cm on average; height measurements showing significant increase at each follow-up time point (p<0.001). Patients (88%) reached skeletal maturity at final follow-up. Upper thoracic (UT), main thoracic (MT), and thoracolumbar/lumbar (TLL) curves showed significant decrease at each follow-up time point. No significant changes were noted in kyphosis and lordosis (p<0.05). Forced vital capacity (FVC)% and forced expiratory volume in 1 second (FEV1)% showed significant increase from preop to 1 year, as well as from 1 to 2 years (mean FVC% 80.5, 85.2, and 87.6, respectively; mean FEV1% 80.5, 87.8, and 90.4, respectively, p<0.001). Pulmonary, mechanical and curve behavior complications rates were 12%, 19%, and 33%, respectively. Two patients (4.8%) were converted to fusion. At final follow-up, 92% patients had ≤30° residual curve. The Scoliosis Research Society-22 mental health, self-image and subtotal scores increased significantly.

Conclusions: This study reports a single European center experience on 42 consecutive patients with ≥2-years follow-up who had undergone thoracic-only VBT surgery. Surgical correction was followed by growth-dependent correction attained during follow-up. Spontaneous correction was also noted in the non-operated upper thoracic and thoracolumbar levels. Pulmonary function showed a gradual increase. Thoracoscopic VBT surgery prevented fusion in 95% of patients of whom 92% had good radiographic (≤30° residual curve) and clinical outcomes; however, it is not without complications. Overall pulmonary, mechanical and curve behavior complications rates were 12%, 19%, and 33%, respectively. Some complications may be avoided with a better understanding of the growth modulation and advancement of technical skills and technology.

PS-FP-12-9

Clinical and Radiographic Outcome at 7 Years of Follow-up after Cervical Total Disc Replacement

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Purpose: This retrospective study was done to investigate long term efficacy of cervical total disc replacement (CTDR) with regards to its clinical and radiological outcome.

Methods: A total of 32 patients (male:female, 22:10; mean age, 39.9 years; range, 29–55 years) who were treated with single-level CTDR between 2009 to 2013 were retrospectively analyzed. The records of clinical and radiological examinations were assessed preoperatively and postoperatively at 1-, 5-, and 7-year follow-up (FU). Clinical scores outcome included scores such as Neck Disability Index (NDI), Visual Analog Scale (VAS)-arm and neck pain. The radiological outcome variables included range of motion of implanted prosthesis between maximum flexion-extension radiographs, radiographic heterotopic ossifications (HO), and adjacent segment disease (ASD). Complications and revision surgeries were also explored.

Results: All the clinical outcome scores were statistically significant at any time during FU period. At 7-year FU, mean improvement was NDI (26–6), VASarm (6.3–2), VASneck (6.6–2.2) (p<0.05). An increase in the incidence of HO was seen during postoperative course. Grade 4 HO with solid fusion (9.38%), grade 3 (18.75%), grade 2 (25%), grade 1 (37.5%), and grade 0 (9.38%). There was no significant correlation between HO and clinical scores. The prosthesis mobility declined from 9.2° preoperatively to 9° at 1-year FU and 7.5° and 7.3° at 5- and 7-year FU. Radiographic ASD was seen in 11/32 (34.37%); however, in only 3/32 (9.38%) had clinical symptoms which were managed conservatively. There was a positive correlation between poor device mobility and occurrence of ASD and ASD appeared earlier in cases with grade 3 or 4 HO.

Conclusions: In this study, favorable 7-year FU clinical and radiological outcomes were observed. Clinically motion restricting HO was associated with higher ASD.

PS-FP-13-1

Fully-Automated Deep Learning Prediction of Spinal Deformity Alignment Irrespective of Image Quality Obtained via Smartphone Photographs

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Purpose: For facilitating communication, it is popular for

spine specialists to take photos of radiographs with smartphones. An automatic tool to accurately detect vertebral landmarks and alignment provides easy and highly useful information for surgeons. Original X-rays are not easily accessible for telemedicine and existing deep learning-based automated Cobb angle (CA) predictions are not accurate on suboptimal quality X-rays. The aim of study was to develop an automated CA prediction system irrespective of image quality, with no restrictions on curve patterns to facilitate clinical practice and telemedicine.

Methods: A total of 367 consecutive patients attending a scoliosis clinic were recruited prospectively and their coronal X-rays were re-captured using mobile phones. Five-fold cross-validation was conducted (five experiments, each with 294 images to train a deep neural network named Spine_HRNet for endplates landmarks and end-vertebrae detection, and the remaining 73 images were used to test). The predicted heatmaps of the vertebral landmarks were visualized to enhance interpretability of Spine_HRNet. Per-landmark-absolute-errors and recall of the landmark detection results were calculated to assess the accuracy of the predicted landmarks. Further calculated CAs were quantitatively compared with the spine specialists measured ground truth (GT).

Results: The average per-landmark absolute distance error and the recall of the detected endplates landmarks were 2.8 pixels and 0.99, indicating a highly accurate detection. The predicted CAs were all significantly correlated with GT (p<0.01). Compared with GT, the mean error was 3.73°–4.15° and standard error of the measurement was 0.8°–1.7° for the predicted CAs at different spinal regions.

Conclusions: This is the first study using Spine_HRNet on non-original X-rays to automatically and accurately predict vertebral landmarks of the scoliotic spine. Spine_HRNet's applicability is evidenced by our thorough cross-validation, which can be used with telemedicine to facilitate fast reliable auto-diagnosis and follow-up.

PS-FP-13-3

Evaluation of the Basal Metabolism of Degenerative Lumbar Intervertebral Discs Based on Pfirmann Grade and Presence of Instability

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Purpose: Intervertebral disc (IVD) degeneration is implicated in back pain, a leading cause of spine-related disability. It may also cause segmental instability. Both local and systemic inflammatory processes have been implicated in the pathophysiology of IVD degeneration, though it is unclear if Pfirmann grade severity or presence of instability affects degenerative IVD metabolism. These differences have not previously been investigated. Hence, this study was designed to examine the basal metabolism of degenerative lumbar IVD tissues collected from patients undergoing lumbar microdiscectomy or fusion with the hypothesis that tissues from patients with higher Pfirmann grades and those with instability would produce significantly higher levels of degradative enzymes and inflammatory mediators.

Methods: Degenerative IVD tissue excised as part of a standard-of-care spinal surgery, was obtained from patients (n=7; mean age, 53, 4 female) being treated for symptomatic degenerative lumbar IVD disorders. Pfirmann grading (1–5) of the IVD was determined by evaluation of magnetic resonance imaging (grade 3, n=3; grade 4, n=4), and for instability as defined by the presence of a spondylolisthesis on upright lateral radiographs (unstable, n=2; stable, n=5). Tissues comprised of degenerative nucleus pulposus (NP) was collected and explants were created. Cultured for 3 days, after which media were collected for biomarker evaluation. Media analyses: Media were tested for monocyte chemoattractant protein (MMP)-1, MMP-2, MMP-3, MMP-7, MMP-8, MMP-9, MMP-13, tissue inhibitor of metalloproteinase (TIMP)-1, TIMP-2, TIMP-3, TIMP-4, growth-related oncogene (GRO)-α, monocyte chemoattractant protein (MCP)-3, platelet-derived growth factor (PDGF)-AA, PDGF-AB/BB, interleukin (IL)-2, IL-4, IL-6, IL-8, MCP-1, macrophage inflammatory protein (MIP)-1α, MIP-1β, RANTES