

# Current Surgical Strategies to Restore Proper Sagittal Alignment

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## Mini Review

The lumbar lordosis is essential to the human spine, as it enhances biomechanical strength and facilitates the unique upright posture of the human species [1]. On average, 90% of the lumbar curve is attributed to the wedging of the discs, emphasizing the important contribution of them in maintaining lumbar lordosis [2]. In this way, minor changes in sagittal balance increase muscle activity and spinal load, that results in loss of disc height and facet arthrosis. In a degenerated spine, the neural arch can be responsible for up to 70% compressive force, as the disc load capacity is reduced by pathological alterations [3]. Consequently, humans have developed adaptive strategies to maintain a balanced spine due to degenerative changes. These include increased hip flexion, plantarflexion, increased cervical spine lordosis, pelvic retroversion, thoracic hyperkyphosis, bent knee and bent hip strategy similar to primates, all of them related to increased oxygen consumption [4]. The excessive energy expenditure is related to accelerate degenerative postural changes, also affecting adjacent joints, and evidences the need of an early intervention to keep intact the bipedal efficiency of the human spine.

Several studies have shown that lumbar spine surgery of sagittal alignment improves health-related quality of life parameters, as spontaneously restores compensatory strategies like pelvic retroversion and thoracic hyperkyphosis [5-9]. Schwab et al. [10] have shown that lumbar spine deformity is determined by the difference between lumbar lordosis (LL) and pelvic incidence (PI), being  $LL = PI \pm 9^\circ$ . Other utilized global radiological parameter of sagittal alignment is the sagittal vertebral axis (SVA), defined as the horizontal offset between the C-7 plumb line and posterior superior aspect of the S-1 vertebral body. The pelvis plays an important role in sagittal balance and the measured parameters are PI, pelvic tilt (PT) and sacral slope (SS). As the PI is a fixed measure, SS and PT are commonly affected by strategies utilized by patients with loss of lumbar lordosis, as pelvic retroversion and knee flexion.

Accordingly, the surgical goals must be alleviation of clinical symptoms and proper correction of sagittal alignment of the spine. The achieved C7-SVA must be less than 5cm and pelvic tilt less than  $20^\circ$ , while diminishing LL/PI mismatch. Degenerative changes of the spine, discs and ligaments can difficult the optimal lordosis restoration, and release maneuvers must be performed by posterior and/or anterior approach depending on the involved structures, while performing fusion in an operative position that recreates physiologic lordosis. The posterior approaches include resection of spinous processes, lamina and facetectomy, with soft tissues retractions, foraminotomy and intervertebral disc distraction performed by dilators and/or rods and screws. The anterior approaches include resection of the anterior longitudinal ligament, osteophytes, and complete discectomy. Also, the posterior longitudinal ligament can be released when necessary in anterior approaches [11].

Three-column osteotomies, like Pedicle subtraction osteotomy (PSO), are indicated for patients with rigid sagittal imbalances [12]. While being a demanding procedure and requiring excellent knowledge of the principles of sagittal balance, the technique consists of a posteriorly shortening of the posterior column respecting the length of the anterior column, with a mean gain of  $20^\circ$  to  $40^\circ$  of lordosis. However, complication rate can reach 45% of the patients, with a risk of

reoperation of 25% after 5 years. Massive blood loss has been reported in literature, reaching >4,000ml and average percentage of total blood volume lost up to 55%, and neurological deficits are also frequent, reaching 15% of the patients [12,13]. Less invasive approaches or hybrid techniques come in order to mitigate some complications and allow corrective surgeries in elderly or poorer clinical condition population [14-16]. In general, as regard to the power of correction, less invasive approaches still are less powerful than hybrid and open techniques that have been shown to be similar to each other. In the other hand, complication rates are diminished with hybrid and even more with less invasive surgical options.

In an attempt to avoid these complications, the anterior approaches have been utilized to reconstruct sagittal alignment, while restores disc height and provides solid fixation of spinal segments. Up to date, anterior lumbar interbody fusion (ALIF) and lateral lumbar interbody fusion (LLIF) have shown promising results as they utilize large cages that redistribute spinal load [17]. Also, these techniques increase fusion potential as they are placed under direct compression whereas middle and anterior column provide more than 90% of the vascular osseous surface area [18]. However, ALIF presents some complications that must be taken in account for multilevel surgeries. Disadvantages of ALIF include the necessity of an access surgeon, high incidence of vascular injury and retrograde ejaculation. In addition, ALIF is associated with increased operating time and blood loss, as well as prolonged recovery time [19].

The LLIF presents as a minimally invasive option for multilevel degenerative conditions of the spine [20]. Minimally invasive surgical techniques have been demonstrated to provide a large number of benefits, which include less tissue trauma, preservation of normal anatomical structures and faster return to daily activities. LLIF consists of an anterior interbody fusion that realigns the endplates to a horizontal position through bilateral annular release and allows the placement of a large implant across the disc space reaching the ring apophysis bilaterally, maintaining intact all ligaments that play a role in ligamentotaxis, generating indirect decompression while stabilizing the motion segment [21]. Indications for the lateral approach are the same as those for any interbody fusion, with the limitation of access only disc levels above L5. For sagittal reconstructions, the technique involves complete anterior longitudinal ligament (ALL) and annulus release, with the use of hyperlordotic intervertebral cages. Early report shows that lateral LLIF has the ability to boasts equivalence to SPO correction of these global radiographic parameters while simultaneously creating additional disc height and correcting coronal imbalance [22].

In conclusion, lumbar lordosis is essential in human species as

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it allows less energetic expenditure to maintain bipedalism and is a consequence of pelvic parameters, spinal muscles, healthy intervertebral discs and vertebral wedging. Consequently, any changes in one of these features lead to sagittal mis alignment and alter load distribution over spinal structures. Surgical restoration of good sagittal alignment improves patient's quality of life and allows a painless and balanced position. Different strategies permits restoration of adequate lordosis, but less invasive techniques have been successfully introduced in the arsenal of surgical strategies for sagittal alignment of the spine, with less morbidity and improved clinical and radiological results.

## References

1. Sparrey CJ, Bailey JF, Safaee M, Clark AJ, Lafage V, et al. (2014) Etiology of lumbar lordosis and its pathophysiology: a review of the evolution of lumbar lordosis, and the mechanics and biology of lumbar degeneration. *Neurosurg Focus* 36: E1.
2. Been E, Barash A, Marom A, Kramer PA (2010) Vertebral bodies or discs: which contributes more to human-like lumbar lordosis? *Clin Orthop* 468: 1822-1829.
3. Adams MA and Hutton WC (1980) The effect of posture on the role of the apophysial joints in resisting intervertebral compressive forces. *J Bone Joint Surg Br* 62: 358-362.
4. Dolan P, Adams MA (2001) Recent advances in lumbar spinal mechanics and their significance for modelling. *Clin Biomech Bristol Avon* 16 Suppl 1: S8-S16.
5. Akbarnia BA, Mundis GM, Moazzaz P, Kabirian N, Bagheri R, et al. (2014) Anterior column realignment (ACR) for focal kyphotic spinal deformity using a lateral transpoas approach and ALL release. *J Spinal Disord Tech* 27: 29-39.
6. Berjano P, Damilano M, Lamartina C (2012) Sagittal alignment correction and reconstruction of lumbar post-traumatic kyphosis via MIS lateral approach. *Eur Spine J* 21: 2718-2720.
7. Bridwell KH, Lewis SJ, Lenke LG, Baldus C, Blanke K, et al. (2003) Pedicle subtraction osteotomy for the treatment of fixed sagittal imbalance. *J Bone Joint Surg Am* 86-A (3): 44-50.
8. Dimar JR, Glassman SD, Vemuri VM, Esterberg JL, Howard JM, et al. (2011) Lumbar lordosis restoration following single-level instrumented fusion comparing 4 commonly used techniques. *Orthopedics* 34: e760-e764.
9. Pellet N, Aunoble S, Meyrat R, Rigal J, Le Huec JC. (2011) Sagittal balance parameters influence indications for lumbar disc arthroplasty or ALIF. *Eur Spine J* 5: 647-662.
10. Schwab F, Ungar B, Blondel B, Buchowski J, Coe J, et al. (2012) Scoliosis Research Society-Schwab adult spinal deformity classification: a validation study. *Spine* 37: 1077-1082.
11. Barrey C, Darnis A (2015) Current strategies for the restoration of adequate lordosis during lumbar fusion. *World J Orthop* 6: 117-126.
12. Barrey C, Perrin G, Michel F, Vital JM, Obeid I (2014) Pedicle subtraction osteotomy in the lumbar spine: indications, technical aspects, results and complications. *Eur J Orthop Surg Traumatol Suppl* 1: S21-S30.
13. Bianco K, Norton R, Schwab F, Lafage V (2013) Complications and intercenter variability of three-column osteotomies for spinal deformity surgery: a retrospective review of 423 patients. *Evid Based Spine Care J* 4: 157-159.
14. Haque RM, Mundis GM, Ahmed Y, El Ahmadi TY, Wang MY, et al. (2014) Comparison of radiographic results after minimally invasive, hybrid, and open surgery for adult spinal deformity: a multicenter study of 184 patients. *Neurosurg Focus* 36: E13.
15. Uribe JS, Deukmedjian AR, Mummaneni PV, Fu KM, Mundis GM, et al. (2014) Complications in adult spinal deformity surgery: an analysis of minimally invasive, hybrid, and open surgical techniques. *Neurosurg Focus* 36: E15.
16. Park P, Wang MY, Lafage V, Nguyen S, Ziewacz J, et al. (2015) Comparison of two minimally invasive surgery strategies to treat adult spinal deformity. *J Neurosurg Spine* 22: 374-80.
17. Lee CS, Hwang CJ, Lee D-H, Kim Y-T, Lee HS (2011) Fusion rates of instrumented lumbar spinal arthrodesis according to surgical approach: a systematic review of randomized trials. *Clin Orthop Surg* 3: 39-47.
18. Mummaneni PV, Haid RW, Rodts GE (2004) Lumbar interbody fusion: state-of-the-art technical advances. Invited submission from the Joint Section Meeting on Disorders of the Spine and Peripheral Nerves, March 2004. *J Neurosurg Spine* 1: 24-30.
19. Rajaraman V, Vingan R, Roth P, Heary RF, Conklin L, et al. (1991) Visceral and vascular complications resulting from anterior lumbar interbody fusion. *J Neurosurg* 91: 60-64.
20. Pimenta L, Forti F, Oliveira L, Marchi L, Jensen R, et al. (2015) Anterior column realignment following lateral interbody fusion for sagittal deformity correction. *Eur J Orthop Surg Traumatol* 1: 29-33.
21. Ozgur BM, Aryan HE, Pimenta L, Taylor WR (2006) Extreme Lateral Interbody Fusion (XLIF): a novel surgical technique for anterior lumbar interbody fusion. *Spine* J 6: 435-443.
22. Manwaring JC, Bach K, Ahmadian AA, Deukmedjian AR, Smith DA, et al. (2014) Management of sagittal balance in adult spinal deformity with minimally invasive anterolateral lumbar interbody fusion: a preliminary radiographic study. *J Neurosurg Spine* 20: 515-522.

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