

Initial Fixation Strength of Bioabsorbable ACL Interference Screws

Objective

The objective of this study was to evaluate the effect of implant design on initial fixation strength of bioabsorbable screws using synthetic bone blocks to mimic bone-tendon-bone fixation. The screws used for this study are pictured in Figure 1. Table 1 lists the manufacturer, screw size, material, and lot numbers.

Table 1

Device	Screw Size	Material	Lot #
BioScrew Linvatec Largo, FL	7x25 mm	PLA	176081
Bio-Intf. Screw Arthrex Naples, FL	7x23 mm	PLA	15515
BIORCI® Smith & Nephew Mansfield, MA	7x25 mm (8 mm Head)	PLA	404582

Methods

Initial fixation strength using the bone-tendon-bone repair model was evaluated using the BIORCI Interference Screw (Smith & Nephew), the BioScrew (Linvatec) and the Bio-Interference Screw (Arthrex). Analogous screw sizes from each manufacturer were used to allow direct comparison of results. Synthetic bone blocks were chosen so that the insertion material would be normalized and the strength of the “repair” would be based on the geometry. All interference screws were inserted according to the manufacturer’s instructions. The bone-tendon-bone models consisted of a 1 mm gap between a synthetic bone plug and the tunnel wall of a synthetic bone block. The screws were inserted between the bone tunnel and the bone graft. Using an Instron electro-mechanical testing machine, the bone grafts were pushed in a direction opposite that of screw insertion, while holding the bone block stationary, simulating in-vivo loading on both the bone graft and interference screws. The load-displacement curves and the peak loads were recorded and are presented in Figure 2.

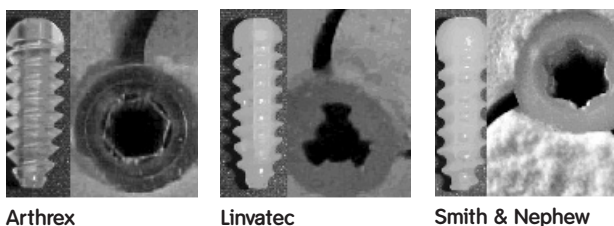


Figure 1 Fully inserted screws used in testing.

Materials

1. Bone graft plugs: 1.5" long and 3/8" diameter 20 pcf sawbone cylinder (Pacific Research, Vashon, WA).
2. Bone tunnel: 20 pcf sawbone block (Pacific Research, Vashon, WA) with 27/64" holes spaced at 1.0".
3. Five 7x25 mm (8 mm head) BIORCI Interference Screws, with BIORCI driver (Smith & Nephew).
4. Five 7x25 mm BioScrew Interference Screws, with BioScrew driver (Linvatec).
5. Five 7x23 mm Bio-Interference Screws, with starter and Bio-Interference driver (Arthrex).
6. Instron 4411 electromechanical test machine (Instron, Canton, MA).

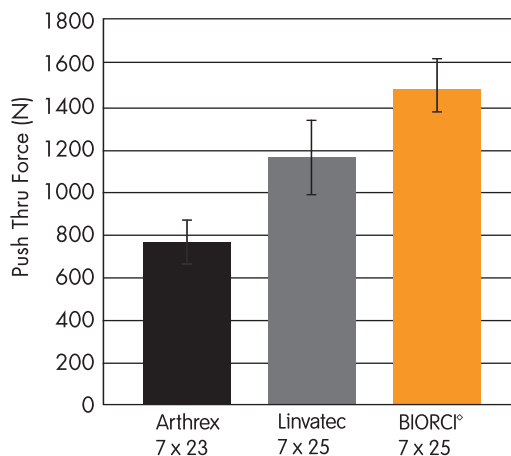


Figure 2 7 mm Screw Comparison Test Using BTB Model.

Test Procedures

1. Create five standard bone-tendon-bone synthetic models for each screw type using a 20 pcf sawbone block with four 27/64" holes drilled 1.5" from each corner.
2. Insert a 1.5" long x 3/8" diameter 20 pcf sawbone cylinder into each drilled hole.
3. Using an Arthrex starter, create a tunnel notch to aid the self-tapping interference screw.
4. Insert one screw into the tunnel notch using the appropriate driver. Complete insertion is verified when the screw is flush with the surface of the block.
5. Using an Instron 4411 electro-mechanical test machine, or equivalent, push the synthetic bone cylinders through the block in the direction opposite the insertion direction.
6. Record the peak push force for each screw

Results

All screws were successfully inserted into the bone blocks. The BIORCI[®] screw fixation strength was both substantially and significantly higher (T Test $p < 0.05$) than both Linvatec and Arthrex (see Figure 2). The BIORCI screw fixation strength is 93% higher than that of the Bio-Interference Screws (Arthrex) and 28% higher than that of the BioScrew (Linvatec). The other failure mode was the hex of the screw being stripped out by the driver (see Figures 2a and 2b).

Discussion

Study of these three interference screws demonstrates that the design of the interference screw is an important factor in determining initial fixation strength. As patients and healthcare professionals speed up the rehabilitation of ACL injuries, it is important to maximize fixation strength of these ACL reconstructive devices. Results from this study show substantial differences between these designs, however further study is needed to correlate specific design features to fixation strength.