the distal tip of this screw geometry engaging the threads faster, thus, potentially allowing the threads to do the work of inserting the screw and thereby reducing the axial insertion load. In this study, higher axial insertion loads were correlated with increased damage to the threads.

All of these biocomposite screws can be used to provide adequate fixation during ACL reconstruction procedures.7 However, the statistically significant improvements in axial insertion load, maximum strength, and thread damage offered by MILAGRO ADVANCE System may provide a benefit to some patients.

References