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

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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 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?

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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

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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.

Methods: Aspiration of the IM cavities of 5 patients' femurs with matched ICBMA was performed. The long-bone-fatty-bone-marrow (LBFBM) aspirated was filtered (70 μm) and the solid fraction digested for 60 min (37 °C) with collagenase. MSCs were isolated from LBFBM-liquid/LBFBM-solid fractions and from matched ICBMA. Enumeration of MSCs was achieved via colony-forming-unit-fibroblast (CFU-F) assay and flow-cytometry on fresh sample using $CD45^{low}$ $CD271^{+}$. MSCs were cultured by virtue of their plastic adherence and passaged in standard, non-haematopoietic media. Passaged (P2) cells were differentiated towards osteogenic, adipogenic and chondrogenic lineages with their phenotype assessed using flow-cytometry CD33, CD34, CD45, CD73, CD90, CD105.

Results: MSCs were isolated from all fractions. Using the CFU-F assay median number of colonies: ICBMA = 8 (2–21), LBFBM-liquid = 14 (0–53), LBFBM-solid = 116 (23–171) per 200 μl of sample with MSC frequency, as percentage of total cells, using flow-cytometry, providing similar results. MSCs isolated from the LBFBM phases appeared to be not inferior to ICBMA in terms of osteogenic, chondrogenic or adipogenic differentiation. Passaged cells from all fractions had a phenotype consistent with other reported sources.

Discussion: The IM cavity of the femur is a depot of MSCs which are closely associated with fat but are at least equivalent to ICBMA in terms of osteogenic/chondrogenic differentiation. Intramedullary cavities of long-bones are frequently accessed by the orthopaedic/trauma surgeon and reaming/removal of IM contents is necessary for the nailing/insertion of prostheses. Removal of the LBFBM prior to standard reaming, using a syringe and suction tubing, is a 'low-tech' method of harvesting LBFBM that can be briefly digested to give high yields of MSC. The volumetric concentration of MSCs within this fraction is significantly higher than that for ICBM (~10 fold) and we postulate that this would aid its use as an alternative for autologous/allogenous use.

Conclusion: High concentrations of MSC can be achieved by brief digestion of aspirated IM fat from the femur. These cells appear appropriate for orthopaedic applications.

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1A.59

The reamer–irrigator–asiprator (RIA): a systematic review

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Background: The 'reamer–irrigator–aspirator' (RIA) is an innovation developed to reduce fat embolism (FE) and thermal necrosis (TN) that can occur during reaming/nailing of long-bone fractures. Since its inception its indications have expanded to include the treatment of post-operative osteomyelitis and as a harvester of bone-graft/mesenchymal-stem-cells (MSCs).

Purpose: To review the sources reporting on this device and comment on its effectiveness to (1) prevent FE and TN; (2) treat post-operative osteomyelitis; (3) harvest bone-graft and MSCs; and (4) operate safely.

Methods: A systematic review via pubmed and google scholar using the keywords 'reamer', 'irrigator' and 'aspirator'.

Results: Experimental data supports the use of the RIA in preventing FE and TN, however, there is a paucity of clinical data. The RIA is a reliable method in achieving high volumes of bone-graft and MSCs. High union rates are reported when using RIA bone-fragments to treat non-unions, however, papers are subject to confounding factors. Evidence suggests possible effectiveness in treating post-operative ostemyelitis. The RIA appears safe, with a low rate of morbidity provided a meticulous technique is used.

Conclusions: Current evidence suggests that the RIA is safe to use and effective in (1) preventing FE and TN; (2) treating post-operative osteomyelitis; (3) harvesting bone-graft and MSCs. This RIA demands further investigation especially with respect to the optimal application of MSCs for bone repair strategies.

Conflict of interest: The authors declare that there is no conflict of interest.

Ethical statement: Not applicable.

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1A.60

Comparing the prognostic performance of S100B with prognostic models in traumatic brain injury

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Introduction: There are currently two prognostic tools available for predicting outcome in traumatic brain injury (TBI). The first involves prognostic models combining clinico-demographic characteristics of patients for outcome prediction, whilst the second employs serum brain injury biomarkers. S100B is a widely acknowledged biomarker of brain injury.

Objective: To identify which method has better prognostic strength and explore how combining these methods might improve the prognostic strength.

Methods: We analysed data from 100 TBI patients, all of whom were admitted to the intensive care unit and had venous S100B levels recorded at 24-h after injury. TBI prognostic models A and B, constructed in Trauma Audit and Research Network (TARN), were run on the dataset and then S100B was added as an independent predictor to each model. Furthermore, another model was developed containing only S100B and subsequently, other important TBI predictors were added to assess their ability to enhance the predictive power of this model. The outcome measures were survival and favourable outcome at 3 months.

Results: Among all the prognostic variables (including age, cause of injury, GCS, pupillary reactivity, Injury Severity Score (ISS) and CT classifications); S100B has the highest predictive strength on multivariate analysis. No difference between performance of prognostic models or S100B in isolation was observed. Addition of S100B to the prognostic models improves the performance (e.g. Area Under