Introduction

Unstable pelvic ring injuries treated conservatively are associated with long hospitalization, inappropriate fragment reduction and a high mortality rate [1]. Surgical intervention with percutaneous sacroiliac (SI) screws combined with anterior pelvic plating has shown a high rate of functional success and a low complication rate. However, anatomical reduction can be challenging with this percutaneous approach and screw purchase in osteoporotic bone is often limited [2]. Recently a method for sacral fracture fixation using two Locking Compression Plates (LCP’s) was developed as an alternative to SI-Screw fixation [3]. Cortical screws aim to bridge the fracture on the peripheral part of the plate and short monocortical screws provide rotational stability. The aim of this study was to evaluate the biomechanical performance of three methods of fixation in osteoporotic sacrum fractures and to compare it to the presented concept of double plating.

Methods

Unstable vertical sacrum fractures were created bilaterally in zone 1 according to Denis classification on 16 human cadaveric pelves, preserved by the method of Thiel. The 32 hemi-pelves were divided in four different study groups of eight specimens each (n = 8). Fixation was performed with either a 7.3 mm SI-Screw, two 6-hole 3.5 mm LCP’s (double plating), combined SI-Screw and EXPEDIUM Spine System (triangular fixation), or using the EXPEDIUM Spine System alone (spino-pelvic fixation). Each side of the pelvis underwent a cyclic loading test in an upright standing position at a rate of 2 Hz. Compression along the machine axis was applied to the fifth lumbar vertebral body via a ceramic ball. While the valley load was held constant at 20 N, the peak load, starting at 50 N, was increased at a rate of 0.1 N/cycle until 30 mm axial displacement of the machine actuator were reached. Interfragmentary movements in terms of displacement of the most superior osteotomy aspect and opening at the fracture gap were measured with optical motion tracking.

Results

Mean axial stiffness (N/mm) was 97.8 ± 13.2 (SD) for SI-Screw, 56 ± 19.6 for double plating, 133.1 ± 53.4 for triangular fixation and 73.7 ± 18.7 for spino-pelvic fixation. It was significantly higher for the triangular fixation compared to double plating and spino-pelvic fixation (P ≤ 0.022), as well as for the SI-Screw fixation compared to double plating, P < 0.001. Numbers of cycles to 1 mm displacement were significantly higher for triangular fixation compared to spino-pelvic fixation, P = 0.025. Number of cycles to 2, 3, 5 and 8 mm displacement were significantly higher for triangular fixation in comparison to all other techniques, P ≤ 0.041 (Fig. 1).

Discussion

Triangular fixation was the biomechanically most superior construct and therefore represents a valid alternative to all other fixation methods. Double plating revealed the lowest initial stiffness with comparable performance to SI-Screw and spino-pelvic fixation.

References


Acknowledgements

The Voluntary Academic Society of Basel (Freiwillige Akademische Gesellschaft Basel, FAG) is acknowledged for its financial support to this study. DePuy Synthes is acknowledged for the delivery of all implants. This investigation was performed with the assistance of the AO Foundation.