COA Paper Session 19: Trauma Upper Extremity and Trauma General ●
Moderator Christopher Graham, MB

175 –
Evaluation of Primary Care Management for Isolated Limb Injury: Study on 166 Consecutive Patients Referred to Orthopaedic Surgery in a Level 1 Trauma Center
Dominique Rouleau, Hôpital Sacré-Coeur de Montreal; Stefan Parent, Hôpital Sacré-Coeur de Montreal; Debbie Feldman, Université de Montreal; **Valérie Deslauriers**, Université de Montreal

176 –
Patient Satisfaction Following Clavicle Fracture Fixation: Horizontal versus Vertical Incision
John Choi, The Alfred Hospital; Elton Edwards, The Alfred Hospital

Purpose: To document outcomes and patient satisfaction in relation to the incision used following clavicle fracture fixation. In literature, the incidence of incisional numbness following operative fixation of clavicle fractures is reported to be between 7-29%. Such wound related problems contribute significantly to the dissatisfaction of patients with operatively treated clavicle fractures. Wound related problems can be bothersome and disabling and this is poorly documented. **Method:** All primary clavicle fractures treated with plating at the Alfred Hospital between 01/06/2003 and 01/06/2006 were included in the study. Patients were asked to complete paper-based questionnaires assessing satisfaction, pain, scar satisfaction, presence of numbness and the degree of disability following clavicle fixation. Their clinical notes and X-rays were reviewed for evaluation. The study sample was then divided into two groups; horizontal incision versus vertical incision then the data was analysed. **Results:** The response rate was 65% (35/54). 74% of patients reported as having “good” or better outcome following their clavicle fracture fixation. There was no statistically significant difference in pain scores. However, there were statistically significant differences observed in the presence of numbness (vertical 21% versus horizontal 62%) and the disability from the numbness between the two incision types. Overall satisfaction between the two groups was also significantly different. **Conclusion:** This study confirms that scar-related problems significantly affect the satisfaction following plating of clavicle fractures and numbness appears to be one of the most significant factors. Vertical incisions appear to reduce the incidence of numbness and lead to better patient satisfaction. Our results suggest that vertical incision is an attractive alternative approach in clavicle fracture fixation.

177 –
Locked Plate Fixation versus Non-operative Treatment for Displaced, Extra-articular Proximal Humerus Fractures: Are Functional and Quality of Life Outcomes Better?
Gerard Slobogean, UBC; Mohit Bhandari, McMaster University; Peter J. O'Brien, UBC

Purpose: To compare the functional outcome and quality-of-life following a displaced extra-articular proximal humerus fracture treated with open reduction and locking plate fixation versus non-operative management. To provide preliminary data for a subsequent prospective clinical trial. **Method:** Eligible subjects were identified through retrospective searches of a large emergency department admission database and the orthopaedic trauma database. All subjects ages ³ 55 treated for a proximal humerus fracture between 2002 to 2005 were invited to participate. The Disabilities of Arm, Shoulder, and Hand (DASH), Health Utilities Index Mark 3 (HUI), Euroqol-5D (EQ-5D), and the SF-36 questionnaires were mailed to all eligible subjects. Initial radiographs were reviewed using the AO/OTA classification system. Only patients with A3, B1, B2, or B3 fractures were included. **Results:** Thiry-four subjects were included: 15 were treated with sling immobilization and 19 with locked plate ORIF. The non-operative group was approximately seven years older (mean age 74 versus 67, p = 0.046). DASH scores were similar between the groups: ORIF 26.6 ± 24 and Sling 26.5 ± 20. The 95% CI surrounding the 0.01 point difference (-16.0 to 15.9) slightly exceeds the 13 point cutoff for the instrument's measurement error (minimal detectable change). Using univariable analysis, no statistically significant differences in health state values were detected. The mean HUI value for the ORIF group was 0.68 versus 0.75 for the sling (p=0.48). Mean EQ-5D values were 0.77 for the ORIF group and 0.80 for the sling group (p=0.73). The SF-36 PCS scores were also similar between the two groups: ORIF 41.1 versus Sling 39.8 (p=0.77). When controlling for age and pre-injury function, a 0.09 point difference in HUI values was detected favouring the sling treatment (p=0.036). No differences in DASH, EQ-5D, or SF-36 PCS scores were detected using regression models. **Conclusion:** The results of this small cohort suggest, for extra-articular fractures, the functional and quality of life outcomes may be similar between the two interventions. No trial comparing locked plate fixation and non-operative management has been reported. A total of 96 subjects will be needed for a prospective clinical trial comparing the two treatments (DASH difference 15, 80% power, 0.05 two-sided alpha).

178 –

Type 2D Monteggia Elbow Fracture-dislocations: Pattern of Injury, Surgical Technique of Fixation and Outcome

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Purpose: To describe the pattern of injury, surgical technique and outcomes of Monteggia type IID fracture dislocations. **Method:** Design: Retrospective review of prospectively collected clinical and radiographic patient data in orthopaedic trauma database with prospectively collected outcome scores. Setting: Level 1 university based trauma center. Patients / Participants: All patients with Monteggia type IID fracture dislocations admitted from January 2000 to July 2005. Intervention: Review of patient demographics, fracture pattern, method of fixation, complications, additional surgical procedures, and clinical and radiographic outcome measures. Main Outcome

Measurements: Clinical outcomes: elbow range of motion, QuickDASH (Quick Disabilities of the Arm, Shoulder and Hand), PREE (Patient Rated Elbow Evaluation), complications. Radiographic outcomes: quality of fracture reduction, healing time, degenerative change and heterotopic ossification. **Results:** Sixteen patients were included in the study. All fractures united. There were seven complications in 6 patients including 3 contractures with associated heterotopic ossification, 1 pronator syndrome and late radial nerve palsy, 1 radial head collapse and a DVT in the same patient and 1 with prominent hardware. Outcome scores were obtained on 11 patients at an average of 49 months (range 25 – 82 months) post-operatively. The average Quickdash score was 11 (range 0-43) and the average PREE score was 13 (range 0-34). **Conclusion:** Monteggia IID fracture dislocations are complex injuries with a recurring pattern. Rigid anatomic fixation, early range of motion and avoidance of complications leads to a good outcome.

179 –

Elbow Hemiarthroplasty for Distal Humeral Fractures

Alex Malone, University of Otago, Christchurch; **Peter Zarkadas,** Lions Gate Hospital; Stuart Jansen, Royal North Shore, Sydney; Jeff Hughes, Royal North Shore, Sydney

Purpose: This study reviews the early results of elbow hemiarthroplasty for distal humeral fractures. **Method:** Elbow hemiarthroplasty was performed on 30 patients (mean 65 years; 29-91) for unreconstructable fractures of the distal humerus or salvage of failed internal fixation. A 'triceps on' approach was used in six and an olecranon osteotomy in 24. A Sorbie Questor prosthesis (Wright Medical Technology) was used in 14 patients and a Lattitude (Tornier) in 16. Clinical review at a mean of 25 months (3-88) included the American Shoulder and Elbow Surgeons elbow outcomes instrument (ASES), Mayo Elbow Performance Index (MEPI) and radiological assessment. **Results:** At follow up of 28 patients mean flexion deformity was 25 degrees, flexion 128 degrees, range of pronosupination 165 degrees, mean ASES 83, MEPI 77 and satisfaction 8/10. Acute cases scored better than salvage cases. Re-operation was required in 16 patients (53%); two revisions to a linked prosthesis for periprosthetic fracture and aseptic loosening at 53 and 16 months, 12 metalwork removals and four ulnar nerve procedures. Posterolateral rotatory instability was present in one elbow, four had laxity and pain on loading (two with prosthesis or pin loosening), four had laxity associated with column fractures (two symptomatic) and ten had asymptomatic laxity only. The triceps on approach had worse laxity and clinical scores. Uncomplicated union occurred in all olecranon osteotomies and 86% of column fractures. One elbow had an incomplete cement mantle and seven had lucencies >1 mm; one was loose but acceptable. Five prostheses were in slight varus and two were flexed. Two elbows had early degenerative changes and 15 developed an osteophytic lip on the medial trochlea. **Conclusion:** Early results of elbow hemiarthroplasty show good outcomes after complex distal humeral fractures, despite a technically demanding procedure, metalware removal in 40%, symptomatic laxity in

12% and column non-union in 8%. Better results are obtained for treatment in the acute setting and with use of an olecranon osteotomy.

180 –
Compartment Syndrome Causes a Systemic Inflammatory Response and Remote Organ Injury
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Purpose: Severe compartment syndrome is associated with renal failure, end organ damage, and systemic inflammatory response syndrome (SIRS). Intravital videomicroscopy (IVVM) is a useful tool to study capillary perfusion and inflammation in end organs such as the liver and lungs. In this study, the systemic effect of hindlimb compartment syndrome was studied using hepatic IVVM. The purpose was to measure the effect of increased hindlimb intracompartmental pressure on hepatocyte viability, inflammation, and blood flow in a rodent model. **Method:** Ten Wistar rats were randomised into control (C) and Compartment Syndrome (CS) groups. Animals were anaesthetized with 5 % isoflurane. Mean arterial pressure was monitored using a carotid artery catheter. Elevated intracompartmental pressure (EICP) was induced by saline infusion into the anterior compartment of the hind limb and maintained for 2 hours between 30–40mmHg in the CS group. Two hours following fasciotomy, the liver was analyzed using IVVM to quantify capillary perfusion as a measure of microvascular dysfunction. The numbers of adherent and rolling leukocytes in venules and sinusoids were quantified to measure the inflammatory response. Irreversible hepatocyte injury was measured using a fluorescent vital dye which labels the nuclei of severely injured cells. **Results:** Hepatocellular injury was significantly higher in the CS group (325±103 PI labeled cells/10-1 mm2) compared to controls (30±12 PI labeled cells/10-1 mm2)(p=0.0087). The number of adherent venular white blood cells (WBC) was significantly higher for the CS group (5±2/hpf) than controls (0.2±0.2)(p=0.0099). Volumetric blood flow was not significantly different between CS and controls. **Conclusion:** After only 2 hours of compartment syndrome in this animal model, the number of activated white blood cells increased 25-fold and liver cellular injury increased 10-fold compared to controls. Marked systemic inflammation and hepatocellular damage was detected in response to isolated limb compartment syndrome. Compartment syndrome is a low-flow ischemia/reperfusion injury with a profound inflammatory response. Further research into the severe end-organ damage associated with compartment syndrome is required.

181 –
Hypothermia in Compartment Syndrome
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Purpose: Compartment syndrome is a limb-threatening condition. Treatment is urgent decompression by fasciotomy. However, orthopedic surgeons are

often confronted by a limb at risk for compartment syndrome, in which treatments to preserve tissue might be considered. Hypothermia has shown promise as a technique of maintaining tissue viability in transplant surgery, replant surgery and soft tissue injury. Cooling reduces microvascular dysfunction, inflammation and edema. This study was designed to determine whether tissue cooling might reduce muscle damage in the setting of elevated intracompartmental pressure. Purpose This study investigated the effect of hypothermia on tissue perfusion, viability and the inflammatory response in an animal model of elevated intracompartmental pressure. We hypothesize that hypothermia will preserve muscle tissue viability in an animal model of elevated intracompartmental pressure. **Method:** Twenty Wistar rats were randomized. Five animals had elevated intracompartmental pressure for 2 hours (CS). Five had elevated pressure and hindlimb cooling to 25oC (CS-HY). Five had hindlimb cooling to 25oC (HY) and 5 were control animals (C). All animals were anaesthesized for study. Core temperature was maintained over 30oC. Elevated ICP was maintained (30mmHg) using a saline infusion technique (groups CS and CS-HY). After 2 hours, fasciotomies were completed and intravital microscopy was used to measure tissue viability, microvascular perfusion and inflammation. **Results:** The use of hypothermia reduced tissue damage by approximately 50% in the CS-HY group (8.2% injured cells) compared with the CS group (16.5% injured cells). There was no difference in capillary perfusion comparing the CS and CS-HY groups ($p>0.05$). The number of adherent inflammatory cells was fewer comparing the CS-HY with the CS groups, but this did not reach statistical significance with the numbers available for study. **Conclusion:** Hypothermia preserved tissue viability in an animal model of elevated intracompartmental pressure. Fasciotomy remains the gold standard treatment for established compartment syndrome. However cooling may be useful to preserve tissue viability in extremities that are at risk of developing compartment syndrome. The clinical utility of hypothermia for compartment syndrome requires further study.

182 –

A Comparison of Complication Rates and Outcomes Following Limb-lengthening for Post-traumatic versus Congenital/ Developmental Deformity

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Purpose: To conduct a study to identify differences in complication rates and outcomes between previously recognized sub-groups commonly treated for limb length discrepancies (LLD). **Method:** Forty-two males and 13 females were treated for LLD at two level-one trauma centres. Mean LLD was 4.4 cm (range 1.8 to 18cm). There were 44 femoral segments (in 41 patients) and 14 tibia segments lengthened. Forty were post-traumatic, and 18 congenital/ developmental. Objective data regarding complications, length achieved, and lengthening duration was collected from patient records. Two

groups were compared for differences: Developmental (congenital and developmental etiology combined; LLD occurred prior to skeletal maturity and treatment involved creating new length) versus post-traumatic (restoration of previously existing length), and tibia versus femoral lengthening. **Results:** A mean of 4.4 cm of length was achieved over a mean duration of 83 days, for a mean lengthening index of 18.9 days/cm. Superficial pin tract infections were the most common complication, occurring in 33 segments (56%). Deep infection occurred in six segments (10%). Three of these six had a history of open fracture, and a fourth had a history of infection during initial fracture management. All were successfully treated with irrigation and debridement, and exchange nailing. The developmental group had significantly greater incidence of flexion contracture (13% versus 78%, $p<0.001$), and surgical correction for a contracture deformity (5% versus 61%, $p<0.001$). The post-traumatic group had a significantly higher rate of painful hardware requiring removal following successful treatment of their LLD (45% versus 16%, $p=0.04$). Tibia segments had a significantly greater lengthening index (29 d/cm versus 18 d/cm, $p=0.03$). **Conclusion:** Limb lengthening is an involved process with potential for serious complications. Patients who had limb-lengthening for congenital/ developmental discrepancies had a higher rate of adjacent joint contracture and subsequent requirement for surgical release. Patients with post-traumatic lengthening had a higher rate of hardware removal, and the lengthening index was greater for tibiae than femora. Deep infection remains a significant concern. This study provides information for physicians and patients on the rate and type of complications that can be expected both overall, and within specific LLD treatment groups.

183 –

Locked Plating of Open Distal Femur Fractures

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Purpose: Non-union and secondary reduction loss complicate open distal femur fractures with bone loss. We hypothesize that locking plates decrease subsequent bone grafting in these injuries, yet maintain alignment; immediate post-fixation radiographic features predict primary union. **Method:** From 2001 to 2004 inclusive, 34 adults with 36 open AO/OTA C-type distal femur fractures were reviewed. All were treated with locking plates and 3-month minimum follow-up. Union required radiographic bridging callus on 2/4 cortices combined with lack of symptoms. Alignment was assessed on initial and united radiographs. Antibiotic beads within a metaphyseal defect defined clinically important bone loss. **Results:** Eleven of 20 fractures with bone loss (55%) underwent staged bone grafting to achieve union, versus two of 16 fractures without bone loss (13%). The presence of antibiotic beads was significantly associated with staged bone grafting ($p<0.01$). Of those with bone loss and staged grafting, three had posterior cortical bone loss, and only three had medial and posterior cortical bone loss, and five had segmental defects. Of nine fractures with bone loss not requiring grafting, all had radiographic posterior cortical contact; seven had radiographic medial

cortical contact. Posterior (p<0.001) and medial (p<0.025) cortical continuity were associated with injuries not requiring bone graft. Thirty-four had accurate frontal plane reductions; thirty-five had accurate sagittal plane reductions. Complications included two non-unions, and one reduction loss. **Conclusion:** Despite metaphyseal bone loss, locking plates obviate the need for routine bone grafting of some open distal femur fractures. Those with radiographic posterior cortical contact and/or medial cortical contact are strongly correlated with primary union.

184 –

Pattern of Physical Injury Associated with Intimate Partner Violence in Women Presenting to the Emergency Department: A Systematic Review and Meta-analysis

Victor Wu, McMaster University; Harold Huff, McMaster University; **Mohit Bhandari,** McMaster University

Purpose: To examine patterns of physical injury associated with intimate partner violence (IPV) among women presenting to emergency room departments. **Method:** Systematic searches of Medline, EMBASE, and CINAHL electronic databases from their earliest entries up to February 2008. Reference lists from the studies included from the electronic database search were reviewed for published and unpublished studies. We contacted study authors regarding published and unpublished information. After titles and abstracts were initially screened by a single reviewer, two reviewers screened the remaining full-text articles for inclusion into the review. Studies were included if they pertained in whole or in part to women who presented to an emergency department because of IPV and reported the location or type of injuries. Studies without comparison groups of non-IPV women and case series/case reports were excluded. We performed a meta-analysis of the available data using the random effects model. **Results:** We identified 262 potentially relevant titles and abstracts, of which 7 articles were included in the review. The association between head, neck, or facial injuries and IPV was higher among studies that excluded women with verifiable injuries such as witnessed falls or motor vehicle collisions (pooled odds ratio 24 (95%CI: 15 Ã¯Â¿Â½ 38)). Thoracic, abdominal, or pelvic injuries were non-specific for IPV (pooled odds ratio 1.07 (95% CI: 0.89 Ã¯Â¿Â½ 1.29)). Injuries in the upper extremities were suggestive of non-IPV etiology (pooled odds ratio 0.51 (95%CI: 0.41 Ã¯Â¿Â½ 0.54)), as were lower extremity injuries (pooled odds ratio 0.15 (95%CI: 0.04 Ã¯Â¿Â½ 0.56)). **Conclusion:** Among women presenting to emergency room departments, unwitnessed head, neck, or facial injuries are significant markers for intimate partner violence. Conversely extremity injuries are less likely to have been the consequence of IPV.