

## **COA Paper Session 21: Paediatrics •**

Moderators Kishore Mulpuri, BC, and Ron El-Hawary, NS

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### **Minimizing Tourniquet Pressure in Paediatric Anterior Cruciate Ligament Reconstructive Surgery: A Blinded, Prospective Randomised Controlled Trial**

**Christopher W. Reilly**, UBC; James A. McEwen, UBC; Lise Leveille, UBC; Angeliki Perdios, UBC; Kishore Mulpuri, UBC

**Purpose:** Tourniquet cuff pressures in paediatric patients are commonly set at standard pressures. Recent evidence on adult subjects has shown that safer and more effective cuff pressures can be achieved by measuring limb occlusion pressure (LOP) and using a wide, contour cuff. There is little evidence validating these techniques in children. The primary objective of this study was to evaluate if a difference in tourniquet cuff pressure can be achieved in a paediatric population using a wide contour cuff in conjunction with measured LOP when compared to a standard cuff and pressure. **Method:** Subjects aged 10 to 17 years that underwent anterior cruciate ligament repair were included and randomised into either the control group or the experimental 'LOP' group using variable block randomisation. The tourniquet cuff was inflated to 300 mmHg in the control group or to the recommended tourniquet pressure based on LOP measurement in the LOP group. The surgeon was blinded to cuff selection, application and pressure throughout the surgical procedure. Immediately following the surgical procedure, the surgeon rated the quality of the bloodless field on a visual analogue scale (VAS). This study was powered as an effectiveness trial and intention to treat analysis was used. **Results:** Following a planned interim analysis at mid-point, complete data was recorded for 11 patients (control group) and 10 patients (LOP group). The quality of the surgical field was not different between groups ( $p = 0.053$ ). There was a statistically significant difference in mean cuff pressure between the control group (300 mmHg) and the LOP group (151 mmHg) ( $p < 0.001$ ). We ran the same analysis comparing the LOP data to hypothetical control data of 250 mmHg and our results remained statistically significant ( $p < 0.001$ ). **Conclusion:** The use of an automatic LOP measurement with the use wide contour cuffs can significantly reduce average tourniquet cuff pressures in paediatric patients compared to typical practice of 300 mmHg or 250 mmHg without compromising the quality of the surgical field.

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### **Gait Analysis After Initial Non-operative Treatment for Clubfeet: Intermediate Follow-up at Age 5 Years**

**Ron El-Hawary**, IWK Health Centre; Kelly A. Jeans, Texas Scottish Rite Hospital for Children; Lori A. Karol, Texas Scottish Rite Hospital for Children

**Purpose:** To compare gait kinematics and kinetics in five-year old children treated initially with Ponseti casting versus French physical therapy. A third group, consisting of patients initially treated with these non-operative

methods and then undergoing surgery consisting of more than a tendoachilles lengthening, was compared to those children treated entirely non-operatively. **Method:** Ninety patients (125 clubfeet) were tested at age five years. Thirty-four feet had undergone only Ponseti treatment, 40 the French program, and 51 had initial non-operative treatment with either the Ponseti or French protocols but later had surgery at an average age of 2+3 years. Kinematics and kinetics were compared to age-matched normal subjects. **Results:** Average stance-phase dorsiflexion did not differ between groups or from normal. Incidence of equinus: French 5%, Ponseti 0%; Increased stance-phase dorsiflexion: French 3%, Ponseti 24%, Surgical 18% ( $p < 0.05$ ). A similar number of feet that were not operated upon at age five had in-toeing: 30% French, 32% Ponseti. Decreased ankle power generation at push-off: 53% French; 47% Ponseti; 67% Surgical. Average ankle power generation: 2.21 W/kg French, 2.36 W/kg Ponseti, 1.97 W/kg Surgical (2.83 W/kg in normal 5-year-old children). There was a difference in ankle power generation between normal feet and both the French and surgical groups ( $p < 0.001$ ). Feet in the non-operative groups that had undergone Achilles tenotomy ( $n=28$ ) had similar ankle power to those feet ( $n=42$ ) that did not have tenotomies ( $p = 0.223$ ). Hip power generation was increased 33% in children who had undergone Ponseti treatment (1.38 W/kg), and 41% after French nonoperative treatment (1.47 W/kg), compared to normal (1.04 W/kg). This may be to compensate for poor ankle push-off. **Conclusion:** The gait characteristics of those feet that have not had surgery reveal that the majority had normal ankle kinematics, but reduced efficiency is demonstrated by reduced ankle push-off power, regardless of whether or not an Achilles tenotomy was performed. Decreased ankle power and persistent internal rotation are more frequently seen in feet that have undergone surgery despite initial nonoperative treatment, compared to those treated only by either the Ponseti protocol or the French physical therapy program.

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### **Long Term Results of Ilizarov Treatment in Relapsed Club Feet- A Comparison of Scoring Systems with a Patient's Perspective of Outcome**

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**Purpose:** The Ponseti method of clubfoot treatment has revolutionised the management of this condition. Prior to the introduction of the Ponseti regime to the UK in the late 1990's children were frequently treated by open surgical releases. The aim of our study is to compare the patient's perspective of outcome following Ilizarov treatment against the long-term outcome generated by the formal scoring systems. **Method:** We identified nine patients and 14 feet from the theatre logbooks, treated by the senior author (CB), with recurrent deformity of idiopathic clubfeet, using an ilizarov external fixator between 1994 and 1996. A variety of objective and subjective scoring systems were used to compare the results following Ilizarov treatment.

**Results:** International Clubfoot Study Group (ICFSG) scores on six patients gave two excellent feet, one good foot, four fair feet and one poor foot. Giving an excellent/good rate of only 37.5% with a mean follow up of 13.5 years. The Reinker & Carpenter scoring system resulted in five feet graded as excellent, one as good and two were rated poor. Giving an excellent/good rate of 75%. Functional questioning was also undertaken, six of seven (85%) patients deemed their treatment a success and were glad to have undergone treatment with an ilizarov frame. All but one patient is in higher education pursuing a vocational career or are in full time employment. **Conclusion:** Our results show that 85% of our patients who were treated with an Ilizarov frame for correction of a relapsed clubfoot were happy with their long term outcome. Thus the patient's perspective of the long term results of Ilizarov treatment for relapsed club foot are very encouraging. These results do not appear to correlate well with the International Clubfoot Study Group scores.

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### **Supracondylar Humerus Fractures in Older Children: Treatment Modalities and Outcomes**

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**Purpose:** The treatment algorithm for supracondylar humerus fractures in children under age seven is well-established. However, the best treatment option for these fractures in older children (8-14 year olds) is debated. The purpose of this study was to assess the efficacy of closed versus open fixation methods of this fracture type in older children. We hypothesize that closed reduction and percutaneous pinning (CRPP) is as effective as open reduction and internal fixation (ORIF). **Method:** A retrospective chart review was completed of all patients 8-14 years old treated for supracondylar humerus fractures at one centre from 2000-2007. IRB approval was obtained for this study. Demographics, treatment methods, pre- and post-operative complications, functional and radiographic outcomes were reviewed. Values are reported as mean  $\pm$  standard deviation. **Results:** Seventy-eight eligible patients were identified: 60 (76.9%) were treated with CRPP, and 18 (23.1%) were treated with ORIF. Demographics and fracture characteristics were similar between the CRPP and ORIF groups, although patients treated with ORIF were older ( $p < 0.001$ ) and weighed more ( $p < 0.001$ ). The ORIF group had higher post-operative complication rates ( $p = 0.016$ ). Five patients treated with CRPP required additional surgery (3 underwent ORIF; 2 underwent repeat CRPP) compared with none in the ORIF group. Children treated with ORIF had greater limitations on active flexion ( $99.70 \pm 18.2$  ORIF,  $140.50 \pm 23.5$  CRPP,  $p < 0.001$ ) and active extension ( $34.30 \pm 19.0$  ORIF,  $11.90 \pm 21.2$  CRPP,  $p < 0.001$ ) at first follow-up. Limitations in active flexion persisted in the ORIF group, but not in the CRPP group, at time of last follow-up ( $120 \pm$

14.8 versus  $150.40 \pm 17.8$ ,  $p < 0.001$ ). There were no group differences in active extension at last follow-up ( $p = 0.093$ ). On radiographs, significant differences between the groups existed for Bauman's angles ( $15.50 \pm 5.5$  ORIF,  $19.30 \pm 4.9$  CRPP,  $p = 0.013$ ) and carrying angle ( $12.40 \pm 5.7$  ORIF,  $16.60 \pm 5.4$  CRPP,  $p = 0.008$ ). Radiographic union was achieved in all cases. **Conclusion:** Open and closed surgical fixation are both acceptable treatment options for supracondylar humerus fracture in older children. While ORIF appears to result in reduced range of motion, no further operations were required for fracture alignment in this group.

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### **Reproducibility of Herring's Classification Using Two Different Techniques and its Alteration During the Evolution of the Disease**

**Renjit Varghese**, UBC; Kishore Mulpuri, UBC; **Benjamin Joseph**, Kastruba Medical College

**Purpose:** The lateral pillar classification for Perthes disease described by Herring in 1992 has gained wide acceptance as a method of predicting outcome and planning treatment. Our purpose was to determine the reproducibility of Herring's lateral pillar classification using visual estimation and by direct measurement and determine if the Herring's grading alters as the child passes through the stage of fragmentation in Perthes' disease.

**Method:** One hundred AP and frog lateral radiographs of children with unilateral Perthes' disease in the stage of fragmentation were classified according to the Herring's classification by two investigators utilizing a visual and measurement technique. The change in Herring's grading with progression of disease was evaluated in 86 patients with sequential radiographs in the stage of fragmentation. **Results:** The level of intra-observer agreement by the measurement technique was excellent for both AP and lateral radiographs (Kappa = 0.92 and 0.98) as compared to the visual method for which the agreement was moderate (Kappa = 0.65 and 0.5). The inter-observer reproducibility was moderate by the visual method for both AP and lateral radiographs (Kappa = 0.51 and 0.43). The level of agreement for the measurement method was good for the AP radiographs (Kappa = 0.66) and was only moderate for the frog lateral radiographs (Kappa = 0.53). Of the total 86 cases that had sequential radiographs in the stage of fragmentation, 33 showed change in Herring's grading. Among these 33 cases, 25 showed a change in the extent of epiphyseal collapse in the AP radiographs alone whereas 8 cases showed a change in lateral radiographs. Upgrading of Herring's grade from A to B was seen in 11 cases and from B to C in 14 cases as observed in the AP radiographs. The clinical variables and radiological variables did not show any association with progression of Herring's grade. **Conclusion:** The measurement technique of assessing Herring's classification is much more reliable than the originally described visual method. However, the Herring's grade changes with the evolution of the disease even during the process of fragmentation and must be used with caution when predicting prognosis.

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**Psychiatric Disorders Associated with Scoliosis: A Prevalence Study**  
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Simon Davidson, University of Ottawa

**Purpose:** In children and youth, the prevalence of psychiatric disorder associated with chronic medical illness approximates 30%. The impact of psychiatric disorder on the management of scoliosis has not been well explored in the literature. The objective of this study was to estimate the prevalence of mental health disorders in patients with adolescent idiopathic scoliosis (AIS). **Method:** Adolescents being treated for AIS completed the Achenbach Youth Self-Report and one parent completed the Achenbach Child Behaviour Checklist. Both measures are validated for screening of mental health disorders. The prevalence of mental health disorder in this population was estimated on the basis of the proportion that screened positive. Univariate analysis and logistic regression analysis was conducted to estimate the association between variables. A sensitivity analysis was performed to estimate the robustness of the results. **Results:** Between October 2006 and February 2008, 61 of 126 adolescents completed the study (48%). Of the 61 subjects, 18 were treated with observation, 26 with bracing, and 17 with surgical intervention. Overall, there were 41 adolescents who screened positive (67%). Sensitivity analysis demonstrated that, of those who did not return the questionnaire, the prevalence of a positive screen would have had to have been less than 0.1% in order to decrease the overall prevalence to 30%. There was a statistically significant difference in the magnitude of the scoliosis between those who screened positive (mean curve magnitude 39 degrees) compared to those who screened negative (mean curve magnitude 30.6 degrees) ( $p=0.03$ ). **Conclusion:** The estimated prevalence of a mental health disorder using the Achenbach questionnaires in patients with AIS is 67%. This is substantially higher than the anticipated prevalence in either the healthy population or those with a chronic illness. The results of this study provide evidence of the high burden of mental health illness amongst those with AIS. The sensitivity analysis demonstrated that the results are robust despite the relatively low response rate.

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**US and European Risser Grading Systems: Which One Best Predicts the Curve Acceleration Phase in Adolescent Idiopathic Scoliosis?**

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**Purpose:** In pediatric orthopedics, Risser sign is used to assess skeletal maturity. Two grading system exist for the Risser sign, one US and one European. In adolescent idiopathic scoliosis (AIS) the curve acceleration phase begin at a digital skeletal age (DSA) score between 400 - 425. The objective was to asses the disagreement between both grading system and evaluate the best estimator of the curve acceleration phase. **Method:** One hundred twenty-one AIS patients had a PA and lateral X-rays of the spine

and a left hand and wrist X-ray. Risser sign was measured according to both grading system and bone age was calculated according to Tanner-Whitehouse III method. Kappa statistics were done to evaluate concordance between US and European grading system and 2 multiple linear regression models were performed to find which stage best predicts the beginning of the rapid acceleration phase. **Results:** Kappa statistic between the US and European system was 0.517 (moderate agreement). US Risser 1 was the best predictor of the curve acceleration phase. DSA scores predicted with Risser 1 were 425 and 445 for US and European system respectively. **Conclusion:** American and European Risser grading system use different criteria to define 6 stages of a same sign. This is reflected in our study with a moderate agreement between both grading systems. US Risser 1 is the stage that best predicts the beginning of the rapid acceleration phase and a close follow up should be made at the beginning of the iliac apophysis ossification.

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### **Intrathecal Morphine Analgesia in Idiopathic Scoliosis Surgery: Does Gender or Racial Group Affect Optimal Dosing?**

**Jochen P. Son-Hing,** Rainbow Babies & Children; **Connie Poe-Kochert,** Rainbow Babies & Children; **Paul A. Tripi,** Rainbow Babies & Children; **Jennifer Potzman,** Rainbow Babies & Children; **George H. Thompson,** Rainbow Babies & Children

**Purpose:** Do children from different gender or racial groups receive different analgesic doses for the same acute pain condition? We previously reported on intrathecal morphine for preemptive analgesia in children undergoing posterior spinal fusion (PSF) and segmental spinal instrumentation (SSI) for idiopathic scoliosis (IS). We determined the optimal dose range to maximize analgesia while minimizing adverse effects. The purpose is to ensure this adopted protocol is equally effective across gender and racial groups.

**Method:** We studied 407 intrathecal morphine patients. Those given a moderate dose of 9-19 mcg/kg (n=293) had the most effective and safe postoperative pain relief. This group consisted of 246 female and 47 male patients. There were 224 Caucasian (CA) and 63 African-American (AA) patients. Other ethnicities were excluded. Factors analyzed included postoperative Wong-Baker visual analog pain scores (VAS), time to first opioid rescue dose, total morphine dose over the first 48 hours, and postoperative complications. **Results:** For female and male gender, mean VAS pain scores in post-anesthesia care unit (PACU) were 0.48 and 0.56, mean times to first opioid rescue dose were 999.1 and 1003.3 minutes, and total morphine over the first 48 hours were 1.5mg/kg in both groups, respectively. Respiratory depression and PICU admission occurred in 2 (4.2%) and 4 (1.6%) patients, respectively. For CA and AA patients, mean VAS pain scores in PACU were 0.48 and 0.46, mean times to first opioid rescue dose were 991.7 and 1031.9 minutes, and total morphine over the first 48 hours were 1.5mg/kg and 1.3mg/kg, respectively. Respiratory depression occurred in 5 (2.2%) and 2 (3.2%) patients and PICU admission occurred in 4 (1.8%) and 4 (6.3%) patients, respectively. Student's t-test

and Fisher exact test demonstrated no significant differences between genders for all variables, and no significant differences between races except less total morphine for AA patients over the first 48 hours ( $p=0.0024$ ). **Conclusion:** An optimal intrathecal morphine dose range of 9-19 mcg/kg provides effective and safe postoperative pain relief in children undergoing PSF and SSI for IS, regardless of gender or race. Intrathecal morphine can be given with the assurance that it does not discriminate against gender or provide less optimal analgesia to AA patients.

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### **Apical Vertebra Pedicle Morphology in Scoliosis**

Denise Mackey, UBC; Firoz Miyanji, UBC; Renjit Varghese, UBC; Davor Saravanja, UBC; **Christopher W. Reilly**, UBC

**Purpose:** There is scant literature with respect to reproducibility in radiological measurements of vertebral morphology. The purpose was to determine the reliability of measurement of various parameters of vertebral morphology in idiopathic scoliosis. **Method:** Ten patients with AIS were investigated with standardised low dose multi-slice helical CT. Axial reconstructions in the plane of the T8 (apical) vertebra were performed prone, as per Jamieson et al (2008). Antero-posterior (AP) canal diameter, left and right pedicle width, canal width, left and right mid-point to medial pedicle length, left and right pedicle length, and cord length, left and right transverse angles, and left and right canal area were measured by our spine surgeons and spine surgery fellow. Statistical analysis for intraclass coefficients (ICC) for intra and inter observer reliability was then performed. **Results:** Intra-observer reliability was excellent, with a mean ICC score of 0.930 (range 0.608-0.996), across all fourteen variables. Inter-observer reliability was very good with a mean ICC score of 0.890 (range 0.360-0.987), across all variables. There was poor inter-observer reliability for measurement of the transverse pedicle angles (0.360 - 0.446). The intra-observer reliability for transverse pedicle angles, whilst good (0.608- 0.861), was worse than any of the other intra-observer reliabilities. **Conclusion:** We demonstrate excellent intra, and inter observer reliability for measurement of apical vertebrae morphology in AIS. This tool can be utilized in the further study of pedicle dysplasia. Measurement of transverse pedicle angle was less reliable than any of the other measurement variables. A standardised measurement of the morphology of vertebral canal, pedicles and vertebral body morphology is reliable both within individual observers, and across a group of observers. A standardised measure for further investigation has been validated which will enable study of the evolution of pedicle dysplasia over time. This will lead to a better understanding of the etiology of pedicle dysplasia in scoliosis.

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### **Continuous Intravenous Morphine Infusion for Postoperative Analgesia Following Posterior Spinal Fusion for Idiopathic Scoliosis**

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**P. Son-Hing**, Rainbow Babies & Children; George H. Thompson, Rainbow Babies & Children

**Purpose:** Postoperative pain is common following posterior spinal fusion (PSF) and segmental spinal instrumentation (SSI) for idiopathic scoliosis (IS). It is often treated with intravenous morphine patient controlled analgesia (PCA), but no studies have examined continuous morphine infusion. The purpose of this study was to identify the safety and efficacy of continuous morphine infusion without PCA for post-operative pain management in these patients. **Method:** We retrospectively reviewed 338 consecutive patients from 1992 to 2006 who received continuous morphine infusion. Following induction of general anesthesia and prior to surgical incision, patients received intrathecal morphine for preemptive analgesia. Anesthesia was maintained with 50% nitrous oxide and up to 0.6% isoflurane, with minimal or no intravenous opioids. Following surgery, pre-ordered morphine infusion (0.01 mg/kg/hr) began when patients first reported pain. The infusion rate was titrated using a strict protocol based on frequent assessment of vital signs, Wong-Baker visual analog pain scores (VAS), and clinical status. The infusion continued until patients were able to take oral analgesics at postoperative day 2-3. Factors analyzed included patient demographics, intrathecal morphine dosage, intraoperative intravenous opioid dosage, pain scores through the third postoperative day, interval to start of morphine infusion, total morphine requirement in the first 48 postoperative hours, and postoperative complications. **Results:** Mean intrathecal morphine dose was 15.45 mcg/kg and mean interval to start of morphine infusion was 15:45 hours. Mean VAS pain scores were 3.05, 4.48, 4.48, and 4.60 at 12 hours, 1, 2, and 3 days postoperatively. The total mean dosage of morphine in the first 48 hours postoperatively was 0.03 mg/kg/hr. Nausea/vomiting, pruritis, respiratory depression, and PICU admissions related to the morphine drip occurred in 13.3%, 4.1%, 0%, and 0% of the patients during the same time period. **Conclusion:** A low frequency of adverse events and a mean postoperative pain score of 5 or less demonstrates that continuous postoperative morphine infusion is a safe and effective method of pain management in children following PSF and SSI for IS. Continuous morphine infusion without PCA is a safe, alternative method of pain control for postoperative patients with IS.