Mechanical Comparison of Arthrex's® Double Compression Plate to Wright Medical's™ Charlotte® CLAW® Compression Plate

Arthrex Research and Development

Objective

To compare the mechanical properties of the Double Compression Plate to the Wright Medical Charlotte CLAW Plate by subjecting the products to four mechanical tests: compressive force, pull-out strength, contraction-distraction, and four-point bending.

Methods and Materials

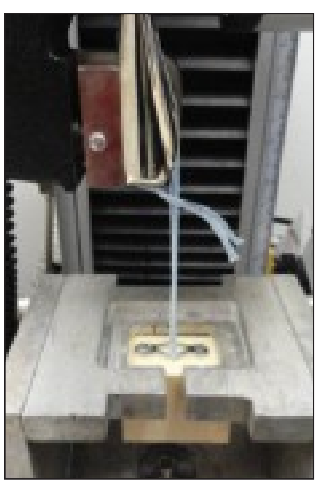
Compression Testing – A load cell was placed between two test blocks that were prepared with appropriate sized-predrill at a calculated distance away from the edge to provide line to line contact. Please refer to Figure 1 for the complete test setup.

Figure 1: Compressive Force Test Setup

The load cell was zeroed initially, and the nonlocking screws were inserted into the compression slot in the loaded position. Compressive force was continuously recorded as screws were inserted. Plates were distracted after full insertion of the nonlocking screws. The Wright Medical plates used two locking screws. The order of insertion was irrelevant to any testing described in this report. The maximum compression force and peak distraction compressive force were noted.

Pull-out Testing – Foam blocks were prepared with two through holes. The compression plates were fixated with 10 mm screws and a strip of FiberTape® was placed under the plate at midpoint. The plates were distracted to mimic surgical conditions. The foam blocks were secured under a metal box fixture that allowed clearance of the plate and screws, and the FiberTape tails were held in a pneumatic clamp, as displayed in Figure 2. A tensile load was applied until implant failure. The ultimate load and mode of failure were noted.

Figure 2: Pull-out Strength Testing Setup



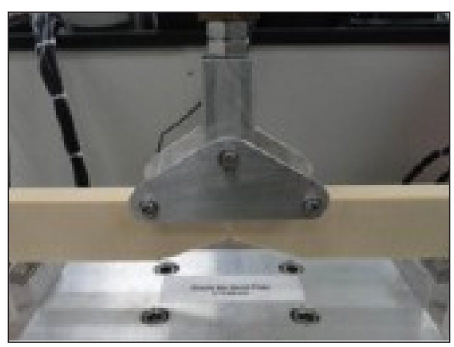
Contraction-Distraction Testing – Foam block was prepared by drilling a hole at a distance from the edge. Screws were partially inserted and initial block distance was measured using digital calipers. All locking screws were fully inserted using appropriate drivers. Nonlocking screws were almost completely inserted, but were not tightened down against the plate. After screws were inserted, calipers were used to measure the first compression of the foam blocks near the plate (high) and furthest from the plate (low), as well as bridge width. Please refer to Figure 3 for measurement locations. The staple/plate Distractor was used to distract the plate, and the distance between the two blocks (high and low), and the plate's bridge width were measured.

Figure 3: A:"High" Measurement
B: "Low" Measurement

Contraction was calculated by subtracting the high 1st compression measurement from the initial block distance. Total contraction was calculated by subtracting high distraction block distance from the initial block distance. Angulations were calculated trigonometrically using difference between the high and low distraction measurement after screw insertion and distraction. Positive angulation is defined as splaying of the distal surfaces. Total distraction is defined as the difference between initial bridge width and final bridge width.

Four-Point Bending – The same samples used for contraction-distraction testing were used to perform the four-point bend testing. The top fixture with two rollers was attached to the crosshead and the base fixture was bolted to the base of the INSTRON machine. The span of the top rollers and offset between the top and bottom were recorded, and both were set to 80 mm for this testing.

Figure 4: A Point Bend Test Setup

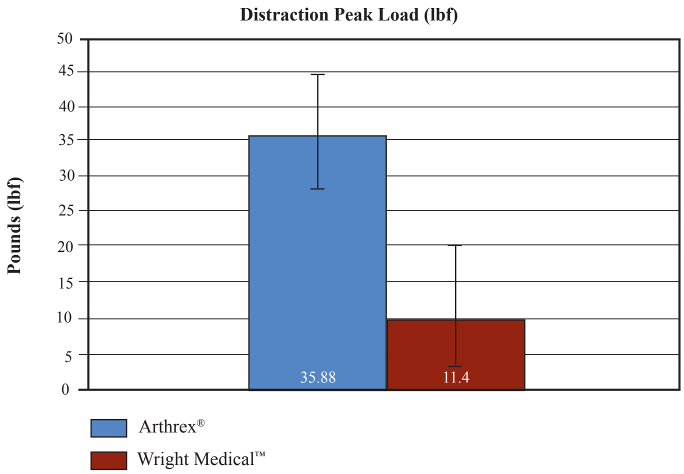


The distracted plates were attached to pre-drilled foam blocks using corresponding screws and drivers. The plate and foam block assemblies were placed on the bottom rollers and positioned so the top rollers were centered about the plate, as shown in Figure 4. A compressive load was applied, and the failure mode was recorded.

Results

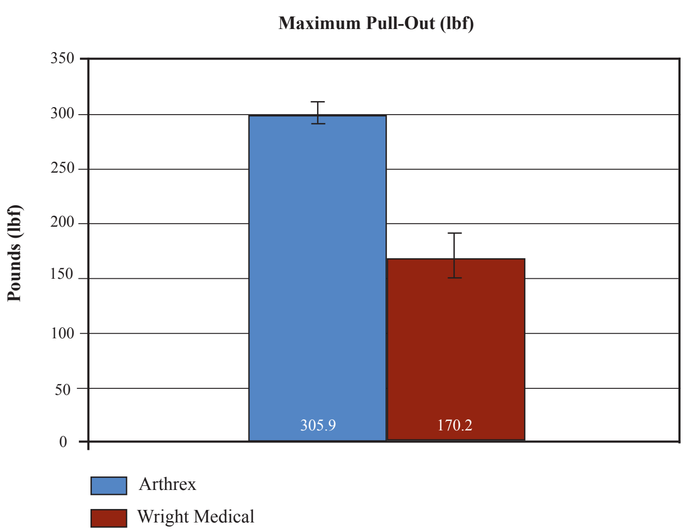
The average values and standard deviations for compression testing are shown below in Figure 5, and pull-out strength testing can be seen in Figure 6.

Figure 5: Compression Testing Results



Though Wright Medical compression plates do not have a slot, Arthrex's average compression slot peak load was 12.87 ± 1.17 lbf.

Figure 6: Pull-Out Strength Testing Results



The average values, standard deviations and comparison statistics for significance are shown below in Table 1 for contraction-distraction testing, and Table 2 for four-point bend testing.

Table 1: Contraction-Distraction Results and Significance

Group	Distraction Angulation	Screw Contraction (mm)	Distraction (mm)	Width of Plate after Distraction (mm)
Arthrex	1.0 ± 1.0	1.31 ± 0.36	1.83 ± 0.36	1.89 ± 0.21
Wright Medical	1.5 ± 0.9	0.25 ± 0.25	0.49 ± 0.06	2.65 ± 0.07
Significance	p = 0.502	p - 0.008	p < 0.001	p < 0.001

Table 2: Four-Point Bend Test Results and Significance

Group	Bending Stiffness (N/mm)
Arthrex	4.9 ± 0.9
Wright Medical	5.7 ± 0.3
Significance	p = 0.189

Conclusion

Arthrex 2-Hole Double Compression Screws either performed equivalently to or outperformed Wright Medical's 2-Hole Charlotte® CLAW® Compression Plate in mechanical performance for the categories tested. The smaller distraction width observed in the Arthrex plates provides a smaller footprint at the repair site.

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