

for treating children's fractures, with minimal long-term complications.

**Keywords:** Elastic intramedullary nails; Paediatric fractures

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### 8B.8

#### A biodegradable scaffold for the treatment of a diaphyseal bone defect of the tibia

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**Purpose:** The aim of our study was to evaluate bone formation and angiogenesis produced within a biodegradable poly-D,L-lactide-co-glycolide acid / calcium phosphate (PLGA/CaP) scaffold when used to treat a diaphyseal tibia defect.

**Methods:** Canine tibiae were reamed to 7.0 mm and fixed with a 6.5 mm statically locked intramedullary nail after creation of an 8.0 mm diaphyseal defect. Eighteen canines were allotted into 3 treatment groups: (1) empty ( $N=5$ ), (2) iliac crest autograft ( $N=6$ ), or (3) PLGA/CaP biodegradable scaffold (Tissue Regeneration Therapeutics Inc., ON, Canada) ( $N=7$ ).

Fluorescent labels were given at 6, 9, 11 and 14 weeks. Animals were sacrificed at 15 weeks and perfused with a barium compound. Samples were analyzed with radiography, Micro CT, and brightfield and fluorescent microscopy.

**Results:** Bone and vasculature volume within the tibial defect site were reported as a percentage of the total volume of the defect site. The percent bone volume within the defect site was not different between treatment groups ( $p=0.112$ ). There was greater percent vasculature volume in the scaffold group than the autograft group ( $p<0.001$ ).

Bone formation at the osteotomy sites was defined as the distance from the original osteotomy site to the tip of newly formed bone. Osteotomy bone formation was significantly greater in the scaffold group than the autograft group ( $p=0.015$ ). Osteotomy sites associated with greater angiogenesis displayed greater bone formation.

Bone formation rates were reported as the distance between the fluorescent bone labels. Autograft samples had the greatest bone formation rates within the periosteum. Autograft and scaffold samples had the greatest rate of bone formation within the cortex.

**Conclusions:** Our canine tibial defect model provides a satisfactory facsimile of the traumatic tibia fracture with associated bone loss. The PLGA/CaP biodegradable scaffold we have employed promotes angiogenesis within a defect and could be used with autografting.

**Keywords:** Bone defect; Scaffold for bone; Tibia fracture; Bone substitute

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### 8B.9

#### Results of use of bone morphogenic protein-2 (BMP-2) in the treatment of long bone fracture non-union—A series of 25 cases

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**Introduction:** Bone Morphogenic Protein 2 (BMP-2) has been used as a bone substitute in various orthopaedic procedures including spine surgery and acute high energy open tibial fractures with bone loss. There were no reported series in the literature in the use of BMP-2

as the bone graft in the fracture non-union treatment. Our aim was to use BMP-2 in non-unions and to review the results.

**Methods:** We have treated 25 long bone fracture non-unions over a period of 2 years with BMP-2 during surgical fixation. We followed all the patients until union or failure requiring further surgery. Functional assessment was performed by short musculoskeletal functional assessment score (SMFA). 20 patients had BMP-2 only as the bone graft (group-1). 5 patients had iliac crest graft in addition to BMP-2 (group-2).

**Results:** There were 15 males and 10 females. Non-unions were spread across clavicle (4), humerus (3), ulna (2), femur (8), tibia (6) and lateral malleolus (2). 18 cases (90%) in group-1 and 5 cases (100%) in group-2 had clinical and radiological union. The mean time from original fracture to surgical intervention with BMP-2 was 15.21 months. Mean time from intervention with BMP-2 to further union was 7.43 months. There were no complications with use of BMP-2 either intra or postoperatively. The mean SMFA score has improved from 66.6 to 34.9.

**Conclusion:** BMP-2 may be an alternative to autologous bone grafting to avoid donor site morbidity in management of fracture non-union and can produce good results. Further studies with randomisation between autologous bone graft and BMP-2 will be required.

**Keywords:** Non-union; Fractures; BMP-2

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### 8B.10

#### BMPs and non-unions: A prospective randomised clinical study on 120 patients

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The purpose of this prospective randomised study, conducted between April 2005 and August 2007 at the Orthopaedic Institute G. Pini (University of Milan), was to compare the efficacy of recombinant bone morphogenetic protein 7 (rhBMP-7) and Platelet Rich Plasma (PRP) as bone-stimulating agents in the treatment of persistent fracture non-unions.

Long Bone NU is a very challenging condition that require adequate mechanical stabilization and often a concomitant biologic stimulation; to date, apart the use of Autologous Bone Graft (ABG) still considered the golden standard, Bone Growth Factors are available in clinical practice: recombinant human BMPs (rhBMP-7) or Autologous Growth Factors (AGFs) contained in Platelet Rich Plasma (PRP).

One hundred and twenty patients were randomised into two treatment groups (group rhBMP-7 vs group PRP). The number of males and females was 32 M–28 F for the rhBMP-7 group and 35 M–25 F for the PRP group. Sixty patients with sixty fracture non-unions were assigned to each group (median age:  $46.4 \pm 1.98$  years for the rhBMP-7 group and  $42.5 \pm 1.76$  years for the PRP group). Each patient underwent non-emergent operation for the treatment of their atrophic non-union, where adjuvant bone grafts were used according to the surgeon's preference. Revision of fixation method was implemented when deemed necessary.

In the rhBMP-7 group there were fifteen tibial non-unions, ten femoral, fifteen humeral, twelve ulnar, and eight radial non-unions. In the PRP group there were nineteen tibial non-unions, eight femoral, sixteen humeral, eight ulnar, and nine radial non-unions. The median number of operations performed prior to our intervention was  $2.6 \pm 0.62$  and  $2.7 \pm 0.74$  with autologous bone graft being used in twenty-three and twenty-one cases for the rhBMP-7 and PRP groups, respectively.

After surgical treatment the patients were followed up for at least 9 months, a time frame which was set as the primary end-point of our study. Successful completion of treatment was defined as the accomplishment of both clinical and radiological union.

Both clinical and radiological union occurred in 52 (86.6%) cases of the rhBMP-7 group compared to 41 (68.3%) cases of the PRP group, with a lower median clinical and radiographic healing time observed in the rhBMP-7 group (3.5 vs 4 months and 8 vs 9 months, respectively). This study supports the view that in the treatment of persistent long bone non-unions, the application of rhBMP-7 as a bone stimulating agent is superior compared to that of PRP in regards to their clinical and radiological efficacy.

**Keywords:** rhBM-7; PRP; Long bones non-union; Risk factors non-union

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### 8B.11

#### Can changing the mechanical environment increase the speed of fracture healing? A pilot study in tibial fractures

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We hypothesized that fracture healing could be speeded up by changing the mechanical environment from initial rigidity followed by micro movements (dynamization) to initial macro movement followed by rigidity. We based this hypothesis on two tenets. Firstly, callus requires movement for its formation and its production is limited to the first few weeks after fracture. Secondly, that callus would mature faster in the absence of movement (based on theoretical reasoning and supported by a prior rabbit experiment).

An external fixator was built that would allow axial macro movements (up to 5 mm) and then compression to produce a rigid configuration. Permission from the Helsinki Ethical Committee was obtained for a pilot trial. 15 patients with an isolated closed (12 patients) or open grade 1 (3 patients) tibial fracture were treated.

The average time of removal of the fixator was 11 weeks (range seven to 15.4 weeks) which was faster than other comparable series.

This trial indicates that it is possible to speed up the healing of tibial fractures by changing the mechanical regimes used today of initial rigidity followed by dynamization to one of initial macro movement followed by rigidity

**Keywords:** Healing; Tibia; Fracture; Biological

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### 9A.1

9A: Upper Limb Trauma

#### Uncomplicated displaced supracondylar humer fractures in children—Complications in early versus delayed management

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**Introduction:** Displaced supracondylar fractures are traditionally managed as a surgical emergency. We looked into our practice of supracondylar fracture management in children to look at the complications in those treated before or after 6 h from injury.

**Methods:** There were 61 children who underwent surgery for displaced supracondylar fractures over a period of 3 years. Of these 27

had reduction and pinning within 6 h and 34 after 6 h. Children with open fractures, multiple injuries and pulse less limb were excluded from the study. Both the groups were similar in age, gender distribution ( $p > 0.05$ , Fishers exact test).

**Results:** The rate of open reduction is 13% (8) in early group and 8% (5) in the delayed group. There were 2 (3%) iatrogenic nerve injuries in each group. The most significant complication is the loss of reduction in 3 cases in the early group. At an average follow-up of 14 weeks loss of extension was noticed in 4 (6.5%) of early and 1 (1.5%) patient of delayed group.

**Conclusion:** Our study demonstrated a general increase in complications with early surgery which is usually during the night. We support the hypothesis that uncomplicated supracondylar fractures operation at night can be avoided following the NCEPOD regulations of 'Who Operates When' and can be managed as 'urgent' rather than 'emergency'.

**Keywords:** Supracondylar humeral fracture; Delayed surgery; Children

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### 9A.2

#### Surgical treatment of complex distal humeral fractures: Internal fixation using pre-contoured anatomical elbow plates

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**Introduction:** Restoration of painless early range of movement after distal humeral fracture requires anatomical reconstruction of the articular surface and restoration of the elbow's geometry with stable internal fixation. The purpose of this study was to determine the outcome of open reduction and internal fixation of these complex fractures using the Mayo Clinic Congruent Distal Humerus Plates (Acumed Ltd., UK).

**Method:** A retrospective review of 15 consecutive patients, who underwent internal fixation between 2003 and 2008. All operations were performed by one surgeon using the same implant and post-operative regime. The patients were assessed clinically and radiographically.

**Results:** Mean age was 42 years (range 20–78 years). There were 11 females and 4 male patients. Average follow up was 9.5 months. Thirteen fractures were AO Type C and two were Type A. Complete union was achieved in all patients at final review. There were no cases of superficial or deep infection. There were no cases of hardware failure or fracture displacement. Three patients had associated fractures (1 calcaneal, 1 distal radius and 1 proximal phalanx of small finger). Complications included one removal of prominent olecranon tension band wire, one ulna nerve neuritis and one hypertrophic scar. One patient required removal of plates for pain but not all screws were completely removed. Mild heterotopic ossification was seen in one patient radiographically. The mean flexion was 109 degrees and extension was 38 degrees and full pronation/supination. The mean DASH score was 46.7.

**Conclusion:** This study presents the first non-inventor single surgeon series demonstrating the use of the Mayo Clinic Congruent Distal Humerus Plates. Anatomically pre-contoured angular stable implants facilitate operative reduction and stabilization of these challenging fractures with high union rates and low implant failure. However, when removing the implant, screw extraction can be difficult.

**Keywords:** Distal humerus; Fracture; Internal fixation; Pre-contoured plate

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