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EXPERT'S COMMENT

Expert's comment concerning Grand Rounds case entitled "Management of a pseudarthrosis with sagittal malalignment in a patient with ochronotic spondyloarthropathy" by Alkasem W, Boissiere L, Obeid I, Bourghli A (Eur Spine J; 2019: doi.org/10.1007/s00586-019-06020-2)

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The authors are to be congratulated on salvaging a post-laminectomy pseudoarthrosis in a patient with alkaptonuric ochronosis [1]. Destabilizing a rigid spine by laminectomy and lateral posterior element removal was truly emphasized as the surgeon's failure during index surgery done.

Although the clinical and radiographic features of alkaptonuric ochronosis in a deformity patient are similar to those in ankylosing spondylitis, distinct challenges are related to osseous elements and myofascial structures appearing bridle, fibrotic, and poorly vascularized due to the underlying systemic disease of *ochronotic spondyloarthropathy*.

This case is worthy to be reported and discussed because it sheds light on a rare systemic disease in a spinal deformity patient, which is of importance to be detected before treating it like ankylosing spondylitis (AS) with global sagittal imbalance and thoracolumbar major deformity. Accordingly, in the assessment of the deformity the authors well stressed the residual spinal flexibility as shown by comparison of standing (e.g. X-rays) and supine imaging data (e.g. sagittal CT reconstructions) of the lumbar spine and thus uncover the alleged severe global sagittal imbalance as a semi-rigid deformity. This differs significantly from the commonly rigid thoracolumbar spine in AS patients seeking deformity treatment.

Re-analysis of the original image material, however, also reveals residual flexibility of the thoracic hyperkyphotic spine. With the authors performing fusion from T10 to the pelvis, one might recommend careful long-term observation of the thoracic levels, because up to one third of patients with active AS or incomplete thoracic fusion tend to experience kyphosis increase in the postoperative course, if the instrumentation does not reach upper thoracic levels at the index procedure [2].

The authors report an uneventful clinical course and successful outcome and can be congratulated on an excellent sagittal correction of the deformity. Unfortunately, outcome data regarding the patient's perception of her coronal balance are missing. Follow-up AP radiographs reveal coronal imbalance with C7-S1 centre sacral vertical line (CSVL) deviation to the left by 3–4 cm with mild leg length discrepancy of less than 1 cm left-sided. Residual coronal imbalance > 4 cm is a frequently reported finding in large adult spinal deformity databases. This case emphasizes the challenges we are all facing with true 3D-plane correction in adult spinal deformity. The article also stresses a scotoma, spine surgeons might have developed during the last decade of "sagittal plane correction surgery". In a recently presented study on 144 patients with adult scoliosis, Theologis et al. [3] reported that 17% of patients with a preoperative CVSL

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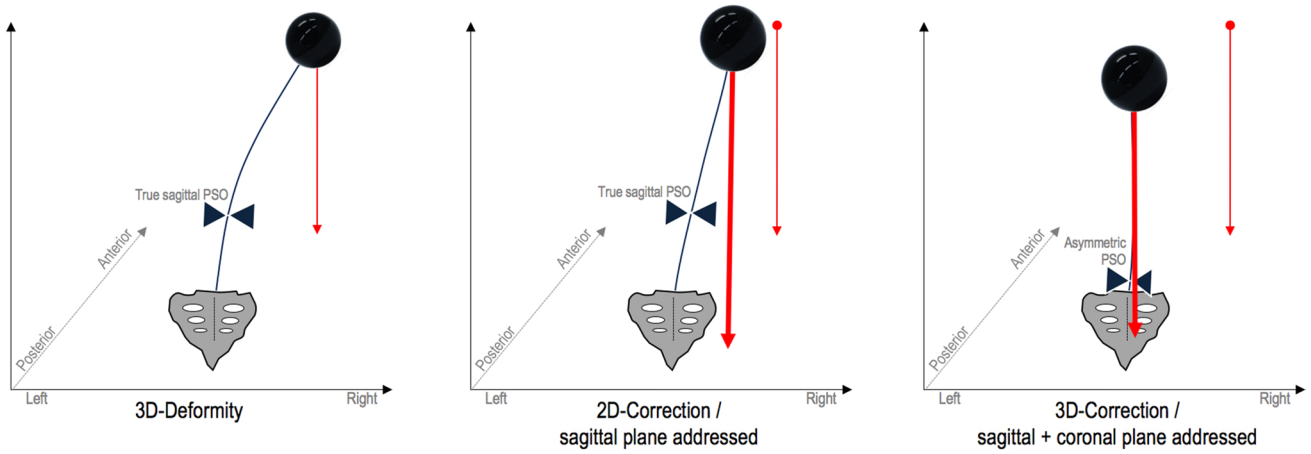

Fig. 1 The geometry of biplanar spinal correction

smaller than 3 cm worsened after adult deformity surgery, 67% of patients with a preoperative CSVL > 3 cm further worsened, and only 33% improved after surgery. Although the main driver of clinical outcome remains sagittal alignment measures, postoperative coronal imbalance can impact outcome in terms of validated outcome measures and function [4, 5]. While the prediction of postoperative sagittal alignment is difficult and inaccurate using most recent mathematic prediction models, as summarized in a previous article [2], the addition of coronal plane deformity makes planning and prediction of postoperative alignment largely a result of appropriate strategy selection as well as surgeon's experience and expertise.

With uniplanar sagittal plane correction in a patient with both frontal and sagittal deformities, postoperative sagittal correction will be successful; however, coronal malalignment will not be addressed (Fig. 1 left vs. middle). Using asymmetric correction strategies either by applying a 3-column osteotomy (e.g. asymmetric PSO) or by tailoring compression towards the convex site of the lumbar curvature in a poly-segmental correction technique, global sagittal and coronal balance can be achieved. Unfortunately, 3D-planar correction causes the need to balance the extent of sagittal with coronal plane correction. This means to achieve the same amount of sagittal plane correction in a patient with combined sagittal and coronal malalignment compared to a patient with uniplanar sagittal deformity, advanced space for the geometry of the 3D-correction is necessary. That means, for example, increasing the height of an anterior column defect created during a 3-column osteotomy (e.g. PSO variants, VCR) or during a segmental approach with discectomy providing a larger space for posterior shortening and biplanar correction.

Intraoperative alignment control C7 to pelvis using T-type rods can improve postoperative coronal balance (Fig. 2). Fine-tuning and correction of residual coronal malalignment noticed at the end of surgery can be accomplished by adjusting the CSVL deviation at the foundation of the correction at L5-S1 or L4-S1 via unilateral compression and mild contralateral distraction.

Fig. 2 Rod-cross. A device of the author to control spinal balance intraoperatively using radiographs

A recently published overview by Obeid et al. [6] serves valuable information on both the conceptional planning and the surgical techniques available to address coronal plane deformity in adult spinal deformity. These techniques can be merged well with the concepts and techniques applied for sagittal plane reconstructions.

Compliance with ethical standards

Conflict of interest There is no conflict of interest.

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