Free papers parallel session - nurses and non-surgeons
Chairmen: Lotte J. Schumacher and Marianne Lorenzen
Abstract:
No. 1 Surprisingly high rate of withdrawal symptoms after elective spine surgery .......................... 4
No. II Pain treatment after spine surgery - An interdisciplinary teamwork is essential ..................... 5
No. III Does a web-based spine platform featuring social interaction and animated information affect patient reported outcomes in patients undertaking lumbar spine fusion surgery? A randomized clinical trial ................................................................. 6
No. IV Exploring factors associated with symptoms of anxiety and depression in adults undergoing spine surgery - insights from a systematic integrative review ................................................................... 7

Free papers session 1
Chairmen: Peter Helmig and Søren Eiskjær
Abstract:
No. 1 High user satisfaction magnetically controlled growing-rod treatment in early-onset scoliosis - the MCGR satisfaction questionnaire .................................................................................................... 8
No. 2 2-year results of the first 4 patients with a dynamic growth friendly technique based on a Spring Distraction System (SDS) ..................................................................................... 9
No. 3 Outcomes of Growing Rod Surgery for Severe Compared with Moderate Early-Onset Scoliosis A Matched Comparative Study .......................................................................................... 10
No. 4 3-year follow-up of single magnetically controlled growing rod (MCGR) with contralateral gliding system and apical control for early onset scolioses .................................................. 11

Free papers session 2
Chairmen: Haisheng Li and Thomas Kibsgård
Abstract:
No. 5 Ultrasound Measurement Methods of the Scoliotic Spine and their Relation to the Cobb Angle: a CT Based Study ................................................................................................................. 12
No. 6 New sagittal classification of AIS: validation by 3D modeling ..................................................... 13
No. 7 Augmented reality surgical navigation using intraoperative 3D imaging for pedicle screw placement ................................................................................................................................. 14
No. 8 Why almost any orthopaedic subspeciality is preferable to spine surgery? .............................. 15

Free papers session 3
Chairmen: Ilkka Helenius and Poul Gerdhem
Abstract:
No. 9 Radiographic follow-up of idiopathic scoliosis fusion surgery; challenging the consensus ................................................................................................................................... 16
No. 10 Progression of adult spinal deformity in the coronal and sagittal plane - a radiographic analysis ............................................................................................................................................. 17
No. 11 Anterior Spinal Overgrowth, a Comprehensive and Detailed Analysis of the Different Contributing Structures ........................................................................................................... 18
No. 12 Reproducibility of the Classification og Early-Onset Scoliosis (C-EOS) - application in a consecutive single-center cohort ........................................................................................................ 19
Free papers session 4
Chairmen: Mikkel Andersen and René Castelein
Abstract:
No. 13 Providence Night-time Bracing are effective in Treatment of Adolescent Idiopathic Scoliosis, Even in Curves larger than 35° .......................................................... 20
No. 14 Potential pitfalls in serial casting for infantile scoliosis .......................................................... 21
No. 15 Back Pain related to Providence Night-time Bracing, in Adolescent Idiopathic Scoliosis Patients - a retrospective cross-sectional study .......................................................... 22

Free papers session 5
Chairmen: Ebbe Stender and Kariman Abelin Genevois
Abstract:
No. 16 Comparison of circular, partial and full deformity rod options on the sagittal balance restoration in adolescents undergoing pedicle screw instrumentation for idiopathic scoliosis …… 23
No. 17 Surgical Outcomes of Anterior versus Posterior Fusion in Lenke Type 1 Late-onset Idiopathic Scoliosis .......................................................... 24
No. 18 The Outcomes of Spinal Deformity Surgery in Parkinson’s Disease .............................................. 25
No. 19 Re-operations after long segment fusions for adult scoliosis in the lumbosacral region: iliac versus non-iliac distal fixation .......................................................... 26
No. 20 Sagittal balance 28 to 41 years after fusion in situ for high-grade isthmic spondylolisthesis .......................................................... 27

Free papers session 6
Chairmen: Leah Carreon and Kristian Hay
Abstract:
No. 21 Predictive modelling of postsurgical outcome for araclytic spondylolisthesis .......................................................... 28
No. 22 Core Set of Outcome Measures for Adult Spinal Deformity Surgery: A Global Consensus-Based Approach From Experts of the Scoliosis Research Society .......................................................... 29
No. 23 Quality of life in males an females with idiopathic scoliosis .......................................................... 30
No. 24 Scoliosis surgery within the 22q11.2 Deletion Syndrome: Risks and Complications ......................... 31
No. 25 Spinal hydralid disease mimics malignancy: Lack of correct diagnosis of spinal infection for several years .......................................................... 32
No. 26 ABM/P-15 versus allograft in non-instrumented lumbar fusion surgery - 1 year postoperative intertransverse segmental fusion rate. A double-blind RCT .......................................................... 33
No. 27 Fusion performance of AttraX® Putty vs. autograft in instrumented posterolateral spinal fusion; a randomized intra-patient controlled non-inferiority trial .......................................................... 34
No. I. Surprisingly high rate of withdrawal symptoms after elective spine surgery

Sudergaard, MM, Pedersen, HB
Spine Surgery, Spine Center of Southern Denmark – part of Lillebaelt Hospital

Introduction and aim:
Most spine surgery patients receive opioids as part of their pain treatment. Some of them experience withdrawals as they cease the use of medication. The aim of this study was to examine the complexity of the withdrawal symptoms (WS) in order to improve care and optimize the patient information during and after hospitalization.

Methods:
To find the prevalence of WS among spine surgery patient’s two surveys was conducted, the main one was with 202 patients. An audit on hospital records was carried out on the same patients to identify factors such as the dosage of opioids and duration of treatment. Finally six individual semi-structured interviews were performed to further explore the patient’s experiences in connection to WS.

Results:
A minimum of 14% (n=28) of patients having spine surgery experienced WS as they stopped taking opioids. There was no difference in the presence of WS between the different kinds of opioids.

The majority of patients (n=21) who experienced WS, were already in opioid treatment before hospitalization. However, seven patients who had opioids prescribed post-surgery also experienced WS. WS were more prevalent in the evening and during the night. Some of the most commonly experienced WS were: restlessness, rapid heartbeat and sleeplessness.

The interviews showed five themes of importance for the experience off WS. Those were: Handling of pain, cease of opioids, to recognize WS, overcoming the WS and craving for opioids.

The WS are dominant in the patients daily life, some of them experience a few days of discomfort while others are severely affected for several weeks. The patients rarely remembered the verbal information given during the hospitalization. They expressed great benefit from the phase-out-program even though in many cases the program was not followed. The interviews showed furthermore that more patients than expected were addicted to opioids.

Discussion:
Our results showed that at least 14% of the spine surgery patients included in this current study reported withdrawal symptoms. However, whether this number reflects the true prevalence can be discussed due to limitations of the used methods. A larger number of informants could have helped us explore the risk factors of withdrawal symptoms more thoroughly.
No. II. Pain treatment after spine surgery – An interdisciplinary teamwork is essential

Pedersen Anette K: RNA, Nurse specialist
Randrup K: RN; Nurse specialist,
Sestoft B: RNA, MHH, Clinical Nurse Specialist
Kaptain K: RN, MScN, Clinical Nurse Specialist
Schumarcher L: RN, Nurse specialist

Department of Anaesthesiology and Intensive Care & Department of Orthopaedic Surgery Aarhus University Hospital, Denmark

Introduction and aim:
At the Department of Orthopaedic Surgery, Aarhus University Hospital, 3-4 patients daily undergo spine surgery; elective as well as acute.
International studies have shown that orthopaedic surgery causes severe pain. It is also known that spine surgery postoperatively causes severe pain among those patients at the recovery unit (RU) as well as at the surgical ward. Furthermore international studies have shown that patients in general do have severe and long lasting pain after spine surgery.
Severe pain after spine surgery may result in chronic pain and a delayed discharge from the recovery unit and from the surgical ward. The nurses experienced insufficient pain treatment among the patients who underwent spine surgery consequently two projects dealing with the patients’ impression of severe pain after spine surgery were completed, 2010/11 and 2012/13.
A team involving spine surgeons, anaesthesiologists, nurse anaesthetists, recovery nurses and ward nurses was established and a systematic and structured manual for the pain treatment to patients undergoing spine surgery was developed. It has an individual focus, especially on the patients who already take opioids as painkiller.

The aim of this study was to explore if the implementation of a guideline for systematic pain treatment after spine surgery has resulted in postoperative pain relief.

Methods:
Demographic data were registered as well as Numeric Rating Scale (NRS) and the pain treatment in the period February 2017 till January 2018. The main focus was NRS at arriving at the recovery, during the stay at RU and three times a day at the ward.
160 adult patients undergoing elective spine surgery were included.

Results:
Preliminary results show that the goal pain intensity at rest NRS ≥ 4 have decreased from 49% to 26% among the patients.
Focusing on the pain treatment (opioid naive versus opioid tolerant) before surgery improved the postoperative pain treatment.

Discussion:
Interdisciplinary teamwork has to be established to improve pain treatment. The different educated healthcare professionals have to understand the different experiences related to pain treatment after spine surgery.
No. III. Does a web-based spine platform featuring social interaction and animated information affect patient reported outcomes in patients undertaking lumbar spine fusion surgery? A randomized clinical trial

Strøm, J1,2, Nielsen, CV2,3, Jørgensen, LB1,4, Laursen, M1
1Centre of Elective Surgery, Regional Hospital of Silkeborg, Denmark, 2Department of Public Health, Section for Clinical Social Medicine and Rehabilitation, Aarhus University, Denmark, 3 DEFACTUM, Central Denmark Region, 4Department of Clinical Medicine, Section for Public Health, Aarhus University, Denmark, 5CairosConsult A/S, Copenhagen, Denmark

Introduction and aim:
Approximately one third of patients going through spine surgery are found to have symptoms of anxiety and depression and these symptoms are found to correlate with surgical outcomes as greater pain, functional disability and lower health related quality of life. The use of web-based informative strategies before surgery and principles from cognitive behavioural therapy has been applied in other patient groups, facilitating mobility and encouraging beneficial pain coping behaviour. However, these didactic techniques have not together been targeted patients going through spine surgery. The aim of this study was to examine the effect of a web-based Spine Platform featuring Interaction and Information by Animation (w-SPIINA) on symptoms of anxiety and depression, disability, health related quality of life and pain in patients undergoing lumbar spine fusion (LSF) surgery.

Methods:
A total of 114 patients going through 1-3 level instrumented LSF, were randomized into two groups; a control group receiving a standard regimen containing a joint two-hour patient information session, and an intervention group which in addition to the standard regimen, had access to w-SPIINA. Primary outcome: Change in Hospital Anxiety and Depression Scale (HADS) from baseline to 3 months follow-up. Secondary outcomes: Change in HADS (6 months), disability (ODI), quality of life (EQ-5D-5L) and back and leg (LBPRS) 3 and 6 months after surgery.

Results:
Minimal clinically important differences (MCID) in HADS was not reached in either of the two groups at 3 or 6 months follow-up. In each of the two groups MCID was reached in LBPRS, ODI and EQ-5D-5L at 3 and at 6 months after surgery. Comparing the two groups, no statistically significant differences were found in the overall change of anxiety, depression, disability, health related quality of life or pain neither at 3 nor 6 months after surgery.

Discussion:
Providing patients with access to w-SPIINA in addition to a standard two-hour joint patient information meeting has no additional effect on HADS and patient reported outcome 3 or 6 months after surgery. Thus, our findings support the need for further research in order to accommodate symptoms of anxiety and depression in patients going through LSF.
Introduction and aim:

Spinal fusion is a frequently performed surgical procedure for many spinal conditions. Autologous bone grafting is the gold standard to establish a bony fusion, but this procedure has some drawbacks including graft harvesting morbidity and limited amounts of autograft. This has led to development of different alternative grafts over the past decades. We aimed to investigate non-inferiority of a promising synthetic ceramic material (AttraX® Putty, NuVasive Inc.) in comparison with autograft in instrumented posterolateral spinal fusions.

Methods:

After ethical approval, 108 non-traumatic adult patients indicated for primary instrumented posterolateral fusion between T10 and S1 with autografting were enrolled. After instrumentation and according to randomization, one side of the spine was grafted with AttraX® Putty instead of a mixture of local bone and iliac crest bone. So each patient served as its own control. As primary outcome, fusion performance of both the AttraX® Putty and autograft condition was assessed at 1 year follow-up on CT-scans. Each segment and side was scored as fused, doubtful fusion or nonunion by two blinded observers. The non-inferiority margin was set at 15%. Secondary outcomes included the Oswestry Disability Index, EQ-5D and Visual Analogue Scale for back pain.

Results:

Of the 100 patients operated on, 87 were available for analysis of the primary outcome. There were 42 males and 45 females with a mean age of 55 (range 33-79) years. A mean of 1.7 (range 1-8) spinal segments were fused and 63% of the patients underwent an additional interbody fusion. The overall posterolateral fusion rate was 71%. At the AttraX® Putty side and autograft side, 55% and 52% of the segments respectively were scored as fused. After correction for multi-level fusions, the McNemar’s test showed no difference in fusion performance (p=0.868). No adverse events that could be directly related to the use of AttraX® Putty were reported.

Discussion:

This randomized intra-patient controlled study including 87 patients demonstrated non-inferiority of AttraX® Putty in comparison with iliac crest bone graft in terms of fusion performance. Therefore, we conclude that this synthetic ceramic is an effective and safe alternative for autograft in instrumented posterolateral spinal fusions.
No. 1. High user satisfaction with magnetically controlled growing-rod treatment in early-onset scoliosis – the MCGR satisfaction questionnaire

Skov ST, Røffing JHD, Li H, Valancius K, Høy K, Hansen ES, Helmig P, Bünger C
Department of Orthopaedic Surgery, Aarhus University Hospital, Denmark

Introduction and aim:
The use of magnetically controlled growing-rods (MCGR) is considered by many to be a major evolution in the surgical management of early-onset scoliosis (EOS). Because MCGR treatment entails high initial costs (i.e. implant costs), financing it under the auspices of a public health care system may prove challenging.

The aim of the study is to investigate whether EOS patients and their next of kin experience the MCGR lengthening procedures as psychologically and physically stressful as well as their satisfaction and pain in conjunction with the procedure.

Methods:
A cross-sectional study of 19 EOS patients, median age 11 (range 7-17) years, with MCGR implantation between 2014 and 2017. All patients had undergone unsedated MCGR distraction at three months intervals.

The parents answered a seven-item MCGR Satisfaction Questionnaire. The answers were scored on a 0-10 Likert scale.

Results:
The median (range) questionnaire response to the seven-item questionnaire was: 0(0-5) for physical strain on the patient, 0(0-7) for psychological strain on the patient, 1(0-2) regarding pain, and 0(0-5) regarding anxiety level of the parents. The median satisfaction with the MCGR treatment was 10(8-10) [very satisfied], and the median likelihood of requesting MCGR if they were to repeat surgery was also 10(9-10) [no preference regarding method, 10 highest preference for MCGR].

Discussion:
Overall satisfaction with MCGR was uniformly high to very high. If given the choice, five out of five parents with previous experience with other growth instrumentation would choose MCGR in preference over other growth instrumentation. Both the physical and psychological strain and pain in conjunction with the unsedated lengthening procedure were low.

No. 26. ABM/P-15 versus allograft in non-instrumented lumbar fusion surgery - 1-year postoperative intertransverse segmental fusion rate. A double-blind RCT.

* Center for Spine Surgery & Research, Region of Southern Denmark, Østre Hougvej 55, DK-5500, Middelfart, Denmark.
§ Department of Orthopaedic Surgery and Traumatology, Odense University Hospital, Sdr. Boulevard 29, DK-5000 Odense C, Denmark

Introduction and aim:
Lumbar spinal stenosis is the most common indication for spinal surgery and as a result of the demographic shift, caused by prolonged life expectancy in developed countries, the prevalence is expected to increase. In the elderly, due to poor bone stock, decompression supplemented with non-instrumented posterolateral fusion is often preferred in Scandinavia, when instability is present. The current gold standard fusion graft is harvested iliac crest bone. This procedure has many disadvantages with donor site pain being the most frequent complication. The use of allograft has inherent problems as the donor has to be tested several times for infectious diseases and the need for subzero storage. The presence of these factors justifies the necessity and use of the shell bone graft substitutes. Bone grafts studies conducted in spinal surgery have a massive publication bias favoring BMP, which necessitate tests of different bone graft materials.

To evaluate the intertransverse segmental fusion rate in elderly patients suffering symptomatic LSS and DS undergoing decompression and posterolateral intertransverse non-instrumented fusion surgery in a double-blind RCT.

Methods:
From March 2012 to April 2013, 101 ASA 1+2 patients age 60+ referred to Lillebaelt Hospital, with lumbar spinal stenosis and degenerative listhesis verified on MRI and lateral standing radiographs, agreed to participate. All patients had completed a minimum of 3 month of nonoperative therapy with little or no effect. Patients were randomized 1:1 to either i-Factor™ (mixed 50/50) or allograft bone (30 g/level), both mixed with local lamina autograft from the decompression, and underwent one-year postoperative evaluation. Fine cut CT-scans (0.9 mm) with reconstructions were used to establish fusion 1-year postop. The CT-scans were evaluated independently by 3 reviewers, who were blinded to the treatment and evaluated digital films on PACS using axial cuts with sagittal and coronal reconstruction viewed simultaneously. The fusion was determined by consensus of 2 of the 3 reviewers as fusion or nonfusion.

Results:
3 patients were excluded due to reoperation (2 ABM/P-15 and 1 allograft patient, nonsignificant) leaving 98 patients for fusion evaluation (49 in each group). Patient groups were comparable on all preoperative parameters (BMI, sex, diabetes, hypertension, grade of listhesis, amount of decompressed bone, p>0.05). All patients were non-smokers. In the ABM/P-15 group, 14 patients had 2-level fusion and in the allograft group, 8 patients had 2-level fusion, leaving 126 and 114 intertransverse segments for evaluation, respectively. The overall intertransverse segmental fusion rate was 63/126(50%) in the ABM/P-15 group versus 23/114(20.2%) in the allograft group (p<0.001). In 1-level listhesis patients, the fusion rates were 29/72(40.28%) and 17/80(21.25%) respectively (p=0.011) and in 2-level patients 34/54(62.96%) and 6/34(17.64%) respectively (p<0.001).

Discussion:
Enhancing fusion rate in non-instrumented fusion surgery is a massive challenge in geriatric lumbar spinal surgery. This RCT showed that ABM/P-15 is significantly superior to allografted bone in enhancing intertransverse fusion in both one and two level patients.
No. 25. Spinal hydatid disease mimics malignancy: Lack of correct diagnosis of spinal infection for several years


Department of Orthopaedic Surgery, Aarhus University Hospital, Denmark

Background:
Hydatid cyst disease also known as cystic echinococcosis (CE) is a zoonosis caused by Echinococcus Granulosus. We report a case of spinal CE mimicking malignancy in which correct diagnosis was delayed for years.

Case resumé:
A 62-year-old male immigrant from the rural countryside of the Balkans. When in his 20s he had back pain and developed a drop foot. Therefore, he was operated in Bosnia, but the drop foot persisted.

In 2013, severe back pain and radicular pain in both legs progressed rapidly within a few days. L3-L5 Corpectomy and L1-S1 spondylodesis was performed for major destructive processes. Surprisingly, the intraoperative biopsies were negative for both malignancy and infection including TB. He was asymptomatic the next 2 years.

In 2016, he had relapse with lower back pain and radicular pain. A rapid progressing gait impairment developed with major paresis. His general condition deteriorated. At the same time, a large local fluctuating hump was noted at the surgical site. Again, a slight increase in CRP and eosinophilic leucocytes. Repeated MRI and a PET-CT was conducted, revealing multiple cystic tumors in the area of the lumbar spine, which had increased in size and numbers and spread to lung and liver. Especially the tissue surrounding the abdominal aorta was affected, causing an aortic aneurism. Open biopsy in the lumbar region on suspicion of malignancy or infection was again found negative.

On suspicion of CE, serological Western Blot analysis confirmed parasitic Echinococcus Granulosus infection. Anthelmintic albendazole treatment was initiated and by combined anterior and posterior approach a secondary surgery was performed on suspicion to obtain correct diagnosis to ensure timely diagnosis and appropriate treatment.

Discussion:
CE and other parasitic infestations can cause severe disease patterns even in non-endemic areas. An increased suspicion must be raised when the histopathological and microbiological findings are not in accordance with the clinical presentation and the general condition of the patient. The importance of anamnestic exposures in immigrants and travelers alike is emphasized. Appropriate paraclinical tests should be performed on suspicion to obtain correct diagnosis to ensure timely diagnosis and appropriate treatment.
No. 3. Outcomes of Growing Rod Surgery for Severe Compared with Moderate Early-Onset Scoliosis A Matched Comparative Study


Growing Spine Foundation, Milwaukee, Wisconsin, USA.

Introduction and aim: Early-onset scoliosis (EOS) is defined as a spinal deformity occurring before the age of ten. Severe EOS is associated with increased risk of mortality if untreated. We aimed to (1) characterize patients with severe EOS (major curve >90°) and (2) compare outcomes of growing rod surgery in children with severe vs. matched controls with moderate EOS (major curve<90°).

Methods: A retrospective review of a prospective EOS database identified 107 children (mean age 5.6 years; 14 congenital, 22 idiopathic, 34 neuromuscular, and 37 syndromic) with severe EOS (major curve≥90°, <10 years at surgery) who had been treated using growing rods with minimum 2-year FU and ≥3 lengthenings. From same database, 107 controls (matched for age, etiology, and index surgery) were retrieved. 99 children in both groups underwent index procedure using traditional and eight children with magnetically controlled growing rods. Patients had mean 6.0 years FU and underwent mean 7.3 lengthenings.

Results: Mean major curve was 101° in the severe group and 67° in the moderate group (p<0.001). At final follow-up, curves were corrected to 57° in the severe group and 40° in the control group (p<0.001). T1-S1 height increased by a mean 54mm in the severe group and 27mm in the moderate group at the initial surgery (p<0.001) and by 50 mm and 54 mm, respectively, during distraction (p=0.84). The mean number of complications per patient was 2.6 in the severe and 1.9 in the moderate group (p=0.040). Rod fractures were more common in the severe group (40%) than in the moderate group (24%) (p=0.013). Neurologic deficits occurred in five patients (4.6%) in the severe group and three (2.8%) in the moderate group. The use of laminar hooks was not associated with neurological complications.

Discussion: Severe EOS can be treated effectively using growing rods, but the risk of complications is high.

No. 24. Scoliosis Surgery within the 22q11.2 Deletion Syndrome: Risks and Complications

Jelle F. Homans, MD1, Rob C. Brink, MD1, Moyo C. Kruyt, MD PhD2, Vincent F. X. Deeney, MD1, Terrence B. Crowley1, Donna M. McDonald-McGinn, MS, LGCC 3,4, J.M. Flynn, MD1, René M. Castelein, MD PhD1

1Department of Orthopaedic Surgery, University Medical Center Utrecht, Utrecht, The Netherlands; 2Department of Orthopaedic Surgery, The Children's Hospital of Philadelphia (CHOP) and The Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania, USA; 3Division of Human Genetics and 22q and You Center, The Children's Hospital of Philadelphia (CHOP), Philadelphia, Pennsylvania, USA; 4The Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania, USA

Introduction and aim: The 22q11.2 Deletion Syndrome (22q11.2DS) is the most common microdeletion syndrome which occurs in 1:2000-4000 newborns and is characterized by wide phenotypic variability. Scoliosis has a prevalence of 48-49%, of whom 18% need scoliosis surgery. In general, syndromic scoliosis is associated with higher complication rates. However, the risks and complications of scoliosis surgery within 22q11.2DS have never been investigated. Our aim is to identify the short and long term complications associated with 22q11.2DS. We hypothesize that the surgical outcomes are influenced by the 22q11.2DS, due to comorbidities as thrombocytopenia and hypocalcaemia.

Methods: A retrospective review was performed on all 22q11.2DS patients from two 22q11.2DS centers. Patients who were treated by a posterior spondylodesis with a minimal follow-up of six weeks were included. The medical records were reviewed for demographic variables, peri- and postoperative complications and the need for blood products. Continuous variables were analyzed for normality and shown as mean with standard deviation (SD) or medians with Inter Quartile Range.

Results: Nineteen patients (male=9) with an age of 15.4 (SD:2.3) and a follow-up of 2.03 years(SD: 0.5) were included for analysis. The surgeries were performed between 2001 and 2017. The pre-operative Cobb angle was 61 degrees (SD 4.4) and there was a 44% postoperative improvement (SD: 5%). Four patients (16%) needed revision surgery; one infection (< three months), one scoliotic curve progression (< 30 months) and one surgery was converted into a two stage procedure due to peri-operative loss of neurological signals (neurologically intact after surgery). Moreover, one patient had peri-operative neurological signal loss due to low mean arterial pressure and one patient had migration of a distal screw which was treated conservatively. The mean blood loss was 1256mL (SD: 233mL) and subsequently 63 % of the patients needed peri- or postoperative blood products: platelets (n=5), red blood cells (n=10) or plasma (n=4).

Discussion: Scoliosis surgery within 22q11.2DS is associated with several peri- and postoperative risks. The majority (63%) of the patients needed blood products. This might be related to (peri-operative) thrombocytopenia and hypocalcaemia. Therefore, multidisciplinary care, before and after scoliosis surgery is essential.
No. 23. Quality of life in males and females with idiopathic scoliosis

Diarbakerli E, Grauers A, Danielsson A, Abbott A, Gerdhem P
Department of Clinical Science, Intervention and Technology, Karolinska Institutet

Introduction and aim:
Idiopathic scoliosis is a three-dimensional deformity affecting the growing spine. The prevalence of larger curves, requiring treatment, is higher in females. The aim of this study is to describe quality of life in males and females with idiopathic scoliosis.

Methods:
This cross-sectional study comprised 1519 individuals with idiopathic scoliosis (211 males) with a mean (SD) age of 35.3 (14.9) years. They all answered the Scoliosis Research Society 22 revised (SRS-22r) questionnaire and EQ-5D. 528 (78 males) were surgically treated, 535 were brace treated (50 males) and 456 were untreated (83 males). The SRS-22r subscore (excluding the satisfaction domain), the SRS-22r domains and the EQ-5D index score were calculated. Subgroup analyses based on treatment and age were performed. Statistical comparisons were performed using analysis of covariance with adjustments for age and treatment. A p-value less than 0.05 was considered as statistical significant.

Results:
The mean (SD) SRS-22r subscore was 4.19 (0.61) in males and 4.05 (0.61) in females (p=0.010). The males had higher scores on the SRS-22r domains function (4.56 vs 4.42), pain (4.20 vs 4.00) and mental health (4.14 vs 3.92) (all p<0.05). The mean (SD) EQ-5D index score was 0.85 (0.22) for males and 0.81 (0.21) for females (p=0.10). There were minor differences when comparing males and females in treatment and age groups, but both treated and untreated groups had reduced quality of life compared to the national norms.

Discussion:
When compared to females, males with idiopathic scoliosis tend to have slightly higher scores in the scoliosis specific SRS-22r but not in the generic quality of life measurement EQ-5D when compared to females. Quality of life is overall similar between males and females in treatment and age groups, but reduced in comparison with the general population.

No. 4. 3-year follow-up of single magnetically controlled growing rod (MCGR) with contralateral gliding system and apical control for early onset scoliosis

Skov ST1, Wijdicks SPJ2, Bünger C1, Castelein RM2, Li H1, Kruyt MC2
1Department of Orthopaedic Surgery, Aarhus University Hospital, Denmark
2Department of Orthopaedic Surgery, University Medical Center Utrecht, The Netherlands

Introduction and aim:
The magnetic controlled growing rod (MCGR) method for growth sparing treatment of severe early onset scoliosis has gained popularity lately worldwide, because of the non-invasive lengthenings. Disadvantages are: high initial costs and lack of apical control. To overcome these, we combined a single concave MCGR with a contralateral sliding rod system with apical control. The aim of the study was to investigate the feasibility, 3D correction, spinal growth and complications of this new MCGR-hybrid principle after minimum 2 years of interval lengthenings.

Methods:
A consecutive series of patients treated with this new principle at two European spine centers were evaluated retrospectively, including all patients operated between Sept. 2014 and June 2016. Demographics and clinical parameters were recorded from patient files. Length, Cobb angles and rotation (Nash-Moe method), were measured on standard digital radiographs.

Results:
Eighteen patients with a median age at treatment of 9 years with a mean follow-up time of 3 years (range 2-3.7). The frontal Cobb angle was reduced from mean 59 preoperatively to 30 post-operatively and slightly increased to 36 at latest follow-up. Rotation of the apical vertebra improved from mean 27 to 18 post-operatively but was partially lost to 24 during follow-up. Kyphosis increased 5 degrees during follow-up. Instrumented spine growth was mean 12 mm/year the first year and averaged 10 mm/year at last follow-up. There were 8 total complications, with 7 device related complications. 3 patients required unplanned revision; two because of failure of MCGR distraction and one because of rod breakage. There were no infections.

Discussion:
These early results show satisfactory 3D correction and maintained spinal growth with few complications. This new apical control single growth engine approach seems cost-effective in providing 3D correction and to maintain spinal growth in EOS.
No. 5. Ultrasound Measurement of the Scoliotic Spine and their Relation to the Cobb Angle: a CT Based Study

Tromp IN1, Brink RC1, Homans JF2, Schloesser TPC1, van Stralen M2, Kruyt MC1, Chu WCW1, Cheng JCY3, Castelein RM1

1Department of Orthopaedic Surgery, University Medical Center Utrecht, Utrecht, The Netherlands; 2Imaging Division, University Medical Center Utrecht, Utrecht, The Netherlands; 3Department of Imaging and Interventional Radiology, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong; 4Department of Orthopaedics and Traumatology, Prince of Wales Hospital, The Chinese University of Hong Kong, Hong Kong.

Introduction and aim:

For ultrasound imaging of adolescent idiopathic scoliosis (AIS) patients, the spinous processes (SP), transverse processes (TP) and center of lamina (COL) can be used as anatomical landmarks to assess curve severity. However, no standardized ultrasound equivalent for the Cobb angle exists. The aim of this study was to use reconstructed CT scans to investigate whether these posterior landmarks can represent the conventional coronal Cobb angle in AIS patients.

Methods:

A consecutive series of CT scans of 105 AIS patients was used for this study. The coronal Cobb, SP, TP and COL angle were measured for the main thoracic and (thoraco) lumbar curves. The validity as compared to the coronal Cobb angle and reliability of the SP, TP and COL angles were tested.

Results:

The median Cobb, SP, TP and COL angle were, 53°, 36°, 48° and 50° in the thoracic curves and 32°, 24°, 29° and 32° in the (thoraco) lumbar curves. Spearman’s rank correlations for the thoracic and (thoraco) lumbar curves between the SP and Cobb angle were 0.80 and 0.62, the TP and Cobb angle 0.84 and 0.84 and the COL and Cobb angle 0.80 and 0.73, respectively. Intraclass correlation coefficient (ICC) values for inter-rater measurements were 0.70, 0.85 and 0.93.

Discussion:

The SP, TP and COL angles represent structures located more posteriorly to the spine than the vertebral bodies, and consequently show different curve angle measurements. Taking this difference into account, these measurements are valid and reliable for assessment of coronal curve severity in AIS patients. Based on our CT analysis, the TP angle shows the best validity as compared to the Cobb angle, while the measurements of the COL angle show the best reliability.

No. 22. Core Set of Outcome Measures for Adult Spinal Deformity Surgery: A Global Consensus-Based Approach from Experts of the Scoliosis Research Society

Faraj SSA, van Hooff ML, Haastra TM, Wright A, Polly DW, Glassman SD, De Kleuver M

Orthopedics, Radboud University Medical Center, Nijmegen, the Netherlands Research, Sint Maartenskliniek, Nijmegen, The Netherlands Norton Leatherman Spine Center, Louisville, USA Orthopedic Surgery, University of Minnesota, Minneapolis, USA Neuroscience Institute, Virginia Mason Medical Center, USA

Introduction and aim:

Routine outcome monitoring by means of registries are valuable for evaluating treatment strategies. Such outcome registries are most valuable if outcome data are comparable between institutions and include outcomes that cover the full cycle of care. In ASD surgery a lack of a standardized systematic approach toward outcome measurement and reporting exists, hindering optimal monitoring and comparison of the quality of care delivered in different settings globally. The aim of this study was to define a standardized set of core outcomes for ASD surgery that ultimately facilitates benchmarking within and between (inter)national institutions.

Methods:

A systematic review of the ASD surgical literature was performed and reported outcomes were classified in WHO’s International Classification of Functioning, Disability and Health (ICF), which subsequently was used as input for a modified Delphi study. A geographically balanced panel of 25 ASD experts from the Scoliosis Research Society participated in multiple Delphi rounds in which a standard set of patient-relevant outcomes most essential to monitor in the full cycle of care for ASD surgery. A threshold of 75% similar votes was used for consensus.

Results:

The standard set encompasses the collection of patient-reported and surgical procedure-related outcomes covering the full cycle of care, including survival (30-day mortality), degree of health or recovery (aspects of functional status), time to return to recovery (time to return to work and achievement of functional status), disutility of care (operative mortality, immediate revision, infection, spinal cord injury, nerve root injury), sustainability of health and nature of recurrences (30-day readmission and revision), and long-term consequences (implant breakage, pseudoarthrosis, progression of deformity, disability due to complication).

Discussion:

The results of this study can be used as input for future decisions in the emerging landscape of outcome assessment (e.g. patient questionnaires and computer-adaptive testing) and to determine contributing case-mix variables for risk stratification. The implementation of standardized outcome assessment facilitates comparisons across studies, registries, and nations in order to improve the quality of daily clinical practice in ASD surgery and reach new avenues in predictive analytics. This will ultimately lead toward value-based health care.
No. 21. Predictive modelling of postsurgical outcome for arcolytic spondylolisthesis

Casper Friis Pedersen¹, Mikkel Osterheden Andersen¹, Soren Eiskjaer²
¹Spine Surgery and Research, Spine Center of Southern Denmark—part of Lillebaelt Hospital.
²Department of Orthopaedic Surgery, Aalborg University Hospital

Introduction and aim:
An evidence-based decision support system (DSS) is under development. The purpose of the DSS is to aid patients in cooperation with surgeons to choose the treatment option that best aligns with their preferences by presenting individually tailored possible benefits and disadvantages of operative intervention. The core of the DSS is predictive modelling of outcome measures based on the Danish national surgical spine database (DaneSpine). The aim of this study was to identify the best predictor and the minimal clinically important difference (MCID) of postsurgical EuroQol (EQ-5D) outcome for patients with arcolytic spondylolisthesis.

Methods:
327 patients met the inclusion criteria in DaneSpine. 77 % had complete follow-up data at 1 year and was selected for analysis. Bivariate correlation was conducted to identify predictors. Variables that were clinically relevant or achieved a significance level of <0.2 were included. The MCID of EQ-5D was calculated using ROC curves. The SF-36 questionnaire Compared to one year ago, how would you rate your health in general now? was chosen as anchor.

Results:
The strongest predictor of postsurgical EQ-5D outcome at 1 year was Pre EQ-5D score (rho = .435, p=0.000). MCID for postsurgical EQ-5D outcome was 0.07. 25% of the variation in self-perceived improvement could not be accounted for by the MCID. 44 patients (18 %) who reported an improvement had an EQ-5D delta < 0.07. 18 patients (7 %) who reported an absence of improvement had an EQ-5D delta > 0.07. The groups who reported an improvement with MCID > 0.07 versus < 0.07 differed significantly in presurgical levels of EQ-5D, as did the group who did not report an improvement (p<0.001).

Discussion:
Presurgical levels of EQ-5D might be an independent factor in respect to postsurgical self-perceived outcome. Patients with relatively low levels of pre EQ-5D scores are less likely to report an improvement regardless of EQ-5D delta scores. Patients with relatively high levels of pre EQ-5D scores are less likely to report an absence of improvement regardless of EQ-5D delta scores. A better understanding of this could guide the choice of predictive model algorithms and allow for better accuracy.
No. 7. Augmented reality surgical navigation using intraoperative 3D imaging for pedicle screw placement

Gerdhem P, Edstrom E, Burstrom G, Nachabe R, and Elmi-Terander A.
Neurosurgery department, Karolinska University Hospital

Introduction and aim:
Computer-assisted navigation with intraoperative 3D imaging has demonstrated improved accuracy of pedicle screw placement. However, current navigation technologies use passive infrared cameras for patient tracking of an invasive reference frame attached to the spine. We introduce an augmented reality navigation technology with non-invasive patient tracking.

Methods:
Twenty consecutive patients had spine surgery with pedicle screw placement in this prospective study (13 scoliosis cases). An intraoperative 3D scan is acquired with a C-arm with integrated optical video cameras to plan the direction of pedicle screw insertion after automatic identification of the pedicles (Philips Healthcare, the Netherlands). The direction of the screws is augmented to the video display of the surgical field. Accuracy was defined as being the proportion of screws placed within the pedicle or encroaching the cortex. Efficiency was assessed by measuring each part of the surgical procedure. Safety corresponds to clinical outcome, radiation exposure to the patients and surgical staff.

Results:
The accuracy of the augmented reality system according to the Gertzbein grading was 94% (238/253 navigated screws). Thirteen of the screws not considered as accurate had larger diameter than the pedicle they were placed in. The average procedure time was 402 min. Navigation time accounted for ¼ of the total procedure time. The average patient radiation dose was 159 mGy. The total cumulative staff occupational dose corresponded to 0.05% of the scatter radiation dose from the patient.

Discussion:
This study is the first clinical study using augmented reality navigation with intraoperative 3D imaging for pedicle screw placement. This study demonstrated an accuracy of 94% without any device-related adverse event. The usage of the navigation system including 3D imaging accounted for a quarter of the total procedure time only. The staff radiation dose was virtually null as no peri-operative X-ray was used and the staff was few meters away from the C-arm during 3D imaging.

No. 20. Sagittal balance 28 to 41 years after fusion in situ for high-grade isthmic spondylolisthesis

Joelson A1, Danielson B2, Hedlund R3, Wretenberg P1, Frennered K3
1Orebro University School of Medical Sciences
2Department of Radiology, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg
3Department of Orthopaedics, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg

Introduction and aim:
Since in situ fusion does not reduce the sagittal deformity in high-grade isthmic spondylolisthesis, there might be some long-term sagittal balance issues when the degenerative changes of aging alter the sagittal alignment of the spine. Therefore, we evaluated sagittal balance three decades after in situ fusion for high-grade isthmic spondylolisthesis.

Methods:
Sagittal balance, pelvic parameters and compensatory mechanisms were evaluated on standing lateral radiographs of the spine and pelvis for 28 of 39 consecutive patients, 28 to 41 years after in situ fusion for high-grade spondylolisthesis. The mean age at surgery was 14 years (range 9-24) and the mean age at follow-up was 48 years (range 39-59). A subset of the radiographic parameters was compared with the corresponding data of an 8-year follow-up of the same patients. Health-related quality of life was evaluated with the Scoliosis Research Society (SRS)-22r questionnaire.

Results:
Three of twenty-eight patients had sagittal imbalance (T1 spinopelvic inclination > 0°). Signs of compensatory mechanisms, like reduced thoracic kyphosis and pelvic retroversion, were frequent. There was a statistically significant decrease in sacral slope compared with 8-year data. The median SRS-22r subscore was similar to Swedish normative data. We found no correlation between radiographic parameters and SRS-22r outcome.

Discussion:
Three decades after in situ fusion for high-grade spondylolisthesis, radiographic signs of non-compensated sagittal imbalance were observed only in a few individuals. There was no correlation between any radiographic parameter and SRS-22r outcome. From a long-term functional point of view our results lend no support for surgical reduction of high-grade spondylolisthesis.
No. 19. Re-operations after long segment fusions for adult scoliosis in the lumbosacral region: iliac versus non-iliac distal fixation


Department of Orthopaedic Surgery, Aarhus University Hospital, Denmark

Introduction and aim:

Adult scoliosis is a complex disorder, often associated with pain and functional impairment. Surgical treatment can restore function and improve QoL. Deciding where to end long segment fusion can be a challenge and some surgeons advocate for prophylactic iliac fixation to reduce distal junctional problems, whereas others avoid lumbosacral fusion to preserve motion.

The aim of this study is to investigate the re-operation rates and pain improvements of iliac fixation versus lumbar or lumbosacral fixation in adult scoliosis patients.

Methods:

A retrospective single-center cohort study of adult scoliosis patients with 4 or more lumbar segment fusion and at least 3-year follow-up. 71 adult patients (58 female) fulfilled our inclusion criteria and were operated from March 2010 to May 2015. Average age 65 years (range: 41-85). Pre-op and post-op X-rays, electronic patient files and DaneSpine data were audited. Revision rate and back pain reduction rate were compared between groups.

Results:

The groups were comparable with respect to age, sex and fusion levels. Iliac level was chosen for lowest instrumented level in 38 patients and non-iliac fixation in 33 patients. Postoperative back pain (VAS 100-scale-score) improved 38 points and 30 points at 2 year and 5 years in iliac group, as compared to 20 points and 19 points improvements in the non-iliac group. In total 24 patients (34%) had re-operations; 9 underwent 1 re-operation, 10 underwent 2 re-operations, 2 underwent 3 reoperations and 2 underwent 4 re-operations. 10 (30%) in the non-iliac group versus 14 (37%) in the iliac group had re-operation(s) (p=0.54). The main reason for re-operation in both groups were implant related complications (e.g. hardware failures, screw loosening), followed by deformity progression and pain. The re-operated patients in the iliac group had their first re-operation after an average of 21 months (3-months later than the non-iliac group).

Discussion:

Long fusion to ilium or non-iliac screw-fixation distally seems to entail similar re-operation rates. However, lumbar pain-score showed similar improvements at one year but deteriorated non-significantly in the non-iliac group. On the other hand, iliac screw fixation is a prerequisite in severe lumbo-sacral degeneration and in poor bone quality.

No. 8. Why almost any orthopaedic subspeciality is preferable to spine surgery

Eiskjær SP, Petersen PH

Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark

Background:

Resident’s choice of subspeciality is influenced by many factors. Spine surgeons are in demand in most European countries (Okafor et al.). However, spine surgery ranks low among the subspeciality choices (Sanaz et al.). The reasons for this are mostly unknown.

Methods:

Participants in the mandatory 3-day spine surgery course for orthopaedic residents 2018 were asked to complete a survey regarding career priorities and choice of subspeciality. They were asked to give a reason for not choosing spine surgery.

Results:

37 current residents participated in the survey. 10 women. Only 1 out of the 37 wanted to pursue a career in spine surgery (3 %). Most residents opted for arthroplasty 9/27 (24 %), hand 8/37 (22 %), traumatology 8/37 (22 %), and sports 5/27 (14 %). A high proportion of outpatient surgery was given as the main reason for the choice of subspeciality by 15/37 (41 %) of participants, geographic location in 12/37 (32 %) and minimal on call duties in 9/37 (24 %). The reason for not choosing spine surgery was stated as prolonged duration of surgery 16/37 (43 %) and the belief that many patients suffers from psychosomatic diseases 12/37 (32 %).

Conclusion:

If only 2-3 percent of orthopedic residents choose spine surgery as their subspeciality it is questionable if status quo can be maintained or any expansion in numbers can be achieved. The reasons for not choosing spine surgery as a subspeciality is based on the false belief that all spine surgeries are long lasting and that our indications for surgery likewise are wrong resulting in many patients with psychosomatic diseases undergoing surgery. We should do our utmost to correct these misunderstandings.
No. 9. Radiographic follow-up of idiopathic scoliosis fusion surgery; challenging the consensus

RH Mens, ML van Hooff, RE Geuze, M. Spruit, PP Horsting, M. de Kleuver, LWL de Klerk
Department of orthopedics, Sint Maartenskliniek & Radboud UMC, Nijmegen, the Netherlands

Introduction and aim:
For patients with adolescent idiopathic scoliosis (AIS), undergoing fusion surgery, international consensus exists that a 2-year radiographic follow-up is needed to evaluate surgical success. This standard lacks empirical evidence. The purpose of this study was to investigate the radiographic follow-up after fusion surgery in adolescent and young adult patients with AIS, from preoperative assessment until 2 years after surgery.

Methods:
63 patients, surgically treated for AIS in the period 2014-2015, age ≤25 (mean 14 years [SD = 3, range = 11-22 years]), providing 2 years radiographic follow-up, were enrolled. Prospectively gathered data of a single centre outcomes registry, following a cohort study design, was analysed retrospectively. Most recent preoperative and postoperative radiographs at 1 and 2 years follow-up were used. A series of coronal and sagittal angle- and balance parameters were measured on every radiograph, with the major Cobb angle as the primary outcome measure. Change in Cobb angle over time was analysed using Friedman’s ANOVA (p<0.05). Measurement error was assumed to be 5°.

Results:
The major Cobb angle did change significantly between pre- and 1 year postoperative (Z = -6.85, p < 0.01), but not between 1- and 2-year follow-up (Z = -0.96, p = 0.34). Radiographs of 763 patients showed a change exceeding the error of measurement (5°) from 1 to 2-year follow-up (maximum change 7.5°). Curve progression was seen in only two patients, the other five showed a decrease in curve size. These seven patients did not differ significantly from the complete cohort on patient characteristics or baseline radiographic measurements. None of the secondary outcome parameters changed significantly beyond the error of measurement, between 1- and 2-year follow-up.

Discussion:
No statistically significant change in major Cobb angle was found from 1- to 2-year postsurgical follow-up. Findings of this study are not supportive of routine radiographs 2 years after fusion surgery in AIS patients. This length of follow-up has no added value, but does add to the exposure of these young patients to radiation that is potentially harmful. A critical evaluation of the frequency of radiographic follow-up is needed.

No. 18. The Outcomes of Spinal Deformity Surgery in Parkinson’s Disease

Demirel A., Valancius K., Hoey K., Helmig P., Li H., Bünger C., Hansen ES.
Department of Orthopedic Surgery - Spine Section, Aarhus University Hospital, Denmark

Introduction and aim:
Parkinson’s disease (PD) is the second most common neurodegenerative disorder. Truncal dystonia in long standing PD often causes loss of spinal balance. Previous studies showed that the spine surgery with Parkinson’s patients can be complicated due to poor bone quality and muscular dysfunction. The literature on deformity surgery in patients with PD is remarkably scarce with many reports of complications and failures, and it is still unclear whether patients with spinal deformity due to PD benefit from operative treatment. The aim of the present single center study is to outline the development of complications, patient outcomes and subsequent change in surgical strategy for Parkinson’s patients with spinal deformity.

Methods:
We investigated all patients with PD and extensive deformity and spinal fusion surgery between 2002-2016. Patients answered PDQ 39, SRS-22, EQ-5D, SF-36 questionnaires and the question “If you had the knowledge that you have today, would you have said yes to your first operation”. Pre- and postoperative radiographs were analyzed by plumb line displacement. Complications and revision surgeries were noted.

Results:
18 patients, 13 men and 5 women, were operated upon. Mean age was 71.7 (SD 4.5). Satisfaction score in SRS-22 was 4.07 (SD 0.8). According to questionnaires, the patients had good social and emotional results, while they score low in mobility and functional parameters. Sixteen patients answered the question regarding treatment acceptance positively. No patient had chronic worsening of Parkinson’s symptoms. Revision surgeries were frequent but declined with learning. Revision incidents were caused by: Rod breakage (12), screw loosening (7), and wound revision (1). Plumb line displacement analysis showed improved spinal balance post-operatively in most cases.

Discussion:
Deformity surgery in PD must be extensive with restoration of sagittal and coronal balance and fusion to the ilium. Instrumental complications and revisions must be expected. The satisfaction level of Parkinson patients operated on for spinal deformity appears high despite frequent instrumental problems and revisions. Prospective studies comparing life quality before and after surgery are warranted. In this way, a better treatment strategy can be developed which might help health professionals to assess the possible challenges with the index surgery and the cost-effectiveness of it.
No. 17. Surgical Outcomes of Anterior versus Posterior Fusion in Lenke Type 1 Late-Onset Idiopathic Scoliosis

Vavruch L1,2, Brink RC1, Malmqvist M1,2, Schlösser TPC1, van Stralen M1, Abul-Kasim K1, Ohlin A6, Castelein RM1, Tropp H1,2
1Department of Clinical and Experimental Medicine, Linköping University, Sweden. 2Center for Medical Image Science and Visualization, Linköping University, Sweden. 3Department of Orthopaedic Surgery, University Medical Center Utrecht, The Netherlands. 4Imaging Division, University Medical Center Utrecht, The Netherlands. 5Division of Neuroradiology, Diagnostic Centre for Imaging and Functional Medicine, Faculty of Medicine, Lund University, Skåne University Hospital, Malmö, Sweden.
6Department of Orthopaedic Surgery, Faculty of Medicine, Lund University, Skåne University Hospital, Malmö, Sweden.

Introduction and aim:
Different surgical techniques have been described to prevent curve progression and to restore spinal alignment in idiopathic scoliosis. The spine can be accessed via an anterior or a posterior approach. However, the surgical outcomes, especially in three dimensions, for different surgical approaches remain unclear. The objective of this study was to describe surgical results in two and three dimensions and patient-reported outcomes of scoliosis treatment for Lenke type 1 idiopathic curves with an anterior or posterior approach.

Methods:
Cohorts of patients with Lenke curve type 1 idiopathic scoliosis who had undergone anterior or posterior spinal fusion were retrospectively recruited from two centres. Curve characteristics were measured on conventional radiographs before and after surgery and after 2 years follow-up. Vertebral axial rotation, true mid-sagittal anterior-posterior height ratio of individual structures, and spinal height differences were measured on 3D reconstructions of pre- and postoperative supine low-dose computed tomography scans. The patients completed the SRS-22 and EQ-5D-3L questionnaires postoperatively.

Results:
Fifty-three patients with Lenke curve type 1 idiopathic scoliosis (26 in the anterior cohort and 27 in the posterior cohort) were analysed. Fewer vertebrae were instrumented in the anterior cohort compared with the posterior cohort, resulting in a smaller number of implanted screws (p<0.001). Less surgery time and lower intraoperative blood loss were recorded in the anterior cohort (p<0.001). The Cobb angle correction of the primary thoracic curve directly after surgery was 57±12% in the anterior cohort and 73±12% in the posterior cohort (p=0.001) and 55±13% and 66±12% (p=0.001) at 2 years follow-up. Lumbar curve correction, thoracic kyphosis, and lumbar lordosis after 2 years follow-up as well as postoperative alignment restoration in three dimensions and the questionnaires showed no significant differences between the cohorts.

Discussion:
This study suggests that Lenke type 1 curves can be effectively managed surgically with either an anterior or posterior approach. Each approach, however, has specific advantages and challenges, as described in this study, which must be considered before treating each patient.
No. 11. Anterior Spinal Overgrowth, a Comprehensive and Detailed Analysis of the Different Contributing Structures

Brink RC1, Schlösser TPC1, van Stralen M2, Vincken KL3, Kruyt MC4, Hui SCN5, Viergever MA1, Chu WCW6, Cheng JCY7, Castelein RM1
1Department of Orthopaedic Surgery, University Medical Center Utrecht, Utrecht, The Netherlands; 2Imaging Division, University Medical Center Utrecht, Utrecht, The Netherlands; 3Image Sciences Institute, University Medical Center Utrecht, Utrecht, The Netherlands; 4Department of Imaging & Interventional Radiology, Prince of Wales Hospital, The Chinese University of Hong Kong; 5Department of Orthopaedics and Traumatology, Prince of Wales Hospital, The Chinese University of Hong Kong, Shatin, Hong Kong.

Introduction and aim:
It has been known for a long time that the anterior part of the spine is longer than the posterior part in idiopathic scoliosis. Recent 3D analyses demonstrated that this length discrepancy is centered around the apex, and that the disc contributes more than the vertebral body. The relative contribution of the laminae and the changes in the interlaminar space to this differential length could not be determined. The present study quantifies the contribution of the osseous and non-osseous structures in the anterior as well as the posterior elements in adolescent idiopathic scoliosis (AIS).

Methods:
A consecutive series of high-resolution CT scans of eighty-eight AIS patients (Cobb angle range 46-109°), acquired for navigation purposes, and thirty non-scoliotic controls were included. Complete 3D coordinate systems of the individual vertebral bodies, including the laminae, and discs of the scoliotic curvatures were reconstructed using a previously validated image processing technique. By correcting in 3D for rotation and tilt of each individual endplate, the height of the vertebral bodies and discs on the anterior and posterior side as well as the height of the laminae and interlaminar space were measured semi-automatically. Total length was calculated from Cobb to Cobb end vertebrae in the scoliotic patients and matched levels in the controls.

Results:
The anterior side of the vertebral bodies and discs was (mean±standard deviation) 3.4±2.7% longer as compared to the posterior side, and 6.4±6.0% longer as compared to the length measured along the laminae (p<0.001). Compared to the controls, the non-osseous structures (discs and interlaminar space) contributed most to the segmental wedging (at least 3 times more than osseous parts; p<0.001).

Discussion:
Based on this in vivo analysis, the true three-dimensional anterior-posterior length discrepancy of AIS curves was found to occur through both anterior column shortening as well as posterior column shortening, with the facet joints functioning as the fulcrum. The vertebrae contribute partly to the anterior-posterior length discrepancy accompanied by more significant and possibly secondary increased anterior intervertebral discs height.

No. 16. Comparison of circular, partial and full deformity rod options on the sagittal balance restoration in adolescents undergoing pedicle screw instrumentation for idiopathic scoliosis

Lastikka M, Oksanen H, Pajulo O, Helenius I
Department of Paediatric Orthopaedic Surgery, Turku University Hospital and University of Turku, Finland

Introduction and aim:
Posterior spinal fusion with pedicle screws is widely used for spinal deformity correction and definitive spinal fusion in adolescent idiopathic scoliosis. Common concern is how to maintain thoracic kyphosis. We studied the effects of three different Cobalt chromium rod designs on the sagittal balance restoration in adolescents undergoing surgery for idiopathic scoliosis.

Methods:
A prospective comparative study of 93 consecutive adolescents (mean age 15.6 years, range 11-21 years) with juvenile (JIS) or adolescent idiopathic scoliosis (AIS) undergoing posterior spinal fusion using bilateral segmental pedicle screw instrumentation with cobalt-chromium rods. Deformity correction was achieved using en bloc direct vertebral column derotation with direct translation. Fifty-six children (44 females) were operated with circular rods, 19 (14 females) with partial apex rods, and 18 (14 females) with full apex rods. Twelve (21%), 8 (42%), and 7 (39%) adolescents had apical SPOs (p=0.14).

Results:
Major coronal curves were similar preoperatively and at six months follow-up with mean (SD) correction percentages of 77% (8.5%), 75% (5.8%), and 77% (8.7%) at six months in the circular, partial, and full apex rod groups, respectively (p>0.10 for all comparisons). Similarly, mean (SD) thoracic kyphosis (T5-T12) was 19° (13°), 20° (11°), 21° (13°) preoperatively and 16° (6.5°), 20° (6.6°), and 21° (5.9°) at six months follow-up (p=0.043 circular vs. partial apex; p=0.065 circular vs. partial rod; p=0.065 circular vs. full apex; p=0.88 partial vs. full apex).

Discussion:
Correction of coronal curves is excellent using bilateral segmental pedicle screw instrumentation for JIS and AIS. Flattening of thoracic kyphosis can be avoided using sagittal balance reinforced cobalt chromium rods.
Introduction and aim:
The aim of the study was to investigate the presence of back pain and anatomical area of pain AIS patients, after termination of treatment with Providence Night Time Braces.

Methods:
62 AIS patients, received a questionnaire collecting information of the frequency of back pain, functional and social limitations due to back or leg pain, all derived from the Dallas Pain Questionnaire (DPQ) and the Dallas Pain Drawing (DPD) by mail. All patients had received treatment with Providence Night Time Braces. Cobb was determined on the latest standing AP radiograph at termination of treatment, 12 months after brace weaning. The results were analysed for correlation between Cobb and the total pain score (Q-total) and correlation between Cobb and physical activity or social function. DPQ was used to investigate the pain modalities experienced by the patients.

Results:
62 AIS patients participated in the study. The intensity of pain was measured in mm from the 7 questions included in the DPQ, and a total sum score was calculated. The severity of pain was divided into three groups, Mild pain, 0-30 mm. Moderate pain 31-69 mm and Severe pain 70-100 mm. All patients reported some sort of back pain, but 81 % reported pain in the Mild category. No correlation was found between Cobb and the intensity of back pain, Cobb and Physical activity or Cobb and Social function. A correlation was detected between Global and Depression. Deep and stapping pain was the most frequent pain modality reported by the patients. Correlation was found between the curve type and the and the area of pain in the DPD.

Discussion:
Back pain is frequently reported from AIS patients, after termination of Providence Night Time Brace treatment. The majority of patients reports mild intensity of pain, and pain is primarily located in the thoracic or lumbar region. The presence of back pain in 80 % of the patients after termination of part time bracing, might suggest that physiotherapy is not only beneficial for AIS patients being braced >16 hours daily.

No. 12. Reproducibility of the Classification of Early-Onset Scoliosis (C-EOS) – application in a consecutive single-center cohort.

Casper Drågestad1, Søren Ohnt-Nissen1, Dennis Winge Hallager1, Niklas Tøndevold1, Thomas Andersen2, Benny Dahl2, Martin Gehrchen2
1Spine Unit, Department of Orthopaedic Surgery, Rigshospitalet, University of Copenhagen, Denmark
2Department of Orthopedics and Scoliosis Surgery, Texas Children’s Hospital and Baylor College of Medicine, TX, USA

Introduction and aim:
The Classification of Early-Onset Scoliosis (C-EOS) is a promising classification system for future research in patients with early-onset scoliosis (EOS). However, the reliability has only been examined in written cases without measuring radiographs and not including the annual progression rate (APR) modifier. The aim was to assess the agreement and reliability of the C-EOS across all categories.

Methods:
A rater agreement and reliability study was conducted. We included a single-center consecutive cohort of patients diagnosed with EOS, no history of deformity surgery, and seen in the outpatient clinic from January 1 to June 30, 2015. Five raters with different levels of experience in spine surgery participated. 70 patients were identified; the first 6 entered a pilot study, 4 were excluded due to insufficient radiographs leaving 60 for the final study. Patient histories were systematically summarized and presented to the raters with radiographs in a blinded setup. Two anterior-posterior full spine radiographs taken minimum 6 months apart and one sagittal radiograph were measured by all raters for each case. Categories were assessed with crude frequency of overall agreement (OA) and interrater Fleiss kappa (κ) statistics and continuous variables with intraclass correlation coefficient (ICC) and standard error of measurement (SEM) using a linear mixed effects model.

Results:
Mean age was 8.7±3.4 years and etiologies were congenital/structural (n=20), idiopathic (n=20), neuromuscular (n=12) or syndromic (n=8). For etiology OA was 73.3% and κ = 0.79 (95%CI 0.69-0.88). For major curve angle OA was 83.3%, κ = 0.88 (95%CI 0.80-0.95), ICC = 0.97 (95%CI 0.96-0.98) and SEM = 4.9°. For kyphosis OA was 55.0%, κ = 0.55 (95%CI 0.41-0.70), ICC = 0.86 (95%CI 0.80-0.91) and SEM = 7.6°. For annual progression rate OA was 66.7%, κ = 0.57 (95%CI 0.42-0.73), ICC = 0.75 (95%CI 0.66-0.82) and SEM = 7.1°.

Discussion:
We found substantial agreement for etiology and almost perfect agreement for major curve angle. For kyphosis and APR, we found only moderate agreement and higher interrater variability in measurements indicated by higher SEM. This variability must be considered when using the C-EOS and APR possibly based on more than just two radiographs.
No. 13. Providence Night-time Bracing are effective in Treatment of Adolescent Idiopathic Scoliosis, even in Curves larger than 35°.

Ane Simony MD PhD, Inge Beuschau CPO B.Sc, Lena Quisth CPO B.Sc, Stig Mindedahl Jespersen MD, PhD, Leah Yaccat Carreon MD, Msc, Mikkel Osterheden Andersen MD.

Spine Surgery and Research, Spine Center of Southern Denmark – part of Lillebaelt Hospital. Orthopedic department, University Hospital Odense, Denmark.

Introduction and aim:
In 2007 the primary conservative treatment of AIS in Denmark, went from full time bracing to night-time bracing. The purpose of this study is to evaluate the effectiveness of night-time bracing in a cohort of AIS patients, with curves from 25-45°.

Methods:
Patients diagnosed with AIS, skeletal immature and initial Cobb between 20-45° was included in this study. All patients had curves with apex at T6 or below and were instructed to wear the Providence Night-time brace at least 7-8 hours pr. night. No other previous treatments were accepted, and no physiotherapy was applied during brace treatment. Treatment was continued until two years post menarche or for male patients until growth arrest for 6 months was observed. All patients had their last follow radiograph, at least 12 months out of brace. Cross-measured x-rays was used to compare the primary Cobb angle, the in-brace correction and the outcome cobb angel. The brace treatment was considered failed if progression more than 5 degrees occurred and if surgery were performed.

Results:
A total of 124 consecutive patients were included in this study, 80 patients completed brace treatment and 12 months follow up. 68 females and 12 males were included in this study. To evaluate the effect of bracing in curves > 35° the patients were divided into groups, according to Cobb when treatment was initiated 20-29°, 30-39° and 40-45°, see table 1 for further demographics. Brace treatment was effective in 83.3 %, and progression of the deformity was observed in 16.7 % of the patients. Only 5% of the patients were referred to surgical treatment.

Discussion:
Providence night time braces are effective, as a treatment in adolescent idiopathic scoliosis patients. This study reports a success rate of 88.7 % and the results are comparable to fulltime treatment with Boston braces or other TLSO. In brace correction is crucial in part time bracing and we recommend at least 70 % curve correction, if part time bracing should be considered.


Krista te Kronnie1, Sebastiaan P.J. Wijdicks, MD, Moyo C. Kruijt, MD PhD, René M. Castelein, MD PhD1
1Department of Orthopaedics, University Medical Center Utrecht, Utrecht, the Netherlands

Introduction
Progressive infantile idiopathic scoliosis can be treated by serial casting at early age. Mehta showed that casting with the technique of Cotrel could cure scoliosis or delay eventual surgery. However, successful casting requires proper training and equipment in combination with close parental guidance. The aim of the study was to investigate the proper technique and potential pitfalls of serial casting.

Methods
Since 2014 infantile scoliosis has been managed in the Wilhelmina Children’s Hospital in Utrecht with serial casting. The cast jacket is placed under general anesthesia. We used a Cotrel frame to place children in traction. The posterior ribs are pushed anteriorly to rotate the thoracic cage. An anterior window is used to relieve chest and abdomen. Every 2-3 months the cast is replaced to allow for growth and further correction. Three experienced orthopedic cast technicians were questioned on potential pitfalls and asked for potential solutions.

Results
12 cases were treated with serial casting. Three potential pitfalls were exemplary to our experience in our clinic. A 2-year-old boy had a diastase of the M. rectus abdominis that became more visible in his cast. It was non-symptomatic but worried parents. Because of these worries and the curve reduction from 43° to 9°, treatment was converted to removable brace. Second case was a 4-year-old boy with a pressure ulcer after his second cast. Although the curve had reduced from 65° to 40° we considered curing of the spine an unrealistic goal and converted to brace. Finally, a 3-year-old girl presented with stomach pains, vomiting and loss of appetite after the first cast. Because of suspicion of a superior mesenteric artery syndrome we removed the cast. After symptoms disappeared, we started again. After enlarging the anterior window, the complaints subsided. After 4 casts, the scoliosis reduced from 30° to 22°and treatment was converted to brace.

Conclusions
The conservative treatment of idiopathic scoliosis by serial casting requires experience but has the potential to cure the scoliosis or delay surgery. Proper casting techniques are required to minimize complications. Close communication and early education of parents is needed to maximize success of serial casting.