Paper #13

Early Onset Scoliosis: Results of Cotrel Mehta Casting from a Single Institution

Kim Hammerberg, Jennifer Schottler

Summary: Early onset scoliosis can lead to significant chest wall deformity resulting in severe restrictive pulmonary disease and premature demise. Treatment of the spinal deformity should control the curvature but allow for continued growth of the spine and thorax. Serial derotational casting can potentially preserve and redirect spinal growth to achieve curve correction.

Hypothesis: Serial derotational casting can achieve and maintain improvement in EOS.

Design: Retrospective review.

Introduction: Serial derotational casting is used as a definitive treatment or a delaying strategy in progressive idiopathic (IS) and non-idiopathic (NIS) early onset scoliosis (EOS).

Methods: A retrospective chart and radiographic review of subjects who underwent serial casting for progressive EOS between 2005 and 2017 at a single institution.

Results: One hundred twenty-five consecutive subjects entered serial cast treatment. Twenty-three are currently being casted, forty-four completed cast treatment and were converted to thoracolumbosacral orthosis (TLSO), eight were converted to observation only, sixteen were treated surgically, 32 were lost to follow-up, and two were excluded for kyphosis. Diagnosis of IS was found in 73 subjects while 50 had NIS. At presentation the Cobb angle (CA) of the IS group (M=48.6o, SD=14.8) did not differ significantly from the NIS group (M=53.2o, SD 22.9; p=.250). At last casting, however, CA of the IS group (M=24.8o, SD=19.1) was significantly different from the NIS group (M=42.9o, SD=28.4; p=.001). Average CA improvement following casting was significantly better in the IS group (48.6o to 24.8o) than the NIS group (52.6o to 42.9o; p<.001). In the IS group 6/73 were converted to growth constructs and 10/50 in the NIS group. Average CA of those who converted to growth constructs was 66.8o at first and 78.9o at last cast. Initiating casting prior to 24 months yielded better curve correction (49.2o to 24.5o vs. 54.2o to 43.5o; p=.002) in the IS group but not in the NIS group.

Conclusion: IS subjects had better curve correction with casting than NIS subjects and initiating casting prior to 24 months in the IS group yielded better results. Subjects who transitioned to TLSO or observation have demonstrated good maintenance of curve correction over time. Subjects who required growing constructs had a higher age and CA at presentation than those who transitioned to a TLSO.

Author disclosures: Kim Hammerberg: none. Jennifer Schottler: none.

Paper #14

Curve Reduction, Radiation Exposure, and Anesthesia Exposure in Serial Elongation De-Rotation Flexion Casting

Christopher Migdal, Joel Lerman, Blythe Durbin-Johnson, Rolando Roberto

Summary: We present our experience with serial elongation de-rotation flexion (EDF) casting at a single center, focusing on reduction of primary coronal curve angle and the cumulative exposure to general anesthetics and diagnostic radiographs.

Hypothesis: Serial EDF casting will result in significant coronal curve reduction, but will require significant radiation and anesthetic exposure.

Design: Retrospective Review.

Introduction: In recent years, serial EDF casting has become the primary modality of treatment for many forms of early-onset scoliosis (EOS) in children between the ages of 2 and 5 years. However, the current literature surrounding the treatment of EOS with serial EDF casting remains sparse. As ionizing radiation used in spinal imaging and general anesthetics are associated with potentially negative health effects, we sought to tabulate the cumulative exposure to these agents during our standard treatment protocol.

Methods: A retrospective review of a single center's experience treating 22 EOS patients with serial EDF casting. All patients treated at our institution with serial EDF casting were included in this study.

Results: There were 17 idiopathic, 4 syndromic, and 1 neuromuscular scoliosis patients. Of the 22 total patients, 13 patients completed treatment. The 13 patients who completed treatment started treatment on average at the age of 2.5 and completed treatment on average at the age of 4. They averaged 6.5 casting episodes and were under anesthesia for an average of 8 hours throughout their treatment. They received an average of 9 spine radiographs throughout their treatment course. Our linear mixed effects model incorporated data from all 22 patients. It estimated that they had an average initial primary Cobb angle of 59 degrees which decreased to 37 degrees following the first casting procedure, and continued to decrease roughly 2.5 degrees following each subsequent casting procedure. Upon removal of the cast, the primary Cobb angle averaged 31 degrees.

Conclusion: Our patients responded well to serial EDF casting with approximately 50% reduction in their primary Cobb angle during treatment. While serial EDF casting is an effective treatment for EOS, the effects of sequential radiographs and anesthetic exposures warrant further study.

Imaging, Anesthesia, and curve correction in patients who Completed Treatment

	μ	σ	Range
Spine x-rays (#)	8.9	5.0	(3-21)
AT per casting (hours)	1.3	0.3	(0.8-2.8)
Total AT per patient (hours)	8.3	4.2	(2.5-16.3)
CCM pre-EDF (degrees)	54.9	12 8	(35-74)
CCM after finnl cast (degrees)	21.2	12.1	(3-46)
First CCM out of cast (degrees)	30.6	15.1	(5-50)

AT=Anesthesia time, CC=Coronal curve magnitude, μ=mean, σ=std. dev

Author disclosures: Christopher Migdal: none. Joel Lerman: none. Blythe Durbin-Johnson: none. Rolando Roberto: none.

Paper #15

A United Kingdom single centre review of the impact of extended waiting times in Early-Onset Scoliosis: the effect of a delay to surgical treatment of greater than 12 months.

Morgan Jones, Matthew P. Newton Ede, Jwalant Metha, Adrian Gardner, Jonathan B. Spilsbury, David Marks

Summary: Early onset scoliosis (EOS) represents a uniquely challenging demographic with increased complexity compared to other forms of scoliosis. Timely intervention is necessary to ensure optimal outcome. Delays to surgery can lead to impaired physical function, reduced pulmonary function or a change in planned surgery. The extent that pulmonary development is impaired by surgical delay is difficult to quantify.

Hypothesis: Delayed treatment in EOS results in impaired physical function, more complex surgery and potentially compromises outcome.

Design: Retrospective case series review.

Introduction: EOS is a progressive deformity leading to impaired physical and respiratory function. The aim of this study was to quantify the effect of delayed treatment in EOS.

Methods: All patients awaiting surgery for EOS were identified at a specialist centre for paediatric deformity. Cases where surgical intervention was still pending at 12 months after recommendation for surgery were identified. Each case underwent review by 2 consultant spinal surgeons. Factors leading to delayed treatment, radiologic

assessment of deformity progression and changes in planned surgical management as a result of delay were recorded. Patients were graded on the degree of harm suffered as a consequence of delayed treatment utilising the National Patient Safety Agency harm criteria (United Kingdom).

Results: 94 patients were awaiting surgery for greater than 12 months (range 12 - 80). Of these 4 patients were graded as suffering severe harm including reduced pulmonary function. Average age at surgery was 7.8yrs (4-12.8). Average curve deterioration whilst awaiting surgery was 27 (14-43) degrees for major and 21 (8-56) degrees for minor curves. Postoperative correction averaged 37% (61-14%) for major and 48% (72-17%) for minor curves. Planned anterior surgery was abandoned in 1 patient and 1 patient underwent definitive posterior instrumented fusion instead of growing rods due to curve progression or worsening respiratory function. 2 patients suffered moderate harm requiring an unplanned anterior release due to delay. In all cases combined factors contributed to delays. Organisational delays along with composite delays in medical management across specialties significantly contributed to delayed surgery.

Conclusion: Delayed surgical intervention in EOS can result in severe patient harm. Greater integration of medical and surgical specialties with investment in organisational infrastructure could potentially reduce episodes of harm in our organisation.

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Paper #16

HIF-1α critical to Somitogenesis and interacts with the Notch pathway leading to vertebral malformations

Angela Yao, Frances Farley, Ernestina Schipani

Summary: HIF-1α is critical to somitogenesis. Lack of HIF-1α disrupts the Notch signaling pathway which leads to vertebral malformations seen in congenital scoliosis.

Hypothesis: To develop a knockout mouse model for Jarcho-Levin Syndrome using HIF-1α knock out mice.

Design: To produce and characterize a HIF-1α knockout mouse. We sought to characterize this mutant mouse and test the mutant mouse for common Notch pathway genes.

Introduction: HIF-1α is a gene that is up regulated in a hypoxic environment. Jarcho-Levin syndrome includes severe congenital scoliosis and is associated with 4 genes in the Notch pathway of somitogenesis.

Methods: A HIF-1α knockout mouse model was produced. The mutant phenotype was characterized. The mutant phenotype was tested to see whether the vertebral malformation was affected during somitogenesis versus endochondral bone development by conditional knocking out HIF-1α chondrocytes using Col2a1-Cre mouse line. The mutant HIF-1α-CKO embryos were tested for the expression of four Notch pathway genes (Dll1, Lfng, Hes7, and Mesp2).

Results: 25 HIF-1α CKO mutant mice were analysed from embryonic 14.5 days to Newborn. These mutant mice have many vertebral and rib abnormalities similar to those seen in Jarcho-Levin Syndrome. Conditional knocking out HIF-1α chondrocytes using Col2a1-Cre mouse line did not produce the vertebral abnormalities. 31 mutant embryos analyzed by whole mount in situ show an abnormal pattern of segmented somites, and there was disrupted expression of Dll1, Lfng, Hes7, and Mesp2 in the mutant embryos.

Conclusion: The HIF-1α-CKO mutant mice are a mouse model for Jarcho-Levin Syndrome. HIF-1α is important in somitogenesis. Notch signaling pathway is disrupted in the HIF-1α-CKO mutant mice.

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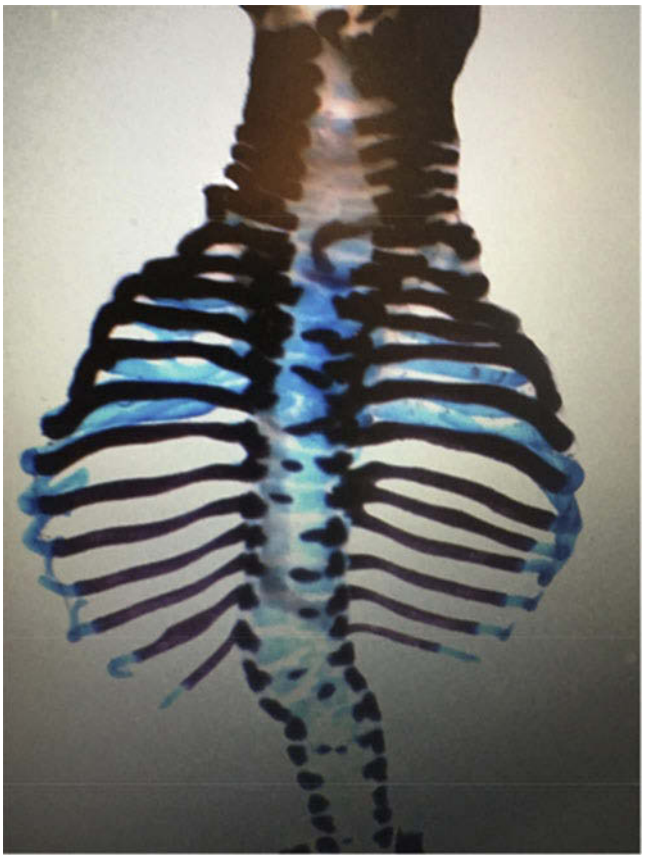

Paper #17

Early Onset Scoliosis within the 22q11.2 Deletion Syndrome (22q11.2DS)

Jelle Homans, Vyaas Baldew, Tom Schlösser, Moyo Kruyt, René Castelein

Summary: 22q11.2DS is the most common microdeletion syndrome. It is characterized by a wide phenotypic variability, including scoliosis. This is the first epidemiological study that shows that the prevalence of early onset scoliosis within this vulnerable group of patients is around 40%. A congenital heart defect (CHD) irrespective of surgery was an independent risk factor, with an Odd′s Ratio of 12.09.

Hypothesis: The prevalence of early onset scoliosis within 22q11.2DS is increased

Design: Cross-sectional, based on prospectively collected data.

Introduction: 22q11.2DS is the most common microdeletion syndrome with a prevalence of 1:4000 new-borns. It is known to have wide phenotypic variability, including scoliosis, that, often, strongly resembles idiopathic scoliosis. The prevalence of scoliosis within 22q11.2DS is unknown. This epidemiological study on prospective data identifies the prevalence and clinical risk factors associated with the development of early onset scoliosis within 22q11.2DS.

Methods: Since 2014 all 22q11.2DS patients are radiographically screened for scoliosis in our 22q11.2DS clinic. All patients less than ten years old that visited the outpatient clinic between January 2014 and June 2017 were included. The prevalence of scoliosis (>10 degrees Cobb Angle) was determined. The criteria defined by Spiegel et al. (2003) were used to divide curves into ′typical′ (idiopathic-like) or ′atypical′ curves. Furthermore, clinical characteristics that may be associated with the presence of a scoliosis, like CHD with or without