A Biomechanical Evaluation Of Vancouver Type B1 Femoral Periprosthetic Fracture Fixation Using A Purpose-Designed Plating System.

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Introduction:

Femoral periprosthetic fractures around a well-fixed stem are challenging to treat successfully. Research using newer systems is required to appreciate which fixation configuration provides sufficient stability to prevent fixation failure.

Aim:

To evaluate the stiffness and mechanical behaviour of different femoral periprosthetic fracture fixation configurations around a well-fixed prosthesis.

Methods:

Four different configurations using the NCB system to fix femoral periprosthetic fractures around a stable cemented collarless, polished, tapered femoral stem (CPT, Zimmer) were prepared using composite synthetic femora. Constructs tested had increasing degrees of cement mantle intrusion from none (cables-only) to six bicortical locking screws in the proximal fragment. Constructs were loaded in three modes, then cyclically loaded in axial compression, and post-cycling loading to determine the overall stiffness and maximum load to failure. Digital Image Correlation was utilised to detect overall displacement in three planes and Acoustic Emission testing was used to determine energy released from construct damage.

Results:

Pre-cycling mechanical testing produced erratic results however, after cycling, ‘bedding in’ of the prosthesis into the cement mantle occurred and there was a reliable correlation observed. Bicortical locking screws in the proximal fragment inferred the greatest construct stiffness, particularly in torsion. Additionally, the bicortical screw fixation construct yielded the greatest maximum load to failure. A trend was observed with progressive decrease in cement mantle intrusion. The cables-only construct was deemed to be the least stiff and unsatisfactory for fixation stability. Digital Image Correlation and Acoustic Emission testing data concomitantly reinforced the results seen on load vs. displacement curves, with least overall displacement and damage detected in the bicortical screws construct.

Conclusion:

Polyaxial bicortical locking screws that breach the cement mantle and bypass the femoral stem leads to greatest construct stiffness. Cables-only fixation does not provide sufficient stability to prevent excessive displacement and should be avoided.