pared to other lag screw positions ($p < 0.01$ all four pairings). No statistical differences were noted for lateral stiffness. Superior and central lag screw positions had significantly greater mean load-to-failure than anterior ($p < 0.01$ and $p = 0.02$) and posterior ($p < 0.01$ and $p = 0.05$) positions. There were significant negative linear correlations between stiffness tests with CalTAD, and load-to-failure with TAD. Power was >95% for axial stiffness, torsional stiffness and load-to-failure.

*Conclusions*: The inferior lag screw position produced the stiffest construct in axial and torsional testing. Central and superior lag screw positions produced the highest load-to-failure. Position of the lag screw in the femoral head affects the biomechanical properties of the implant-femur construct. Central placement of the lag screw with minimization of TAD may provide the best combination of stiffness and load-to-failure.

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**1A.54**

## A biomechanical comparison of static versus dynamic lag screw modes for cephalomedullary nails

P.R.T. Kuzyk[1,*], G. Higgins[1], R. Zdero[2], S. Shah[2], M. Olsen[2], J.P. Waddell[1], E.H. Schemitsch[1]

[1] *Division of Orthopaedic Surgery, University of Toronto, Toronto, ON, Canada*
[2] *Martin Orthopaedic Biomechanics Laboratory, St. Michael's Hospital, Toronto, ON, Canada*

*Purpose*: Cephalomedullary nails rely on a large lag screw that provides fixation into the femoral head. There is an option to statically lock the lag screw (static mode) or to allow the lag screw to move within the nail to compress the intertrochanteric fracture (dynamic mode). The purpose of this study was to compare the biomechanical stiffness of static and dynamic modes for a cephalomedullary nail used to fix an unstable peritrochanteric fracture.

*Methods*: Thirty intact synthetic femur specimens were potted into cement blocks distally for testing on an Instron. A Long Gamma 3 Nail (Stryker, Mahwah, NJ) was then inserted into each of the femurs. An unstable four-part fracture was created, anatomically reduced, and the cephallomedullary nail was reinserted. Mechanical tests were conducted for axial, lateral, and torsional stiffness with the lag screws in: (1) static and (2) dynamic modes. A paired Student's *t*-test was used to compare the 2 lag screw modes.

*Results*: The axial stiffness of the cephalomedullary nail was significantly greater ($p < 0.01$) in the static mode (484.3 ± 80.2 N/mm) than in the dynamic mode (424.1 ± 78.0 N/mm) (Fig. 1A). Similarly, the lateral bending stiffness of the nail was significantly greater ($p < 0.01$) in the static mode (113.9 ± 8.4 N/mm) than in the dynamic mode (109.5 ± 8.8 N/mm) (Fig. 1B). The torsional stiffness of the nail was significantly greater ($p = 0.02$) in the dynamic mode (114.5 ± 28.2 N/mm than in the static mode (111.7 ± 27.0 N/mm) (Fig. 1B). A post hoc power analysis with $\alpha = 0.05$ and $\beta = 0.20$ revealed that the paired t test on 30 samples was sufficiently powered to determine a difference in mean axial stiffness of 33.0 N/mm (6.8% of static stiffness), a difference in mean lateral bending stiffness of 3.6 N/mm (3.2% of static stiffness) and a difference in mean torsional stiffness of 3.4 N/mm (3.0% of static stiffness).

*Conclusion*: Our results show that there is a 60 N/mm reduction in axial stiffness of the cephalomedullary nail when the lag screw is changed from static to dynamic mode. This represents a 12.4% reduction in axial stiffness. Given the significant reduction in axial stiffness with dynamization of the cephalomedullary nail construct, we recommend use of the static mode when treating unstable peritrochanteric fractures with a cephalomedullary nail.

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**1A.55**

## Fixing Eggshells?—some comparative results for the performance of three different condylar fracture fixation devices

C.J. Brown[a,*], R.A. MacInnes[a], P. Procter[a,b], G.V. Oldenburg[c], I.D. McDermott[d,e]

[a] *School of Engineering and Design, Brunel University, Uxbridge, UK*
[b] *Stryker Osteosynthesis, Switzerland*
[c] *Stryker Osteosynthesis, Germany*
[d] *London Sports Orthopaedics, London, UK*
[e] *School of Sports Science, Brunel University, Uxbridge, UK*

In previous work we have shown that finite element models of three different retrograde intramedullary nail constructs for "T" type unstable fractures of the distal femur (condylar bolts—the T2SCN, a distal femoral nail—DFN, and a plate construction—DCS) could be developed, compared well to experiments, and gave interesting comparative results. The geometry and boundary conditions (hard contact at the tibial plateau giving approximately 2/3 load through the medial condyle, and 1/3 lateral) represent patient loading, and two distinct load cases have been considered; (a) an axial load of 2000 N along the mechanical axis and (b) a torsion load of 10 Nm about the mechanical axis. The general distal femur geometry was taken from the standard model provided by the BEL repository, but a fracture was introduced by removing a transverse 15 mm slice of material and a sagittal slice of 1 mm thickness.

The use of the standard geometric model proved restrictive, as the cortical thickness in the condyle region approached 6 mm, and we consider this to be atypical. Surgical experience suggests that

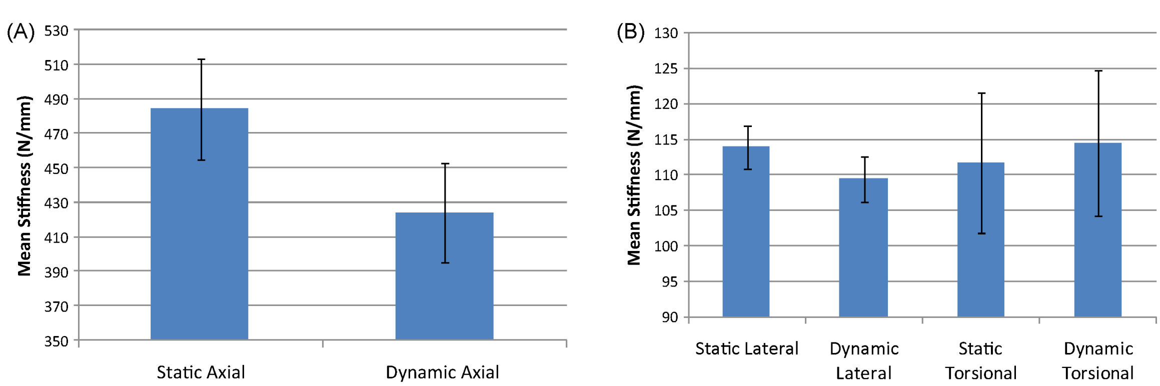


**Fig. 1.** (A) Mean axial stiffness for static and dynamic modes. (B) Mean lateral and torsional stiffness for static and dynamic modes. Error bars = ±2× SEM.

fixing such condylar fractures is frequently akin to joining eggshells. However, our previous work has also shown that the clamping forces (in the case of the T2SCN), and the stiffness of the cancellous bone and cortical shell contribute to the different mechanisms of load transfer that can occur in these devices.

This paper shows some recent work that examines variations in cortical shell thickness, cancellous bone modulus, and the compression force from condylar bolts. A significantly reduced cortical thickness is used while a range of cancellous bone moduli representing good quality bone and weak osteoporotic bone are examined.

The model examines both strength and stiffness. In general the pre-compression from the condylar bolts (T2SCN) produces localised compressive stress in the region adjacent to the end washer, but can provide a stiffer construct for subsequent loading. However, this outcome is also dependent on the quality of the cancellous bone adjacent to the nail. With low modulus cancellous bone cortical engagement may restrict the friction developed between bone and nail.

Under torsion, the nail constructs are always more effective than side plate constructs, and generally the locked nail provides good load-carrying capacity against torsion loads.

*Keywords*: Finite element modelling; Fracture fixation; Distal femur.

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**1A.56**

**A novel form of electrical stimulation increases osteoblast activity: potential implications for enhanced fracture healing**

M. Griffin (BSc)*, A. Sebastian (PhD), A. Bayat (MD, PhD)

*Plastic and Reconstructive Surgery Research (PRSR), Manchester Interdisciplinary Biocentre (MIB), University of Manchester, 131 Princess Street Manchester, M1 7DN, England, UK*

*E-mail address:* michelle.griffin@postgrad.manchester.ac.uk (M. Griffin).

Delayed facture repair and bony non-unions pose a clinical challenge. Understandably, novel methods to enhance bone healing have been studied by researchers worldwide. Electrical stimulation (ES) has shown to be effective in enhancing bone healing, however the best wave form and mechanism by which it stimulates osteoblasts remains unknown. Interestingly, it is considered that osteoblast activity depends on specific waveforms applied. Therefore, the aim of this study was to evaluate whether particular waveforms have a differential effect on osteoblast activity. An osteoblast cell line was electrically stimulated with either capacitive coupling (CC) or a novel degenerate wave (DW) using a unique *in vitro* ES system. Following application of both waveforms, the extent of cytotoxicity, proliferation, differentiation and mineralisation of the osteoblasts were assessed using various assays. Differentiation and mineralization were further analysed using quantitative real-time PCR (qRT PCR) and immunocytochemistry (ICC). DW stimulation significantly enhanced the differentiation of the osteoblasts compared to CC stimulation, with increased protein and gene expression of alkaline phosphatase and type 1 collagen at 28 h ($p < 0.01$). DW significantly enhanced the mineralization of the osteoblasts compared to CC with greater Alizarin Red S staining and gene expression of osteocalcin, osteonectin, osteopontin and bone sialoprotein at 28 h ($p < 0.05$). Moreover, immunocytochemical assays showed higher osteocalcin expression after DW stimulation compared to CC at 28 h. In conclusion, we have shown that ES waveforms enhanced osteoblast activity to different extent but importantly demonstrate for the first time that DW stimulation has a greater effect on differentiation and mineralisation of osteoblasts than CC stimulation. DW stimulation has potential to provide a secure, controlled and effective application for bone healing. These findings have significant implications in the clinical management of fracture repair and bone non-unions.

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**1A.57**

**Can DCP and LCP plates generate more compression?**

F. Yaish*, M. Sukeik, A. Nanu, A. Cross

*Sunderland Royal Hospital, UK*

*Aims*: This is a biomechanical study aiming to assess the advantage in using more than one eccentric screw in DCP and LCP fixation, the appropriate order of their insertion, the advantage in using different drill guides in DCP fixation, and compare the compression generated by the DCP and LCP.

*Methods*: A customized load cell placed in a transverse osteotomy performed on synthetic generic bone models was used to measure compression. The staring pressure across the osteotomy site was standardized to allow comparison. 4.5 mm narrow DCP and LCP plates were used for fixation. The compression screws were inserted in two sequences: all on the compression side, or alternating between the initial compression and neutral sides. Loading and universal drill guides were compared in DCP fixation.

*Results*: A second compression screw increases compression significantly in both sequences ($p = 0.002$). In the DCP, a third compression screw improved compression only when placed in alternating sequence ($p = 0.002$). Fourth compression screw resulted in no significant compression ($p = 0.23$) and loss of reduction. The universal guide generated higher compression than the loading guide ($p = 0.002$).

There was no significant difference in the compression generated by the first or second eccentric screws in DCP and LCP plate fixation ($p = 0.28, 0.25$).

*Conclusion*: Fracture compression can be improved by using extra eccentric screws in LCP and DCP, and the universal drill guide in DCP fixation. Although the compression hole in the LCP is shorter, it generates compression comparable to the DCP.

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**1A.58**

**Extraction of high numbers of mesenchymal stem cells (MSCs) from intramedullary cavities of long bones**

George Cox (BMBS)[a,*], Peter V. Giannoudis (MD)[a], Sally Boxall (PhD)[b], Conor Buckley (PhD)[c], Elena Jones (PhD)[b], Dennis McGonagle (PhD)[b]

[a] *Academic Department of Trauma & Orthopaedics, School of Medicine, University of Leeds, United Kingdom*
[b] *Academic Unit of the Musculoskeletal Diseases, Leeds NIHR Biomedical Research Unit, United Kingdom*
[c] *Trinity College, Dublin, Ireland*

*Introduction*: Iliac crest bone marrow aspirate (ICBMA) is frequently cited as the 'gold-standard' source of MSCs. It was the first location MSCs were identified and its ease of access/handling have encouraged its use as the standard. Previous studies have suggested that MSCs are resident in the intramedullary (IM) cavities of long-bones. However, a comparative assessment in terms of number, phenotype and differentiation capacity with matched ICBMA has not yet been performed.