Biomechanical pull-out test between Synthes LAG screws, Bioretec ActivaScrew™ LAG and Bioretec ActivaScrew™ with porcine fibula

Introduction:
The purpose of this study was to investigate and compare the biomechanical pull-out force of metallic screw fixation and bioabsorbable screw fixation of the acromioclavicular joint. The fixation is necessary for severe separations of fixation of the acromioclavicular joint. The common surgical practice, the Bosworth screw fixation, was selected as a surgical technique.

Methods:
The test setup was made using porcine fibula to simulate clavicle and coracoid. The fibula was cut in half and the posterior portion acted as the clavicle and distal portion acted as coracoid, see Figure 1.

![Figure 1. AC joint anatomy in the left and porcine fibula split in two in the right.](image)

The implants used in this study were:

- Synthes 6.5 mm Cancellous bone LAG screw, L 45/16 mm, REF: 216.045
- Bioretec 4.5mm ActivaScrew™ LAG, L 45mm, REF: B-AL-4545
- Bioretec 4.5 mm ActivaScrew™, L 45mm, REF: B-AS-4545
The 3.2 mm drill bit was used to drill a hole to both parts of the fibula, see Figure 2. For ActivaScrews™, also 4.5 mm tap was used to make a thread for the screws. For ActivaScrew™ LAG, also countersink was used to make space for the head of the screw.

![Figure 2. Drilling of the fibula with 3.2 mm drill bit.](image)

Synthes 6.5 mm cancellous bone LAG screw was inserted with a washer so that the screw came slightly out of the bone acting as coracoid. The ActivaScrew™ LAG was inserted in the same depth and the head was positioned in the countersink. See Figure 3 for details.

![Figure 3. Positions of LAG screws of this study](image)
The fully threaded ActivaScrew™ was inserted in the same depth and the screw was cut about 5 mm above the bone surface. The protruding screw was melted using hot tip cautery to form a head. The details can be seen in Figure 4.

![Figure 4. Melting of the head of the fully threaded ActivaScrew™.](image)

The bones were turned in 90 degrees angle upon one another and both bones were placed in a grip in a mechanical testing machine. The system was placed in a water bath at +37ºC to better simulate the human body conditions. The upper bone was started pulling upwards 10mm/min and the force generated was recorded to measure maximum pull-out force. The test set up can be seen in Figure 5.

![Figure 5. The test setup for the biomechanical pull-out test.](image)
Results:
The average maximum pull-out force results are shown in Figure 6.

Figure 6. Maximum pull-out results of the tested screws. The results are an average of 3 parallel samples. There are also min and max values presented with the line segments and the average value is shown at the base of each column.

The method of breakage was breaking of the upper bone for the both LAG screws and breaking of the thread for the fully threaded ActivaScrew™. More details can be seen in Figure 7.

Figure 7. The breakage method of the tested screws.
Conclusion:

The test demonstrated that the bioabsorbable 4.5 mm ActivaScrew™ give similar pull-out force in a simulated acromioclavicular joint fixation when compared to metallic 6.5 mm LAG screw. The ActivaScrew™ LAG shows the best results of all the screws in the test.

According to this biomechanical test the bioabsorbable ActivaScrew™ are safe to use in acromioclavicular joint fixation and yield similar results as the metallic fixation but without a need or removal surgery.