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STABILITY OF AN OTA 62-B1.2 ACETABULAR FRACTURE FIXED WITH SMALL FRAGMENT PLATES AND SCREWS COMPARED TO THE POLYAXIAL FIXATEUR INTERNE

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INTRODUCTION: Pelvic fractures are very difficult to fix properly with standard plates and screws because of the severe 3 dimensional contours of the boney surfaces requiring careful prebending of the plates to fit the surface. Then the screws which anchor the bone to the plate must be placed in the locations and directions dictated by the screw holes in the plate.

A new polyaxial fixateur interne, (PFI), has been developed that allows the surgeon to place the screws in whatever place and direction that will optimize their fixation to the bone. Then the screws can be joined by a simple rod that fixes to the polyaxial heads of the screws and compression can be applied between th screws along the rod. The rod is round in cross-section so that it can be easily contoured in all planes to fit to the location and orientation of the screws. Thus the theoretical advantage for PIF is not only its ease of accurate fit to th one, but the ability to locate the screws in the optimum location and the ability to compress the fracture surfaces prior to locking the rod to the screw heads in order to maximize the strength of fixation of the construct.

PURPOSE: The purpose of this study was a quantitative comparison of the rigidity of fixation of plate and screw fixation (PSF) to the PFI in a juxtatectal, transverse acetabular fracture (type 62-B1.2).

METHODS: Six human pelvis models made of polyurethane foam, Sawbones® #1295 & #1297 had a juxtatectal, transverse acetabular fracture (type 62-B1.2) simulated by cutting the bone with a saw.

All implants were applied by the senior author, an experienced trauma surgeon, familiar with the treatment of these fractures. The PIF was applied with a compression force of 155 N using a compression clamp. The time for each procedure was separately recorded (drilling, bending, insertion). The PSF consisted of a 7 hole small fragment pelvic band (10.5 cm) with 4 - 50 mm small fragment cortical bone screws (3.5mm) and the PFI construct consisted of 2 50mm screws (5mm) and a 4.5mm rod with a length of 60mm, see Figure 1. Each acetabulum was initially fixed with the plate and screw construct.

METHODS (CONT'D.): An abductor mechanism was added to each pelvis spanning from the greater trochanter to the illiac crest, see Figure 2. The Sawbones® femur was mounted in an angle vise with the femoral shaft angled at 8 degrees of varus, see Figure 2. The turnbuckle was then adjusted to position the pelvis level when there was no load applied to the setup. Three LED's from the Selspot system were mounted each on the superior and inferior fragments of the hemipelvis to monitor the 6 DOF of movement which could occur under load. Each pelvis was then placed in the loading apparatus and loaded from 5 to 60 N vertical load in a sinusoidal compression cycle. Stiffness of the construct was monitored by the MTS machine.

Next the plates and screws were removed and the fracture was fixed with the PIF fixation system and the loading and measurements repeated.

Data was recorded in the MTS computer and output to Excel files for analysis. The torque-angle curves were evaluated for slope. A linear region was identified, and that slope was used to describe structural stiffness as a single number.

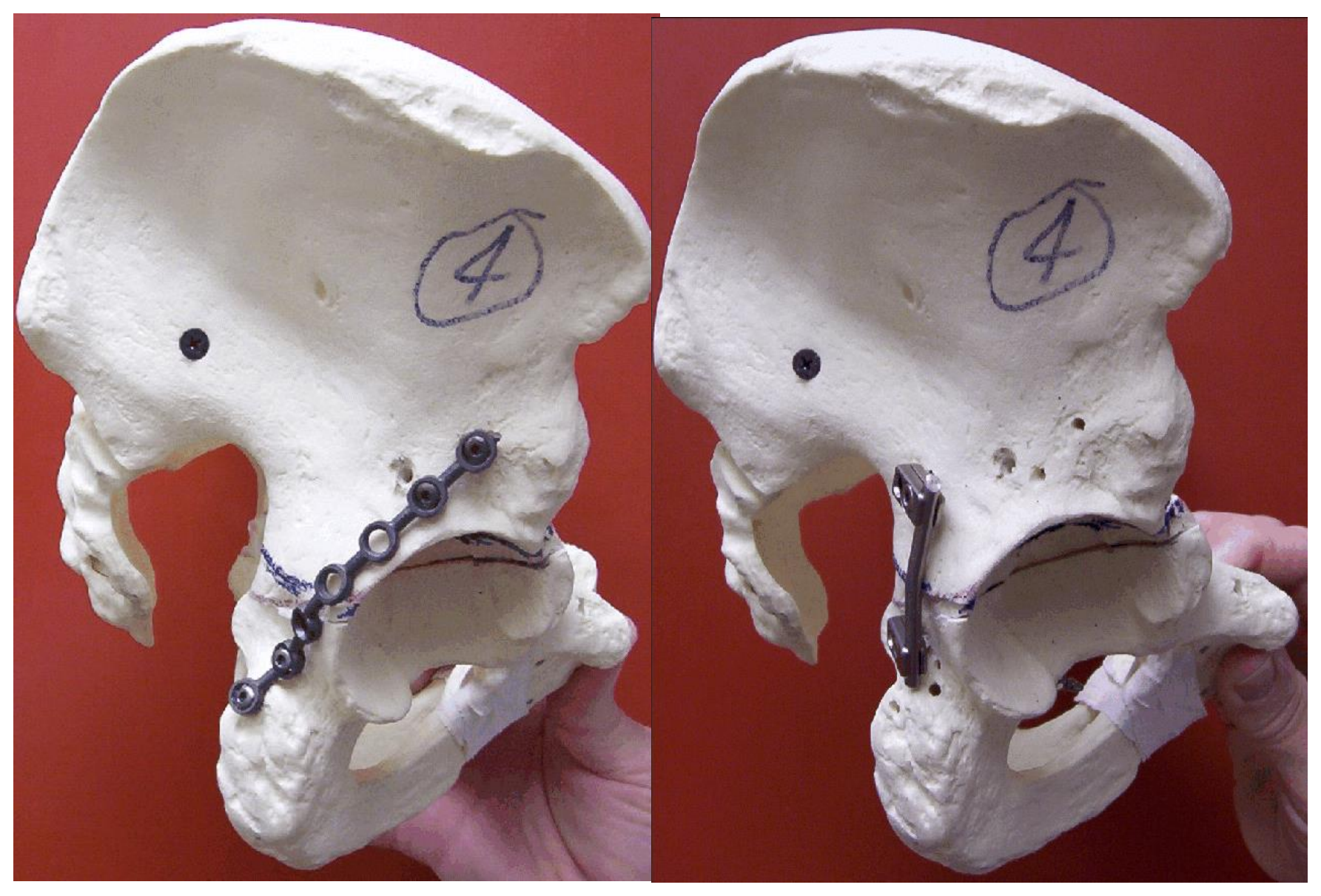

Figure 1: PSF (left) and PFI (right) fixation for a simulated 62-B1.2 fracture.

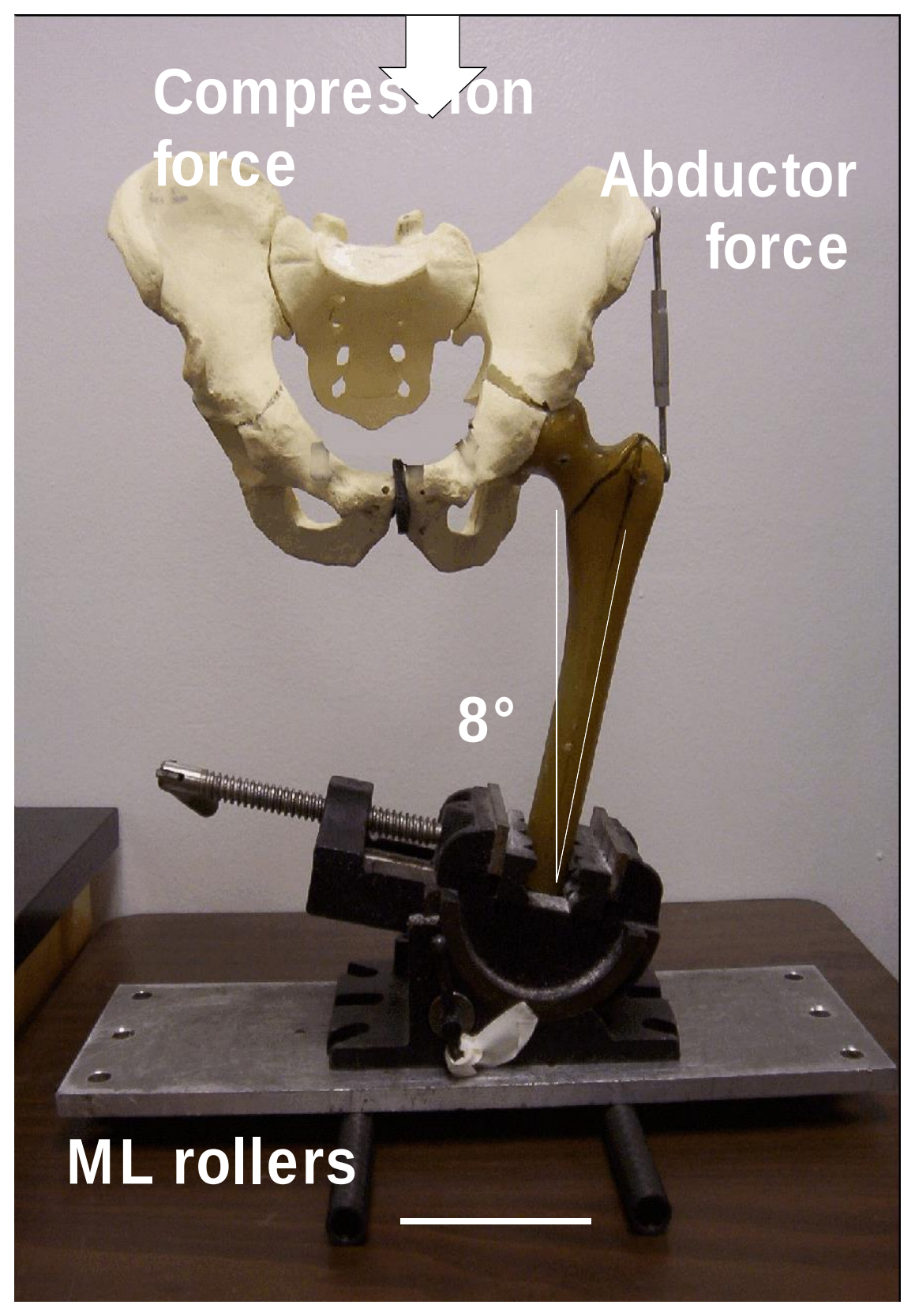

Figure 2: Positioning and loading of the pelvis

RESULTS: The application time was statistically significantly different between the 2 techniques. Application averaged 9 min 28 sec (" 1 min 40 sec) for the PSF, versus 2 min 55 sec (" 25 sec) for the PFI (p<0.003). The PFI was applied over three times faster in the Sawbones® model than the PSF.

The calculated stiffnesses from the MTS load and displacement curves showed no statistically significant difference (18.2 " 4.0 N/mm PSF versus 18.6 " 1.8 N/mm PFI).

The only statistically significant difference measured was for shearing motion in the AP plane, see Table.

	movements across the osteotomy site, in mm		
PFI	ML shear	AP shear	gap opening
Mean v SD	0.38 v 0.24	0.18 v 0.16	0.39 v 0.27
PSF			
Mean v SD	0.46 v 0.39	0.39 v 0.29	0.32 v 0.27
PFI/PSF	Paired PFI vs. PSF in % difference		
Mean v SD	-4% v 16%	-53% v 39%	28% v 52%

DISCUSSION: The limitations of this model include the use of Sawbones® models and creation of an osteotomy instead of a true fracture in real bone. But all comparisons were of the difference between the 2 fixation systems, which both utilize bone screws for their anchoring mechanism. The absolute numbers may not be exactly what one would obtain with human bones, but the relative differences at low levels of load should be similar.

The application is much easier with the PFI compared to PSF, the time to fix the bone was significantly less *in vitro*, which should translate into less surgical risk, less blood loss and less operating time in general with *in vivo* application.

There was no measurable advantage in fixation rigidity in 2 of the 3 planes measured for the PFI, despite its ability to apply a compression preload at the fracture site. But this may be due to the fact that this fixation was of an osteotomy with 2 smooth surfaces "articulating". Fixation of a true fracture with anatomic reduction and compression of "rough" surface inter-digitation should be much more rigid (particularly in shear).

CONCLUSIONS: The ability to compress the fracture surfaces only provided a measurable advantage in control of fracture site movement in AP shear for this model and loading conditions. The advantages in forming the rod and applying the screws for the PFI did provide a measurable difference in application time.

ACKNOWLEDGEMENTS: This project was supported in part by the Department of Orthopaedics and Rehabilitation, Univerity of Mimai and the Max Biedermann Institute for Biomechanics/Mt. Sinai Medical Center, Miami Beach, FL.