Periosteal Response Following Resection

Rajeev Chaudhary, Ming-Song Lee, Ellen Leiferman, Connie Chamberlain, Kevin Eliceiri, Wan-Ju Li, Paul Campagnola, Matthew Halanski
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**Purpose** Increased longitudinal bone growth occurs following periosteal resection. The long accepted mechanism for such growth is that the periosteum serves as a simple mechanical tether restricting growth. Previously we utilized Second Harmonic Generation (SHG) imaging to demonstrate that periosteal fiber alignment adjacent to the physis did not change immediately following periosteal resection. In this follow-up study we measured (1) changes in the periosteal fiber alignment over time following periosteal resection using SHG imaging (2) the biologic response of the periosteum to mechanical stimuli and (3) changes in the expression of several growth factors in vivo following the procedure.

**Methods** (1) SHG Imaging: twelve seven-week old New Zealand White rabbits were equally divided into non-operative controls and unilateral proximal tibial periosteal resections, sacrificed at 2, 4 and, 8 weeks post-op. Tibiae were carefully removed and the periosteal fibers imaged on the bone using SHG. (2) Three, freshly harvested periosteal samples were used to assess the relative mRNA expression of TGFβ-1, –2, –3, Ihh, PTHrP, Gli, and Patched when periosteal samples were exposed to tensile strain of 1.14%, 2.5%, or 5% in a bioreactor using RT-PCR. (3) An additional nine rabbits underwent periosteal resection and tibiae harvested at 0, 2, and 8-weeks post-resection and immunohistochemistry (IHC) performed.

**Results** SHG imaging demonstrated that periosteal fiber alignment adjacent to the proximal physis remained unchanged (p = 0.6) over time despite changes in growth rates while periosteal fiber alignment in the region adjacent to the resection increased from two to four weeks (p = 0.01). The periosteal strips were found to significantly (p<0.05) up-regulate and down-regulate specific growth factors (TGFβ-1, 2, Ihh, PTHrP) in response to changes in strain. Preliminary blind rank analysis of IHC samples suggest increased expression of PTHrP in the proximal tibial growth plate at eight weeks post-resection.

**Conclusion** Periosteal fiber alignment adjacent to the growth plate does not change over time despite changes in physesal growth rates, making it unlikely that these fibers are responsible for mechanically restraining growth. However, as fiber alignment changes in the region of resection and the periosteum in this region is capable of translating mechanical stimuli into biologic responses, it is plausible that the periosteum is regulating growth through secreted growth factors.

**Significance** The periosteum may function as sensor for bone growth, biologically regulating the physis in response to stimuli, rather than acting as a simple mechanical restraint.
**Purpose** Surgical anatomy of peripheral nerves in the upper extremity is well described in adults with frequently cited “safe zones,” or reference distances from anatomic landmarks. Most studies investigating peripheral nerve surgical anatomy of the upper extremity use adult cadaveric models, which understandably make similar investigations in children less feasible. Precise quantifiable relationships between neurovascular structures and bony landmarks in the pediatric population remain ambiguous. The goal of this study was to develop a model to reliably predict the location of the radial and axillary nerve in the upper extremity of a pediatric patient.

**Methods** We conducted a retrospective review of MR studies including the entire humerus of skeletally immature patients from 2001 to the present. Cases with distorted anatomy secondary to an underlying pathologic process and insufficient resolution to identify major peripheral nerves were excluded. Arm length (AL) was measured as the distance from the most lateral aspect of the acromion to the lateral epicondyle. The location of the radial nerve as it crossed the medial cortex of the humerus, the middle of the posterior humerus, the lateral cortex of the humerus, and the point at which it crossed from the posterior to the anterior compartment of the upper arm was identified. The distance between the radial nerve and corresponding distal bony landmarks (medial epicondyle, transepicondylar line, and lateral epicondyle) was recorded and expressed as a percentage of AL. The distance of axillary nerve from the most lateral aspect of the acromion was also measured and expressed as a percentage of AL.

**Results** The axillary nerve was predictably identified 19.8% of AL inferior to the lateral edge of the acromion. The radial nerve was predictably found crossing the medial cortex of the posterior humerus 60.1% of AL up from the medial epicondyle, the middle of the posterior humerus 51.2% of AL measured up from the transepicondylar line, the lateral cortex of the posterior humerus approximately 40.6% of AL measured from up from the lateral epicondyle, and the nerve crossed from the posterior to anterior compartment 31.2% of AL up from the lateral epicondyle.

**Conclusion** The position of peripheral nerves in the upper extremity can be reliably predicted as a proportion of arm length based on osseous landmarks.

**Significance** This is the first study to describe the location of peripheral nerves in the upper extremity as a proportion of arm length for surgical application in the skeletally immature patients.

**Wednesday, May 3–Saturday, May 6**

**Hip**
6:00 AM–6:00 PM

**Poster 3 / 6:00 AM–6:00 AM**

An Analysis of Femoral Version in Patients Undergoing Periacetabular Osteotomy

Ira Zaltz, Eduardo Novais, Jeffrey Nepple, John Clohisy, Ernest Sink, Wudbhav Sankar

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**Poster 4 / 6:00 AM–6:00 AM**

Correlation of Functional and Radiological Results with Three-Dimensional Gait Analysis in Patients with Unilateral Slipped Capital Femoral Epiphysis

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**Purpose** Slipped capital femoral epiphysis (SCFE) is known to produce characteristic deformities in proximal femur, which affect hip motion and may cause gait disturbance. The aim of this study was to evaluate correlation between kinematic-kinetic changes related to postoperative residual deformity after in situ pinning of SCFE and clinical and also radiographic results.

**Methods** Three-dimensional gait analysis of SCFE patients who were treated with in situ pinning were evaluated. To measure patient’s quality of life and physical function, Harris hip score and Pediatric Outcomes Data Collection Instruments (PODCI) scores were used. Preoperative and sixth months postoperative Southwick angles (SA) in the anterior–posterior (AP) and lateral views and Articulo-Trochanteric Distance (ATD) were measured. A control group consisted of age-matched healthy people with no history of any medical problems that resulted in problems during gait.

**Results** Thirty-one patients with mean age of 16 years were included. The average age of patients at surgery was 12.9 years and mean follow-up time was 3.3 years. The mean preoperative Southwick angles of the patients in AP view was 19.68 and lateral view was 32.78. Postoperative measurements of the SA in AP and lateral views were 14.48 and 23.38 respectively. The Southwick angles in postoperative AP view showed significant correlation with the mean knee flexion, thorax tilt and gait velocity (p < 0.05).

There was a significant correlation between the SA in postoperative lateral view and minimum knee flexion during swing (p < 0.05) and gait velocity (p < 0.01). There was a significant correlation between ATD with maximum internal rotation of hip, maximum knee abduction angle and knee abduction (p < 0.05). The Harris hip scores correlated significantly with maximum ankle dorsiflexion and foot progression angle (FPA) (p < 0.05). The Adolescent Global Functions Scales significantly correlated with pelvic tilt, the FPA, mean spine tilt and minimum spine tilt (towards to standing limb side, maximum spine tilt (towards swinging limb). The Adolescent Happiness Scales correlated with mean pelvic internal rotation and FPA (p < 0.01). The Adolescent Pain and Comfort Scales correlated with FPA (p < 0.05). The Adolescent Sports and Physical Function Scales correlated with the pelvic tilt, FPA and spine tilt. The Adolescent Transfer and Basic Mobility Scale significantly correlated with pelvic tilt, spine tilt and FPA (p < 0.05).

**Conclusion** There were significant correlations between both functional and radiological results with the gait analysis data of patients with unilateral SCFE.

**Significance** Three-dimensional gait analysis can be used as an evaluation tool for functional and radiographic outcomes of patients with SCFE.

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**Wednesday, May 3–Saturday, May 6**

Hip
6:00 AM–6:00 PM

**Poster 5 / 6:00 AM–6:00 AM**

**Incidence of Acetabular Dysplasia in Breech Infants Following Initially Normal Ultrasound: The Effect of Variable Diagnostic Criteria**

Christopher Brusalis, Charles Price, Wudbhav Sankar
Children’s Hospital of Philadelphia, Philadelphia, PA, United States

**Purpose** Breech presentation is an important risk factor for developmental dysplasia of the hip (DDH). The purpose of this study was to determine the prevalence of acetabular dysplasia at 6 months of age in patients with breech presentation and previously normal hip ultrasounds, reporting primary radiographic measurements to allow for comparison with other patient cohorts.

**Methods** A retrospective analysis of breech infants with initial normal clinical examinations and hip ultrasounds was performed to determine the rate of subsequent acetabular dysplasia and the distribution of acetabular index (AI) at approximately 6 months of age. Exclusion criteria included presence of an underlying diagnosis, prior treatment with Pavlik harness, or absence of relevant imaging data. AI was measured bilaterally on anteroposterior (AP) pelvic radiographs and reported using descriptive statistics.

**Results** Forty-seven breech infants (38 female, 9 male) were eligible for analysis. All infants demonstrated normal ultrasound findings at a mean age of 6.9 ± 1.7 weeks and returned for follow-up at a mean age of 6.4 ± 0.5 months. On follow-up AP pelvic radiographs, mean right hip AI was 25.0° (SD ± 3.6°, Range = 18°–40°) and mean left hip AI was 25.5° (SD ± 4.9°, Range = 18°–40°). (Figure 1) If one uses a single standard deviation above the population mean (AI ≥28°) as criteria for diagnosing acetabular dysplasia, 16/47 patients in this cohort (34.0%) would be dysplastic. Alternatively, if two standard deviations above the population mean (AI ≥30°) are used to diagnose dysplasia (the most commonly used single threshold), only 5/47 patients (10.6%) would meet diagnostic criteria. However, strict adherence to Tönnis’ previously established normative AI values stratified by gender and laterality results in only 3/47 patients (6.4%) qualifying as dysplastic.

**Conclusion** The significant proportion of breech infants who, despite normal initial ultrasound findings, were diagnosed with dysplasia at approximately 6 months of age supports continued observation of breech-born patients beyond six weeks of age. However, reliance on different threshold values for diagnosing acetabular dysplasia can lead to wide discrepancies in reported prevalence rates.

**Significance** Acetabular dysplasia is an important concern for breech infants even after normal initial US, but the prevalence can vary from 6–34% within the same cohort simply due to variable diagnostic criteria. For future studies, we encourage the reporting of primary AI values and distribution to facilitate direct comparison and meta-analysis of study data.
**Purpose** In late-presenting DDH, intra-articular soft tissue interpositions may prevent concentric reduction of the femoral head into the acetabulum. The purpose of this study is to assess changes in soft tissue interpositions after overhead traction (OHT) using serial MRIs and to compare them between pre-walking and walking children.

**Methods** This is a prospective study of 60 children aged 6–31 months with DDH conservatively treated with OHT, our previously described method (IPO 2013), between 2007 and 2015. All hips were successfully reduced. One week after reduction, the hips were immobilized with cast for 1 month followed by hip flexion-abduction brace for 3–5 months. MRI was routinely performed at 1 and 6 weeks after reduction. The 3rd MRI was done only when concentric reduction was not achieved at the 2nd examination. The distance between the femoral head and acetabulum (DFHA), the thickness of the ligamentum teres (TLT), and morphological abnormalities (hypertrophy/inversion) of superior, anterior, and posterior labrums were measured using the T2-weighted coronal and axial images. Comparisons were made between pre-walking and walking children.

**Results** Fourteen children who underwent MRI only once for various reasons were excluded. The remaining 32 pre-walking (34 hips) and 14 walking (14 hips) children were analyzed, and the mean ages at reduction were 9 (range, 7–13) and 22 (range, 13–33) months, respectively. Serial MRIs demonstrated that the intra-articular interpositions tended to disappear with time in all cases. On the 1st and 2nd MRIs, there were significant differences between the pre-walking and walking groups in the DFHA (p = 0.0003 and p<0.0001) and the TLT (p = 0.0193 and p = 0.0008) (Table 1). The abnormal labrums which were frequently observed on the 1st MRI in both groups, decreased in pre-walking children but sustained in walking children on the 2nd MRI (superior, p = 0.0043; anterior, p = 0.0001; posterior, p = 0.0130) (Table 1). Seven pre-walking (22%) and 10 walking (71%) children underwent the 3rd MRI at 4–8 and 4–10 months after reduction, respectively. Although there was still a significant difference between the groups in the DFHA (p = 0.0274), the TLT and the abnormal labrums decreased even in the walking children (Table 1).

**Conclusion** In both pre-walking and walking children with DDH, intra-articular soft tissue interpositions of the hips gradually decreased during immobilization following OHT. The interpositions of pre-walking children normalized more rapidly than those of walking children.

**Significance** This study suggests that most children aged <3 years with DDH do not need surgical treatment of intra-articular interpositions which are usually observed soon after reduction.

**Wednesday, May 3–Saturday, May 6**

**Hip**

**Poster 6 / 6:00 AM–6:00 AM**

Disappearance of Soft Tissue Interpositions After Gradual Reduction Using Overhead Traction in Late-Presenting DDH: A Prospective Comparative Study on Serial MRIs Between Pre-Walking and Walking Children

Hiroshi Kaneko, Tadashi Hattori, Koji Iwata, Masaki Matsushita, Hiroki Furuhashi, Hiroshi Kitoh

Aichi Children’s Health and Medical Center, Obu, Aichi, Japan

**Purpose** To analyze the occurrence of residual dysplasia after successful closed reduction of developmental dysplasia of the hip (DDH), and to find out the correlation of arthrogram-guided closed reduction quality with residual dysplasia with a new intraoperative radiographic criteria.

**Methods** A consecutive series of patients with DDH treated at our institution by arthrogram-guided closed reduction during 2006 March to 2013 June were reviewed retrospectively. A total of 126 patients with 139 hips were included in this study. There were 23 males and 103 females involving 88 left hips and 51 right hips. The average age at closed reduction was 14 months (range, 7–19 months), and the average follow-up was 36 months (range, 24–100 months). Femoral head coverage (FHC) and arthrography type (A/B/C) on best reduced arthrographic image, acetabulum index and Wiberg Center-Edge (CE) angle on antero-posterior (AP) pelvis radiograph at latest follow-up were measured. Residual hip dysplasia was determined according to Harcke acetabular dysplasia radiographic standard. Patients were divided into non-late acetabular dysplasia (non-LACD) group and late acetabular dysplasia (LACD) group according to final results, and age at reduction, gender, and side were compared between two groups. The correlation between FHC and arthrography type with residual hip dysplasia were analyzed. Multiple Logistic regression analysis was used to analyze gender, AI at CR, arthrography type and FHC with late acetabular dysplasia. ROC curve analysis was used to determine the cutoff value of FHC.

**Results** Forty-five hips were determined as residual hip dysplasia among 139 hips, and the occurrence rate of residual hip dysplasia was 32.4%. 11(7.9%) hips occurred AVN, of which 9(81%) hips showed acetabular dysplasia. There was no significant difference among age at reduction, gender and side between two groups. There was significant difference with FHC (51.2 ± 15.3% and 28.5 ± 15.9% respectively, t = 4.718, P = 0.000) between two groups. And the percentages of LACD in the arthrography type C group was significantly higher than type A and B groups (χ² = 17.170, p = 0.017). However, the FHC value was the only prognostic factor for late acetabular dysplasia according to multiple logistic regression analysis. There was a clear cutoff value of FHC (30%) under which 81.8% hips were determined as late acetabular dysplasia according to ROC curve analysis.

**Wednesday, May 3–Saturday, May 6**

**Hip**

**Poster 7 / 6:00 AM–6:00 AM**

Intraoperative Arthrogram Predicts Residual Dysplasia After Successful Closed Reduction of DDH

Zhongli Zhang

Tianjin Hospital, Tianjin, China, People’s Republic of China

**Purpose** To analyze the occurrence of residual dysplasia after successful closed reduction of developmental dysplasia of the hip (DDH), and to find out the correlation of arthrogram-guided closed reduction quality with residual dysplasia with a new intraoperative radiographic criteria.

**Methods** A consecutive series of patients with DDH treated at our institution by arthrogram-guided closed reduction during 2006 March to 2013 June were reviewed retrospectively. A total of 126 patients with 139 hips were included in this study. There were 23 males and 103 females involving 88 left hips and 51 right hips. The average age at closed reduction was 14 months (range, 7–19 months), and the average follow-up was 36 months (range, 24–100 months). Femoral head coverage (FHC) and arthrography type (A/B/C) on best reduced arthrographic image, acetabulum index and Wiberg Center-Edge (CE) angle on antero-posterior (AP) pelvis radiograph at latest follow-up were measured. Residual hip dysplasia was determined according to Harcke acetabular dysplasia radiographic standard. Patients were divided into non-late acetabular dysplasia (non-LACD) group and late acetabular dysplasia (LACD) group according to final results, and age at reduction, gender, and side were compared between two groups. The correlation between FHC and arthrography type with residual hip dysplasia were analyzed. Multiple Logistic regression analysis was used to analyze gender, AI at CR, arthrography type and FHC with late acetabular dysplasia. ROC curve analysis was used to determine the cutoff value of FHC.

**Results** Forty-five hips were determined as residual hip dysplasia among 139 hips, and the occurrence rate of residual hip dysplasia was 32.4%. 11(7.9%) hips occurred AVN, of which 9(81%) hips showed acetabular dysplasia. There was no significant difference among age at reduction, gender and side between two groups. There was significant difference with FHC (51.2 ± 15.3% and 28.5 ± 15.9% respectively, t = 4.718, P = 0.000) between two groups. And the percentages of LACD in the arthrography type C group was significantly higher than type A and B groups (χ² = 17.170, p = 0.017). However, the FHC value was the only prognostic factor for late acetabular dysplasia according to multiple logistic regression analysis. There was a clear cutoff value of FHC (30%) under which 81.8% hips were determined as late acetabular dysplasia according to ROC curve analysis.
**Conclusion** Intraoperative arthrogram femoral head coverage (FHC) is an alternative predictor for residual hip dysplasia in DDH closed reduction, and FHC ≤30% can be considered as unacceptable reduction criteria.

**Significance** Intraoperative arthrogram femoral head coverage (FHC) can be used to determine the reduction acceptable or not.

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**Wednesday, May 3–Saturday, May 6**

**Hip**

6:00 AM–6:00 PM

**Poster 8 / 6:00 AM–6:00 AM**

The Boston Periacetabular Triple Osteotomy for the Treatment of Hip Instability in Down Syndrome - Preliminary Results

Young Jo Kim, Daniel Maranho, Travis Matheney, Michael Millis, Eduardo N. Novais

Boston Children's Hospital, Boston MA, United States

**Purpose** To investigate the outcomes of a modified anteverting periacetabular triple osteotomy in skeletal immature Down syndrome patients with hip instability.

**Methods** After IRB approval, 20 Down syndrome patients (11 females, nine males) with hip instability who underwent a modified anteverting triple osteotomy (29 hips) were evaluated. The average age at the time of surgery was 7.4 ± 2.2 years, and follow-up was 3.4 ± 2.4y (1.0–8.9y). There were 22 dislocatable/reducible hips (Bennet-II), six dislocatable hips with incongruent reduction (Bennet-III), and one fixed dislocation (Bennet-IV). Four patients (five hips) had previous varus derotational femoral osteotomy (VDRO) that failed to stabilize the hip. Radiographic evaluation included pre- and postoperative lateral (LCEA) and anterior (ACEA) center-edge angle, and acetabular inclination angle (AI). At the final follow-up, a modified Harris Hip Score (HHS) was used to assess hip pain and function. Failure was defined as persistent postoperative instability.

**Results** At the final follow-up, 25 hips (86%) were stable, and the mean HHS was 84.6 ± 18.3. There was a significant radiographic improvement, with a mean increase of 17.9 ± 12.9º on LCEA (p<0.0001); 8.7 ± 12.4º on ACEA (p = 0.03), while the AI angle showed a decrease of 13.7 ± 9.6º (p<0.0001). Three patients underwent VDRO simultaneously to Triple. There were 22 (76%) hips with no complications or complications that did not require change in postoperative course; six (21%) minor complications requiring ambulatory treatment and one major complication (3%). There were four failures (14%), one in a GMFCS-4 household patient, and three hips in two patients that are currently being treated with a brace. The most common complications were a stress reaction on the inferior ischiopubic ramus (9/29 hips-31%) that healed without an intervention and asymptomatic non-union of the ischial or pubic portion of the osteotomy (6 hips-21%). Two cases presented a premature closure of the triradiate cartilage without further residual dysplasia. There was one self-limited avascular necrosis of the femoral head.

**Conclusion** Our modified anteverting triple osteotomy provided global deformity correction and hip stability in 86% of the unstable Down hips after a mean follow-up of 3.4 years. However, we noticed that one third of the patients develop a stress reaction at the ischiopubic synchondrosis.

**Significance** Hip instability in Down syndrome presents a complex surgical challenge. A complete redirection anteverting osteotomy of the acetabulum with adequate correction of acetabular retroversion allows for correction of the instability in the majority (86%) of the patients with a low rate of major complications.

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**Wednesday, May 3–Saturday, May 6**

**Lower Extremity**

6:00 AM–6:00 PM

**Poster 9 / 6:00 AM–6:00 AM**

Long Term Outcome Following Multilevel Surgery in Cerebral Palsy

Mark Jones, Rick Gardner, Martin Gargan, Jane Pyman, Fergal Monsell

Bristol Royal Hospital for Children, University Hospitals Bristol, Bristol, United Kingdom

**Purpose** Multilevel surgery (MLS) is an established modality in the management of progressive musculoskeletal deformities that occur in Cerebral Palsy (CP). This study evaluates the long-term outcome of a consecutive, single centre cohort.

**Methods** Formal authorisation to conduct this investigation was obtained from the National Health Service, Health Research Authority via a local Research and Ethics Committee. A long-term retrospective study was performed on all patients with diplegic CP who had undergone MLS more than ten years previously.

Gait analysis was performed using the Edinburgh Visual Gait Score (EVGS) and Functional Walking Score (FWS) six months preoperatively, three years postoperatively and at most recent review. The Short Form-36 (SF-36), Western Ontario and McMaster University Osteoarthritis Index (WOMAC) Functional Scale questionnaire and a verbal qualitative interview were used to evaluate outcome.

**Results** Complete assessment was performed in 27 of 39 patients who met the inclusion criteria. Four patients were uncontactable, six patients refused to participate and two patients had incomplete data.

The mean follow-up was 17.7 years (range 10.7–23.8 years) and mean age at final review was 31 years (range 24–41).

The mean FWS at the most recent review was 6.9 (range 2–9) with a mean increase of 1.0 compared with preoperative gait analysis.

There was a mean improvement in the EVGS of 18.4 (range 4–44) compared to the preoperative assessment, but a mean deterioration of 2.9 points, compared to the initial postoperative analysis.

The mean Physical Health and Mental Health Scores for the SF-36 were 39.5 (range 17–61) and 53.0 (range 23–69) respectively. The mean WOMAC Functional Score was 54.2 (range
In short, patients with U-SCFE's were more commonly male, 1 demonstrates differences between U-SCFEs and S-SCFEs. 

Methods We performed an IRB-approved, retrospective analysis of patients with SCFE's that were treated with in-situ fixation at our institution between 2005 and 2016. Pre- and post-operative clinical and radiographic information was collected. The complication rate, presence of impingement, and final hip ROM were recorded. The outcome of U-SCFE's was compared to that of stable ones (S-SCFE). The influence of multiple clinical and radiographic factors on the outcome was analyzed.

Results During the study period, a total of 184 SCFEs were treated in 154 patients. There were 100 males and 54 females, with an age range of 12 years, median weight of 72 kg, and a mean follow-up of 108 weeks (24 to 354). The SCFE was classified as stable in 166 cases (U-SCFE -90.2%), and unstable in 18 cases (U-SCFE -8.7%). Mean length of symptoms prior to admission was 13 weeks. Mean Southwick angle at presentation was 33° (0° to 79°). All surgeries were performed in a flat-top table, without mechanical traction. A single screw was used to fix all S-SCFE's, while a combination of 1 (66.7%) or 2 (33.3%) screws was used to fix U-SCFE's. For U-SCFE's, the joint was decompressed by either needle aspiration or small capsular incision. Mean length of surgery was 57 minutes. Table 1 demonstrates differences between U-SCFEs and S-SCFEs. In short, patients with U-SCFE's were more commonly male, lighter, had shorter duration of antecedent pain, more severe deformity, and required longer surgeries. The final ROM of the affected hip was comparable in both groups. A total of 11 complications (6%) were seen, including AVN (2.1%) and the need for subsequent surgery (3.9%). The rate of AVN in U-SCFEs and S-SCFEs was 11.1% and 1.2%, respectively (p = 0.04). The rate of impingement in U-SCFEs and S-SCFEs was 44.4% and 27.6%, respectively (p = 0.1).

Conclusion U-SCFEs are challenging. Patients with U-SCFEs tend to be lighter, have a more severe pre-operative deformity and present a greater operative challenge as suggested by longer operative times. The greater preoperative deformity seen in U-SCFEs correlated with a higher rate of radiographic impingement during follow up.

Significance While the results of this study suggest that the risk of AVN is significantly higher in U-SCFEs, it does appear that the rate is much lower than previously reported in smaller series of U-SCFE's.

Wednesday, May 3–Saturday, May 6

Lower Extremity
6:00 AM–6:00 PM

Poster 10 / 6:00 AM–6:00 AM

The Outcome of In-Situ Fixation of Unstable Slipped Capital Femoral Epiphysis: Is the Rate of Avascular Necrosis (AVN) as High as Previously Reported?

Pamela Lang, Erin Delfosse, Hemali Panchal, Mauricio Silva

Orthopaedic Institute for Children, Los Angeles, CA, United States

Purpose There is limited information regarding the outcome of unstable Slip Capital Femoral Epiphysis (U-SCFE). Available series are small, with rates of AVN as high as 50%. We report the outcome of a relatively large group of U-SCFE's that were treated with in-situ fixation.

Methods We performed an IRB-approved, retrospective analysis of patients with SCFE's that were treated with in-situ fixation at our institution between 2005 and 2016. Pre- and post-operative clinical and radiographic information was collected. The complication rate, presence of impingement, and final hip ROM were recorded. The outcome of U-SCFE's was compared to that of stable ones (S-SCFE). The influence of multiple clinical and radiographic factors on the outcome was analyzed.

Results During the study period, a total of 184 SCFEs were treated in 154 patients. There were 100 males and 54 females, with an age range of 12 years, median weight of 72 kg, and a mean follow-up of 108 weeks (24 to 354). The SCFE was classified as stable in 166 cases (S-SCFE -90.2%), and unstable in 18 cases (U-SCFE -8.7%). Mean length of symptoms prior to admission was 13 weeks. Mean Southwick angle at presentation was 33° (0° to 79°). All surgeries were performed in a flat-top table, without mechanical traction. A single screw was used to fix all S-SCFE's, while a combination of 1 (66.7%) or 2 (33.3%) screws was used to fix U-SCFE's. For U-SCFE's, the joint was decompressed by either needle aspiration or small capsular incision. Mean length of surgery was 57 minutes. Table 1 demonstrates differences between U-SCFEs and S-SCFEs. In short, patients with U-SCFE's were more commonly male, lighter, had shorter duration of antecedent pain, more severe deformity, and required longer surgeries. The final ROM of the affected hip was comparable in both groups. A total of 11 complications (6%) were seen, including AVN (2.1%) and the need for subsequent surgery (3.9%). The rate of AVN in U-SCFEs and S-SCFEs was 11.1% and 1.2%, respectively (p = 0.04). The rate of impingement in U-SCFEs and S-SCFEs was 44.4% and 27.6%, respectively (p = 0.1).

Conclusion U-SCFEs are challenging. Patients with U-SCFEs tend to be lighter, have a more severe pre-operative deformity and present a greater operative challenge as suggested by longer operative times. The greater preoperative deformity seen in U-SCFEs correlated with a higher rate of radiographic impingement during follow up.

Significance While the results of this study suggest that the risk of AVN is significantly higher in U-SCFEs, it does appear that the rate is much lower than previously reported in smaller series of U-SCFE's.

Wednesday, May 3–Saturday, May 6

Trauma
6:00 AM–6:00 PM

Poster 11 / 6:00 AM–6:00 AM

The Management of Paediatric Open Tibial Fractures – Nine Years’ Experience of 61 Cases at a Paediatric Specialist Centre: A Retrospective Case-Series.

Rajpal Nandra, Feiran Wu, Andrew Gaffey, Christopher Bache

Birmingham Children’s Hospital, Birmingham, West Midlands, United Kingdom

Purpose Open tibial fractures are complex and difficult to treat, with current evidence pre-dating the introduction of national standards in 2009. We investigate the management of skeletally immature open tibia fractures at a paediatric trauma centre, encompassing a multi-disciplinary combined orthopaedic and plastic surgery pathway.

Methods A retrospective review was performed over nine years. Sixty-one children were treated with a mean age of nine years and median follow-up of ten months. Patients received intravenous antibiotics, early debridement and combined multidisciplinary treatment of skeletal and soft tissue injuries in line with BOA standards.

Results There were 37 diaphyseal fractures and 24 distal tibial fractures. Of the distal fractures, eight involved the physis. Motor vehicle collisions accounted for two thirds of the injuraies and 38 patients arrived out of normal working hours. The fracture stabilisation methods comprised: casting in 9 cases (15%); elastic nailing in 19 (31%); Kirschner wiring in 14 (23%); IM nailing in 1 (2%); ORIF in 3 (5%); and external fixation in 15 (25%). Wound management comprised: primary wound closure in 24 cases (39%), delayed primary closure in 11 (18%), SSG in 8 (13%), local flap with SSG in 17 (28%) and a free flap in one case. Seventy percent of cases were Gustilo grade 3.

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We observed four superficial (6.6%) and three deep (4.9%) infections. Two deep infections occurred following open reduction and plate fixation and the third after Kirschner wire stabilisation of a distal injury. No patients who underwent primary wound closure developed infection. No patients failed to unite, although nine patients did require revision of mono-lateral to circular frame for delayed union (2/9) or unsatisfactory limb alignment or length (7/9). Median time to union was 14 days longer in diaphyseal compared to distal fractures (76 vs. 91 days, \( p = 0.016 \)). We found adolescent children had a longer time to union compared to patients under 12 years old (114 vs. 80 days, \( p = 0.045 \)). Gustilo grade 3B injuries required twice the hospital stay compared to less severe injuries.

**Conclusion** Paediatric patients have favourable healing potential with better outcomes than adults. We discourage the use of internal plate devices but advocate aggressive debridement in theatre with early definitive combined orthopaedic and plastic surgery skeletal stabilisation and synchronous soft tissue cover.

**Significance** A large sample, multi-surgeon study where treatment regime of urgent antibiotic administration and multi-disciplinary early debridement had a low deep infection rate of 4.9%.

**Wednesday, May 3–Saturday, May 6**

**Poster 12 / 6:00 AM–6:00 AM**

**Health-Related Quality of Life After Midshaft Fractures of the Clavicle in Children and Adolescents.**

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**Purpose** Midshaft clavicle fractures are among the most common fractures in children and adults. There is a considerably debate regarding the preferred treatment strategy. While this used to be a classic domain for conservative treatment, there is a notable trend in the literature towards operative treatment, both in adults in children, especially in displaced fractures. In pediatric traumatology, there is only a limited number of trials that include a clinical long-term follow up which include a larger number of patients. The aim of this study was to examine the health-related quality of life after pediatric and adolescent midshaft clavicle fractures in a large pediatric trauma center.

**Methods** We identified a total of 785 patients treated conservatively or operatively for a fracture of the clavicle in our institution between 01.01.2004 and 31.06.2015. Exclusion criteria were age greater than 16 years, inability to fill in the questionnaire because of language deficiencies, neurologic or metabolic disorders or birth trauma. Of these, 682 had a midshaft clavicle fracture, as defined by the middle 1/3 of the clavicle. All patients were sent a questionnaire that included the Quick-DASH (Disabilities of the Arm, Shoulder, Hand) and the Peds-QL (Pediatrics Quality of Life).

**Results** Currently, we were able to follow-up on 183 boys and 148 girls, resulting in a follow-up rate of 48.5%. The average age of the study participants was 6.78 (range 0.46 to 18.86) years. Of these, 324 were treated conservatively and 7 were treated operatively (ESIN (n=4), plate (n=1), Ex Fix(n=2)). At a mean follow-up of 6.1 years (range 0.99 to 12.33 years) the mean Quick Dash was 2.99 (SD 6.08) and the mean PedsQL Score was 96.74 (SD 8.23). In addition, 91% of participants reported good to excellent satisfaction with the cosmetically appearance. Data collection is continuing and data from a more complete follow-up will be presented.

**Conclusion** In our preliminary analyses of 331 children and adolescents with a midshaft fracture of the clavicle, there were good to excellent result in the majority of our patients who were treated conservatively. While these preliminary results might be biased due to a non-complete follow-up, there was not statistically significant effect of age at accident, gender or initial dislocation. Therefore, conservative treatment appears to result in high health-related quality of life in this patient group.

**Significance** Our data do not justify the current trend towards operative treatment for midshaft fractures of the clavicle in children and adolescents.
(thoracic 0.81 cm/year and lumbar 0.59 cm/year) (p<0.05) and 6–8 years (thoracic 0.70 cm/year and lumbar 0.54 cm/year). The mean growth rates in the upper thoracic and lumbar vertebral height in the 0–3 years were greater than the ones in the 6–8 years (p<0.05), with no significant difference between 4–5 years and 6–8 years. The growth rate of the lumbar vertebral height was greater than the middle thoracic which was greater than the upper thoracic during the 0–3 years of age (p<0.0001) (Table).

Conclusion The initial growth spurt of the spine in IIS is in the first three years of life and is greatest in the lumbar spine.

Significance Initiating casting prior to 3 years of age will provide the greatest opportunity for success since rapid growth occurs in this time period.

Wednesday, May 3–Saturday, May 6

Spine
6:00 AM–6:00 PM

Poster 14 / 6:00 AM–6:00 AM

Peri-Operative Outcomes in Obese Vs. Non-Obese Children Following Posterior Spinal Deformity Surgery: An ACS-NSQIP Analysis

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Purpose Posterior spinal fusion for the treatment of scoliosis is one of the most common spinal procedures in the pediatric population. However, the role obesity may play on outcomes following this extensive surgery is poorly understood. The purpose of this study was to evaluate the effects of obesity on short term peri-operative outcomes in posterior spinal deformity surgery.

Methods The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database for children was queried to identify pediatric patients who underwent posterior spinal deformity correction surgery. Children were categorized as obese if their BMI exceeded 95th percentile for their age group in months or if their BMI exceeded 30 kg/m2. They were then compared in regards to demographics, medical conditions, or post-operative complications. Statistical analysis was performed utilizing independent t-tests for continuous variables and chi-square analysis for categorical data. An alpha level of <0.05 denoted statistical significance.

Results A total of 4410 patients met the inclusion criteria for the study. Of these, 3768 patients were non-obese while 642 patients met the criteria for pediatric obesity. Preoperatively, obese patients were more likely to be males (35.5% vs. 29.3%, p<0.05), younger (13.1 ± 2.8 vs. 13.7 ± 2.9, p<0.05), and diabetic (0.9% vs. 0.3%, p<0.05). Obese patients also demonstrated a lower incidence of cerebral palsy (5.0% vs. 12.1%, p<0.05) and nutritional support (3.6% vs. 10.5%, p<0.05). Intra-operative findings demonstrated longer total operative time (314.5 ± 118.9 vs. 293.6 ± 116.6 mins, p<0.05) and time under anesthesia (423.4 ± 133.6 vs. 401.0 ± 132.2 mins, p<0.05) in the obese cohort. Post-operatively, obese patients demonstrated a higher incidence of superficial surgical site infection (SSI) (2.2% vs. 0.8%, p<0.05), deep SSI (2.3% vs. 0.9%, p<0.05), and pulmonary embolism (0.2% vs. 0.0%, p<0.05). No other differences were observed in demographics, medical conditions, or post-operative complications.

Conclusion Obesity significantly increases the risk for early complications in pediatric patients undergoing spinal deformity surgery. Obese patients are at increased risk for longer operative time, anesthesia exposure, postoperative infection, and pulmonary embolism.

Significance These potential complications contribute significantly to morbidity and may even be life threatening. As such, spine surgeons should be cognizant of these potential adverse outcomes and should consider the benefits of prophylactic protocols. In addition, prospective standardized studies should be conducted to elucidate the risk obesity may play in the development of adverse outcomes following spinal deformity surgery in the pediatric population.

Wednesday, May 3–Saturday, May 6

Spine
6:00 AM–6:00 PM

Poster 15 / 6:00 AM–6:00 AM

Anterior Spinal Growth Tethering Leads to Asymmetric Growth of the Apical Vertebra

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Purpose Anterior spinal growth tethering (ASGT) is a relatively new non-fusion method of spinal growth modulation that aims to create asymmetric growth of vertebrae resulting in progressive scoliosis correction during the adolescent growth spurt. The purpose of this study was to evaluate if ASGT results in asymmetrical apical vertebral body growth and leads to scoliosis correction.

Methods A retrospective review of patients treated with ASGT between 2011 and 2014 was conducted. Patients with >17 months of follow-up and simultaneous bi-planar x-rays were required for inclusion. Patients were excluded if there was evidence of tether breakage prior to 18 months of follow-up. 3D reconstructions based on the bi-planar images were subsequently reconstructed (SterEOS software) and various dimensions/angles of each apical vertebra were serially quantified via custom Matlab (Mathworks, Natick, MA, USA) software. The rate of change over time in each variable of interest (Cobb angle, apical vertebra body convex and concave side heights, apical vertebra body anterior and posterior heights, apical vertebra coronal plane wedging angle, apical vertebra sagittal plane wedging angle) was calculated for the individual patients and compared between groups utilizing nonparametric statistics: patients with scoliosis correction/improved Cobb angle and those with no correction/continued curve progression.

Results Of 13 subjects included, 9 had progressive improvement in their scoliosis and 4 did not improve or worsened.
The average age at tether placement was 11.8 ± 1.8 years with a mean pre-operative scoliosis Cobb angle of 51° ± 11° (35°-69°). All patients were Risser 0. Follow-up ranged from 17–36 months with 4 to 7 post-operative visits. Following tether placement the FE Cobb angle was reduced to 34° ± 8°. Over time, the correction group demonstrated significantly less apical vertebral wedging in the coronal plane, (ave rate of change -0.11°/mo) compared to the no correction group (0.04°/mo, p=0.02). The correction group also showed increased vertebral height over time on the concave side of the curve (0.11 mm/mo), as compared to the no correction group (0.01 mm/mo, p=0.005). Figure 1 is a case example of how the apical vertebral wedging decreased and vertebral height on the concave side increased over 22 months.

**Conclusion** ASGT in immature patients with thoracic scoliosis has the potential to asymmetrically modulate the growth of the apical vertebra. Greater concave sided growth was associated with greater degrees of overall Cobb angle correction.

**Significance** This study offers convincing 3D radiological evidence that ASGT works to modulate vertebral growth as the mechanism of progressive scoliosis correction.

**Wednesday, May 3–Saturday, May 6**

**Spine**

6:00 AM–6:00 PM

**Poster 16 / 6:00 AM–6:00 AM**

**Construct Levels to Anchored Levels Ratio and Rod Diameter Are Associated with Implant-Related Complications in Traditional Growing Rods**

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**Purpose** Implant-related complications (IRC) are among the most common adverse events in traditional growing rod (TGR) surgery for early-onset scoliosis. The current study hypothesized that anchor type and anchor configuration are associated with IRC.

**Methods** A multicenter EOS database was queried. Patients with: 1) age ≤10 years at surgery; 2) spine-based dual TGR; 3) minimum 2-year follow up; and 4) available imaging were included. Cephalad and caudal foundations were grouped based on number of instrumented levels and anchor type. All radiographs were reviewed and IRC was defined as rod fracture, anchor pull out, prominence, and loosening. Based on statistical findings, a “Construct Levels to Anchored Levels” (CL/AL) ratio was calculated, which is the number of levels spanned by instrumentation divided by the number of levels with bone-anchor fixation. Receiver operating characteristic curve was used to define CL/AL threshold.

**Results** 274 patients divided to complicated (n=140) and non-complicated (n=134) groups. Mean follow up was 6.3 years (2.1–18.0 years). No significant differences in age, gender, BMI, ambulatory status, etiology, primary curve size, T1-S1 height, coronal and sagittal balance, and rod material were observed between two groups. Comparative analysis showed that connector type, presence and location of cross-links, number of levels instrumented, number and type of anchors, presence of pelvic fixation, and mirroring of cephalad and caudal foundations were not different (Table 1). However, maximum kyphosis and rod diameter were significantly different. CL/AL ratio threshold was 3.5. Multivariate analysis of kyphosis, rod diameter and CL/AL ratio showed a significant association with IRC (p<0.05).

**Conclusion** While patient characteristics like kyphosis have been proven to be associated with instrumentation failure, it is a combination of characteristics that include rod diameter and CL/AL ratio that showed significant correlation with IRC. It is recommended to validate the proposed CL/AL ratio in future studies.

**Significance** In addition to patient characteristics consideration of length of construct to number of anchored levels ratio and rod diameter should be a part of preoperative planning to minimize implant-related complications.

**Wednesday, May 3–Saturday, May 6**

**Spine**

6:00 AM–6:00 PM

**Poster 17 / 6:00 AM–6:00 AM**

**Correcting for Patient Rotation with Respect to the X-Ray Scanner Improves the Prediction of the 3D Sagittal Spinal Measurements from Radiographs**

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**Purpose** To estimate the 3D thoracic kyphosis from 2D radiographical measurements in the frontal and sagittal view.

**Methods** 46 right thoracic AIS patients received biplanar radiographs. Using a dedicated software, 3D reconstructions of the spine were generated to provide 3D measurements of T1-T12, T1-T4 and T4-T12 kyphosis, L1-S1 lordosis, and pelvic rotation. Using the same radiographs, 2D T1-T12, T1-T4, T4-T12 kyphosis and L1-S1 lordosis, thoracic and lumbar Cobb angles, and the frontal Cobb deformity between T1-T4, T4-T12 were manually measured. Pelvic axial rotation was measured using the frontal and sagittal distances between the two femoral heads on the X-ray images (Fig.1). In addition, 2 factors determining the direction of rotation of the lumbar and pelvis (+1 clockwise, 0 counter clockwise) were considered. A multiple linear regression model was used to predict 3D kyphosis/lordosis from 2D kyphosis/lordosis, 2D frontal curve measurements of the thoracic and lumbar, 2D femoral head rotation, and the two directional factors.

**Results** 2D and 3D pelvic rotation were significantly correlated (r = 0.84, p<0.05). 3D T1-T12 kyphosis was predicted from 2D T1-T12 kyphosis, 2D pelvic rotation, 2D thoracic Cobb, and the direction of pelvic rotation (R² = 0.80, p<0.05). The 3D L1–S1 lordosis was significantly predicted by the 2D L1–S1 lordosis, 2D pelvic rotation, and the direction of lumbar rotation (R² = 0.60, p<0.05). The mean absolute error between
the predicted T1–T12 kyphosis and 3D kyphosis was 4.1° and between predicted lordosis and 3D lordosis was 6.7°. The prediction of the segmental sagittal measurements (T1–T4 and T4–T12 kyphosis) was only predicted by 2D T1–T4 ($R^2 = 0.34$, $p<0.05$) and 2D T4–T12 ($R^2 = 0.66$ $p<0.05$) kyphosis; the corresponding segmental measurements of the frontal thoracic (T1–T4 and T4–T12 Cobb) and pelvic rotation did not appear significant $p>0.05$.

**Conclusion** Considering the pelvic rotation correction can significantly impact the prediction of the 3D kyphosis and lordosis measurements from the 2D radiographic measurements. The T1-T4 and T4-T12 kyphosis do link to the overall rotation of the scoliotic curve, thus could not be predicted by the frontal plane spinal deformity and pelvic rotation.

**Significance** While discrepancies in patient positioning are unavoidable, the presented method permits to correct for patient’s rotation with respect to the scanner and use the 2D radiographical measurements to achieve a better estimate of true 3D sagittal plane measurements.

**Wednesday, May 3–Saturday, May 6**

**Poster 18 / 6:00 AM–6:00 AM**

**Expect Minimal Further Correction and Higher Risk of Complications in Revisions from Traditional Growth Rods to Magnetically Controlled Growing Rods**

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**Purpose** Magnetically controlled growing rods (MCGR) first appeared in the U.S in 2014. While MCGR may minimize surgeries needed for lengthenings compared to traditional growth-friendly instrumentation for early onset scoliosis (EOS) patients, research studies are still lacking. In this study, the spinal deformity correction and complications between new MCGR implants and conversions from other growth-friendly instrumentation were compared. We hypothesize greater curve correction in new MCGR implants compared to conversions, while complications will be higher in conversions.

**Methods** In this retrospective cohort study, MCGR patients were queried from a multi-center EOS registry between 2014 – 2016. Major Cobb and kyphosis angles at immediate postoperative to 40.9°/43.2° immediately after surgery, and 45.4°/46° at 1-year evaluation. The change for the conversions was 63.1°/52.5° to 61.3°/57.4°, and finally 56.1°/58.5°. There were significant decreases in both Cobb and kyphosis angles for the new implants immediately after surgery ($p<0.05$), but not for the conversions. There were 16/49 (33%) unique patients with complications and 24 incidences. Complications occurred for 26% and 44% of the new implants and conversions respectively and the difference trended towards significance ($p=0.18$). While there was a clinically significant difference in complications between the groups, there was no difference in severity per the Smith Classification.

**Conclusion** New MCGR implants had significant Cobb and kyphosis angles correction while conversions did not, due to their previous implants’ correction. The higher complication risk for the conversions is likely influenced by prior spine surgeries. Despite this, the conversion goals were achieved by minimizing the need for repeat lengthening surgeries and by maintaining curve correction.

**Significance** MCGR has significant benefit in treating EOS patients by obviating the need for repeat surgical lengthening procedures. This study demonstrates that MCGR is successful in achieving spinal deformity correction in newly implanted patients, while also maintaining prior correction in converted patients. The higher risk of complications in conversions was expected due to prior surgical history, but still reduces converted patients’ future exposure to surgical lengthenings.

**Wednesday, May 3–Saturday, May 6**

**Poster 19 / 6:00 AM–6:00 AM**

**Incidence of Preoperative Intra-Spinal and Extra-Spinal MRI Abnormalities in Adolescent Idiopathic Scoliosis**

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**Purpose** Indications for the routine use of preoperative magnetic resonance imaging (MRI) in patients with adolescent idiopathic scoliosis (AIS) remain controversial. Previous studies have reported an incidence of intra-spinal MRI abnormalities between 2.8% and 28%, however none of these studies comment on the incidence of extra-spinal abnormalities. A large prospective study concluded that patients with clinical and radiographic diagnosis of AIS should not have preoperative MRI. The purpose of this study was to determine the incidence of intra-spinal and extra-spinal MRI abnormalities in patients with a clinical and radiographic diagnosis of AIS, and to determine if any of these findings required surgical management prior to spinal deformity surgery.

**Methods** We retrospectively reviewed the medical records of a consecutive series of patients with AIS managed with surgery from 1996 – 2015. All patients were evaluated by a single surgeon and all underwent a routine neural axis MRI prior to surgery. MRI reports were reviewed for all patients, and intra-spinal
and extra-spinal abnormalities were recorded. Abnormalities were classified into the following groups: Chiari malformation, syringomyelia, intra-spinal mass, other CNS abnormality, extra-spinal abnormality, spondylolysis/spondylolisthesis, and degenerative changes. Descriptive statistics were used to describe the incidence and types of abnormalities.

**Results** Medical records and MRI reports were available for a consecutive series of 261 patients with AIS. MRI abnormalities were noted in 121 patients (46%). After excluding patients with degenerative changes, MRI abnormalities were noted in 69 patients (26%). The incidence of Chiari malformation was 1.5% and syringomyelia was 5.4%. Extra-spinal abnormalities were noted in 10% of patients, and these findings ranged from benign cysts to malignant soft tissue tumor. Most notably, a massive syrinx associated with Chiari type 1 malformation was discovered in a completely asymptomatic patient with normal preoperative evaluation and reflexes. This finding resulted in neurosurgical decompression prior to spinal deformity surgery. Similarly, a Wilms tumor was discovered in another patient that was treated with surgical resection prior to spinal deformity surgery. Preoperative MRI findings altered surgical management in 0.7% of patients with AIS.

**Conclusion** Significant intra-spinal and extra-spinal MRI abnormalities were noted in patients with AIS. Routine preoperative MRI prior to spinal deformity surgery may be indicated, and it may provide additional health benefits and possibly cost savings.

**Significance** Preoperative MRI may reveal significant intra-spinal and extra-spinal abnormalities requiring surgical management prior to spinal deformity surgery.

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**Purpose** Pre-operative halo gravity traction (HGT) has been utilized in the operative management of severe curves in neuromuscular scoliosis (NMS). Recently, intra-operative halo-femoral traction (IHFT) has become more widely used, but there is a paucity of data comparing these two techniques in the cerebral palsy (CP) patient population. Thus, the purpose of this study was to assess clinical outcomes of HGT versus IHFT in the management of NMS in patients with CP.

**Methods** Retrospectively, patients were included with a diagnosis of NMS secondary to CP who underwent posterior spinal fusion. The HGT cohort included patients with pre-operative HGT and IHFT, where the IHFT cohort received no pre-operative intervention. Pre-treatment and follow-up data points were collected, which included curve type, curve magnitude, presence of hyperkyphosis (>60°), pelvic obliquity (degrees from horizontal), duration of hospitalization (LOS, days) and associated post-operative complications. Statistical significance was defined as p ≤0.05.

**Results** 12 patients (75% male) were treated with HGT and 21 (57% male) were treated with IHFT. See Figure 1 for demographic and initial spinal curve characteristics of the cohorts. Maximal coronal curve correction was 63° (± 31.0°) and 65° (± 18.4°) for the HGT and IHFT groups respectively (p=0.19). Lumbar curve correction was 43° (± 25.9°) for HGT and 62° (± 22.9°) for IHFT (p=0.05). Change in pelvic obliquity was 10° (± 9.6°) in HGT and 19° (± 9.6°) in the IHFT cohort (p=0.03). LOS averaged 36 (± 9 days) in the HGT compared to 16 (± 12 days) in IHFT (p=0.01). 5 patients in the HGT cohort had hyperkyphosis, with average correction of 11° (± 6.4°) compared to nine patients in the IHFT with an average of 26° (± 20°) of correction (p=0.07). There was one complication (wound infection) in the HGT cohort (8%) and four complications (femur fracture, wound infection, hardware removal, revision PSF) in the IHFT (19%) (p=0.88) cohort.

**Conclusion** The HGT and IHFT cohorts had similar pre-operative demographics and curve severity, with the exception of increased weight placed in the IHFT cohort. Post-operatively, there was no difference in maximal coronal or sagittal curve correction in the cohorts. However, there was statistical improvement in lumbar curve correction, pelvic obliquity and decreased LOS in the IHFT group.

**Significance** Consideration should be given to the use of IHFT for the management of severe curves in patients with NMS secondary to CP, since IHFT achieves improved lumbar curve and pelvic obliquity correction without the incremental increase in hospital stay associated with HGT.