The Biomechanical Stability of a Novel Supra-acetabular Pedicle Screw Internal Fixation Device for Vertically Unstable Pelvic Fractures

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INTRODUCTION:
Experimental and clinical studies have shown that the mechanical stability of internal fixation for a disrupted pelvic ring is far superior to that of external fixation. However, external fixation is preferred in the acute setting due to its relative ease and speed of application. Complications associated with external fixation are numerous, including pin site infection, loosening, and frame bulkiness, hindering nursing care and interfering with general surgery procedures. An innovative technique using available spinal implants and principles of pelvic external fixation has been developed (Fig 1). The device uses the same techniques as supra-acetabular external fixation pin placement; however, the pedicle screws are fixed under the skin, and attached to a bendable rod which is tunneled subcutaneously. This device would combine the benefit of rapid placement with having the construct entirely under the skin, thus avoiding many of the complications associated with external fixation.

METHODS:
Nine synthetic pelvic (1301-21, Sawbones, Vashon, WA) with a simulated anterior posterior compression (APC) type III injury were placed into the following groups:
1. INFIX (n=3), by 7.0 mm x 80 mm titanium polyaxial pedicle screws and 6.0 mm stiff titanium rod (Click’X Pedicle Screw System, Synthes, West Chester, PA)
2. Internal fixation (n=3), by 3.5 mm 4-hole locking pubic symphysis plate (Synthes, West Chester, PA)
3. External fixation (n=3), by 2 supra-acetabular 5.0 mm Schanz pins, with an 11 mm carbon fiber rod (Synthes, West Chester, PA)

A single orthopaedic surgeon prepared all the specimens. A custom device was attached to the sacrum and connected to the load cell of a uni-axial servohydraulic testing device (Instron Corp, Canton, MA) through a ball and socket joint which was allowed to articulate freely (Fig 2). A unipolar hemiarthroplasty prosthesis was potted at 15º through a ball and socket joint which was allowed to articulate freely (Fig 2). A unipolar hemiarthroplasty prosthesis was potted at 15º

RESULTS:
The mean displacement at the pubic symphysis was 20 mm, 9 mm and 0.8 mm for external fixation, INFIX and internal fixation, respectively (Fig 3). This difference was statistically significant for the INFIX device when compared to external fixation (P=0.017). There was also a significant difference between internal fixation and external fixation (P=0.01). There was no significant difference in SI joint displacement between any of the groups.

DISCUSSION:
The purpose of this investigation was to compare the relative stiffness of three anterior pelvic fixation constructs. A significant difference was observed between the constructs for pubic symphysis displacement. This is consistent with previous studies that have indicated that there is wide variability between fixation devices at this point (1,2). A limitation to this study was the small sample size for each construct; however, there was a significant difference observed in pubic symphysis gaping. It is possible that the sample size was too small to accurately examine the difference in stiffness, and future studies should include a larger sample size. Another concern is that neither the INFIX nor the external fixator would clinically be placed under a single leg stance, as these are temporary fixation techniques used while the patient would be non-weight bearing. However, this biomechanical test model represents the worst-case scenario in terms of force transmission that would be seen clinically and provides a repeatable, previously used biomechanical testing method to compare the stiffness of the constructs.

The data show that both the INFIX and the external fixator are stiffer than the INFIX (9.7% vs 6%). The data show that both the INFIX and the external fixator are stiffer than internal fixation (10.5% vs 5.6%) in overall stiffness and also stiffer at the pubic symphysis (1.1% vs 0.3%). At the superior portion of the anterior SI joint, external fixation was stiffer than the INFIX (9.7% vs 6%).

REFERENCES: