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Abstracts from the 3rd International Congress on Early Onset Scoliosis and Growing Spine, 20–21 November 2009, Istanbul, Turkey

FREE PAPERS

1

CONCURRENT TETHERED CORD RELEASE AND GROWING ROD INSERTION—IS IT SAFE?

Jon Oda, Suken Shah, William Mackenzie

Summary: We reviewed our experience with 3 patients who underwent tethered cord release and growing rod implantation under one anesthetic. All procedures were successfully performed with no neurologic complications. We believe that this combination of procedures is safe when modern surgical and monitoring techniques are utilized.
Introduction: Historically, patients with scoliosis associated with a tethered cord were treated in a staged fashion, due to concerns of neurologic injury. However, recent advances in neurophysiologic monitoring techniques have increased the margin of safety.
Methods: This is a retrospective case series of all patients who underwent concomitant tethered cord release and growing rod insertion with neurophysiologic monitoring (SSEP, tcMEP, EMG) at our institution.
Results: We identified 3 patients meeting criteria for this study. There were no intraoperative neurophysiologic monitoring alerts, and there were no postoperative neurologic changes. We achieved an average of 43.3° (47.6%) of correction.
Conclusion: To our knowledge, this is the first report of simultaneous tethered cord release and growing rod insertion. We believe this combination can be performed safely; further studies with larger numbers are necessary. We recommend that combination neurosurgical/orthopaedic procedures be performed under multimodality neurophysiologic monitoring, and that the amount of distraction applied be modest.
FDA Disclosure: Cleared: No.

- pedicle screws.

	Age at surgery	Type of scoliosis	Comorbidities	Preoperative Neurologic Baseline	Surgical Procedures	Neuromonitoring	EBL	Preoperative Curve Magnitude	Immediate Postoperative Curve Magnitude	Postoperative Complications
#1	7	infantile	Partial sacral agenesis, VATER, TEF, developmental delay, hearing loss, GERD, asthma, short stature	Clinically no focal deficits	Tethered cord release via L5 laminectomy, PSF T3-T4 and L2-L3 with dual growing rod insertion	baseline SSEP with decreased posterior tibial nerve stimulation, normal baseline TcEMG, no change during procedures	80	90 T5-L2	36 T5-L2 (60% correction)	SIADH, resolved spontaneously
#2	4	Infantile	Unknown skeletal dysplasia, cervical stenosis status post C1 laminectomy	Neurogenic bladder, mildly increased tone left lower extremity	Tethered cord release via L5 laminectomy, PSF T3-T4 and L4-L5 with dual growing rod insertion	Poor SSEPs but functioning bilateral TcMEP, no change during procedures	125	90 T11-L3	53 T11-L3 (41% correction)	none
#3	6	Congenital, mixed type	Polycystic kidney, hip dysplasia treated previously in a pavlik, restrictive lung disease, hemiatrophy	Clinically no deficits	Tethered cord release via S1 laminectomy, PSF T2-T3 and L3-L4 with dual growing rod insertion	Baseline SSEP with decreased posterior tibial and ulnar nerve responses, normal TcMEP, no change during procedures	240	93 T7-L3	54 T7-L3 (42% correction)	none

2

DISTAL PEDICLE SCREWS MIGRATION IN GROWING RODS, DOES IT REALLY HAPPEN?

Hazem Elsebaie, Hossam Salah

Summary: A retrospective review of radiographs of 23 patients treated with single growing rods with a minimum of 4 distractions. We found that the change of screws position toward a more caudal direction in relation to the vertebral body after serial distractions is a frequent occurrence in the distal pedicle screws with single growing rods; despite being significant in some cases, it does not seem to have any adverse clinical effects.

Introduction: The change of position of the distal pedicle screws with growing rods in relation to vertebral bodies was described as "Pedicle Screws Migration"; pedicle screws are subjected to serial distractive forces pushing them down with every distraction, in addition there is continuous growth of the vertebral bodies during the treatment period; these the two factors can affect the change of position of the pedicle screws in relation to the vertebrae during the use of growing rods. To the authors' knowledge this finding has never been studied, confirmed or quantified.

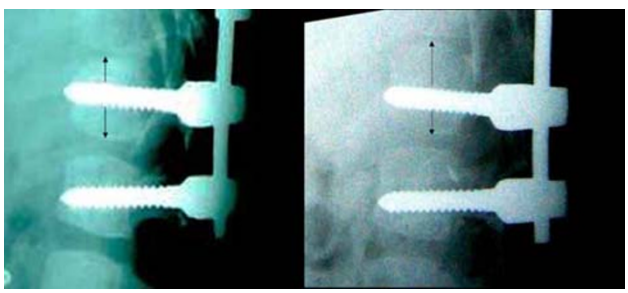
Methods: This is a retrospective review of the radiographs and operative notes of 23 consecutive cases of early onset scoliosis treated with single growing rods with proximal hooks and distal screws constructs. Age at index surgery was 4 year 2 months–8 year 9 months, the number of distractions was 4–11 per patient. Measurements were done on post index and latest follow up true lateral radiographs with optimal initial position of the screws in the pedicle, we calculated the distance between the upper end plate and the pedicle screw (distance superior to the screw SS) and the distance between the screw and lower end plate (distance inferior to the screw IS) and we had this ratio as a percentage: SS/IS X 100. Any increase in this percentage with time denoted a more caudal position of the pedicle scew; however a change in the percentage of less than 10% was considered insignificant as we are looking only for clear obvious changes.

Results: Seven cases were excluded because of inadequate radiographs within the distal construct, measurements of the upper pedicle screw showed that: Six cases had a change of <10% and were considered insignificant. Ten cases had change more than 10%: five had between 10 and 50% change, three between 50 and 100% and two more than 100% change. The changes in the lower screws were always less than the upper one. None of the patients had adverse clinical outcome related to this change.

Conclusion: Change of screw position with time is a frequent occurrence in the distal pedicle screws with single growing rods; despite being significant in some cases, it does not seem to have any adverse clinical effects.

FDA Disclosure: Cleared: No.

- Tandem connector for serial distractions.



3

VERTEBRAL BODY GROWTH DURING GROWING ROD INSTRUMENTATION: GROWTH PRESERVATION OR STIMULATION?

Deniz Olgun, Houman Ahmadiadli, Ahmet Alanay, Muharrem Yazici

Summary: While the growing rod treatment is known to permit growth of the instrumented spine, there still exists doubt as to whether growth is preserved or stimulated. The purpose of this study is to evaluate the effect of the growing rod treatment on the growth of vertebral body within and outside the instrumentation of children treated with the growing rod technique and had sufficient follow up for growth to occur.

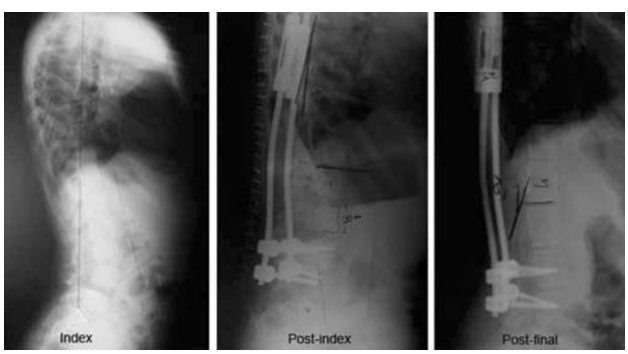
Introduction: While the growing rod treatment is known to permit growth, there is doubt as to whether growth is preserved or stimulated. Posterior distraction has been shown to stimulate vertebral growth. Although it has been shown that a greater amount of growth than expected can be achieved with regular lengthenings, this has not been investigated properly. The purpose of this study is to evaluate the effect of the growing rod treatment on growth of vertebral body within and outside the instrumentation.

Methods: Inclusion criteria were: deformities that permit measurement of a normal vertebra each within and outside instrumentation levels (down to L4), minimum of 4 lengthenings regularly every 6 months, clear X-ray data with scale information. The height of selected vertebra within instrumentation levels (WIL) was measured in post-index and post-final X-rays, the difference compared with a vertebral segment outside instrumentation (OIL) levels. For this purpose, a segment visible on post-index and post-final X-rays was chosen for each patient and measured. The difference in height was calculated by subtracting final postoperative data from index.

Results: 17 patients matched the criteria. The av. age of patients at index operation was 66.2 month (38–105). The patients underwent an av. of 5.5 (4–8) lengthenings. The av. OIL height was 17.6 mm (14.5–22) at post-index and 21.4 mm (17.7–22.8) at post-final. The av. WIL height was 15.7 mm (12.1–21.1) at post-index and 19.7 mm (15–23.3) at post-final. Post-index and post-final measurements were significantly different in both groups ($p = 0.005$), indicating growth. Mean difference in height in the OIL was 3.9 (± 1.6252) while that in the WIL was 4.1 (± 3.1259). The difference in height of these levels was compared and found statistically insignificant ($p = 0.596$).

Conclusion: Post-index and post-final measurements in both levels indicate that significant growth has occurred, which agrees with previous data that growing rod allows growth in non-fused segments within the instrumentation. Although the amount of growth that occurred in WIL vertebrae appears to be more than OIL, it was found insignificant. In a study with a larger cohort and longer follow-up times, this difference might be found significant.

FDA Disclosure: N/A.



4

GROWING RODS FOR SPINAL DEFORMITY: CHARACTERIZING CONSENSUS AND VARIATION IN CURRENT USE

Justin Yang, Mark Mcelroy, Behrooz Akbarnia, Pooria Salari, Daniel Oliveira, George h. Thompson, John Emans, Muharrem Yazici, David Skaggs, Suken Shah, Patricia Kostial, Paul Sponseller

Summary: This article focuses on characterizing the current use of growing rods through surveys and analysis of a multi-center database. We found there were some consensuses on indications for surgery including curve size, flexibility, diagnosis and age. There is also some consensus regarding lengthening intervals and final fusion methods.
Introduction: Growing rods (GR) are a commonly used form of growth guidance for patients with early onset scoliosis, but no studies exist to characterize their use among surgeons.
Methods: A survey regarding GR use preferences and a case-based survey regarding early onset scoliosis were completed by an international group of surgeons. 265 growing rod patients in the GSSG database were analyzed and compare it to the survey.
Results: In the case-based survey, there was correlation ($p = 0.04$, $r = 0.58$) between increasing curve size and the choice to use GRs over non-operative treatment, rib-based distraction (VEPTR), growth guidance (Shilla) and primary fusion. In practice, GRs were used for most types of early onset spine deformity. Most surgeons preferred to initiate GR treatment in a curve over 50°–60° (10/13) in a patient younger than 8–10 years (14/17). In practice, mean curve size at insertion was 73 ± 20° and age was 6.0 ± 2.5 years. Other preferred indications for GRs included curve rigidity (8/17), brace intolerance (6/17) and syndromic diagnoses, such as NF1 (2/17). The most common preferred surgical lengthening interval was six months. However, in practice, lengthenings actually occurred at a mean of every 8.6 ± 5.1 months. In the database, the number of GR insertions per year ($p = 0.02$, $r = 0.96$) and percentage of surgeons using dual rods over single rods ($p = 0.065$, $r = 0.93$) increased over the years of the study. Insertion age ($p = 0.075$, $r = -0.87$) and lengthening interval ($p = .006$, $r = -0.69$) decreased as time progressed. The most common stated indication on the survey for final fusion was skeletal maturity (13/17), and 7/13 surgeons used Risser 3 or more. Indications to stop lengthening included complications such as infection or implant failure (14/17), curves progressing past 90° (8/17) and failure for implants to distract during an attempted surgical lengthening (6/13). The most common method of final fusion is to remove all GR implants and place new implants with more intermediate anchors.
Conclusion: Practice variation exists in growing rod treatment, but there is some consensus on indications for surgery including curve size, flexibility, diagnosis and age. There is also some consensus regarding lengthening intervals and final fusion methods.
FDA Disclosure: Cleared: No.

- Growing Rods.

	Preference Survey (17 Surgeons)	Growing Spine Study Group Database (265 Patients)
Pre-operative Curve Size	(13/17) Most commonly selected indication (10/13) Minimal curve = 50 - 60°	73 ± 20° 87% of patients > 50°
Pre-operative Skeletal Age	(14/17) Maximum = 8 – 10y	6.0 ± 2.5y 94% of patients < 10y at growing rod insertion
Diagnoses		21.9% Neuromuscular scoliosis 20.4% Infantile idiopathic scoliosis 15.8% Congenital scoliosis 10.6% Juvenile idiopathic scoliosis 29.1% Miscellaneous disorders
Other Indications	(8/17) Curve Rigidity (6/17) Brace Intolerance	
Contraindications	(5/17) None (4/17) MM (3/17) Severe kyphosis (2/17) Chest wall deformities	

5

INFANTILE IDIOPATHIC SCOLIOSIS; VARIATIONS IN PREFERRED TREATMENT OPTIONS

Pooria Salari, Daniel Oliveira, Behrooz Akbarnia, Paul Sponseller, Gregory Mundis, Growing Spine Study Group

Summary: In order to evaluate variations of preferred treatment options for infantile idiopathic scoliosis (IIS), case scenarios were created using clinical and radiographic data of eleven patients. Surgeons were asked to select their preferred treatment option. Surgical treatment was recommended 83% of the time. Distraction based growing rod (GR) was the most commonly used technique. There was a considerable variation in level and type of anchors in GR as well as number and levels of apical fusion in Shilla (Growth directed).
Introduction: There is a paucity of data on definitive treatment of early onset scoliosis (EOS). The purpose of this study is to evaluate the variation of preferred treatment options specifically for infantile idiopathic scoliosis among a contemporary group of specialized surgeons.
Methods: Eleven patients with IIS with mean curve size of 87.5° (72°–109°) were included. Mean age was 51 months (20–84). A case scenario was created for each patient including the initial clinical photo and radiographs (AP and lateral). A power point presentation of all information on eleven cases and a response sheet were sent to forty surgeons. Participants were asked to select the treatment option they would prefer for each patient.
Results: 17 surgeons participated in the study. Mean curve size for patients treated non-operatively and operatively was 76° (72°–90°) and 81° (72°–109°) respectively. Surgery was recommended in 83% of cases and all options involved off-label use of currently available pediatric implants. Non-operative treatment was chosen in 17%. GR was the most commonly used technique (57%). Shilla and VEPTR were recommended 15 and 7% respectively. In GR group, a single rod was suggested in 14% and 4.5 mm rods were used in 50%. There was a notable variation in type and level of anchors in the GR group. In VEPTR group, 85% used Spine to Rib anchors. In SHILLA: 83% of selected foundations were between T2–T4 and L2–L5, there was a considerable variation between number and levels of apical fusion. 87% of all non-operative treatments were casting. The greatest agreement among surgeons polled was seen in a 6 y.o. with no kyphosis, and the greatest variation was in a 2 + 6 y.o. child with almost the same curve size and flexibility, but with thoracolumbar kyphosis of 35°.
Conclusion: Significant variations exist in recommended treatment options for EOS. Non-operative treatment continues to be recommended even in children with large size curves. All surgical treatments involved off-label use of pediatric spine implants. Long-term outcome based data is needed to elucidate which treatment option best serves this variable group of patients.
FDA Disclosure: Cleared: No.

- Off-label use of spinal instruments in children.

6

CT LUNG VOLUMES IN EOS—CLINICAL APPLICATION AND EARLY RESULTS

Charles Johnston, Anna MCClung

Summary: Xray measures of chest dimensions were correlated with CT lung volume in 22 patients with EOS followed serially. About 11 patients having surgical rx showed T1–12 height gain >non-operative patients. This height gain correlated with increased CT volume.

% Change in thoracic height, width, and ΔCobb angle had no correlation with absolute or %CT volume change.
Introduction: Determination of CT lung volume is an important objective 3 dimensional measure of anatomic outcome of EOS treatment which augments 2 dimensional xray parameters of thoracic size.
Methods: Controlled-ventilation CT lung volumes (CTvol) were prospectively obtained in 22 patients. About 11 patients had surgical management, with postop scans to compare to preop volume. About 11 non-op patients are being followed to assess lung growth. Serial Cobb angle, T1–12 height (TH), T6 thoracic width (TW) and pelvic width (PW) were correlated to CTvol and % change. About 2 patients had 2 f/u scans, giving a total of 24 data sets.
Results: There were 11 M, 11 F, mean age 33.6 month (range 5–74) at initial scan. 2nd scans were performed at mean 28 month interval per IRB protocol (q^2 year). The convex lung was larger in 14 patients, concave in 8. PW correlated with initial TH ($r^2 = .64$, p non-op but not significant).
Conclusion: CTvol is an objective anatomic measure serving as an indication for surgical rx (failure to grow) or as an outcome measure especially in patients unable to perform standard PFT's. Data is best utilized to control outcome in individual patients. Small cohort size, variation in xray calibration and technique of CVCT insufflation are hypothesized as explanation for inability to document significant group changes in CTvol over time and with treatment. PW, TH and TW are useful 2 dimensional measures which correlate with 3 dimensional thoracic volume change on CT in operative cases. Standardized technique for CVCT is crucial for reproducibility of CTvol data.
FDA Disclosure: N/A.

7

THORACIC FUNCTION: A NEW THORACIC PERFORMANCE CLASSIFICATION BASED ON DYNAMIC LUNG MRI WITH IDENTIFICATION OF A NEW MECHANISM FOR RESTRICTIVE LUNG DISEASE IN EOS, TERMED POSTERIOR OBSTRUCTIVE BLOCKADE

Robert Campbell, Monica Epelman, John Flynn, Oscar Mayer, Howard Panitch, Michael Nance, Thane Blinman, Joe Mcdonough

Summary: Thoracic Function Index is a new thoracic performance classification based on Dynamic Lung MRI. Posterior Obstructive Blockade of the Diaphragm is observable by dynamic lung MRI and is a new Mechanism for Restrictive Lung Disease in EOS.
Introduction: Children with early onset scoliosis with rib hump chest wall distortion or fused/absent ribs have Thoracic Insufficiency Syndrome (TIS), and commonly respiration is adversely affected by loss of lung volume from chest wall constriction and clinical loss of active rib cage expansion. The dynamic thoracic components of diaphragm/rib cage lung expansion during respiration is poorly characterized by radiograph or CT scan. Pulmonary function tests only summate hemi-thorax performance. Dynamic Lung MRI, however, can visualize both chest wall and diaphragm motion, allowing assessment of each individual hemi-thorax performance, so that a dynamic classification system of the thoracic function could be developed.
Methods: Ten patients with TIS underwent dynamic lung MRI testing as part of the routine clinical preoperative work-up. Each hemi-thorax was graded: (1) Intact motion of both chest wall and diaphragm, (2) primarily loss of chest wall motion with minimal diaphragm abnormality, (3) substantial loss of diaphragm excursion with minimal loss or compensatory hyper-kinesis of chest wall, (4) substantial loss of both diaphragm and chest wall motion. The grades for each hemi-thorax were added and averaged as the Thoracic Function score. Ranges of scores are grouped into levels of clinical thoracic performance. Level I thorax: score from 1 to 1.5, Level II thorax: >1.5–2.5, Level III thorax: >2.5–3.5, Level IV thorax: >3.5–4.0.
Results: In 9 EOS pts, 2 were level I, 3 were level II, and 4 were Level III. In 4 patients there was marked posterior obstruction of diaphragmatic excursion by soft tissue organs. 1 pt with hypoplastic thorax without scoliosis was Level II.
Conclusion: Thoracic Function Index is a new thoracic performance classification based on Dynamic Lung MRI that has potential to identify biomechanical abnormalities of the thorax in EOS that cause restrictive lung disease and may provide insight as to how to reverse the abnormality with new types of surgeries. Posterior Obstructive Blockade of the Diaphragm is identified as a new etiology for components of restrictive lung disease in EOS.
FDA Disclosure: N/A.

8

DYNAMIC THORACOPLASTY FOR ASPHYXIATING THORACIC DYSTROPHY USING A MODULAR DISTRACTION DEVICE

Chukwudi Chukwunyerenwa, Damian Mccormack

Summary: We describe a new method of surgical intervention in an infant with severe asphyxiating thoracic dystrophy in which we gradually expanded the thoracic cavity over a period of 4 years using an internal distracting device, thereby facilitating the normal development of the lungs as the child grew.
Introduction: Asphyxiating thoracic dystrophy (Jeune syndrome) is an autosomal recessive disease manifesting with a broad spectrum of clinical expression including deformities of the thoracic cage, pelvis and extremities. The most prominent clinical presentation is alveolar hypo ventilation as a result of a non compliant thorax. In severe form, death of the infant ultimately results from progressive pulmonary damage unless surgical intervention is carried out.
Methods: A sternotomy was performed in a 3 months old male infant with severe asphyxiating thoracic dystrophy in respiratory distress. Using a craniofacial plate connected to an internal modular distraction device with an external dial (Leibinger), the thoracic cavity was expanded by distracting each half of the sternum laterally by simply turning the dial. The chest was gradually expanded over a couple of weeks using this technique initially and as the child grew, we sequentially performed gradual expansion of the chest by distraction of the ribs in a similar fashion using the same technique.
Results: His respiratory symptoms improved dramatically and he is currently thriving well at 4 years of age with no recurrence of symptoms.
Conclusion: This is a new surgical technique for the treatment of the respiratory problem in an infant presenting with severe asphyxiating thoracic dystrophy that could potentially revolutionize the surgical management of this condition.
FDA Disclosure: N/A.

9

ATYPICAL USAGE OF THE VEPTR IMPLANT FOR CHEST WALL AND SPINAL DEFORMITY

Kit Song, John Waldhausen, Gregg Redding

Summary: We have successfully used the VEPTR to reconstruct 2 chest walls in immature children undergoing large tumor resections and in 3 children with severe anatomic abnormalities that necessitated

retropleural and retroperitoneal placement of the VEPTR device. No serious complications resulted and recovery and subsequent expansions have been similar to conventionally placed VEPTR expansions.
Introduction: VEPTR has been used for growth modulation of the thorax for thoracic insufficiency syndrome. Rib to rib, rib to spine, rib to pelvis, and spine to spine constructs are typically used. We have encountered 5 unique clinical situations requiring thorax reconstruction using atypical VEPTR constructs in growing children.
Methods: We have performed 82 primary VEPTR implants in 48 children since inception of our program in 2002. Two of these were for large chest wall defects due to tumor resection. Titanium wires used as intramedullary rods spanned the defect from rib remnants to the rib to rib VEPTR construct. Three patients, 1 infantile neuromuscular scoliosis with kyphosis, 1 Conradi-Hunermann syndrome with kyphosis, and 1 severe scoliosis with large abdominal wall meningocele had placement of either a retropleural or retroperitoneal VEPTR.
Results: Length of follow-up has ranged from 2 to 5 years. No device failures have occurred and 3/5 have undergone expansions of their device without difficulties being encountered. Recovery and function have been similar to conventionally implanted VEPTR. The thorax and spine abnormalities have remained stable over the period of observation.
Conclusion: VEPTR implants can be used to span large chest wall defects to provide chest wall stability and can be implanted and expanded in a retropleural or retroperitoneal position for very severe anatomical abnormalities that preclude conventional placement.
FDA Disclosure: Cleared: Yes.

10

AIRWAY OBSTRUCTION SECONDARY TO THORACOLUMBAR SCOLIOSIS: AN UNDER-RECOGNIZED COMPLICATION

Gary Mcphail, Robert Wood, R. Boesch, Viral Jain, Steven Agabegi, Eric Wall, Alvin Crawford

Summary: The goal of this retrospective review was to describe the airway anatomy on flexible bronchoscopy in patients with thoracolumbar scoliosis and Obstructive Lung Disease on Pulmonary Function Testing. Ninety-five percent of patients in this study had large airway abnormalities on flexible bronchoscopy to explain the pattern of airway obstruction noted on Pulmonary Function Testing. Eighty-one percent of patients had mainstem bronchial compression, likely secondary to lordoscoliosis, as the explanation for their Obstructive Lung Disease.
Introduction: Obstructive Lung Disease on Pulmonary Function Testing has been described in patients with thoracolumbar scoliosis, but there is scant literature on the causes of airway obstruction.
Methods: We searched local databases for patients that received a diagnosis of scoliosis (congenital, neuromuscular, or idiopathic) who had Pulmonary Function Testing and flexible bronchoscopy at Cincinnati Children's Hospital between 1999 and 2009. Patients were included if they had thoracolumbar scoliosis, a Cobb angle of >30°, and Obstructive Lung Disease on Pulmonary Function Testing as defined by ATS/ERS interpretation criteria. Flexible bronchoscopy reports and photographs were reviewed to describe airway anatomy. CT scans were reviewed to compare large airway findings on CT with large airway findings on flexible bronchoscopy.
Results: Twenty-one patients met inclusion criteria. The mean age was 14.6 years (range 6–26). Nine patients were 13 years or younger. The median Cobb angle was 59° (IQR 47–78). The median Forced Vital Capacity (FVC) was 69% of predicted (IQR 62–77). The median Forced Expiratory Volume in the First Second (FEV1) was 58% of predicted (IQR 45–65). The median FEV1/FVC ratio was 72 (IQR 67–75).
Seventeen patients (81%) had mainstem bronchial compression on flexible bronchoscopy. Six patients with mainstem bronchial compression on flexible bronchoscopy had CT scans available. In each of these patients, the compression was notable on CT and associated with adjacent lordoscoliosis. Four patients (19%) did not have large airway compression on flexible bronchoscopy. Three of these patients had visible tracheal abnormalities (two had tracheomalacia and one had vascular tracheal compression) sufficient to explain their Obstructive Lung Disease. Only one patient (5%) did not have a large airway abnormality on flexible bronchoscopy.
Conclusion: Large airway compression is common in patients with thoracolumbar scoliosis who have Obstructive Lung Disease on Pulmonary Function Testing. The potential mechanism of airway compression, lordoscoliosis, may impact surgical approaches and the timing of surgical interventions in this subset of patients.
FDA Disclosure: N/A.

11

RESULTS AND COMPLICATIONS OF KYPHECTOMY (PVCR) FOR PEDIATRIC HYPERKYPHOTIC SPINE DEFORMITIES (AN SRS GOP REVIEW OF ONE SITE)

Oheneba Boachie-adjei, Elias Papadopoulos, Cristina Sacramento, Matthew Cunningham, Kenneth Paonessa, Yamuna Kanazawa, William Aibinder, Baron Lonner, Francisco Javier S Perez-Grueso, Michael Mendelow, Fred Hess, Munish Gupta, Howard Calder, Bettye Wright

Summary: A retrospective review of 19 pediatric patients with hyperkyphosis were treated with a kyphectomy (PVCR) procedure at an SRS global outreach site Significant improvement in Kyphosis was achieved with a satisfactory clinical outcome using the SRS 22 instruments. One patient who developed neurology deficit fully recovered at follow up in an outreach site where optimal conditions for complex deformity surgery is unavailable, a concerted, and expeditious approach was utilized to treat these complex deformities with a satisfactory outcome and minimal complications.
Introduction: Hypherkyphosis confers very high risk for neurologic compromise. Kyphectomy is most frequently undertaken in myelo kyphosis with resection of entire vertebral column.
Methods: A retrospective chart and X-ray review of 19 patients (4 M: 15 F), avg. age (13.3 years), range (5–21 years), treated and followed at the FOCOS clinics in underserved African countries between 2002 and 2007. Preoperative demographics, neurologic status, surgical data and upright full spine X-rays were collected. The deformity apex was resected via a costotransverse (thoracic) or posterolateral (lumbar) approach. Perioperative complications including excessive bleeding, intraoperative neuro monitoring changes, neurologic deficit and implant failure were recorded. Diagnoses included congenital Kyphosis ($n = 5$) and post TB Kyphosis ($n = 14$). Posterior instrumentation was employed in all 19 patients and anterior structural cage was used in 10 patients. No intraoperative radiograph or cell saver was used in this series of patients.
Results: Deformity apex was thoracic (T1–T11) in 4 pts, T/L (T12–L1) in 6 pts, and Lumbar (L2–L5) in 11 pts. Number of levels resected averaged 3 (range 1–5). Instrumentation comprised of hooks (2), hybrid (8), and all screws (9).The avg. EBL was 1,100 cc (350–2,000 cc). Intraoperative monitoring changes occurred in 2 pts with full recovery. One patient had a dense motor deficit post op that fully recovered by 3 months. Avg. pre op kyphosis was 99° and corrected to 47 post-op ($p < 0.001$).

Conclusion: Kyphectomy (PVCR) was successfully undertaken with acceptable results for the management of thoracic and thoracolumbar hyperkyphosis with improvements in overall kyphosis, spinal balance and clinical outcome.
FDA Disclosure: Cleared: Yes.

12

GROWING RODS FOR EARLY ONSET SCOLIOSIS AND ITSELF COMPLICATIONS. A RETROSPECTIVE STUDY OF 129 PTS WITH 10 YEARS FOLLOW-UP

Milan Filipovič, Martin Repko, Miroslav Nýdrle, Milan Leznar

Summary: The purpose of our contribution is to retrospectively evaluated our group of EOS patients treated by single growing rod systems. The evaluation of X-ray films with measurement of changes in Cobb angle of 129 patients treated in period between 1980 and 1999 as well counting of complications rate were the main methods. An average correction percentage was 47% with the 59% rate in number of complications. The older distractive systems had many advangtages as well as high rate of complications.
Introduction: The golden standard in iuvenile scolitic curves was procedure involving single growing rod using subfascial implantation with simultaneous distraction (Harrington or Ascani instrumentation) and repetitive distractions at every 6 month. Orthosis had been used until the age of definitive posterolateral fusion. The purpose of our contribution is to retrospectively evaluated our group of EOS patients treated by single growing rod systems.
Methods: The evaluation of X-ray films with measurement of changes in Cobb angle during the repetitive distraction period was the main evaluation method. We evaluated also advantages as well as disadvantages of this method and we refered to number and character of repetitive distractions specifical complications. The total number of 129 patients were evaluated treated in period between 1980 and 1999. The average number of distractions was 5, 5 times, av. treatment period was 5.5 year and minimal follow up is 10 years.
Results: The average degree of deformity was 70° (45–150) before first surgery with an average correction percentage of 47% (final result of 38°). The rate of number of complications was 59% with 23% of deep infections, 19.5% of hook luxations and 14% of rod broken.
Conclusion: The main advantages of single rod growing systems were good correction of deformity, possibility of later spondylodesis, simple instrumentation (price), short time of surgery and minimal blood losses. On the other side there were main disadvantages like repeated surgeries, lordotisation and setting of distracted segment, truncal brace during the whole time of treatment, high percentage of complications like dislocation of upper hook, broken of distraction rods and deep infect. The modern distractive systems are the point of prospective evalutation in our department.
FDA Disclosure: N/A.

13

TOPICAL NEGATIVE PRESSURE THERAPY FOR WOUND COMPLICATIONS FOLLOWING VEPTR SURGERY

James Simmons III, Vishwas Patil, Ajeya Joshi, Kent Reinker, Robert Campbell

Summary: Children with Thoracic Insufficiency Syndrome (TIS) treated with Vertical Expandable Prosthetic Titanium Rib (VEPTR) may be vulnerable to post-operative wound complications like deep infection or dehiscence. A subset of our VEPTR patients with wound complications were treated with Topical Negative Pressure (TNP) therapy. TNP therapy simplified wound management and was well tolerated. TNP therapy did not allow implant retention in most cases, but served as a valuable tool in the management of complex post-operative wounds.
Introduction: Children with Thoracic Insufficiency Syndrome (TIS) represent a unique patient cohort with chest wall and spine disorders that produce progressive respiratory restrictive disease. Treatment of TIS with Vertical Expandable Prosthetic Titanium Rib (VEPTR) implantation represents an iterative process, accessing the devices through the same wounds on multiple occasions for progressive device expansion and/or replacement. The objective of the current study was to analyze the management of wound complications associated with VEPTR surgeries using Topical Negative Pressure (TNP).
Methods: A retrospective review was performed identifying TIS patients in our institutional database whose VEPTR treatment was complicated by deep infection or wound dehiscence with subsequent management with TNP therapy. Data collected through inpatient and outpatient chart review included presentation of infection, other surgical treatments besides TNP, microbial profile, and eventual outcome of infection and wound status. Radiographic analysis was performed as well.
Results: Fourteen patients received a total of 19 TNP applications. Recurrent wound infection occurred in 5 of the patients. Mean age at the time of TNP therapy was 69 months (range 12–104 months). Average follow-up was 21 months (range 12–37 months). All wounds healed, 11 by secondary intention, 6 by delayed primary closure, and 2 by a combination of closure methods. Average duration of TNP use per application was 14.5 days (range 5–45 days). MSSA was isolated from 6 wounds, MRSA from 4, and other pathogens in the remainder. Implant retention was possible in 7 out of 19 cases. When VEPTR removal was needed, average interval to reimplantation was 7 months (range 6–11 months), but 5 patients could not be reimplanted due to soft tissue deficiencies in spite of infection resolution. VEPTR removal was associated with variable loss of deformity correction. Patients were tolerant of TNP therapy.
Conclusion: TNP therapy is able to provide good wound conditioning and coverage of exposed implants for VEPTR patients with deep wound infection or dehiscence. Wound management and patient care are simplified, and implant retention is possible in some cases. The technique is well tolerated by patients.
FDA Disclosure: Cleared: Yes.

14

SUBMUSCULAR GROWING RODS: TECHNIQUE, RESULTS AND COMPLICATIONS OF 88 PATIENTS WITH MINIMUM 2-YEAR FOLLOW-UP

Suken Shah, Najma Farooq, Enrique Garrido, Stewart Tucker, Hilali Noordeen

Summary: In this consecutive series of 88 patients with 3.8 years follow up, single submuscular growing rods obtained 5.5 cm of growth (in those pts without an apical fusion) and were effective in correcting deformity (70° preop to 37° at insertion to 39° at last lengthening) with a complication rate favorable to previous reports.
Introduction: The challenges of treating children with early onset scoliosis mandate control of the deformity and maintenance of pulmonary function while allowing spinal and truncal growth. Previous publications have demonstrated safety and effectiveness of the growing rod technique in a limited number of patients. The purpose of this study was to report on a large series of patients managed with growing rods from a single center.

Methods: Retrospective review of 88 consecutive patients lengthened from 1999 to 2006 with minimum 2-year follow up. Diagnoses included infantile and juvenile scoliosis (26), congenital (19), neurofibromatosis (4), syndromic (15) and neuromuscular (24). Number and frequency of lengthening, changes in Cobb angle and complications were recorded.
Results: 88 patients with average age of 6.7 years (range 2.1–11) underwent single submuscular growing rod insertion. About 27 patients had a simultaneous short apical fusion. The mean follow up was 3.8 years (2–9.5 years); pts underwent an average of 4.4 lengthenings with a mean interval of 8.1 months. About 30 patients went on to final fusion at a mean age of 12 years. The preop scoliosis improved from 70° (range 50–110) to 37° (range 14–81) after insertion, 39° (7–75) at last lengthening and 32° at final fusion (18–70). In the group without apical fusion, 5.5 cm of length was obtained, compared to 3.8 cm with apical fusion (p).
Conclusion: Single submuscular growing rod constructs were effective in maintaining spinal growth and correcting deformities in early onset scoliosis. Considering the number of procedures performed per patient, the complication rate was acceptable and favorable to dual rod instrumentation.
FDA Disclosure: Cleared: No.

- Growing Rods.

15

LENGTHENING OF DUAL GROWING RODS: IS THERE A LAW OF DIMINISHING RETURNS?

Wudbhav Sankar, David Skaggs, Muharrem Yazici, Charles Johnston, Pooya Javidan, Rishi Kadakia, Thomas Day, Behrooz Akbarnia, Growing Spine Study Group

Summary: A multi-center study was performed to evaluate the effect of repeated surgical lengthenings on spinal growth and Cobb angle in children with early onset scoliosis and dual growing rods. Cobb angle decreased after the primary implantation but did not change significantly with repeated lengthenings. The T1–S1 gain after each lengthening decreased significantly with repeated lengthenings. As a result, it appears as though the "Law of Diminishing Returns" applies to T1–S1 length over multiple surgical lengthenings of dual growing rods.
Introduction: The purpose of our study was to evaluate the effect of repeated surgical lengthenings and time on spinal growth (as measured by T1–S1 length) and Cobb angle in children with early onset scoliosis and dual growing rods.
Methods: A multi-center study was performed in which initial radiographs, post-implantation radiographs, and radiographs from before and after each lengthening were measured for T1–S1 distance and Cobb angle. Inclusion criteria included children with early onset scoliosis treated with dual growing rods, minimum 2 year follow-up and a minimum of three lengthening procedures. Linear regression and ANOVA were used for statistical analysis.
Results: 38 patients from 5 centers met the inclusion criteria. The average age of our patients was 5.6 years (range 1.7–8.9), and the mean follow-up was 3.3 years (range 2–7). The average interval between lengthenings was 6.8 months. Cobb angle decreased from a mean value of 74° preoperatively to 36° after the primary implantation and did not change significantly with repeated lengthenings ($p = 0.96$). The T1–S1 gain after lengthening decreased significantly with repeated lengthenings ($p = 0.007$). Figure 1—in which lengthening #1 is the first lengthening after the primary implant) When the effect of time was considered, there was also a significant decrease in T1–S1 gain over time ($p = 0.014$).
Conclusion: It appears as though the "Law of Diminishing Returns" applies to T1–S1 length over multiple surgical lengthenings of dual growing rods. Repeated lengthenings still result in a net T1–S1 increase, however, this gain tends to decrease with each subsequent lengthening and over time.
FDA Disclosure: Cleared: No.

- Off-label use of spinal instruments in children.

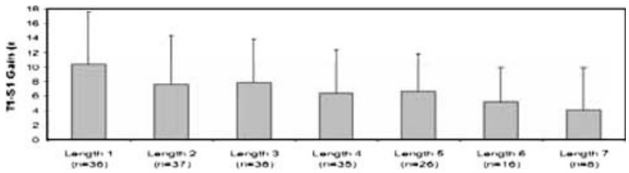


Figure-1 T1-S1 gain with repeated lengthenings

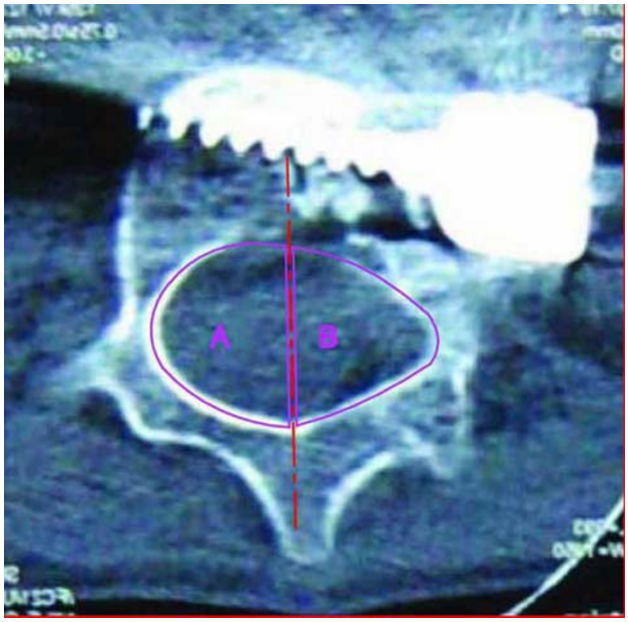
16

EFFECT OF ANTERIOR INSTRUMENTATION IN CHILDREN AGE 1 AND 2 YEARS ON SPINAL CANAL DIMENSIONS

Hazem Elsebaie, Hossam Salah, Hilali Noordeen, Behrooz Akbarnia

Summary: There is an unresolved controversy regarding the effect of screws crossing the Neuro Central Cartilage on spinal canal dimension in immature spine. The results of this retrospective review on 16 anterior vertebral screws inserted in 1 and 2 years old children showed that they are safe however they can encroach on the NCC which seems to cause a decrease in the ipsilateral canal dimension between 10 and 20%.
Introduction: There is an unresolved controversy in the published studies regarding the effect of screws crossing the Neuro Central Cartilage on spinal canal dimension in very young children as well as in experimental animals. Anterior vertebral body screws can encroach and damage the NCC especially at the site of screw insertion where the head of screw lies, this finding as well as its effect on spinal canal dimensions have never been studied.
Methods: Retrospective clinical and radiological analysis of 7 consecutive pediatric cases aged 1 and 2 years treated with anterior vertebral instrumentation by downsized rod screw systems. The mean age at time of surgery was 2 year 4 months (1 year 9 months–2 year 10 months). The average follow up period was 3 year and 3 months (2 year 6 months to 4 year 5 month). A total of 16 screws inserted anteriorely in 16 vertebral bodies were evaluated by a follow up CT scan performed on all of the instrumented levels in addition to one adjacent proximal and distal uninstrumented levels; spinal canals were divided using known anatomical landmarks into right and left hemicanals. The relation of the anterior screws to the NCC and the spinal canal dimension were studied. All clinical or radiological complications ware recorded.
Results: All 16 screws were evaluated regarding their complications; only 11 were suitable for measurements. There was significant difference of 10–20% between the surface areas of the 2 hemicanals in 6 levels where the screw head was passing through or encroaching on the neurocentral cartilage; the canal was always smaller ipsilateral to the affected NCC. The hemicanals were almost symmetrical in 5 levels where the screw heads were away from the NCC except in one in which it was touching the NCC. There was a statistically significant difference between the hemicanal dimension differences in the instrumented levels compared to the adjacent non instrumented levels.

For the 16 screws evaluated there were no recorded complications except for 1 screw breaching the adjacent end plate.
Conclusion: Anterior vertebral body screws are safe however they can encroach on the NCC when inserted in the very young age, this encroachment seems to cause decrease in the ipsilateral canal dimension between 10 and 20%.
FDA Disclosure: Cleared: Yes.



17

POSTERIOR HEMIVERTEBRA/BAR RESECTION AND SEGMENTAL INSTRUMENTATION IN THE TREATMENT OF CONGENITAL SCOLIOSIS AT THE CERVICOTHRORACIC JUNCTION

Lynn Letko, Rubens Jensen, Juergen Harms

Summary: Cervicothoracic junction congenital scoliosis is relatively rare. It may occur in conjunction with Klippel Feil or other syndromes, in conjunction with congenital spine anomalies at other levels in the spine or as an isolated anomaly. The results in 7 patients treated surgically with posterior hemivertebra and/or bar resection and segmental instrumentation are reported.
Introduction: Cervicothoracic junction congenital scoliosis is relatively rare. It may occur in conjunction with Klippel Feil or other syndromes, in conjunction with congenital spine anomalies at other levels in the spine or as an isolated anomaly. The results in 7 patients treated surgically with posterior hemivertebra and/or bar resection and segmental instrumentation.
Methods: About 7 (4 F, 3 M) patients with cervicothoracic junction (C6–T3) congenital scoliosis at the surgically treated (12.01 and 3.07) with posterior hemivertebra/bar resection and segmental instrumentation were retrospectively reviewed. All patients had >2 year follow-up (2 to 9 year + 5 month). Mean age at surgery was 10 years (3 year + 2 months to 15 year + 8 months).
Results: See Table 1.
About 4 patients had additional congenital anomalies at other regions in the spine requiring surgical intervention. About 4 had Klippel Feil syndrome (1/4 Goldenhar syndrome). About 2 patients had a scoliosis below the congenital scolisis pre-operatively and post-operatively that have not required surgical intervention to date. One patient had a cervical kyphosis pre-operatively which remained stable post-operatively.

Pre-operatively, mean curve magnitude was 37° (20°–60°). This corrected post-operatively to a mean of 1.4° (0°–10°) and was maintained at the time of last follow-up. Mean % correction 97% (78–100%).

A halo body jacket was used 3 mos. post-op in 2/7 patients who were instrumented into lower cervical spine.
Complications: About 6 complications occurred in 5 patients, 2 patients instrumented into the lower thoracic region required revisions 2° to screw loosening in that region, 2 patients developed a nerve root irritation post-operatively. This has subsequently resolved, 1 patient developed a post-operative pneumonia and pleural effusion, 1 patient developed a Horner Syndrome.
Conclusion: Posterior hemivertebra/bar resection at the cervicothoracic junction is a technically demanding surgical procedure.
Congenital spinal anomalies are often present at other levels of the spine. These may require operative intervention.

All patients need to be followed until cessation of growth as deformity present prior to surgery or new may develop above or below the surgically treated region in the sagittal or.

FDA Disclosure: Cleared: No.

- I do not know if the FDA has cleared pedicles screw for use in the cervical spine.

Table 1

CT Scoliosis	Pre-op	Post- op	% Correction	Last Follow up	% Correction
C7a (C7 - T4)	40°	0°	100	0°	100
T3 (T2 - T4)	20°	0°	100	0°	100
T3a (T2 - T4)	20°	0°	100	0°	100
T1 (C7-T2)	60°	0°	100	0°	100
T2 (T1- T3)	40°	0°	100	0°	100
Bar C7– T3 (T1 -T4)	35°	0°	100	0°	100
T1a (C6 -T2)	45°	10°	78	10°	78

18

MANAGEMENT AND SURGICAL PLANNING OF SEVERE INFANTILE CERVICAL KYPHOSIS

Dezsoe Jeszenszky, Frank Kleinstueck, Tamas Fekete

Summary: A posterior fusion and decompression in the treatment of cervical kyphosis might worsen the deformity in selected patients. We therefore recommend a combined approach in these selected cases.
Introduction: Congenital cervical kyphosis may, due to cord compression, lead to grave neurological deficit in the infant. The choice of surgical procedure and the age, at which it is indicated, pose a considerable challenge. Inappropriate surgical procedure can produce graver deformity and neurological damage despite best intent.
Methods: Six infants with congenital cervical kyphosis aged 2–7 years, underwent surgery by the senior author. Most of them presented with severe neurological deficit in the form of tetraparesis. Three had been previously subjected to neurosurgical posterior decompression and fusion, which led to recurrence and increase of kyphosis over time. Preoperative kyphosis measured 130°, 125°,

125°, 66°, 60° and 40°. The postoperative followup ranges from 3 to 48 months.
Results: Five cases underwent combined posterior and anterior surgery and one case was operated from anterior alone. Correction was attained and cord decompression was performed in all cases. On average 78% correction of kyphosis was achieved. In one case nerve root neurapraxia was recorded postoperatively but was noted to have recovered completely during followup at 6 months. Two cases demonstrated improvement of tetraparesis postoperatively. There were no intraoperative complications. One infant died 1 week postoperatively due to bolus aspiration. In one case kyphosis progressed below the instrumented levels. Wound infection and implant failure were not evidenced postoperatively or during followup. Correction in previously operated patients was more difficult to obtain.
Conclusion: Infantile cervical kyphosis with neurological deficit poses a significant challenge for the spine surgeon. Posterior decompression and fusion in our previously operated patients did not solve the problem. On the contrary, continuing anterior growth in these patients seemed to aggravate the condition necessitating further combined surgery. We therefore recommend a timely intervention with a combined anterior–posterior approach to balance the spine for future growth in a corrected position. Our initial results have been most encouraging and would lead us to believe, that surgical intervention is warranted.
FDA Disclosure: N/A.

19

COMPLEX CERVICO-THORACIC DEFORMITIES OF GROWING SPINE: SURGICAL RESULTS WITH MINIMUM FOLLOW-UP OF THREE YEARS

Nanjundappa Harshavardhana, Mihir Bapat, Kshitij Chaudhary, Vinod Laheri

Summary: Arrest of deformity progression is necessary to prevent neurological deterioration and optimise outcome in growing spine with complex multi-planar deformity at cervico-thoracic junction. The common etiologies are neurofibromatosis, congenital deformities and infections (tuberculosis). Surgery at cervico-thoracic junction in growing spine has unique challenges. We report a series of 5 cases describing their evaluation, surgical management algorithm and clinico-radiological results. Spine at risk signs and magnitude of deformity are important and emphasis should be on decompression and kyphosis correction.
Introduction: There is paucity of literature on management of rigid and severe kyphoscoliotic deformities at cervico-thoracic junction. Our objectives were to report minimum 3 year f/u clinico-radiological results.
Methods: About 5 patients aged 10.7–16.2 years (mean 13.4 year) having mean cervical kyphosis (CK) of 37 (range 10–60) with its apex between C2–C7 and co-existent structural scoliosis in cervico-dorsal/upper-dorsal region measuring a mean cobb angle of 88 (range 65–115) treated operatively and followed up prospectively for mean 3.9 years (range 3–6 year) formed the study cohort. The etiologies were Neurofibromatosis (3) and Congenital scoliosis with cervical tuberculosis (2). The congenital anomalies seen were hemivertebrae (1) and unilateral unsegmented bar (1). One patient had extradural neurofibromas in cervical spine. Pre-operative halo traction was used in 4 patients. Three patients had neurodeficit [Frankel grades A (1) and B (2)] who underwent staged combined anterior/posterior surgeries whilst 2 with normal neurology had single stage posterior surgery only. Modified manubriotomy was required in 1 case to instrument caudal vertebra. Correction of kyphosis was achieved by intra-operative adjustment of the head assembly with controlled distraction, strut grafting using autologous fibula and anterior instrumentation. The posterior instrumentation was hybrid construct.
Results: The C2–C7 kyphosis measured −5 to 15 at last follow-up resulting in a mean correction of 33 (range 15–49). The mean number of corpectomies performed were 3 (range 1–4) and mean anterior column defect reconstructed was 34 mm (25–44). The average graft subsidence at final f/u was 5 mm (3–8). All 3 patients with neurodeficit improved post-operatively to Frankel E (2) and Frankel D (1). One patient continues to have left hand grip weakness at 4 years post-op. One patient had superficial infection and persistent dysphagia (>3 month).
Conclusion: Neurofibramatous cervical kyphosis of >40 and post-tuberculous cervical kyphosis with ≥2 spine at risk radiological signs, fused facet joints due to disease process or/and presence of neurodeficit requires staged surgery with anterior column reconstruction whilst presence of ≤1 spine at risk sign with normal neurology can be treated by a single stage posterior surgery.
FDA Disclosure: N/A.

20

IN VIVO DISTRACTION FORCE AND LENGTH MEASUREMENTS OF GROWING RODS: WHICH FACTORS INFLUENCE ON THE ABILITY TO LENGTHEN?

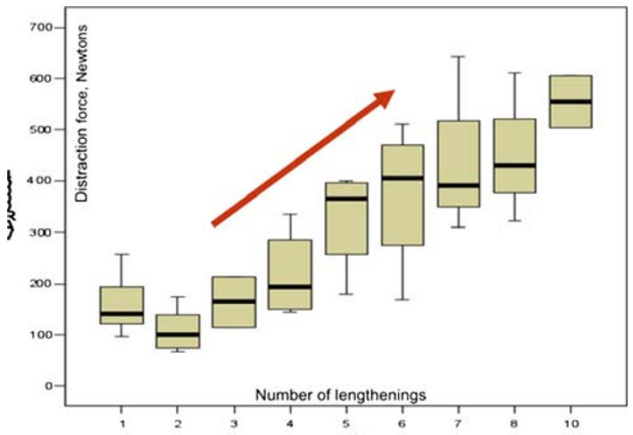
Suken Shah, Enrique Garrido, Najma Farooq, Stewart Tucker, Hilali Noordeen

Summary: In this prospective, consecutive series of growing rod patients undergoing lengthening, significant increases in distraction forces required to lengthen the construct were recorded with each subsequent lengthening. Furthermore, there was a decreasing trend in length achieved with each procedure, especially after the 5th lengthening. Those patients with apical fusions required higher forces to lengthen versus nonfused patients.
Introduction: The goal of the growing rod technique is to achieve deformity correction while maintaining spinal growth. Gradual stiffening or spontaneous fusion of the spine can interfere with the ability to lengthen, and authors have noted increased forces required to lengthen, decreased length achieved and spontaneous fusion already evident at the time of conversion to definitive arthrodesis. The purpose of this study was to measure the forces and amount of distraction over time in a consecutive series of patients with growing rods.
Methods: Distraction forces were measured prospectively during 60 consecutive lengthening procedures in 26 patients by 1 of 2 surgeons. All patients had single submuscular rod constructs with side-to-side connectors. For each measurement, output from a transducer on a dedicated pair of distraction calipers was recorded at zero load status

and at every 1 mm lengthening. Resting load prior to any distraction was recorded. Length obtained at each event was recorded in mm.
Results: Mean peak forces were significantly higher then previously reported (see graph) and increased sequentially with each lengthening. The force required to distract the spine doubled at the 5th lengthening procedure (mean 368 ± 54 N) and the distraction force was significantly higher at the 5th lengthening compared to the previous lengthening (p).
Conclusion: Distraction forces increase significantly after repeated lengthening of growing rod constructs and the length obtained at each procedure exhibits a decreasing trend. The higher distraction forces measured on patients who had an apical fusion may explain the increased incidence of instrumentation failure reported in the literature.

FDA Disclosure: Cleared: No.

- Growing Rods.



21

PORCINE MODEL FOR SCOLIOSIS: PROGRESSION OF VERTEBRAL WEDGING AFTER REMOVAL OF THE MECHANICAL TETHER—A 3D VERTEBRAL AND DISC MORPHOMETRIC ANALYSIS

Ashish Patel, Renaud Lafage, Frank Schwab, Jean-pierre Farcy, Virginie Lafage

Summary: A Porcine Model for Thoracic Scoliosis has been described that shares radiographic and CT features pathognomic for adolescent idiopathic scoliosis (AIS). Scoliosis is induced via application of a posterior unilateral synthetic tether and ipsilateral ribcage tethering in an immature Yorkshire pig. The current investigation demonstrates that scoliosis induction for a mean 5–6 weeks results in progression of vertebral wedging as seen in Adolescent Idiopathic Scoliosis (AIS) even after release of the mechanical tether.
Introduction: Mechanical induction of scoliosis in an immature animal model has been previously described, most recently with the Porcine Model for Progressive Thoracic Scoliosis (PSM). The PSM uses a flexible mechanical tether to induce a progressive three dimensional deformity. Using detailed 3D reconstruction, this study aims to compare the vertebral/intervertebral morphometry between groups with and without tether release.
Methods: 17 spines divided into 2 groups were analyzed: a Scoliosis Model branch (SM, $n = 11$), and a Tether Release branch (TR, $n = 6$). Scoliosis was induced in an identical fashion via a posterior left-sided ligamentous tether fixed with pedicle screws ($\sim$T4-5–L1-2) and ipsilateral ribcage tethering. SM was observed for a mean 10.5 weeks, 54.7° Final Cobb. TR was observed for a mean 5.4 weeks, 49.7° Intermediate Cobb before tether release, than followed for a further mean 20 weeks, with a mean final Cobb angle of 42.4°. Animals were euthanized and spine CT scans obtained. Fine cut axial slices (0.6 mm) were used to create a volumetric 3D reconstruction of the apical level (3 vertebrae, 2 discs). 121 standard markers were used to define vertebral/intervertebral morphology while Matlab was utilized to measurements. Student T-test was used to evaluate differences between SM and TR groups.
Results: TR demonstrated a significant increase in A/P and L/R vertebral heights versus SM. Regarding vertebral wedging, a significant increase in coronal apical wedging was found between the TR and SM group, 30.8° versus 23.0°, $p = 0.04$. Convex minus concave vertebral height was 10.7 mm for SM and 15.4 mm for TR, the increase in vertebral height difference was found to be significant, $p = 0.02$. Regarding intervertebral disc (IVD) height wedging, TR had a significant reduction in coronal apical disc wedging versus SM, 1.7° versus 8.1°, $p = 0.001$. IVD height difference was greater for SM, 3.5 mm than for TR, 1.5 mm, $p = 0.008$.
Conclusion: The current investigation analyzes apical vertebral/intervertebral wedging in the PSM before and after release of the mechanical tether. CT morphometric analysis demonstrates neutralization of IVD wedging between SM and TR. However, significant progression of vertebral body wedging was demonstrated despite removal of the deforming tether.
FDA Disclosure: N/A.

22

ASYMMETRICAL FLEXIBLE TETHERING OF THE SPINE IN A PORCINE MODEL

Neil Saran, Charles Johnston, Hong Zhang

Summary: An asymmetric flexible tether was used to assess growth modulation in an immature porcine model to produce scoliosis without fusion. Consecutive vertebral body screws connected by a polyethylene cable produced scoliosis in 3/6 animals. At necropsy, all spines moved freely with no histologic evidence of fusion or facet injury. Deformity was produced by compressive inhibition of concave apophyseal growth and disc height without apparent physeal damage. With improved bone-screw interface stability, this model may be useful in motion-preserving deformity correction.
Introduction: By implanting an asymmetrical flexible tether, growth modulation of the spine may control or correct scoliosis while preserving motion in the early-onset/juvenile age group. We performed flexible tethering in an immature porcine model to evaluate efficacy of this growth modulation method to produce scoliosis.
Methods: Six 2-month-old pigs were implanted with an anterior flexible tether—3 thoracoscopic, 3 thoracotomy. Six thoracic vertebrae (T7–T12) received single vertebral body screws connected by a polyethylene cable. At 6 months, animals were euthanized for gross, radiographic and histologic examination.
Results: Three animals had tethering failure due to plowing of screws. Coronal deformities measured 7.11 and 18° making this group non-scoliotic. The remaining 3 developed curves of 41.54 and 58°. At necropsy there was gross movement of all tethered spines in the sagittal plane and in all planes once the tether was removed. There was no evidence of anterior or posterior arthrodesis on histology. Convex versus concave superior ($p = .0001$) and inferior (p).
Conclusion: Using a flexible cable tether in 6 consecutive vertebrae created a significant scoliosis in 3/6 animals where vertebral fixation was maintained during growth. All motion segments moved freely with no histologic evidence of fusion or facet injury. Deformity was

produced by compressive inhibition of concave apophyseal growth and disc height, without apparent physeal damage. With improved bone-screw interface stability, this model may be useful in motion-preserving deformity correction.
FDA Disclosure: N/A.

23

NATURAL HISTORY OF SPINE ASSOCIATED WITH ESOPHAGEAL ATRESIA—A LONG-TERM POPULATION-BASED FOLLOW-UP STUDY

Saara Sistonen, Ilkka Helenius, Jari Peltonen, Seppo Sarna, Risto Rintala, Professor, Mikko Pakarinen

Summary: The risk of scoliosis is 13-fold after repair of EA in relation to general population. Nearly half of the patients have vertebral anomalies predominating in the cervical spine. Most of these deformities were not diagnosed primarily or during growth. Spinal surgery is rarely indicated. Risk of cervical spine instability due to block vertebrae necessitates a further study.
Introduction: Spinal anomalies commonly occur in patients with esophageal atresia (EA). The risk of scoliosis is further aggravated by thoracotomy during neonatal period. The natural history of spinal anomalies and scoliosis in these patients is not known.
Methods: A population-based cohort of 100 adults (57 males, mean [range] follow-up time 36 [21–57] years) operated at neonatal period for EA in our hospital were followed up clinically and radiographically for spinal deformities and anomalies up to adulthood. A standing posteroanterior radiograph of the thoracic and lumbar spine as well as cervical spine radiographs were obtained in all patients at final follow-up. Their results were compared to previously published data obtained from normal population based controls ($N = 855$).
Results: Vertebral anomalies were observed in 45 (45%) patients, predominating in the cervical spine in 38 (38%). Any additional anomaly was the most significant risk factor (OR 27, 95% CI 8–100) for the occurrence of vertebral anomalies. Scoliosis (over 10°) was observed in 56 (56%) patients, over 20° in eleven (11%), and over 45° in one (1%). The risk for scoliosis over 10° was 13-fold (OR 13, 95% CI 8.3–21) and for scoliosis over 20° 38-fold (OR 38, 95% CI 14–106) compared with normal population. Thoracotomy-induced rib fusions (OR 3.6, 95% CI 0.7–19) and other associated anomalies (OR 2.1, 95% CI 0.9–2.9) were the strongest predictive factors for scoliosis. The general clinical course of spinal deformities was usually mild and none of the patients had undergone spinal surgery.
Conclusion: The risk of scoliosis is 13-fold after repair of EA in relation to general population. Nearly half of the patients have vertebral anomalies predominating in the cervical spine. Most of these deformities were not diagnosed primarily or during growth. Spinal surgery is rarely indicated. Risk of cervical spine instability due to block vertebrae necessitates a further study.
FDA Disclosure: N/A.

24

THE RIB VERTEBRAL ANGLE DIFFERENCE—IS IT A RELIABLE MEASURE?

Jacqueline Corona, James Sanders, Scott Luhmann, Michel Diab, Hiroko Matsumoto, Michael Vitale

Summary: Despite the general use of the rib-vertebra angle difference, Cobb angle, and space available for lung, there are few studies documenting their reproducibility in patients with idiopathic infantile scoliosis. Low overall intra- and interobserver variability was found in radiographic measurements used to guide treatment of Infantile Idiopathic Scoliosis curves.
Introduction: Radiographic measures such as the rib vertebra angle difference (RVAD), Cobb angle, and the space available for lung (SAL) help guide treatment and measure treatment effect in the infantile idiopathic scoliosis (IIS) population. Despite their general use these measures have not been rigorously examined in this population. Standard radiographic measurement error is magnified by the difficulties in obtaining quality imaging on the very young patient (i.e. bone immaturity, motion artifact). Treatments for IIS range from observation, casting and traction, and surgical management with expandable instrumentation. Understanding the reliability of these radiographic assessments will aid treating physicians as they weigh clinical, radiographic and laboratory data in determining the best course of treatment. This study aims to evaluate the intra- and interobserver variability in radiographic measurements used to guide treatment of IIS curves.
Methods: About 45 spine radiographs of patients (age = 2 months–4 years) with a diagnosis of IIS were measured using Surgimap software. Three pediatric orthopaedic surgeons and a pediatric orthopaedic surgery fellow identified the major curve apex, rib-vertebra phase, Cobb, end vertebrae, and calculated the RVAD and the SAL. Radiographs were measured at 2 separate time points. Descriptive analysis was conducted for parameters at both time points. Inter- and Intrarater reliability of the RVAD, Cobb, and SAL was assessed; Intra-class correlation coefficients (ICC) were calculated (95% CI). Fleiss' Kappa coefficients were calculated for categorical variables.
Results: Cobb angle (ICC = .99) and RVAD (ICC = .84–.89) reliability was high. There was substantial agreement for interrater reliability (ICC = .72) and moderate agreement for intrarater reliability for SAL (ICC = .63). Despite high Cobb agreement, choice of endplates and apical vertebra varied ($\kappa = 0.16$–.54). Substantial agreement was found for apical rib phase ($\kappa = .67$–.71).
Conclusion: Measurements used to guide treatment of IIS curves were found to be reliable despite standard radiographic measurement error and the difficulties in obtaining quality imaging in young patients. Cobb angle and RVAD demonstrated almost perfect agreement, while SAL was less reliable.
FDA Disclosure: Cleared: No.

- Although not the focus of this abstract, the use of Growing Systems in EOS are mentioned. VEPTR, a type of growing system is approved under the Humanitarian Device Exception program.
- Although not the focus of this abstract, the use of Growing Systems in EOS are mentioned. These may/may not use pedicle screws. Pedicle Screws in skeletally immature patients are deemed Class III.

25

INNOVATION IN GROWING ROD TECHNIQUE; STUDY OF SAFETY AND EFFICACY OF REMOTELY EXPANDABLE ROD IN ANIMAL MODEL

Behrooz Akbarnia, Gregory Mundis, Pooria Salari, Burt Yaszay

Summary: Growing rods (GR) are commonly used in treatment of early onset scoliosis (EOS). They require multiple surgeries for lengthening and have a high complication rate. This experimental study evaluates the safety and efficacy of a remotely expandable rod (RER) in an animal model. RER proved to be a safe and effective way

to remotely distract the spine. This technique shows promise as an alternative treatment in the surgical management of EOS in the future.
Introduction: Treatment of severe early onset scoliosis (EOS) is challenging. GR are commonly used but require multiple surgeries for lengthening. Improved technology may allow remote lengthening without surgery. We aimed to evaluate the safety and efficacy of a remotely expandable rod (RER).
Methods: 9 immature male Yucatan pig were randomly assigned to experimental group (E.G, 6 pigs) and sham group (SG, 3 pigs). All had 3 cephalad and 2 caudal foundation levels instrumented with 7–9 levels in between (12–14 total levels). A unilateral RER was implanted in E.G, and no rod in SG. RER contains a non-shapeable actuator. A small magnet in the actuator is used to distract or retract. Follow up was 10 weeks. E.G had 7 mm of remote distraction under sedation for 7 weeks. Implants were removed after 7th week. Both groups had weekly AP and lateral XR. CT was obtained after the index surgery (IS), before implant removal (IR) and before sacrifice. The thoracic and lumbar spines were harvested for further study after sacrifice.
Results: Mean age in E.G and SG was 7.1 and 7.3 months. No difference in weight at IS or throughout the study. One E.G pig died after IS; neurologic complication (comp) caused by screw malposition. Mean distraction achieved in E.G was 39 mm (32–46); less than 48 mm planned distraction. We postulate fat thickness decreased distractions forces resulting in this difference. No comp resulted from distraction. 1 pig had a sterile fluid collection at lower foundation, treated with drainage and prophylactic antibiotics. A retained sponge was found after sacrifice. XRs and CTs showed no implant failure. In the non instrumented segment mean spinal growth at 7 weeks was similar in SG and E.G (8 vs. 7%). However, after IR, spine growth increased significantly in E.G while in SG growth followed a linear rate (Figure). At sacrifice total growth (12–14 levels) was greater in E.G versus SG (27 vs. 12%).
Conclusion: RER proved a safe and effective way to remotely distract the spine in this study. No comp resulted from distraction. Distraction accuracy and retraction features of this device make it more reliable for controlled distraction. RER shows promise as an alternative treatment in the surgical management of EOS in the future.
FDA Disclosure: Cleared: No.

- Off-label use of spinal instruments in children.

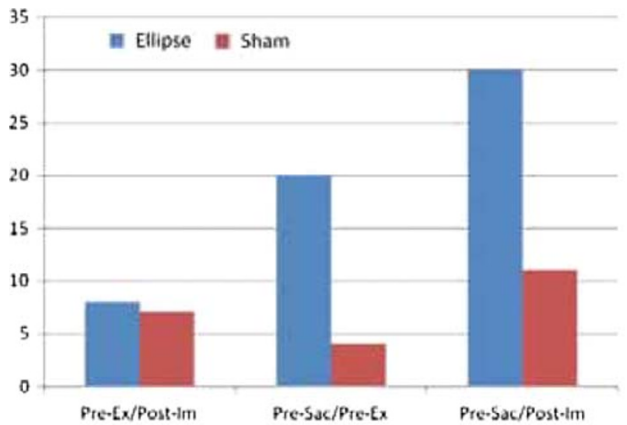


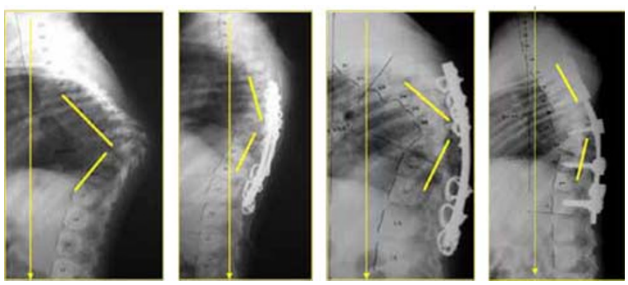
Figure: Growth ratio (percentage) in levels between cephalad and caudal foundations

26

PEDICLE AND VERTEBRAL COLUMN RESECTIONS FOR POST-TUBERCULOUS PEDIATRIC SPINAL DEFORMITIES: SURGICAL RESULTS FROM A SINGLE CENTRE WITH MINIMUM FOLLOW-UP OF 5 YEARS

Nanjundappa Harshavardhana, Mihir Bapat, Kshitij Chaudhary, Vinod Laheri

Summary: The single stage posterior pedicle/vertebral resection osteotomy is a safe and excellent mode of restoring the sagittal/coronal balance in axial immature skeleton facilitating neurological recovery.
Introduction: To define the role and analyse the results of single stage pedicle resection and vertebral column resection osteotomies by posterior approach for management of post-tuberculous pediatric spinal deformities.
Methods: 42 children (35 primary and 7 revision cases) aged 5–16 years with post-tuberculous spinal deformities operated between 1999 and 2004 formed the study group. The kyphosis measured 65–128° (av 76). The deformities were grouped as cervico-dorsal/upper-dorsal (6), dorsal (14), dorso-lumbar (18) and lumbar/lumbo-sacral (4). 11 patients had pre-operative neurological deficits [Frankel grade A (2), B (4) and C (5)]. The mean number of vertebrae at the apex was 2.7 (range 2–5). The apex was grouped as wet (12) and dry (30) based on the nature of tuberculous lesion on MRI. Nine had significant coronal plane deformity measuring 67–125° (av 85). Four patients with rigid cervico-dorsal multiplanar deformities had pre-operative halo traction to asses curve flexibility. Of the 7 revision cases, pseudoarthrosis with loss of correction was seen in 3, multi-drug resistant tuberculosis in 2 and post-surgical deep infection in 2 patients.
Results: A single stage posterior surgery was performed in all patients. The minimum follow-up was 5 years (range 5–10). One died due to pulmonary complications 2 month after the surgery and 1 was lost for f/u. The average kyphosis correction achieved was 65% with mean loss of 7% at final f/u. 1 had post-operative transient neurological deficit. All patients with neurodeficit improved to Frankel grade D (3) or E (8). Implant failure and loss of kyphosis correction occurred in 3 cases warranting a revision surgery of which 1 had dural injury during the revision procedure. Two patients had multi-drug resistant tuberculosis (MDR-TB). Two patients required prolonged ventilatory support for post-op pneumonia. The average correction achieved in revision procedure was 60%.
Conclusion: A single stage posterior pedicle/vertebral resection osteotomy provides excellent correction with column shortening. Application of this technique to the paediatric spine is at times difficult owing to weak bony elements that impedes application of large corrective forces.
FDA Disclosure: N/A.



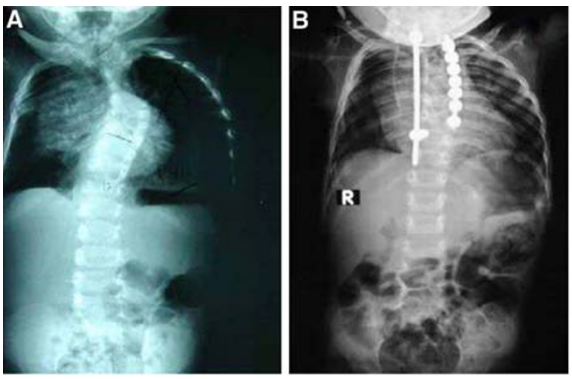
27

CONVEX INSTRUMENTED HEMIEPIPHYSIODESIS WITH CONCAVE DISTRACTION

Ozgur Dede, Muharrem Yazici, Ahmet Alanay

Summary: The results of a modification to standard convex growth arrest procedure is presented. Technique consists of convex instrumented hemiepiphysiodesis with concave instrumented distraction to obviate the need for anterior surgery and to provide early correction of the curve along with the improvement of coronal imbalance. Early results at a mean follow up of 19 months shows that this procedure is safe and effective in treating complex congenital deformities.
Introduction: The convex growth arrest (CGA) procedure has been popularized due to its safety, efficacy, and simplicity compared with other surgical alternatives. Problems with CGA include unpredictability of curve behavior, slow or infrequent correction, necessity of an anterior surgery for completeness of the epiphysiodesis and poor control of the deformity in long sweeping curves over 50°.
We propose a modification to standard CGA procedure. In this procedure, hemiepiphysiodesis and unilateral instrumentation is carried out with pedicle screws, along with compression, involving the convex side of the congenital curve. Then, distraction is employed on the concave side, similar to the growing rod concept, using a pedicle screw-rod construct, without fusion.

Purpose of this study is to analyze the efficacy and safety of this modification on the young patients with progressive congenital.
Methods: Five female patients underwent the procedure. Mean age at index operation was 40 months (17–55). Patients underwent concave distractions every 6 months. Mean follow up was 19 months (13–24 months).
Results: For the coronal plane, the mean magnitude of the preoperative convex instrumented congenital curve was 48.4°. It was corrected to 34.4° postoperatively and found to be 32.2° at final follow-up. Average correction at the final follow-up was 16.2°. For the distracted segment the mean preoperative curve was 35.2°, corrected to 16.4° postoperatively and to 14.8° at final follow-up, with an average correction of 20.4°. In all patients the sagittal alignment at distracted segments was hypokyphotic when compared to the normative data. Change in the sagittal alignment was minimal at final follow up except for one case in which hypokyposis between T4–10 was normalized to 30°. No complications have been encountered.
Conclusion: Our preliminary results imply that the procedure is a less invasive treatment alternative for complex congenital curves which otherwise may necessitate multiple osteotomies and longer thoracic fusions. We propose this technique in young children for upper thoracic deformities with multiple anomalous vertebrae, especially with long sweeping curves.
FDA Disclosure: N/A.



A. Preoperative x-ray of a 17 months old girl with congenital scoliosis.
B. Postoperative x-ray at 18 months follow up.

28

RESULTS OF HEMIVERTEBRA EXCISION FOR THE TREATMENT OF CONGENITAL SCOLIOSIS: A MULTICENTER RETROSPECTIVE REVIEW

Burt Yaszay, Michael O'Brien, Peter Newton, Randal Betz, Harry Shufflebarger, Baron Lonner, Lynn Letko, Juergen Harms, Alvin Crawford, Suken Shah, Paul Sponseller, Michelle Marks

Summary: A multicenter retrospective review of 42 patients undergoing HV excision for the treatment of congenital scoliosis was performed. The average coronal correction was 73% with a 38% complication rate. Greater experience with HV excision appeared to result in improved outcomes.
Introduction: Congenital hemivertebrae (HV) can cause significant and progressive scoliosis and kyphosis. HV resection prior to the development of a severe deformity has been recommended. The purpose of this study is to evaluate the clinical and radiographic outcomes as well as complications following a HV excision.
Methods: A multi-center retrospective study of patients with 1 or 2 HV treated with HV excision was performed. Clinical, radiographic, and complication data was analyzed.
Results: Forty-two patients, with an average age of 5 years and 2-year follow-up, were treated between 1991 and 2004. There were 36 single and 6 double HV. About 33 patients had their excision through a posterior only approach. Pre-op Cobb was 35o. At 2 years, the Cobb was 10o resulting in a 73% correction. Fusion length averaged 3 ± 2 vertebral levels. EBL and operative time averaged 455 ± 461 cc's and 255 ± 89 min, respectively. The overall complication rate was 38% and included 2 wound infections, 5 instrumentation failures, and 4 neurologic complications. Analysis of individual clinical centers demonstrated improved results at the site with the greater experience with HV excisions (Table I).
Conclusion: HV excision can effectively improve the spinal deformity associated with 1 or 2 HV. While the procedure is not without complications, increased experience with HV excision can minimize the risks and improve the clinical outcome.
FDA Disclosure: N/A.

Table I. Comparison of one site (G3) with the other 11 sites.

	G3 (one site only)	Other sites	p value
N	17	25	
Coronal Correction (%)	84±19%	50±25%	p<0.001
Fusion length	2 ± 1	5 ± 4	0.003
EBL (cc)	310 ± 232	602 ± 582	0.06
Operative time (min)	226 ± 48	282 ± 117	0.07
Complications	4 instrumentation, 1 other	2 infection, 4 neurologic, 1 instrumentation, 2 other	

29

NUTRITIONAL IMPROVEMENT FOLLOWING GROWING ROD SURGERY IN CHILDREN WITH EARLY ONSET SCOLIOSIS

Karen Myung, David Skaggs, George H. Thompson, John Emans, Paul Sponseller, Lawrence Karlin, Charles Johnston, Behrooz Akbarnia, Growing Spine Study Group

Summary: Growing rod surgery in children with early onset scoliosis improves nutritional status.
Introduction: Children with severe early onset scoliosis (EOS) often have poor nutritional status as the energy expenditure of breathing approaches the nutritional gain of eating. The use of VEPTR in

children with EOS has been shown to improve their weight. The purposes of this study are to evaluate the nutritional status of children with EOS and determine the effect of treatment with growing rods.
Methods: Data was retrospectively collected on 88 patients with EOS treated with growing rods at seven different institutions. Mean age at surgery was 5.8 years, and mean Cobb angle was 75°. All patients were followed for a minimum of 2 years (mean follow-up of 4.1 years). Preoperative weights were converted to normative percentiles based on the patients' age and gender.
Results: Preoperatively, 47% (41/88) of our patients were 0.05).
Conclusion: Following treatment of EOS with growing rods there was significant improvement in nutritional status in approximately 50% of patients, similar to that reported with VEPTR. These findings support the theory that growing rods improve pulmonary status in children with EOS, as nutritional improvement is one outcome of improved pulmonary status. The relationship between age at initial surgery and nutritional improvement is intriguing.
FDA Disclosure: Cleared: No.

- Off-label use of spinal instruments in children.

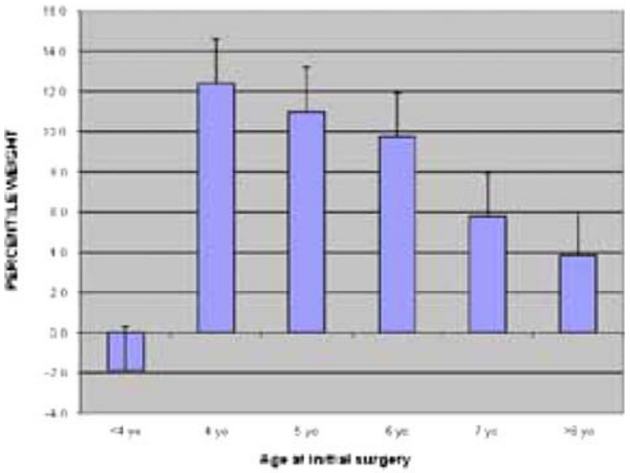


Figure-1 Change in Percentile Weight Vs Age at Initial Surgery

E-POSTERS

100

SEVERE KYPHOSIS DUE TO "DIRA" AT 3 MONTHS OF AGE—CAST AND ANAKINRA TREATMENT—ONE YEAR FOLLOW-UP

Acke Ohlin, Ulf Tedgård

Summary: A 3-month-old male infant with a mutation of IL1RN suffered from an autoinflammatory disorder—"DIRA"—with bone resorption and collapse of two vertebral bodies with a subsequent kyphosis of 60°. An "intelligent treatment" (Postgrad. Med. J. 2007;83: 251–60) with ANAKINRA—a recombinant human interleukin-1-recptor antagonist—was given beside cast treatment with a so far excellent result.
Introduction: At 3 months of age a male infant was presented at the orthopaedic clinic with a thoracolumbar kyphosis of 60°. No neurological deficiencies were observed. CT and MRI revealed bone resorption and collapse of the vertebral bodies of Th12 and L1. At 2 days after birth respiratory distress and mouth ulcers had been observed. Further, heterotopic hyperostosis of proximal metaphyses was found. There were no objective signs of infection—therefore an autoinflammatory disorder was suspected. A 14 month older brother has a less severe illness of the same genetic origin. Genetic analysis of the two showed a mutation of IL1RN encoding the interleukin-1-receptor antagonist. Until now this illness has been described in only 9 cases and the term "deficiency of the interleukin-1-receptor antagonist"—DIRA—has been suggested (NEJM 2009; 360: 2426–37).
Methods:
Treatment:
The orthopaedic treatment consisted of serial body casting correcting the kyphosis to 0° (in cast).

The medical treatment is still daily subcutaneous administration of ANAKINRA (Biovitrum)—a recombinant human.
Results: Radiographically, new bone formation of the collapsed vertebral bodies has been observed.
The 1 year result will.
Conclusion:
Summary: A 3-month-old male infant with a mutation of IL1RN suffered from an autoinflammatory disorder—"DIRA"—with bone resorption and collapse of two vertebral bodies with a subsequent kyphosis of 60°. An "intelligent treatment" (Postgrad. Med. J. 2007; 83: 251–60) with ANAKINRA—a recombinant human interleukin-1-recptor antagonist—was given beside cast treatment with a so far.
FDA Disclosure: N/A.

Acke Ohlin*, Ulf Tedgård**,

Dept of Orthopaedics* and Paediatrics**, Malmö University Hospital, Lund University, Sweden.

At three months of age a male infant was presented at the orthopaedic clinic with a thoracolumbar kyphosis of 60 degrees. No neurological deficiencies were observed. CT and MRI revealed bone resorption and collapse of the vertebral bodies of Th12 and L1. At two days after birth respiratory distress and mouth ulcers had been observed. Further, heterotopic hyperostosis of proximal metaphyses was found. There were no objective signs of infection - therefore an autoinflammatory disorder was suspected. A 14 Mo older brother has a less severe illness of the same genetic origin. Genetic analysis of the two showed a mutation of IL1RN encoding the interleukin-1-receptor antagonist. Until now this illness has been described in only 9 cases and the term "deficiency of the interleukin-1-receptor antagonist" - DIRA - has been suggested (NEJM 2009;360:2426-37).

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The one year result will be presented.

Summary:

A 3 Mo old male infant with a mutation of IL1RN suffered from an autoinflammatory disorder - "DIRA" - with bone resorption and collapse of two vertebral bodies with a subsequent kyphosis of 60 degrees. An "intelligent treatment" (Postgrad.Med.J.2007;83:251-60) with ANAKINRA - a recombinant human interleukin-1-recptor antagonist - was given beside cast treatment with a so far excellent result.

101

LUMBAR AGENESIS: FROM INTRAUTERINE DIAGNOSIS TO SPINAL RECONSTRUCTION. FOLLOW-UP OF A CASE AND LITERATURE REVIEW

Alessio Lovi, Marco Teli, Marco Brayda-bruno

Summary: Lumbar Agenesis may be suspected by uterine ultrasound before birth, and spinal reconstruction can be undertaken in the occurrence of progressive deformity, with promising results.
Introduction: Congenital absence of isolated segments of the lumbar spine is rarely described. Differential diagnosis includes congenital dislocation of the spine, lumbo-sacral agenesis, spinal dysgenesis and spina bifida. No cases of intrauterine diagnosis and spinal reconstruction in lumbar agenesis have been reported.

Methods: Follow-up of a case of lumbar agenesis treated with spinal reconstruction, with review of the pertinent literature.
Results: The absence of a number of spinal segments was suspected on an ultrasound scan and confirmed by X-rays at birth of a female showing thoracolumbar kyphosis and meningocele with bilateral talipes and paraplegia. X-rays confirmed absence of T12, L1, L2 and partially L3, with presence of spina bifida of the caudal segments. The spine was protected by serial casting and bracing until the 8 year of life, when progression of kyphosis mandated spinal reconstruction. This was performed through a postero-lateral approach by a team composed of spinal, plastic and general surgeons.
Conclusion: From 1968 to 2005, 4 indexed publications addressed lumbar agenesis. Clinical features include paraplegia, kyphoscoliosis, flexion contracture of hips and knees and clubfeet. Radiographically, one to eleven missing segments are described. The distal segments may or may not have spina bifida features. The level of neurologic impairment usually corresponds to the proximal level of segmental absence. The recommended management of spinal deformity is conservative. Our patient's deformity had improved to normal kyphosis after posterior spinal fusion. The girl 24 months after surgery is enjoying pain-free activities, attending school and playing in sitting position.
Lumbar agenesis is to be differentiated by other congenital spinal malformations. Its incidence is sporadic. No etiologic factor is known. Its functional prognosis is dependent on the level of neurologic impairment. Survivorship into adolescence has been described. We showed the disease may be suspected by uterine ultrasound before birth, and spinal reconstruction can be undertaken in the occurrence of progressive deformity, with promising results.
FDA Disclosure: Cleared: Yes.

102

HEMIVERTEBRAE RESECTION WITH EGGSHELL PROCEDURE. RESULTS IN CHILDREN AGED 1–7 YEARS

Andres Chahin, Samuel Pantoja, Gonzalo Arriagada, Marcela Chamorro

Summary: Hemivertebrae cause about of 50% of congenital kyphoscoliosis and surgical treatment is usually required. Purpose: Evaluate clinical and radiographic results of hemivertebra resection with an eggshell procedure in children aged 1–7 years. Study design. Retrospective review of patients who underwent hemivertebrae resection with an eggshell procedure. Conclusions. Hemivertebra resection with the eggshell procedure is a safe surgical technique and provides an excelent and immediate correction of congenital kyphoscoliosis at short term follow up.
Introduction: Hemivertebrae cause about of 50% of congenital kyphoscoliosis and surgical treatment is usually required.
Purpose: Evaluate clinical and radiographic results of hemivertebra resection with an eggshell procedure in children aged 1–7 years.
Study design: Retrospective review of patients who underwent hemivertebrae resection with an eggshell procedure.
Methods: From January 2006 to June 2008, seven hemivertebrae were resected in seven consecutive patients aged 1–7 years. A retrospective chart and radiographic review was performed. The mean age at surgery was 3.2 years (range 1–7 years). The mean follow up (FU) was 17 months (range 7–35 month). Cobb's angle in the coronal and sagittal planes pre op and at FU, operating time, transfusion requirements and complications were analyzed.
Results: Average pre-op scoliosis Cobb's angle was 35° and average at FU was 19°. Mean correction at FU was 40%. Average pre-op kyphosis Cobb's angle was 42° and average at FU was 25°. Rate of correction at FU was 33%. Four patients required tranfusion, average 1.25 blood units. The average operating time was 225 min. Complications were encountered in two patients; 1 dural tear and 1 pedicular fracture. No neurological complications. All patients achieved solid fusion at FU.
Conclusion: Hemivertebra resection with the eggshell procedure is a safe surgical technique and provides an excelent and immediate correction of congenital kyphoscoliosis at short term follow up.
FDA Disclosure: N/A.

Case	Gender	Age (years)	Level	Segmentation	Deformity
1	F	7	T10	Fully segmented	Kyphoscoliosis
2	F	2	T12	Fully segmented	Kyphoscoliosis
3	M	3	T10	Fully segmented	Kyphoscoliosis
4	M	2	T11	Fully segmented	Kyphoscoliosis
5	F	1	L1	Semi segmented	Kyphoscoliosis
6	M	1	T10	Fully segmented	Kyphoscoliosis
7	F	7	L5	Semi segmented	Scoliosis
Average		3,2			

103

VEPTR A SIX YEAR FOLLOW-UP IN GERMANY

Axel Scharfstädt, Bettina Westhoff, Marcus Jäger, Christoph Zilkens, Rüdiger Krauspe

Summary: The VEPTR procedure is an operative treatment for the TIS (thorax insufficiency syndrome), which may be caused by scoliosis, Jarcho-Levin-syndrome and Jeune's syndrome. In Düsseldorf 35 patients have been treated with VEPTR since January 2004. Instead of a long period of corset treatment children will have this operative treatment and will still be able to grow.
Introduction: The VEPTR (vertical expandable prosthetic titanium rib) procedure was developed 20 years ago in Amerika. Aim of the treatment is the "TIS" (thorax insufficiency syndrome) which is defined as the inability of the thorax to support normal respiration or lung growth. It may result from such variable conditions as scoliosis, Jarcho-Levin-syndrome and Jeune's syndrome. In Düsseldorf 35 patients have been treated with the VEPTR procedure since January 2004. The titanium rib has got the effect of halting the progression or even reversing scoliosis. The device is designed so that it may also be expanded as a child grows through minor surgical procedures, usually every 4–6 months, depending on the growth rate of the child.

Methods: In this study 35 patients were operated with the VEPTR procedure. The average age was 5.4 years [3 months to 11 years]. There were 15 boys and 20 girls. Seventeen children had a congenital scoliosis, 12 children a neurogenic scoliosis (two out of these had a spina bifida with a severe kyphosis), five children an idiopathic scoliosis and one patient a Jeune's syndrome.
Results: Thirtytwo children with a scoliosis had preoperatively average curves of 61° [22°–130°]. These curves could be reduced due to the first operation by on average 20° [4°–42°]. The one child with a spina bifida had a preoperative kyphosis of 168°, which could be reduced to 100° by the VEPTR procedure. In twelve cases only one titanium rib was used, in twenty cases two ribs were used unilaterally and in three cases one rib was implanted bilaterally. Twenty patients got one opening wedge thoracotomy, six children had two thoracotomies. Nine children did not need a thoracotomy for correction. The boy with the Jeune's syndrome had several ribs cut along a line down the chest wall, then a titanium rib was placed vertically along the site pulling the bony ribs outward to the device.
Conclusion: The results of this study demonstrate the opportunities of the VEPTR procedure. Instead of a long period of corset treatment it is possible to have an operative treatment for children who still will be able to grow.
FDA Disclosure: Cleared: Yes.

104

BIOMECHANICAL DIFFERENCES IN DISTRACTION FORCES AND ANTERIOR COLUMN INTRA-DISCAL PRESSURES WHEN USING DIFFERENT CONSTRUCTS FOR THE PEDIATRIC DUAL GROWING ROD TECHNIQUE

Andrew Mahar, Michael Flippin, Richard Oka; Tucker Tomlinson, Patricia Kostial, Ramin Bagheri, Behrooz Akbarnia

Summary: Dual growing rods are commonly used for treatment of early onset scoliosis. Little information exists toward understanding how different pediatric dual growing rod foundations affect spinal distraction and how posterior distraction forces affect anterior column biomechanics. In this experimental study upper foundation pedicle screws resulted in greater distraction forces compared to hooks. Anterior disc pressures indicate that posterior loads are distributed across multiple levels rather than delivered to the disc immediately adjacent to a foundation.
Introduction: Little information exists toward understanding how different pediatric dual growing rod foundations affect spinal distraction and how posterior distraction forces affect anterior column biomechanics. The purpose of this study was to determine how different foundation constructs affect distraction forces and intradiscal pressures when using dual growing rods for correction of early onset scoliosis.
Methods: Six skeletally immature porcine spines were harvested leaving soft tissues and rib heads intact. L3–L4 motion segments were instrumented with pedicle screws while T3–T4 motion segments were randomly instrumented with pedicle screws or laminar hooks. Proximal constructs (hook vs. screw) were switched after initial distraction testing. The dual rod distractor was instrumented with strain gages and calibrated using a custom force transducer. During distraction, intra-discal pressures immediately inferior to the superior foundation construct and the level equidistant between foundations were measured using needle pressure transducers. Maximum distraction force and maximum anterior disc pressure change were compared between hook and pedicle screw constructs using a one-way ANOVA.
Results: Upper level pedicle screws had significantly greater distraction forces (416 ± 101 N) than upper level hooks (349 ± 100 N). There were no significant differences in disc pressures between levels or between upper foundation constructs. Disc pressures adjacent to the upper foundation consistently demonstrated greater reduction (disc expansion) than the level equidistant within the construct. Pedicle screw constructs consistently demonstrated greater endplate separation compared to hook constructs. Posterior distraction forces generate endplate separation at multiple levels within the spine.
Conclusion: Upper foundation pedicle screws resulted in greater distraction forces compared to hooks, possibly due to hook motion during distraction. Anterior disc pressures indicate that posterior loads are distributed across multiple levels rather than delivered to the disc immediately adjacent to a foundation. The distribution of loads at multiple levels may assist with curve control and may also affect vertebral growth.
FDA Disclosure: Cleared: No.

- Off-label use of spinal instruments in children.

105

A NEW SURGICAL STRATEGY FOR THE TREATMENT OF EARLY-ONSET IDIOPATHIC SCOLIOSIS

Azmi Hamzaoglu, Cagatay Ozturk, Mehmet Tezer, Meric Enercan, Mehmet Aydogan, Omer Karatoprak

Summary: The continuation of anterior growth in the apical and adjacent segments of the deformity and not controlling the rotation in the apical segments are two major problems that the dual growing rod techniques with only proximal and distal fixation points have. Our new treatment strategy provides that the screws in apical and intermediate vertebra controlled the curve, prevent progression, maintain rotational stability and allows continuation of trunk growth.
Introduction: The continuation of anterior growth in the apical segments of the deformity and not controlling the rotation in the apical segments are two major problems that the dual growing rod techniques with only proximal and distal fixation points have. To overcome these problems; we have presented a new surgical strategy allowing spinal growth and lung development and controlling the apical rotation for the surgical treatment of early-onset idiopathic scoliosis.
Methods: Between the years of 2007 and 2008, 6 children (2 males, 4 females; with a mean age of 5 years, ranging from 2 to 8 years) with progressive scoliosis (average 61°) were included in the study. In the initial surgery; polyaxial pedicle screws were placed to the strategic vertebra (apical, end, intermediate and transitional zone vertebrae) after skin and subcutaneous tissue dissection without subperiosteal muscle dissection on midline. Then, rods were placed in situ after achieving correction with the help of intraoperative halofemoral traction. The most proximal and most distal screws were fixed and the rest of the screws were left with nonlocked tap-screws. The lengthening re-operations were performed every 6 months. The coronal plane correction ratio, truncal heigth increase and complications were documented.
Results: Initial curve correction went from 61° (38–88) to and average of 22° (4–40) and maintained at 24° (4–36) at minimum 1 year follow-up. Two lengthening operations were done in 3 patients and one in 3 patients. The average coronal plane correction was 60% and average truncal heigth increase was 12%. In the sagittal plane; decrease of thoracic kyphosis was not seen. No patient had significant changes in the spinal cord monitoring.
Conclusion: Our new treatment strategy provides that the screws in apical and intermediate vertebra controlled the curve, prevent progression, maintain rotational stability and allows continuation of trunk growth. This strategy can also provide that there is no need to develop special instrument designs and production and one can safely perform the treatment with classical instrumentation systems present in the market.
FDA Disclosure: N/A.

106

THE EFFECT OF SACRAL DECORTICATION ON LUMBOSACRAL FIXATION STRENGTH IN A CALF SPINE MODEL

Adrian Thomas, Christopher Kepler, Kate Meyers, Ikemefuna Onyekwelu, Timothy Wright, Daniel Green, Bernard Rawlins

Summary: A calf-spine model was used to evaluate the effect of decortication after lumbosacral instrumentation with and without pelvic fixation. After instrumentation, failure moment was measured during application of a destructural flexural load. No difference was found in the failure moment with and without decortication, although the decortication sites were frequent sites of failure indicating relative weakness. Iliac fixation increased flexural moment required for failure confirming the results of other investigators.

Introduction: Fusion to the sacrum has become common for the treatment of neuromuscular scoliosis, fusions in osteoporotic patients and other applications. Fixation failure after attempted fusion to the sacrum has been attributed to iatrogenic causes such as S1 screw penetration and sacral ala decortication. This study seeks to show the effect of bony destabilization of the lumbosacral junction on force required and pattern of construct failure. We hypothesized that increasing bony destabilization of a bovine cadaveric sacrum by anterior pedicle screw penetration and bilateral alar decortication will decrease the amount of load necessary for failure of the construct and result in failure through the decortication sites.

Methods: About 16 fresh-frozen 6–8 week-old calf spines were tested after instrumentation with pedicle screws and bilateral rods from L2–S1 using four constructs: (1) S1 screws with posterior-only purchase, (2) S1 screws with bicortical purchase, (3) S1 screws with bicortical purchase and sacral alar decortication, (4) S1 screws with bicortical purchase, sacral alar decortication, and iliac fixation. A destructive flexural load was applied at L2 to each construct at a loading rate of 4.4 Nm/s. Ultimate failure moment (Nm) for each construct was compared using a one way analysis of variance combined with Holm-Sidak post hoc test.

Results: There was no significant difference in failure moment between groups 1–3. The addition of iliac fixation (group 4) significantly increased load to failure (*P*).

Conclusion: Sacral alar decortication and anterior pedicle screw purchase did not decrease the failure moment in long instrumentation to the sacrum. Pattern of failure was affected, with alar decortication being the site of fracture in each construct where it was performed. Iliac fixation increased the failure moment under catastrophic loading conditions even when combined with sacral alar decortication and bicortical pedicle screw purchase.

FDA Disclosure: Cleared: Yes.

107

POSTERIOR HEMIVERTEBRA RESECTION WITHOUT FUSION IN A TWO-YEAR-OLD CHILD

Dezsoe Jeszenszky, Tamas Fekete, Frank Kleinstueck

Summary: Case presentation of posterior resection of a hemivertebra with fusionless technique.

Introduction: Resection of a hemivertebra from a posterior approach is a widely accepted technique. However, striving for motion preservation in the mobile lumbar area, by avoiding fusion, is an additional worthwhile aim. We present a case of a fusionless surgical technique. Such a surgical method to correct congenital scoliosis has not been reported before.

Methods: Surgical technique: A 24-month-old girl with a semi-incarcerated hemivertebra between L2 and L3 on the right side, resulting in progressive scoliosis, was operated. Preoperative radiographs and CT scans showed that reconstruction of a facet joint between the right articular processes of the L2 and L3 vertebrae was technically feasible. The surgical technique consisted of placing transpedicular screws in the right pedicles of L2 and L3, and removal of the hemivertebra, taking care to preserve the joint capsules and the cranial endplate of the hemivertebra. After resection, a posterior tension band was applied by connecting the screw heads with wire. The joint capsules were connected by sutures. A brace was applied postoperatively for 3 months, and the implants were subsequently removed.

Results: Preoperatively, the right convex lumbar scoliotic curve was 41° between L1 and L4; the sagittal kyphotic deformity was 12° between L2 and L3, with subluxation. 15 years later, the scoliotic curve was 5° between L1 and L4; the kyphotic deformity had been corrected, and the lordosis angle between L2 and L3 was 10°.

Conclusion: Correction surgery for congenital scoliosis should be performed early, before the development of severe local deformities and secondary structural changes. Posterior resection of the hemivertebra with transpedicular instrumentation and facet joint reconstruction allows for excellent correction in the frontal and sagittal planes. Early correction allows normal growth in the unaffected parts of the spine. When planning surgery for hemivertebra resection, careful preoperative analysis is recommended to assess whether a fusionless technique could be applied.

FDA Disclosure: N/A.

108

THORACIC PEDICLE SUBTRACTION OSTEOTOMY IN THE TREATMENT OF SEVERE PEDIATRIC DEFORMITIES

Georgios Bakaloudis, Mario Di silvestre, Tiziana Greggi, Francesco Lolli

Summary: Posterior based thoracic osteotomies have been recently reported as an alternative treament of severe paediatric deformities, obviating the need of an anterior approach. The present retrospective study reports the preliminary results on a consecutive series of paediatric patients treated my means of a single level posterior thoracic pedicle subtraction osteotomy for their spinal deformity.

Introduction: Posterior based thoracic osteotomies have been recently reported as an alternative treament of severe paediatric deformities, obviating the need of an anterior approach. Purpose of the present stydy is to determine the safety and efficacy of posterior thoracic pedicle subtraction osteotomy (PSO) in the treatment of severe pediatric deformities.

Methods: A retrospective review was performed on 12 consecutive pediatric patients (6 F, 6 M) treated by means of a posterior thoracic PSO between 2002 and 2006 in a single Institution. Average age at surgery was 12.6 years (range, 9–16), whereas the deformity was due to a severe giovanile idiopathic scoliosis in 7 cases, an infantile idiopathic scolosis in 2 cases, a post-laminectomy kypho-scoliosis for a intramedullar ependimoma, an angular kypho-scoliosis due to a spondylo-epiphisary dysplasia (already operated on 4 times); and a sharp congenital kypho-scoliosis (already operated on by means of a anterior–posterior in situ fusion). In all patients a pedicle screws instrumentation was used, under continuous intraoperative neuromonitoring (SSEP, NMEP, EMG).

Results: At an average follow-up of 2.4 years (range, 2–6) the main thoracic curve showed a mean correction of 61°, or a 62.3% (range, 55–70%), with an average thoracic kyphosis of 38.5° (range, 30°—45°), for an overall correction of 65% (range, 60–72%). Mean

estimated intra-operative blood loss accounted 19.3 cc/kg (range, 7.7—27.27). In a single case (a post-laminectomy kypho-scoliosis) a complete loss of NMEP occured, promtly treated by loosening of the initial correction, and a final negative wake-up test. No permanent neurologic damage, or instrumentation related complications, was observed.

Conclusion: According to our experience, posterior-based thoracic pedicle subtraction osteotomies represent a valuable tool in the surgical treatment of severe pediatric spinal deformities, even in revision cases. A dramatic correction of both the coronal and sagittal profile may be achieved. Mandatory the use of a pedicle screws-only instrumentation and a continuous intraoperative neuromonitoring to obviate catastrophic neurologic.

FDA Disclosure: N/A.

109

QUANTITATIVE AND GROWTH-INDEPENDENT ANALYSIS OF SITTING BALANCE IN SPINE DEFORMITY. COMPARISON BETWEEN PATIENTS AND CONTROLS AND PRE- AND POST SURGERY

Helena Saraste, Girts Murans, Elena Gutierrez-farewik, Helga Hirschfeld

Summary: A kinetic method was developed to allow quantitative comparisons over time, pre- and post-intervention, and between groups. It was applied to compare the sitting function and body balance in children with non-idiopathic spine deformities and age-matched controls as well as before and after spine surgery. The method could discriminate pathology from normality and demonstrate surgery dependant changes.

Introduction: An important goal in the surgical treatment of neuromuscular spine deformities is to attain a balanced sitting. Most analysis methods are qualitative and do not consider time and growth factors. A kinetic (force plate) method was developed to allow quantitative between group and intervention dependant comparisons.

Methods: Ten healthy age-matched control children and nine patients with non-idiopathic, progressive, early onset spine deformity, planned for surgery were included. Two forceplates (AMTI, USA), one under each ischial region, parallely mounted, were used. Persons were sitting with support under the whole femora and with hanging feet, but without back support. Each recording period was 10 s. The sampling frequency was 100 Hz. Data was filtered with 4th degree Butterworth low-pass filter at 2 Hz. Stabilogram, center of pressure (COP) trajectory was recorded. Finite oscillations of this trajectory represent inner strive of the body for the balance. In a perfectly stable condition COP oscillations are zero. The more pelvic asymmetry and the poorer sense of balance, the larger oscillation and trajectory area. Area of COP was chosen since it is independent of sampling frequency, time, patient size, and gives a clinically interpretable description. "Matlab" (Mathworks, USA) was used for calculations of polygon area based on outermost points of complex trajectory.

Results: The mean COP trajectory area of both force plates was more than twice as large in patient group than in controls, 0.38 and 0.16 cm^2, respectively. The asymmetry when comparing COP area for each force plate was also much larger in patient group, namely 45.5% relative difference in patients and 12.9% in controls. In an example patient before and after surgery, COP trajectory area improved from 0.63 to 0.20 cm^2. Asymmetry showed a major improvement, too. The values of controls were very homogenous, whereas the values of patients varied largely, always being much larger than those of controls, though.

Conclusion: This method allows a quantitative analysis of sitting function and comparison between study groups as well as pre- and post-intervention and over time. It offers a functional variable for follow-up studies.

FDA Disclosure: N/A.

110

KYPHOSCOLIOSIS IN SPONDYLO-EPI-METAFYSEAL SKELETAL DYSPLASIA

Helena Saraste

Summary: Hybrid system in progressing and rigid kyphoscoliosis with dysplastic bone quality and loss of body balance is presented.

Introduction: In skeletal dysplasias the poor bone quality, lack of anterior support, pelvic anteversion, hip contractures as well as an early progression of thorax and spine deformity and short stature, are problems to consider when choosing the timing and method of the surgery.

Methods: The surgical treatment of a 4 year old boy with severe, rigid and progressing kyphoscoliosis with loss of body balance is presented. Decision making considering the complex pathology from other organs than the spine as well as the problems with long geographical distance (foreign country) are considered.

Results: Good primary correction. Minor implant problems 1 year later. Continuous improvement of thorax form and body balance.

Conclusion: To consider the bone quality, future pathological growth, and skeletal dysplasia related problems from other organs is necessary in more complex neuro-endocrine diseases.

FDA Disclosure: N/A.

111

COMPLETE INTRALESIONAL RESECTION OF ANEURYSMAL BONE CYST OF THE IMMATURE SPINE

Hossam Salah, Hazem Elsebaie

Summary: A retrospective review of a case series of aneurysmal bone cyst of the immature spine. Complete intralesional excison, including the walls of the lesion was performed without the use of any adjuvant systemic or local measures. Soild fusion was obtained in all patients without any local recurrence reported.

Introduction: About 11–24% of aneurysmal bone cysts occur in the spine. It commonly affects the posterior elements and may extend to affect multiple levels. Simple curettage of these lesions has a reported local recurrence incidence of 20–70%. We are reporting our experience in complete intralesional excision of these lesions in the immature spine.

Methods: This is a retrospective review of 13 patients with aneurysmal bone cyst of the spine. There were eight males and five females. The mean at the time of surgery was 11.2 years (range 4–18 years). Five patients had their lesions in the cervical spine, four in the thoracic spine and four in the lumbar spine. Patients presented with axial pain, radiculopathy, a localized spinal deformity, a palpable mass or a neurological deficit. Nine patients (69%) had previous surgery.

Nine patients underwent sequential anterior and posterior surgical resection of the lesion, while four underwent posterior resection only. The aim of the surgery was a complete intra-lesional resection including the walls of the lesion. The mean blood loss was 1,350 ml (range 650–2,700 ml). No preoperative or postoperative adjuvant treatment was used in this series.

Results: The mean follow up period was 4.8 years (range 3.5—8.5 years). All patients reported improvement of their pain, three out of four patients with a neurological deficit showed neurological recovery. All patients showed radiological fusion on their X-rays without evidence of local recurrence.

Conclusion: In conclusion, complete intra-lesional resection of the lesion eliminated local recurrence in our series. Thorough surgical planning, including the resection and reconstruction is mandatory. Some of the technical details related to the resection are discussed. Reconstruction of the tumour defect can sometimes be challenging particularly in young children.

FDA Disclosure: Cleared: Yes.

112

PEDICLE SUBTRACTION OSTEOTOMY FOR CORRECTION OF THORACO-LUMBAR KYPHOSIS IN PARAPARETIC ACHONDROPLASICS; IS ADJACENT LUMBAR DECOMPRESSION NECESSARY?

Hossam Salah, Hazem Elsebaie

Summary: A retrospective case series of four achondroplasics with thoraco-lumbar kyphosis presenting with paraparesis. In two patients the neural compression was localized to the kyphotic area, while in the other two additional stenosis was found below the kyphotic area extending into the lumbar spine. All four underwent pedicle subtraction osteotomy at the apex of the kyphosis. Additional lumbar decompression was also performed for those with associated lumbar stenosis. A favourable neurological and radiological outcome was obtained in our patients.

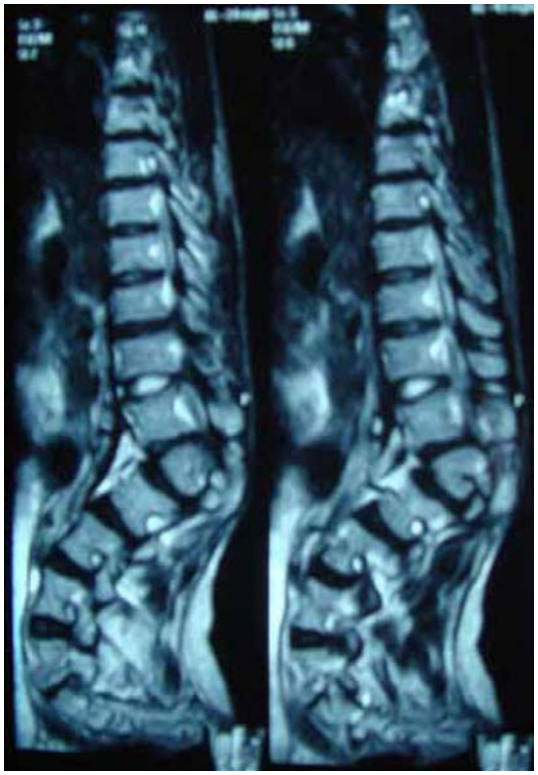
Introduction: This is a retrospective case series of surgically treated achondroplasics with thoraco-lumbar kyphosis presenting with paraparesis. Little has been written in the literature about the management of these cases.

Methods: We report four cases of adolescent achondroplasics with thoraco-lumbar kyphosis who presented with paraparesis. All four patients were male. The mean age at presentation was 15.5 years (range 13—19 years). The preoperative neurological ASIA class was B in one patient, C in two and D in one. Three patients were unable to walk while one walked with an aid. In two patients, the level of neural compression was localised to the area of thoraco-lumbar kyphosis, while in two, there was additional extensive lumbar stenosis below the level of the kyphosis. The mean preoperative thoraco-lumbar kyphosis angle was 58″ (range 45″ to 78″).

A posterior pedicle subtraction osteotomy with segmental pedicle screw fixation was performed in all cases at the level of kyphosis. In the two patients with associated lumbar stenosis, extensive lumbar decompression across four levels was performed as well.

Results: All four patients showed at least one ASIA grade of neurological improvement at their latest follow up. All became walkers without support. The mean postoperative kyphosis angle was 9″ (range 0″–17″), with a mean correction of 73%. One patient developed a dural tear that was repaired without consequence. There were no neurological or implant related complications.

Conclusion: In conclusion, pedicle subtraction osteotomy is an effective method for correction of thoraco-lumbar kyphosis in achondroplasics. The correction of the kyphosis provides adequate decompression of the neural structures. Thorough assessment of the adjacent levels for stenosis is mandatory in these patients.In two of our patients, severe lumbar stenosis below the level of the kyphosis was found that required extension of the decompression into the lumbar spine. A favourable neurological outcome was obtained in our patients.
FDA Disclosure: Cleared: Yes.



113

SIMULTANEOUS POSTERIOR HEMIVERTEBRA RESECTION AND DUAL ROD GROWING INSTRUMENTATION FOR CONGENITAL SCOLIOSIS

Hossam Salah

Summary: A case presentation of congenital scoliosis demonstrating the simultaneous use of posterior hemivertebra excision and dual rod growing instrumentation for its correction. The posterior hemivertebra excision pedicle screw construct acted as the distal foundation for the growing instrumentation with the proximal foundation made up of hooks and a sublaminar cable. This demonstrates the simultaneous use of conventional fusion surgery and non-fusion growing instrumentation in the management of congenital scoliosis.
Introduction: A case of congenital scoliosis managed with fusion and fusionless surgery.
Methods: A 4 year old girl presented with congenital scoliosis. Her X-rays showed a left sided hemivertebra at L4 causing an oblique take off of 35″ and a right sided hemivertebra at T9 causing a T6 to L3 right sided thoracic curve measuring 65″.
A posterior hemivertebra excsion at L4 was performed with pedicle inserted at L3 and L5. Closure of the created defect was performed using a central hook rod construct to avoid overloading the screws. This construct was used as the bottom foundation for a dual rod growing instrumentation with the proximal foundation secured with hooks and sublaminar cable at T3 and T4.
Results: The patient underwent sequential lengthenings at 6 months intervals, a total of four so far without complications. She maintains overall coronal and sagittal balance with level shoulders.
Conclusion: Different modalities of surgery are sometimes needed in the management of complex congenital scoliosis. A posterior hemivertebra excision construct can act as a foundation for growing instrumentation.
FDA Disclosure: N/A.

114

TEMPORARY ATLANTO-AXIAL WIRING WITHOUT FUSION FOR A DISPLACED ODONTOID SYNCHONDROTIC DISRUPTION

Hossam Salah

Summary: A 2 year old girl sustained a displaced odontoid synchondrotic disruption. A Minerva cast failed to maintain the reduction, and was operated upon with temporary sublaminar C1/C2 cable stabilization without fusion. At 2 months the cable was removed. At 1 year follow up she had full range of cervical rotation and maintained C1/C2 motion radiologically. Strict extra-periosteal dissection and early removal of the cable were key factors in prevention of fusion.
Introduction: Displaced odontoid fractures in young children are mostly treated non-operatively. C1/C2 fusion has occasionally been reported for those who fail with nonoperative measures.
Methods: A 2 year old girl was involved in a RTA and sustained a displaced synchondrotic disruption of the odontoid. She was neurologically intact. An attempted gentle manipulation and a Minerva cast failed to maintain the odontoid in a reduced position. She was therefore operated upon with extra-periosteal dissection of C1 and C2 and a sublaminar Titanium cable inserted fixing C1/C2. A paediatric hard collar was then applied. Two months later, the cable was removed to restore C1/C2 motion.
Results: At 1 year follow up she had full range of cervical rotation and her X-rays showed a reduced odontoid with maintained C1/C2 motion.
Conclusion: Temporary stabilization of the atlanto-axial joint can be an option in the management of displaced odontoid fractures in young

children when a Minerva cast fails to maintain the reduction. Strict extra-periosteal dissection and early removal of the cable can prevent C1/C2 fusion.
FDA Disclosure: N/A.

115

NEW METHOD OF SCOLIOSIS ASSESSMENT: PRELIMINARY RESULTS USING COMPUTERIZED PHOTOGRAMMETRY

Rozilene maria Aroeira, Jefferson Leal, Antônio eustáquio Pertence

Summary: A new method for non-radiographic evaluation of scoliosis was independently compared with the Cobb radiogrphic method, for the quantification of scoliotic curvature. The preliminary results presented demonstrate equivalence between the two methods in comparative analysis.
Introduction: Repeated exposure to radiation of children can be harmful to their health. Nevertheless, no non-radiographic method until now proposed has gained popularity as a routine method for evaluation, mainly due to a low correspondence to the Cobb radiographic method.
Methods: Patients undergoing standing posteroanterior full length spine radiographs, who were willing to participate in this study were submitted to dorsal digital photography in the orthostatic position, with surface markers above the spinal process, specifically the vertebrae C7 to L5. The radiographic and photographic images were sent separately for independent analysis to two examiners, trained in quantification of scoliosis for the types of images received. The scoliosis curvature angles obtained by computerized photogrammetry were compared to those obtained through the Cobb radiographic method.
Results: Sixteen individuals were evaluated (14 female and 2 male). All presented Idiopathic Adolescent Scoliosis, and were between 21.44 6.17 years of age; 52.91 5.88 kg in weight; 1.63 0.05 m in height, with a Body Mass Index of 19.86 0.26. There was no statistically significant difference between the scoliosis angle measurements obtained in the comparative analysis of both methods, and a mathematical relationship was formulated between both methods.
Conclusion: The preliminary results presented demonstrate equivalence between the two methods in comparative analysis. More studies are needed to firmly asses the potential of this new method as a co-adjuvant tool in the routine following of scoliosis treatment.
FDA Disclosure: N/A.

116

THE DUAL GROWING ROD METHOD USING PEDICLE SCREWS AS FOUNDATION IN THE BOTH OF UPPER AND LOWER SPINE

Ken Yamazaki, Hideki Murakami

Summary: Recently, there are not a few reports on high complication rates and the failure of the growing rod to spinal deformities in an early onset scoliosis. Six patients were treated with a dual growing rod system from 01/2006 to 01/2009. We fundamentally choose pedicle screws on both ends under a CT based navigation system for small size pedicles. Strong construct using pedicle screws could allow correcting the curve earlier and keeping up with the growth of the spine.
Introduction: The treatment of early onset scoliosis (EOS) remains one of the more challenging aspects of spine surgery. The dual growing rod method provided good maintenance of curve correction. The foundations that provide anchor points for the dual growing rods may incorporate screws, hooks, tapes (ultra high molecular weighted polyethylene tape: Tekmilon tape) or a hybrid construct. We fundamentally choose the pedicle screws as foundation in both upper and lower spine, because strong construct using pedicle screws could allow correcting the curve earlier and keeping up with the growth of the spine.
Methods: Six patients were treated with a dual growing rod system with pedicle screws as a foundation in both ends from 01/2006 to 01/2009. The average age of 6 patients (Boy: Girl = 5: 1) was 6.1 years (2–8). Diagnosis were idiopathic scoliosis (1), SOTOS (1), myelomeningocele (1), NF1 (1), and miscellaneous (2). All patients were followed for a minimum of 6 months (6–42). The frequency of lengthening was an average of 2.8 times (lengthening every 6 months).
Results: Preop. Cobb's angle was an average of 68.7° (43–93). Postop. Cobb's angle decreased to an average of 28.7° (13–52). The Correction rate was an average of 60.2% (44–73). After 1st. op. their standing height increased an average 4.0 cm (2.0–7.0). There were no major complications in any of the patients.
Conclusion: The growing rod instrumentation with pedicle screws on both ends is a safe and effective method in controlling curve of EOS earlier in all three planes. With a careful technique, previously reported high complication rates in the growing rod system can be considerably decreased.
FDA Disclosure: N/A.

117

COMPLICATIONS OF DUAL GROWING ROD SURGERY PERFORMED BY A SINGLE SURGEON IN 25 PROGRESSIVE EARLY ONSET SCOLIOSIS

Koki Uno, Shinichi Satsuma, Norihide Sha

Summary: We examined 25 EOS patient who were performed initial surgery by a single surgeon and were followed up at least 2 years. There were 48 complications in 18 patients. Of the 48 complications, 31 complications out of 89 surgery occurred in boys and 11 out 105 occurred in girls. There were 18 hook dislodgements and 13 rod breakage, 6 screw loosening, 8 infection. Further efforts to lessen the complication rate is necessary.
Introduction: Multicenter study concerning complications of dual growing rod technique has been conducted. However, experience, strategy, indication among surgeons are so different that complications in detail are still unclear. In this study, we examined complications of 25 EOS patient who were performed initial surgery by a single surgeon and were followed up at least 2 years.
Methods: There were 14 girls and 11 boys. Average age at initial surgery was 7.0 (2.0–11.0) years and average follow up was 4.3 (2.0–10.0) years.
Pathology included 5 idiopathic, 3 congenital, 3 neurofibromatosis, 6 bone metabolic disease, 2 Sotos syndrome, 2 thoracic cage defect,and 4 other etiology. Five patients were performed final fusion due to skeletal maturity or due to failure of controlling the deformity. For upper foundation,hooks were placed at T4-6 in early 5 cases and at T1-3 or T2-4 in other cases.For lower foundation, screws were usually used at L2-3. Lengthening was performed every 6 months by junior associates or residents. Complications in these 25 patients are examined in detail.
Results: There were 48 complications in 18 patients. Seven patients had no complications. There were 18 hook dislodgement, 13 rod breakage, 6 screw loosening, 5 deep infection, 3 superficial infection,

2 decompensation, and one decubitis. There was no neurological disturbances. Of the 48 complications, 31 complications out of 89 surgery occurred in boys and 11 out of 105 occurred in girls. Hook dislodgements were mainly observed only in boys. Infections was observed at the site of tandem connectors in patients who had lengthening for 3 years or longer. Patients who had bone fragility, such as neurofibromatosis or bone metabolic dysplasia, had more complications.
Conclusion: Rod breakage, which was observed only in boys, is likely due to patient's activity. Hook dislodgement is due to inappropriate startegy of its placement or bone fragility of the patients. And infection is likely due to multiple procedure. Although dual growing rod for early onset scoliosis can be performed with favorable results, further efforts to lessen the complication rate is necessary.
FDA Disclosure: N/A.

118

VALUTATIONS OF QUALITY OF LIFE AFTER SPINE FUSION IN CHILDREN AFFECTED BY NEUROMUSCOLAR SCOLIOSIS

Luca Colombo, Francesco Motta

Summary: Purpose of this study is to investigate possible chancing in the quality of life in children affected by neuromuscolar scoliosis (SMA, Duchenne D., PCI, Mielomeningocele) after spine surgery. This is a retrospective 5 years follow up study. All the patients were evlueted after 6 month with SRS 22 and a 27 subjective questionnaire.The result demontrate a real improve in the quality of life in this categories of patients after spine surgery.
Introduction: Propose: to investigate the possible chancing in the quality of life in children affected by neuromuscolar scoliosis after spine surgery. We know that scoliosis in these patients is progressive and the conservative treatment is not useful. In these retrospective study (5 years follow up) we analyzed the results of the SRS 22 questionnaire and a 27 subjective questionnaire to validate the real improve of quality of life in these patients. All the patients had the questionnaire after 6 month since the operation.
Methods: Since 2003 we treated 112 patients affected by neuromuscular scoliosis (SMA, Duchenne Dystrophy, Myelomeningocele, Cerebral palsy). This is a retrospective 5 years follow up study of patients underwent posterior spine fusion and Unit Rod instrumentation. Mean age 14 y.o. (range 11–19) 64 girls 48 boys.
Mean preoperative curve magnitude was 84° Cobb range 62° to 120°. All the patients were evaluated after 6 month, from surgery, with SRS 22 and a 27 subjective questionnaire.
Results: The spine curvatures mean correction was 43° range 28°–58°. The preop. pelvic obliquity range 20°–43° mean 31° after surgery the mean correction was 8°. The SRS 22 questionnaire results: Function and activity 3.8—Pain 4.5—Mental Health 3.8—satisfaction with management 4.2—Tot 4.0.
The results of the 27 subjective *Q*: 0% worsened, 32% unchanged, 68% improve.
Conclusion: Scoliosis in neuromuscular patients is an evolutive disease and the conservative treatment is not useful.
In time they loose the balance for the setting position in the wheel chair and they begin to have pain and sores and difficulties in eating and breathing. Propose of these study is to investigate if there is an improve of quality of life after the treatment of scoliois not depending on the technique or the instrumentation.

We analyzed the results of the questionnaire independent from the X-ray results. We found that all the patients had a real improvement of the spinal deformity and of their quality of life. We can concluded that spine surgery is indicated in patients affected by neuromuscular scoliosis to prevent poor expectation of their life.
FDA Disclosure: Cleared: Yes.

119

TWO BROTHERS WITH ESCOBAR SYNDROME ASSOCIATED WITH THORACIC KYPHOSCOLIOSIS

Mehmet Balioglu, Aysegul Bursali, Mehmet Kaygusuz, Ali Oner, Alper Koksal

Summary: Escobar syndrome (ES) associated with thoracic kyphoscoliosis, lordoscoliosis and severe restrictive lung disease. We present two brothers with Multiple Pterygium Syndrome type Escobar who was younger of the patients were submitted to surgical treatment, other was observed. Scoliosis may progress considerably in ES, requiring early surgical treatment.
Introduction: ES is characterized by a web across every flexion crease in the extremities, most notably the popliteal space. In addition, this syndrome is associated with two other structural anomalies: a vertical talus and congenital lordoscoliosis. Our report two brother of scoliosis and kyhposis in ES.
Methods: We present two brothers with ES (11–14 year) who was younger of the patients were submitted to surgical treatment, other was observed. The patient underwent one-stage posterior spinal fusion with instrumentation.
Results: Simple posterior stabilization of the deformity was obtained in younger brother. The patient's postoperative course was normal. There were never any focal neurologic deficits. The patient was a 1 year follow-up with radiographically confirmed maintenance of correction. Clinically, the patient is able to stand upright, can participate in functional activities.
Conclusion: Scoliosis may progress considerably in ES, requiring early surgical treatment. We propose early surgical intervention in this group to prevent curve progression and restrictive lung disease.
FDA Disclosure: N/A.

120

OBSERVATIONS OF SPINAL DEFORMITIES IN PATIENTS WITH SPINA BIFIDA

Mehmet Balioglu, Aysegul Bursali, Mehmet Tacal, Mehmet Kaygusuz, Ali Oner

Summary: In our study we observed 13 patients (children and adolescents) with Spina Bifida (SB) and/or scoliosis/kyphosis. We measured physical functionality of the spine using various methods and the SB Spine Questionnaire (SBSQ). We concluded that, especially with young patients, it is important to ensure sitting balance through physical therapy and to regularly monitor for changes in physical function as SB changes over time due to growth. However, some patients will require corrective spinal surgery.
Introduction: The purpose of this study was to evaluate spinal deformities and physical function in children and adolescents with SB.
Methods: About 13 children and adolescents with SB and/or scoliosis/kyhposis were examined. Spinal deformities were measured using cobb methods, sagittal and coronal balance, pelvic and clavicular obliquity and pulmonary function. Measures of physical function of the spine were evaluated with the SBSQ. If deformity was extreme and patients were unable to use a spinal brace an operation was planned.
Results: Average age of patients (8 male, 5 female) was 5.6 years (6 months–19 years). Only one patient (female age 18), with severe thorocolumbar scolisis and kyphosis, required surgery. All 13 patients were observed with or without spinal braces and all patients received physiotherapy. The patient who received an operation regained sitting balance and was free of pain. After a 1 year follow-up period the patient was satisfied. Other patients using braces encountered problems as they grew older and effectiveness of the braces decreased.
Conclusion: In SB patients it is important to ensure sitting balance and to monitor for any changes in physical function. If problems increase with age the patient's condition should be evaluated and physiotherapy or surgery should be planned accordingly. We recommend regular follow up of these patients.
FDA Disclosure: N/A.

121

GROWING RODS AND NON-FUSION TREATMENT FOR EARLY ONSET SCOLIOSIS

Mehmet Balioglu, Mehmet Kaygusuz, Ali Oner, Ferdi Bozkus, Kadir Abul

Summary: Early Onset Scoliosis (EOS) reduces the movement and capacity of the lung and the chest wall. In this study our aim was the reduction of spinal deformity and increased lung function in 6 EOS congenital and juvenile patients. We employed both growing rod and nonfusion techniques in an attempt to reduce spinal deformity. Our results showed that such techniques were most successful when implemented at the earliest possible age.
Introduction: Early Onset Scoliosis (EOS) reduces the movement and capacity of the lung and the chest wall. In this study our aim was the reduction of spinal deformity and increased lung function. We present our early results of fusionless application in six patients.
Methods: Between 2007 and 2009 posterior instrumentation and distraction were applied to 6 patients (2 juvenile, 4 congenital) with EOS (5 female, 1 male, mean age 7.3; 3.5–11). We applied a single rod (1 patient), double rods (4 patients), VEPTR (1 patient). Distraction period was an average of 6 months. Follow-up period was an average of 15.6 (4–29) months.
Results: The average correction was 42% (12–77) at the final check. Complications consisted of an infection in one patient which developed 4 months after surgery. Debridement was done 3 separate occasions and we changed the implant and the patient recovered. One patient's implant loosened but was reinserted. Single rods were ineffective and needed to be revised twice. We then performed fusion and deformity correction. Neurological deficit did not develop.
Conclusion: Growing rods and VEPTR can stop substantial congenital or infantile curves from becoming extreme in many patients with EOS. Such treatment is subject to various complications—infection, implant insufficiency and loosening and insignificant correction. For all EOS patients, dual rods and nonfusion techniques offered better results than single rods. VEPTR is another option for congenital scolisis with Thoracic Insufficiency Syndrome.
FDA Disclosure: N/A.

122

ESCOBAR SYNDROME ASSOCIATED WITH SCOLIOSIS AND KYPHOSIS: A CASE REPORT

Mehmet Balioglu, Aysegul Bursali, Mehmet Kaygusuz, Ali Oner, Umit Aykut

Summary: Escobar Syndrome (ES) is a rare hereditary disease that can affect the spine and lead to scoliosis and kyphosis. In this case report we evaluated the early clinical and radiological results of an 11 year old male patient who received posterior stabilization and fusion treatment.
Introduction: This study presents a scoliosis patient with ES and the surgical treatment of this patient's scoliosis.
Methods: An 11 year old patient was diagnosed with ES at a medical genetics clinic. His physical examination revealed that he had scoliosis, a high palate, ptosis, low-set ears, arachnodactyly, faciocranial dysmorphism, mild deafness, joint contractures and vertical talus. The Cobb method measurements were 23° for T2–T5, 78° for T5–L3 segments. The MRI study showed that L5 was sacralised, the cauda equine level was at L3. Surgical treatment was performed with T3–L1 vertebrae posterior segmental instrumentation.
Results: Follow-up was performed 9 months after surgery. Postoperative AP Cobb method measurements were: 33° for T5–L3 segments (correction 48.8%). Lateral Cobb measurements were 53° for T3–L1

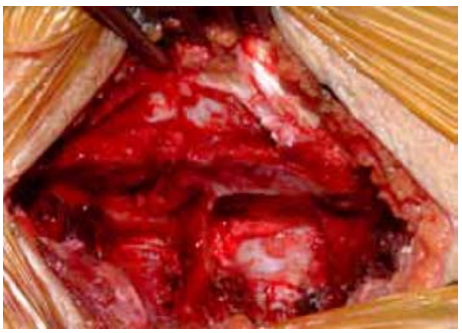
and 36° for T1–T3 thereby showing the development of junctional Kyphosis at T1–T3.
Conclusion: We believe that careful preoperative planning for specific patients and cautious posterior surgical techniques will result in a balanced spinal correction and restoration of pulmonary function.
FDA Disclosure: N/A.

123

THE RESULTS OF SURGICAL TREATMENT FOR PEDIATRIC SCOLIOSIS WITH PAIN DUE TO OSTEOID OSTEOMA AND OSTEOBLASTOMA

Mehmet Balioglu, Mehmet Kaygusuz, Ali Oner, Kadir Abul, Alper Koksal

Summary: Pediatric and adolescent scoliosis with pain could be related to primer bone tumors. Two female patients were diagnosed with scoliosis with pain due to Osteoid Osteoma (OO) and Osteoblastoma (OB). After removing lesions patients were free of pain and significant deformity corrections were achieved.
Introduction: Our aim was to achieve deformity correction and pain reduction via en block resection in the lesion are a without use of instrumentation and fusion.
Methods: Between 2008 and 2009 2 cases (OO patient age 12, OB patient age 7) of Scoliosis with low back pain were examined. Patient history of scolios and pain was approximately 1.5 years prior to the operation. Plain radiography, CT and MRI tests were done. After defining the lesion area an en-block resection was planned. For the OO patient we resected a tumor on the L3 vertabra and for the OB patient on the T10 vertabra. Stabilization and fusion related procedures were not used. Braces were not needed postoperatively. Pre-op and post-op angles were evaluated and compared using Cobb method. Pain was evaluated with Visual Analog Score (VAS).
Results: The follow up period post-op was an average of 9 months (4–14). For the OO patient Cobb angles were preop T5–T12: 20°, T12–L4: 30 and postop T4–L1: 10, L1–L4: 13. For the OB preop were T6–L2: 34, T1–T4: 11 and postop T4–T11 9. At the final check an average correction of 60% (50–73.6) was recorded. Soon after the operation patients were free of pain and there were no complications postoperatively. Average VAS was 10 preoperatively and 0 postoperatively. The patient was satisfied.
Conclusion: Pediatric scoliosis with pain is often due to primary spine tumors (OO and OB). A complete en-block resection of these lesion areas was a successful treatment. This shows that there is no need for stabilization and/or fusion.
FDA Disclosure: N/A.



124

EISENMENGER'S SYNDROME WITH SCOLIOSIS: CASE REPORT

Mehmet Balioglu, Ali Oner, Mehmet Kaygusuz, Osman Cimen, Ornek Serhan

Summary: Case notes of a 12 years old patient diagnosed with Eisenmenger's syndrome (ES) and scoliosis.
Introduction: ES is a complication of uncorrected congenital heart anomalies that produces left-to-right shunting. Increased pulmonary resistance often develops over time, reversing left-to-right shunting to right-to-left shunting. Scoliosis is present in about 1/3 of patients.
Methods: Our patient was 12 years old (female). Diagnosis of the ES was made using Standard cardiac techniques while spinal X-rays and spinal column MRI's were used to define the scoliosis.
Results: Untreated Congenital heart anomalies that result in ES include ventricular septal defect, atrioventricular canal defect, atrial septal defect, persistent truncus arteriosus and transposition of the main arteries. Cardiac catheterization was peformed on the patient with adverse results. Surgery, either cardiac or spinal, is not advised.
Conclusion: Occasionally, very rare cardiac syndromes are encountered. The patient has severe thoracolumber scoliosis which, due to ES, can not be operated upon. Thus, scoliosis is treated using a correction brace and close patient observation.
FDA Disclosure: N/A.

125

VEPTR INSTRUMENTATION ON THORACIC INSUFFICIENCY SYNDROME OF A MONOZYGOTIC TWIN: CASE REPORT

Mehmet Balioglu, Mehmet Kaygusuz, Ali Oner, Ferdi Bozkus, Osman Cimen, Kadir Abul

Summary: Our patient was a monozygotic twin and her sister was normal. She was diagnosed with congenital scoliosis (CS) and thoracic insufficiency syndrome (TIS). A Vertical expandable prosthetic titanium rib (VEPTR) was selected for treatment.
Introduction: VEPTR instrumentaion can be used with young patients (up to 5 years) with CS and TIS to correct deformity. This is a case report of the early results of a patient who received a VEPTR implantation.
Methods: Our patient was a monozygotic twin. Her twin sister's examination showed she was in good health. She was 44 months old. Our Patient, however, had left TIS and cervicothoracic CS. There were fusion anomalies in her left ribs and cervicothoracic congenital anomalies (hemivertebra and tethered cord) were present. Cobb angles were measured. During the operation 2 rib fusion sites were released. A Hybrid VEPTR was implanted on the left side.
Results: Preoperative AP T2–T11 cobb angle was 97°, early postop anglee was 70 and the 4th month visit angle was 83. There were no signs of any complications.
Conclusion: In the pediatric community a VEPTR is recommended for deformity correction and thoracic volume increase in patients with thoracic CS. In this case, left hemithorax deformity was corrected minimally to increase the thoracic capacity. Lengthening was planned for every 6 months.
FDA Disclosure: N/A.

126

SAGITTAL SPINE-PELVIC ALIGNMENT IN PATIENTS WITH JUVENILE SCOLIOSIS TREATED WITH GROWING POLYSEGMENTAL SYSTEM

Mesentsev Andriy, Dmytro Petrenko, Anatolii Levytskyi

Summary: Restoration of the normal sagittal spine-pelvic alignment is the essential condition in the surgical treatment of scoliosis. Study group included 37 consecutive patients with Juvenile Idiopathic Scoliosis aged 8–12 years (mean 10.5 years). All patients were treated with antelateral convex epiphyseodesis and polysegmental posterior growing system without posterior fusion. Investigation shows that polysegmental growing spinal instrumentation allows to maintain Spine-pelvic alignment in normal physiological values.
Introduction: Restoration of the normal sagittal spine-pelvic alignment is the essential condition in the surgical treatment of scoliosis. There are no data regarding spine-pelvic balance in patients with Juvenile Scoliosis treated with different growth compatible implants. We suppose that polysegmental spinal instrumentation allows to save normal spine-pelvic balance during the treatment.
Methods: Study group included 37 consecutive patients with Juvenile Idiopathic Scoliosis aged 8–12 years (mean 10.5 years). All patients were treated with antelateral convex epiphyseodesis and polysegmental posterior growing system without posterior fusion. After skeletal maturity the patients underwent the final posterior fusion. On lateral standing roentgenograms we calculated following parameters: thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), C7 plumbline position. Follow-up (from correction to fusion) was 4 years.
Results: TK values before surgery was 25.1 ± 3.5 and ranged from 27.2 ± 2.13 (after surgery) to 29.05 ± 2.46 (4 years after surgery); LL before surgery was 37.76 ± 3.89, and changed from 33.19 ± 3.23 after surgery to 34.09 ± 3.08 at final fusion; PI before surgery was 55.1 ± 2.99, after surgery 57.71 ± 2.41 and 57.14 ± 2.17—after 4 years; SS before surgery was 41 ± 2.78 and ranged from 38 ± 2.36 to 36.62 ± 2.27 at final follow-up; PT before surgery was 14.14 ± 3.74 and ranged from 10.19 ± 1.32 after surgery to 9.81 ± 1.41 after 4 years; C7 plumbline position before surgery was 1.35 ± 0.16, after surgery 0.74 ± 0.01 and 0.69 ± 0.07 before final fusion (Table 1).
Conclusion: Sagittal Spinal-Pelvic alignment in patients with Juvenile Idiopathic Scoliosis has not been changed dramatically after antelateral convex epiphyseodesis and polysegmental posterior growing system as well as 4 years after spinal growth: Polysegmental growing spinal instrumentation allows to maintain Spine-pelvic alignment in normal physiological values.
FDA Disclosure: N/A.

Table 1
Spine-pelvic alignment evolution during follow-up

	Pre-op	Post-op	0,5 yrs	1 yrs	1,5 yrs	2 yrs	2,5 yrs	3 yrs	3,5 yrs	4 yrs
Toracic kyphosis.	25,1± 3,5	27,2± 2,13	24,43± 2,58	29,65± 2,01	30,5± 2,67	28,95± 2,57	29,81± 2,6	29,24± 2,48	28,95±2, 49	29,05± 2,46
Lumbar lordosis	37,76±3 ,89	33,19± 3,23	29,29± 3,61	32,33± 3,09	33,35± 3,45	33,71± 3,22	33,95± 3,14	33,86± 3,22	34,57±3, 08	34,9± 3,08
Pelvic incidence	55,1± 2,99	57,71± 2,41	59,76± 2,27	58,91± 2,21	58,14± 2,51	58,05± 2,49	57,38± 2,18	57,29± 2,21	57,14±2, 17	57,14± 2,17
Sacral slope	41± 2,78	38± 2,36	38,43± 2,42	38,52± 2,52	36,52± 2,65	36,43± 2,63	36,9± 2,71	36,67± 2,7	36,76±2, 7	36,62± 2,7
Pelvic tilt	14,14±3 ,74	10,19± 1,32	9,52±1, 23	10,19± 1,6	9,9± 1,55	10,09± 1,53	9,81± 1,41	10,29± 1,33	10,29±1, 33	9,81± 1,41
C7 plumbline	1,35± 0,16	0,74± 0,01	0,73± 0,07	0,42± 0,05	0,36± 0,04	0,36± 0,03	0,57± 0,03	0,57± 00,3	0,62± 0,07	0,69± 0,07

127

DIFFICULTIES IN THE TREATMENT OF EARLY ONSET SCOLIOSIS WITH THE USAGE OF VEPTR

Michal Latalski, Marek Fatyga, Tomasz Raganowicz, Andrzej Gregosiewicz

Introduction: The aim of this work is to evaluate the difficulties of surgical treatment using the VEPTR system. The authors present their own experience.
Methods: About 13 pts (38 procedures) treated with the use of VEPTR in the Children Orthopedic Department of the Medical University of Lublin, Poland. Three due to widely spread congenital malformation of the spine), 5 due to progressing neuro-mascular scoliosis, 5 are under treatment due to kyphosis resulting from myelomeningocele. A number of surgeries varies with each child and ranges from 2 to 6. The follow-up ranges from 6 month to 2.5 year.
Results: We observed: Rib fracture, rib cradle displacement, Laminar hook displacement, Drift of rib attachment, Iliac S-hook drift, Chest wall scarring, Rib fusions beneath devices.
Conclusion: VEPTR appears to be a perfect alternative to other surgical solutions in the stage treatment of the chest and spinal deformity. The method is threatened with complications which are to be taken into consideration while starting the treatment and which may affect its final outcome, although these threats do not disqualify.
FDA Disclosure: N/A.

128

GUIDED GROWTH IMPLANTS AS A SOLUTION FOR REVISION SURGERY PROXIMAL JUNCTIONAL KYPHOSIS AFTER BUTTERFLY VERTEBRA RESECTION IN THE GROWING SPINE—CASE REPORT

Michal Latalski, Marek Fatyga, Andrzej Gregosiewicz, Tomasz Raganowicz

Introduction: Butterfly vertebra is a rare malformation of the spine. It is classified as a congenital developmental anomaly in the early embryonic period resulting in a variety of vertebral body malformation. The butterfly malformation may involve two adjacent vertebral bodies. Butterfly vertebra can result in kyphosis due to the diminished height of anteriorly wedged vertebral body.
Methods: A 8 year old boy presented to our institution with severe, progressive rigid sagittal deformity in the thoracolumbar spine.
Results: Roentgenogram showed the presence of a butterfly vertebra at T11 level. He was treated with butterfly vertebra resection and transpedicular fixation. Short posterior spinal fusion end cranially in the lower thoracic region in that case caused an increase in sagittal decompensation at the proximal junction in follow-up. Correction of this deformation in skeletal immature patients should allow further growth of the spine and thorax.
Conclusion: Authors presents transpedicular guided growth implants application for proximal junctional kyphosis.
FDA Disclosure: N/A.

129

MATHEMATICAL APPROACH TO PROGNOSIS OF HEIGHT INCREASE AFTER THREE

Michal Latalski, Jaroslaw Latalski, Marek Fatyga, Tomasz Raganowicz, Andrzej Gregosiewicz

Introduction: One of the visible signs of scoliotic deformation of the spine is proportion disturbances of patient silhouette.
Methods: It is one of the cosmetic problems taking up during anamnesis.
Results: Height deficit depends on severity and the degree of spinal curvature. Authors presents a mathematical approach to the problem of predicted height increase estimation after three dimension correction of the spine.
Conclusion: Developed mathematical model can be assessed and an estimate of the growth of the spine after correction.
FDA Disclosure: N/A.

130

SINGLE GROWING ROD METHOD USING PEDICLE SCREWS IN THE BOTH UPPER AND LOWER SPINE—CASES REPORTS

Michal Latalski, Marek Fatyga, Andrzej Gregosiewicz, Tomasz Raganowicz

Introduction: Using distraction based implants is one of the growth compatible method in treatment of early onset scoliosis. The foundation for growing rods can be composed of hooks, screws or hybrid construct.
Methods: We report the outcome of the 6 cases treated this method.
Results: Five girls and one boy in the age of 7–11 and curve 45°–70°. Follow-up 7 month to 2 years.
Conclusion: Using only screws with single rod can form strong construct which allow good early correction and good support for final fusion. It also contains less metal which means less irritation to soft tissues.
FDA Disclosure: N/A.

131

THE SUBMUSCULAR SINGLE GROWING ROD TECHNIQUE—OUTCOMES OF A DEFINITIVE FUSION

Najma Farooq, Stewart Tucker, Hilali Noordeen

Summary: Use of the submuscular single growing rod construct in the treatment of early onset spinal deformity was able to yield acceptable results in both clinical and radiological parameters in thirteen patients followed up beyond definitive fusion.
Introduction: The aims of treatment in early onset scoliosis are to preserve respiratory function and spinal growth and to achieve a cosmetically acceptable result at maturity.

Patients who had undergone definitive fusion following completion of the growing rod programme were reviewed in order to assess the efficacy of the single submuscular growing rod technique in achieving these goals.
Methods: A retrospective study reviewing clinical and radiological outcomes in thirteen patients who had undergone the insertion of a submuscular single growing rod construct between 2002 and 2005 with subsequent conversion to definitive spinal fusion between 2006 and 2009 at two specialist institutes.
Radiological parameters including assessment of coronal and sagittal balance, T1–S1 heights, Cobb angle and kyphosis measurements were obtained at the outset, following growth rod insertion, prior to definitive fusion and at latest follow-up.

Clinical review noted the incidence of rod fracture, anchor failure, infection, number of distractions, whether associated apical fusion was undertaken or not, levels of fusion and underlying diagnosis.
Results: About 13 patients with an average gain of 4.5 cm in T1–S1 heights at latest followup. The initial cobb angle improved from 68 to an average of 38° at final followup.
Improvement was noted in both sagittal and coronal balance.

Patients remained in the growing rod programme for an average of 4.6 years, undergoing on average 5.6 distractions before definitive fusion.

Six rod fractures were noted in this series with one superficial wound infection.
Conclusion: Acceptable clinical and radiological outcomes can be achieved at definitive spinal fusion without an undue burden of complications following the single growing rod technique at the same time allowing some preservation of spinal growth potential and control of the deformity.
FDA Disclosure: N/A.

132

PELVIC FIXATION IN NEUROMUSCULAR SCOLIOSIS—TECHNIQUE, CLINICAL AND RADIOLOGICAL REVIEW

Najma Farooq, Rajiv Kaila, Sheriff Montgomery, Hilali Noordeen

Summary: The reviewed technique of pelvic fixation has produced favourable midterm clinical and radiological results in a large single surgeon series.
Introduction: Correction of spinal deformity and associated pelvic imbalance in the neuromuscular paediatric population can pose a surgical challenge. Evolving methods of spino-pelvic fixation and instrumentation have aimed to reduce some of the common complications and difficulties encountered in this group of patients.
The study aim is to describe and assess the efficacy of one technique of spino-pelvic fixation performed by a single surgeon in a large series of patients with neuromuscular scoliosis and pelvic obliquity.
Methods: A retrospective evaluation of clinical and radiographic outcomes in 108 patients undergoing posterior spinal deformity correction and pelvic fixation between 2001 and 2007 under the care of the senior author (MHHN). Average age of the patients was 14.1 years with a minimum follow-up of 12 months.
Pelvic instrumentation was performed by a single technique in all patients. The posterior midline scar was used; musculofascial flaps were raised to expose the posterior superior iliac spines. The flaps provided good soft tissue coverage to reduce prominence of hardware. Specific anatomical landmarks were used to gauge iliac screw trajectory.

Clinical outcomes included infection, wound breakdown and implant prominence.

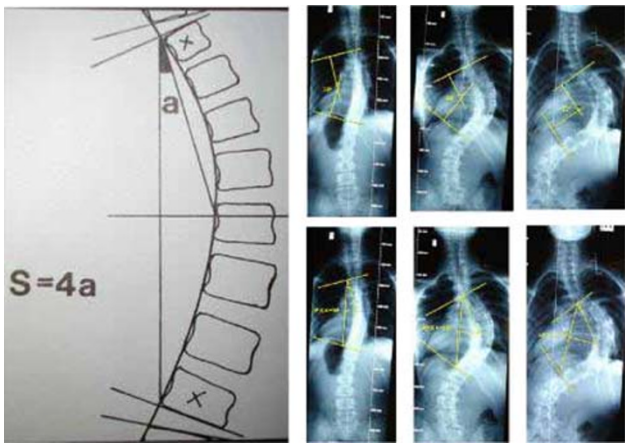
Radiological assessment included pre and post-operative measurements of Cobb angle, pelvic obliquity, coronal and sagittal balance. Other radiological parameters included assessment for malposition of metalware, signs of pseudarthrosis or implant failure.
Results: The average correction of Cobb angle was 45% and of pelvic obliquity 50%. Improvements in both coronal and sagittal balance were achieved. There were no cases of metalware failure of the pelvic fixation. One patient had delayed wound healing requiring prolonged antibiotic treatment. A further patient required removal of prominent proximal metalwork and debridement of the wound.
Conclusion: This mid-term review of a large series of challenging patients with spinal deformity requiring pelvic fixation has demonstrated favourable clinical and radiological results. The paucity of implant and wound complications would support the continued use of this operative technique of pelvic fixation.
FDA Disclosure: N/A.

133

CAPASSO'S METHOD REVISTED: COMPARISON AGAINST CONVENTIONAL MEASUREMENT TOOLS IN EVALUATION OF COBB ANGLE FOR IDIOPATHIC SCOLIOSIS

Nanjundappa Harshavardhana, Harshad Dabke, Ujjwal Debnath, Brian Freeman

Summary: Quantifying the magnitude of scoliosis is the first step and pivotal in decision making in spinal surgery. Numerous studies have highlighted the inherent limitations of gold standard, the Cobb angle. Capasso's method (A new method for the radiographic evaluation of deformity in scoliosis; Ital J Orthop Traumatol, 1981: Apr; 7(1), 127–36) is being revisited. The authors attempt to validate it against the gold standard and discuss its implications on surgical decision-making.
Introduction: More than 90 methods have been described to quantify the magnitude of spinal deformity in scoliosis. Capasso's method (CM) 1 has been described in orthopaedic textbooks to be the most sensitive tool for measuring Cobb angle in scoliosis. This method based on "bi-univocal principle" views the scoliosis curve to be an arc of circumference, to be a true reflection of angular values and hence geometrically more valid. However there is no comparative study between the established measurement tools i.e. Oxford cobbomoeter (OC) & Traditional protractor (TP) versus CM. Our objectives were to to evaluate the sensitivity of CM against OC & TP as a measurement tool for cobb angle in scoliosis and to determine intra & inter-observer reliability of the above three methods.
Methods: Three independent blinded observers measured 24 digital AP radiographs of scoliosis ($14'' \times 17''$ films) on three separate occasions 1 week apart by CM, OC and TP. The three sets of readings obtained were statistically analysed using SPSS 16 for intra-observer (Cronbach's alpha) and inter-observer [Inter-class correlation coefficient (ICC)] reliability between the three methods.
Results: The mean Cobb angle measured by OC was 42.4 (r 13–91), by TP was 45.1 (r 16–89) and by CM was 70.4 (r^2 0–148). The cronbach's α was 0.94 for OC, 0.91 for TP and 0.88 for CM. The ICC were 0.96 for OC, 0.90 for TP and 0.71 for CM. The measurements obtained by CM was higher than the other two methods for all magnitudes of the curves (esp. so for curves).
Conclusion: Capasso's method overestimates the magnitude of scoliosis as compared to other standard and validated measurement tools. Management decisions based on CM would be inappropriate going by current guidelines. CM based on sound geometric principles is perceived to be superior to Cobb angle and has reasonable correlation (Pearson's® 0.74) with it.
The present existing methods have their own limitations and the need of the day is a simple three-dimensional measuring system to accurately quantify the magnitude of the deformity. The best method for picking up curve progression is still not known.
FDA Disclosure: N/A.



134

SPINAL STABILIZATION IN INTERMEDIATED SPINAL ATROPHY PATIENTS (SMA). A REVIEW OF 46 LIVING CASES

Norberto Ventura, Marcelo Pastor, Imma Vilalata

Summary: Retrospective review.
Introduction: Spinal Muscular Atrophy is a genetically determined neuromuscular disorder and is associated with severe scoliosis. Posterior spine fusion at puberty and fusionless techniques in very young children are often required.
Methods: This retrospective review included 43 living patients with SMA having undergone surgical correction of their spinal deformity between 1990 and 2008. Two groups were distinguished with respect to the technique of surgical intervention. Group I, 30 patients underwent posterior fusion T.3 to the pelvis or to L.5, average follow up 9 years (2–18). Group II, 16 patients treated with fusionless surgical techniques (10 growing rods, 6 VEPTER) average follow up 3 years (2–8).
Results: Group I, mean age 11 years, operative time 5 h, 3.7 units of blood, 3 average ICU stay, 16 average hospital stay. Mean pre-operative radiograph: thoracolumbar curves 83° (65°–151°), 60% correction; lumbar 80° (50°–105°), 52% correction; thoracic 52° (40°–93°), 47% correction. Pelvic obliquity 25° (1°–44°) 71% correction. Twenty-four patients had fixation to the pelvis (Galveston/Iliac screw), 6 cases had fixation to L.5.
Group II, mean age 7 years, operative time 2.5 h, 0.7 units of blood, 1 average ICU day stay and 9 average hospital stay. Mean pre-operative radiographs: thoracolumbar curves 90° (73°–108°), 60% correction, thoracic curves 76° (70°–100°), 46% correction, pelvic obliquity 25° (6°–35°), 51% correction.

Complications: group I, 3 (10%) atelectasis, 3 postoperative infections (10%), 1 delay deep infection (3.3%; removal of instrumentation), 1 (3.3%) patient require removal of one iliac screw.

Group II, 2 (15%) cases required removal of implants.
Conclusion: Although the rate of complication is high, surgical treatment for patients with SMA can improved coronal, sagital and pelvic balance with an acceptable risk of complication. The fusionless technique in infantile scoliosis seems to control the progression of the curve and delay posterior fusion.
FDA Disclosure: N/A.

135

PERIPEDICULAR BAND FIXATION IN THE SURGICAL TREATMENT OF THORACIC SCOLIOSIS

Nuri Erel, Murat Aydın, Füsun Özer, Levent Karapınar

Summary: A prospective study was conducted on 23 consecutive patients who underwent surgical correction of thoracic scoliosis between the years of 2004–2008 using peripedicular band fixation on the concave side pedicles of deformity's apex. To evaulate the peripedicular band fixation's correction effect and complication rates. Peripedicular bant usage of minimum 3 and maximum 5 pcs on the concave pedicles of deformity's apex. This technique maintains favourable correction over the 3 planes while minimizing the risks.
Introduction: A prospective study was conducted on 23 consecutive patients who underwent surgical correction of thoracic scoliosis between the years of 2004–2008 using peripedicular band fixation on the concave side pedicles of deformity's apex. Due to anatomical challenge and high risk of neural and vascular injury, the use of pedicle screws remains controversial for the surgical treatment of thoracic scoliosis especially on the concave side pedicles of deformity's apex. Another point under discussion is the inefficiency of pedicle screw usage in lordoscoliotic deformities in providing natural kyphosis.
Methods: Patients were classified into scoliosis sub types 20 idiopathic, 2 congenital and 1 neurofibromatosis.
Peripedicular bant usage of minimum 3 and maximum 5 pcs on the concave pedicles of deformity's apex depends on the curve rigidity and the degree of rotation. Instrumentation starts with the passage of band under the transverse process. After that stage, caudal tip of the band is passed through cauda-cranial direction under the lamina of the same vertebra. By means of this passage, two tips of the band are positioned on the cranial direction of the vertebra. By pulling these two tips cranially, the rest of the band is provided to pass under the inferior facet. Via this maneuver, the band is twisted around the pedicle grasping it completely. After that, tips of the band are passed through the titanium clamp which has initially been positioned on the rod. Following this stage, bands are tightened with specially designed reduction tools. Tightening the bands allows derotation and posteromedial translation maneuvers to be achieved. Finally, set screw of the clamp is tightened and the system is stabilized.
Results: Mean reduction rate was found to be 67%. No complications were observed during per-op or post-op stages.
Conclusion: The authors of this study think that peripedicular band fixation on the concave pedicles of deformity's apex maintains favourable correction over the 3 planes while minimizing the risk of vascular and neural injury. Also the technique is safe, straightforward and has a short learning curve.
FDA Disclosure: N/A.

136

A TECHNICAL REPORT ON THE ELLIPSE TECHNOLOGIES DEVICE: A REMOTELY EXPANDABLE DEVICE FOR NON-INVASIVE LENGTHENING OF GROWING ROD

Behrooz Akbarnia, Gregory Mundis, Pooria Salari, Blair Walker, Scott Pool, Arvin Chang

Summary: Current surgical techniques for treatment of early onset scoliosis require numerous operations before the definitive spinal fusion. This is a report on a newly developed spinal distraction system which allows non-invasive distraction of implanted rods. Safety and efficacy of this device has been tested in animal models. Compared to the current surgical lengthening protocol in growing rods, the number

of surgeries in a typical patient may potentially be reduced significantly in the future.
Introduction: The treatment of early onset scoliosis (EOS) remains challenging. In current operative techniques using growing rods, the patient requires numerous operations before the definitive spinal fusion. The exploration for novel and less invasive treatments led us to develop an implant that can be lengthened by remote control.
Methods: Using a newly developed spinal distraction system [Ellipse Technologies, Inc. Device (ETID)] which comprises two major elements, an implantable distraction rod and an external adjustment device, we are able to non-invasively control distractions and retraction of an implanted rod. Distraction and retraction sensitivity is 0.32 mm.
Results: The implantable distraction rod contains a non-shapeable actuator section that is 9.0 mm diameter; a small permanent magnet in the actuator can be non-invasively activated by the external adjustment device to distract/retract. The shapeable rod extending from this section is available in 4.5, 5.5, and 6.35 mm diameters (Fig. 1a). A fully rigid construct may be chosen, however an alternative construct with freely swiveling joints may be used to lower stress on the construct and bone. It is attached to the spine using standard hooks and screws. The external adjustment device is a portable, hand held unit that uses a pair of permanent magnets to automatically modify the length of the implant through touch of a switch (Fig. 1b). The amount of applied distraction/retraction can be seen on a built in display. The distraction rod is capable of up to 48 mm of lengthening and can generate a mean distraction force of 222 N (169–268 N) at an external magnet to internal magnet separation of 26.5 mm. Lengthening occurs at a rate of 1 mm per 7 s.
Conclusion: The ETID provides a means of non-invasive distraction of the spine in the treatment of EOS. Safety and efficacy of this device has been tested in animal models. A clinical study using this device is under development for use in a selected group of patients. Lengthening can be performed by the surgeon or physician extender in the office. Compared to the current surgical lengthening protocol in growing rods, the number of surgeries in a typical patient may be reduced significantly in distraction based procedures in growing children.
FDA Disclosure: Cleared: No.

- This device is not approved by FDA.

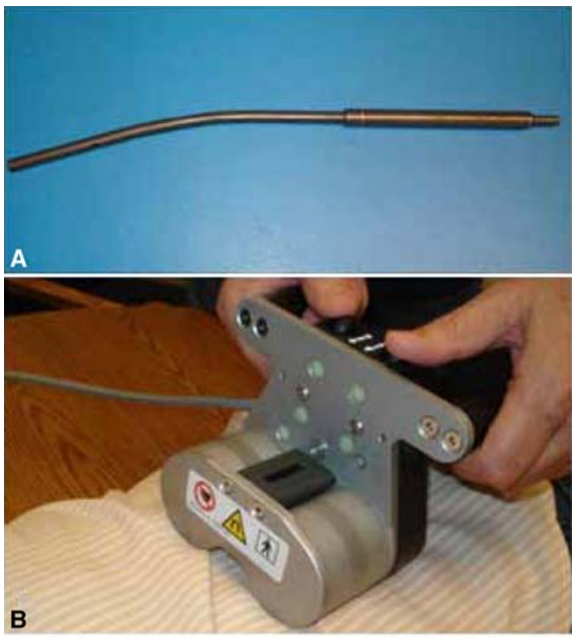


Figure-1: Ellipse Technologies, Inc. Device (ETID). A spinal distraction system which comprises two major elements, an implantable distraction rod (A) and an external adjustment device (B)

137

THE EFFECT OF CALMODULIN ANTAGONISTS ON C57BL/6 MICE SCOLIOSIS

Ibrahim Akel, Seval Tanrikulu, H.gokhan Demirkiran, Ralph Marcucio, Rifat emre Acaroglu

Summary: Melatonin deficit C57BL6 mice develop scoliosis when rendered bipedal. Calmodulin antagonists decrease the incidence and magnitude of the scoliosis when administered before scoliotic curves develop in this mice model. Our new study showed that administration of tamoxifen, a calmodulin antagonist, to scoliotic mice seems to be as effective as pre-emptive tamoxifen protocol.
Introduction: Our aim was to analyze whether the administration of tamoxifen (TMX) after the onset of scoliosis is as effective as pre-emptive use in C57BL/6 scoliosis model. Our previous work suggested that tamoxifen may change the natural course of scoliosis and decrease the incidence and magnitude when administered before scoliotic curves develop in this mice model.
Methods: Twenty female 3-week-old C57BL6 mice underwent amputations of forelimbs and tails. Available 18 mice were received no medications and are observed for 20 weeks. PA scoliosis X-rays were obtained at 20th week and scoliotic curves got recorded. After 20th week, all mice received 10 mg TMX per liter of daily water supply for 20 weeks. Deformities in recent and previous study groups were compared for incidence and the severity of the curves.
Results: At 20th week, overall, upper thoracic (UT), thoraco-lumbar (TL), and double curve scoliosis rates were similar ($p = 0.335$; $p = 0.684$; $p = 0.134$; $p = 0.636$, respectively) but lower thoracic (T) scoliosis rate was lower in previous study's TMX group ($p = 0.53$). At 40th week, although T, TL and double curve scoliosis rates were similar ($p = 0.273$, $p = 0.443$, $p = 287$), overall rate as well as the rates of UT scoliosis of previous study's TMX group were significantly lower ($p = 0.005$, $p = 0.057$ respectively). There were no statistically significant change of curve rates in recent study group except TL rate, which showed a significant increase ($p = 0.025$).
As for curve magnitudes, mean Cobb angles were similar in both study groups ($p > 0.05$) at 20th and 40th weeks.
Conclusion: This study has demonstrated that TMX administered after scoliotic changes are observed seems to be as effective as the pre-emptive TMX protocol in C57BL6 mice model. This may a step forward towards studies on human scoliosis.
FDA Disclosure: N/A.

138

CONGENITAL DISLOCATION OF THE SPINE TREATED AT 2 WEEKS OF AGE—A CASE REPORT

Suken Shah, Jon Oda

Summary: We present a case of a neonate with congenital dislocation of the spine and partially intact neurologic function, treated with a vertebral column resection and simultaneous anterior and posterior spinal fusion at 2 weeks of age.
Introduction: Congenital dislocation of the spine is a rare abnormality, with a dismal neurologic prognosis if not treated expediently. There are only a few reports in the literature of this entity.
Methods: We report a case of a neonate diagnosed at birth with congenital dislocation of the spine at the thoracolumbar junction. The patient had limited voluntary lower extremity movement on presentation.

Results: Age 14 days of age, the patient underwent an extensive laminectomy and a vertebral column resection via simultaneous anterior and posterior exposure, with placement of a titanium mesh cage anteriorly and spinous process wiring posteriorly. The preoperative kyphotic deformity was reconstructed to establish a normal thoracolumbar alignment. His neurologic status improved postoperatively.
Conclusion: We believe that early intervention maximizes neurologic potential, and that simultaneous anterior and posterior exposure helps maintain control over the grossly unstable spinal column.
FDA Disclosure: Cleared: No.

- titanium harms mesh cage.

139

WHAT WE HAVE LEARNED FROM THE LONG TERM FOLLOW UP OF VEPTR (VERTICAL EXPANDABLE PROSTHETIC TITANIUM RIB)

Tarik Yazar, Mehmet Armangil

Summary: Exotic scoliosis describes an early-onset spinal deformity that is more complex in nature, often associated with a thorax that has been distorted by spinal lordosis and curve rotation, thus having a volume-depletion deformity. Here we present 6 cases of VEPTR application for scoliosis. The lung functions and volumes were improved and after removal of the implants thoracic functions remained nearly the same.
Introduction: Exotic scoliosis describes an early-onset spinal deformity that is more complex in nature, often associated with a thorax that has been distorted by spinal lordosis and curve rotation, thus having a volume-depletion deformity as well as thoracic growth inhibition with indirect adverse effects on lung growth. Traditional scoliosis surgery does not directly address this problem and Only Ferguson technique is considered to be related to this situation in the literature.
Methods: Six patients of scoliosis were included and two had prior posterior spinal fusion and those were adults. Expansion thoracoplasty was achieved with using vertical expandable prosthetic titanium rib (VEPTR). The method described by Campbell RM et al. was used in applying VEPTR. Postoperative evaluation was done with X-ray, 3D computed tomography in order to determine the volumetric changes and respiratory function tests were used. The implants were removed and the mean follow up was 4 years.
Results: The mean volume expansion in 3D tomography was %20. In the early postoperative period, the first 3 weeks there was a clinical improvement in patient respiratory functions but that couldn't be correlated with respiratory tests. The respiratory tests after 6 weeks showed an improvement. The X-rays showed partial correction of deformity and decrease in shoulder asymmetry. After removal of the implants the volumetric changes and respiratory functions remained nearly the same. The X-rays showed osseous bridges between the ribs along the implants preventing the thorax to collapse.
Conclusion: VEPTR is a safe and effective procedure with little morbidity to the patient, which helps to improve the lung functions in congenital and adolescent idiopathic scoliosis patients. Subsequent to a mean follow up for 4 years even after removal of the implants we can say it still helps to protect the lung functions. Its efficacy regarding correction of the scoliotic curve is limited which may require addition of a posterior instrumentation procedure if further correction is needed but in cases of thoracic insufficiency it mat be the treatment of choice.
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140

PEDICLE SCREWS ONLY DUAL ROD INSTRUMENTATION AS REVISION SURGERY IN CONGENITAL SCOLIOSIS TREATED BY VEPTR-LIKE IMPLANTS

Tiziana Greggi, Georgios Bakaloudis, Mario Di silvestre, Francesco Lolli

Summary: Dual rod and Veptr-like instrumentation have been extensively reported as the surgical treatment of choice in congenital scoliosis. To our knowledge there is no article reporting on the use of an all pedicle screws dual rod instrumentation as revision surgery in congenital scoliosis already treated by Veptr-like implants.
Introduction: To determine safety and efficacy of a pedicle screws only dual rod instrumentation as revision surgery in congenital scoliosis already treated by means of a Veptr-like implant.
Methods: A prospective clinical and radiographic analysis was performed on a consecutive series of 4 pediatric patients (3 males and 1 female) affected by a congenital scoliosis and surgically treated by means of a dual rod instrumentation with pedicle screws foundations between 2006 and 2007 in a single Institution. All patients sustained a revision surgery for a Veptr-like implant under continuous intraoperative neuromonitoring (SSEP, NMEP, EMG), after an average 2.1 (range, 1–3) lengthening procedures. Indication for conversion

included age superior to 8 years old, high BMI, or instrumentation related complications (breakage/displacement). Radiographic analysis included initial preoperative, postoperative, conversion pre-operative and latest control, whereas a chart review evaluated for overall complications rate.
Results: Average age at dual rod conversion was 8 + 6 years (range, 8 + 0–9 + 3). At a mean follow-up of 15 months (range, 6–22), no cases of permanent neurologic deficit, implant or wound related complications were observed. The main curve showed a mean conversion correction of 31°, or a 42.3% (range, 30–62), with an overall (initial preoperative-latest control) correction of 45° (range, 35–52), with an average latest thoracic kyphosis of 30.4° (range, 20–45). Mean estimated intra-operative conversion blood loss accounted 10.6 cc/kg (range, 7.8–20.3). In two patients a further lengthening procedure has been already performed uneventfully at 6 and 7.5 months from conversion surgery.
Conclusion: The preliminary results of this series of patients which sustained a conversion from a Veptr-like implant to an all pedicle screw dual rod instrumentation seem promising. Our conversion surgery indications (age superior to 8 years old, high BMI, Veptr-instrumentation related complications), probably not universally accepted, guaranteed in these challenging patients excellent short term results, both for what concerns safety and efficacy of a revision/conversion surgery in patients younger than 10 years old.
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141

SPINAL INJURIES IN YOUNG CHILDREN: A POPULATION BASED STUDY FROM 1997 TO 2006 IN FINLAND

Ville Puisto, Tuomas Jalanko, Sakari Kääriäinen, Antti Impinen, Erkki Vartiainen, Timo Parkkila, Mikko Pakarinen, Ilkka Helenius

Summary: The annual incidence of spinal injuries among children under 8 years of age was 15 per million in this population based epidemiological study. Most commonly affected area was cervical spine. Typical injuries were cervical dislocation, lumbar vertebral fracture and fracture of the upper cervical vertebrae. Majority of these injuries are treated without operation.
Introduction: Epidemiological data on spinal injuries in children is sparse and few population based estimates on the incidences exist. Aims of the current study were: to define incidences of spinal injuries in children under 8 years of age, and to evaluate the need for surgical interventions in a population based epidemiological study.
Methods: All spinal fractures and spinal cord injuries in children under 8 years of age treated in hospital between 1997 and 2006 in Finland were included. The data on injuries, hospitalizations, and surgical treatment were collected from the National Hospital Discharge Register which includes all in-patient treatment periods. Fatal spinal injuries were derived from the Official Cause-of-Death Statistics of Finland.
Results: The annual incidence of spinal injuries among young children averaged 15 per million children. Most common injuries were cervical dislocation 36%, lumbar vertebral fracture 22% and fracture of the upper cervical vertebrae (C1–C2) 20%. Majority (88%) of the injuries were treated without operations. The most common procedures were anterior cervical stibiation, closed reposition of spinal dislocation and Halovest application. The mean hospital stay was 2.1 days in cervical dislocation patients, 2.9 days in upper cervical fracture, and 3.5 days in lumbar vertebral fracture. Annual incidence of fatal spinal injury in young children was 1.2 per million.
Conclusion: Spinal injuries among young children are rare. The most commonly affected area in is cervical spine. Majority of these injuries are treated without operation.
FDA Disclosure: Cleared: Yes.

142

THE EARLY POST-OPERATIVE CLINICAL RESULTS IN THE PATIENTS WITH PROGRESSIVE EARLY ONSET SCOLIOSIS THAT UNDERWENT POSTERIOR SPINAL FUSION FOLLOWING GROWING ROD TECHNIQUE

Yunus Atici, Yunus Akman, Alİ Ozluk, Murat Mert, Ilhan Acikgoz, Yusuf Ozturkmen, Onat Uzumcugil, Engin Carkci, Mustafa Caniklioglu

Summary: In the children with early onset scoliosis, the treatment aims to avoid the deformity to progress and help skeletal and respiratory systems to normally develop, before the definitive spinal fusion procedure. This study is prepared to prospectively observe and evaluate the results of subcutaneous distraction technique which provides a normal development and protects the growth potential as much as possible, for the spinal column. Respiratory system development was evaluated with respiratory function test in the early post-operative period.
Introduction: In the children with early onset scoliosis, the treatment aims to avoid the deformity to progress and help skeletal and respiratory systems to normally develop. This study is prepared to prospectively observe and evaluate the results of subcutaneous distraction technique that provides a normal development and protects the growth potential as much as possible.
Methods: Spinal distraction was applied in 8 month intervals using subcutaneous rods, in 5 patients, between 2004 and 2008. The age during onset, the age during surgery, the number of lengthenings, the age during definitive surgery and the period between subcutaneous distraction and definitive surgery, mean increase in height, complications, the length between T1–S1, and respiratory function test results were evaluated. Cobb's angle, frontal and sagittal balance and the length between T1 and S1 were measured radiologically.
Results: Subcutaneous single rod was applied in 4 of the 5 girls with scoliosis, and dual rods were applied in one. The mean age at the beginning of the distractions was 10.4 (8.5–12.1). Mean age during posterior spinal fusion was 12.6 (11.5–14.5). Mean follow-up period after posterior spinal fusion was 8.4 (3–23) months and mean total follow-up time was 35.3 (22.4–60.5) months. During distraction period, in 2 patients there was pull-out of the hooks in the proximal levels, there was pull-out of the pedicle screws in the proximal levels in one patient and in 2 patients the rods broke down for 3 times. During definitive spinal fusion surgery, in 2 patients hemothorax developed an one of the patients had paraplegia. In all of the cases, respiratory functional tests were found normal (FVC > 80) during the last visit.
Conclusion: In early onset scoliosis, periodical spinal distraction without fusion lets the spinal column and the respiratory system develop normally. During fusion surgery, stiffness was present in the deformities in all of the cases. Operation period was long and blood loss was high. We think this was due to excessive fibrose tissue developed in the operation area. In the patient with paraplegia, after the removal of the implants there was improvement in the patients paraplegic status.
FDA Disclosure: Cleared: Yes.