Static and dynamic sagittal lumbar apex: a new concept for the assessment of lumbar lordosis distribution in spinal deformity

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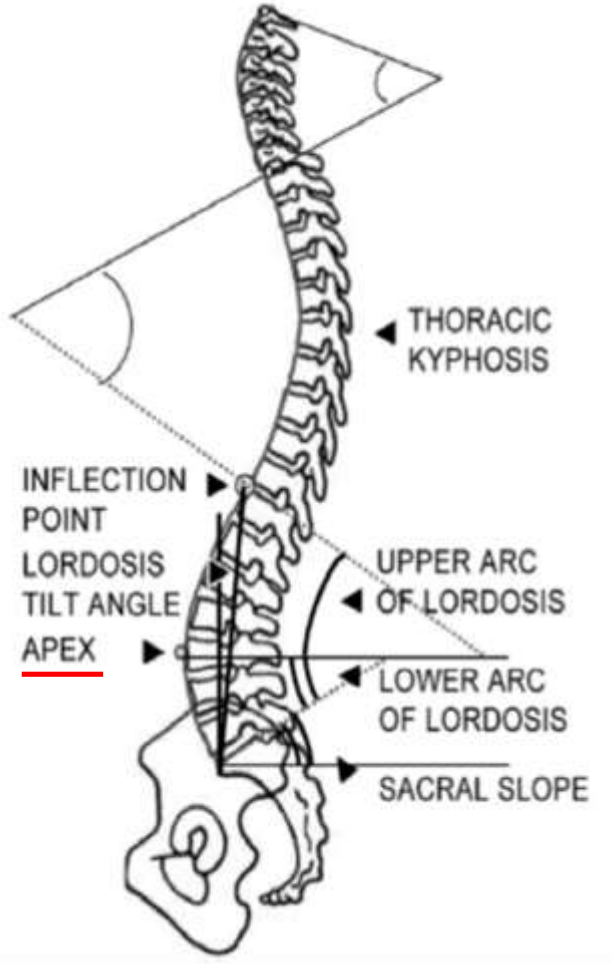
Introduction

- Sagittal lumbar apex has been demonstrated to be a key parameter in sagittal plane morphology



- This study aimed to analyze lumbar apex position variations (using two different concepts of lumbar apex) in a cohort of both non-instrumented and instrumented lumbar spine patients, in relation with patient's posture and pelvic compensation.

Methods

- Prospective observational study with a cohort of lumbar instrumented and non-instrumented patients presenting sagittal malalignment identified from a monocenter database of adult spinal deformities (ASD)

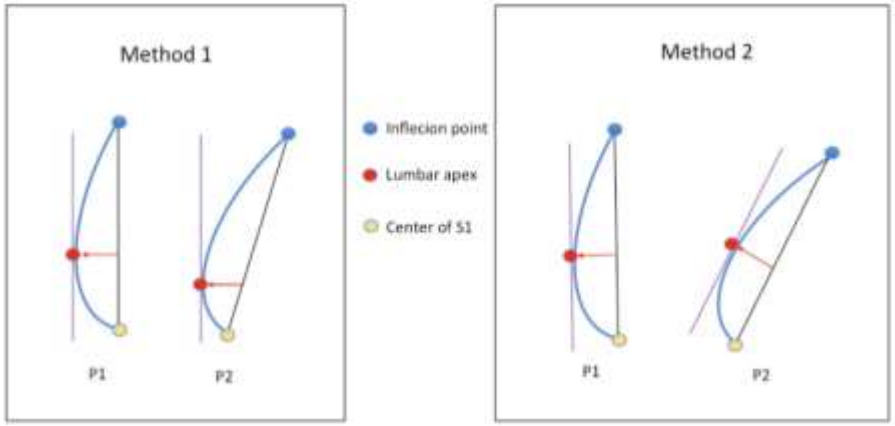
- Inclusion criteria were
    - age>30 years
    - Sagittal vertical axis (SVA)>40mm
    - Pelvic tilt (PT)>20°

Methods

- All patients had full spine EOS radiographs in 2 different positions:
  - position 1 (P1: natural position)
  - position 2 (P2: compensated position)

Methods

- Sagittal alignment, spinopelvic values, and two different methods of assessing lordosis apex location were analyzed in both P1 and P2 positions
  - Method 1: using the concept of the apex as the cornerstone of lumbar distribution.
  - Method 2: the true geometrical definition of the apex of a curve i.e its highest point.



- Changes between P1 and P2 were compared using a paired t-test with a significance level at $p<0.05$

Results

- Twenty-five patients were recruited (21 women and 4 men). The mean age was 64.8 years (range 21-79)

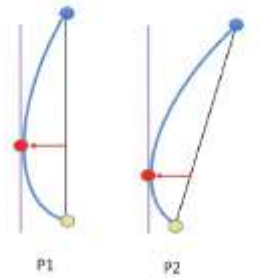
- Comparing P1 and P2, the patient’s main compensation was based on an increase of the femoral shaft angle, and pelvic retroversion, with a subsequent decrease of sacral slope, and therefore of the lower lumbar arc

Results

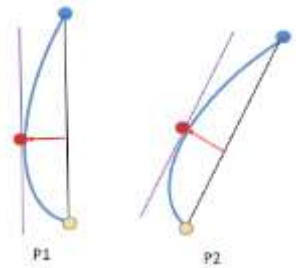
Variables	P1	P2	Difference	*P*
Femoral shaft angle	6.5 ± 6.1	16 ± 8.9	−9.5 ± 8.5	0.000*
PI	55.4 ± 10.8	55.2 ± 11	0.2 ± 2.4	0.683
PT	27.1 ± 8.5	32.1 ± 9	4.9 ± 5.7	0.000*
SS	28.2 ± 10.2	21.9 ± 10	−6.3 ± 8.3	0.000*
SSA	107.9 ± 14.1	107.6 ± 13.6	−0.3 ± 5	0.757
GT	37.5 ± 15.5	37.6 ± 15.7	−0.1 ± 0.3	0.909
Maximum kyphosis	54.2 ± 18.7	59.7 ± 20.8	5.5 ± 10.6	0.015*
Upper thoracic arc	38.7 ± 15.9	34.9 ± 16	−3.8 ± 9.7	0.061
Lower thoracic arc	15.9 ± 10.8	24.5 ± 11.9	8.6 ± 6.1	0.000*
Maximum Lordosis	45.8 ± 4.7	49.5 ± 16.6	3.6 ± 5.3	0.002*
Upper lumbar arc	17.5 ± 11.2	25.5 ± 13.4	8.1 ± 6.1	0.000*
Lower lumbar arc	28.6 ± 9.7	23.3 ± 9.8	−5.3 ± 4.5	0.000*

Results

- When the lumbar apex was calculated as the most anterior point touching the vertical line in a lateral radiograph, postural compensation changes modified its location usually shifting it to a more caudal position, which may give an incorrect impression of satisfactory sagittal alignment



- When the lumbar apex was assessed as the most distant point of the global lumbar lordosis, its position remained stable regardless of compensation



Discussion

- The current study showed how compensation alters sagittal distribution to regain balance
- Pelvic retroversion leads to femoral shaft angulation, and upper lumbar arc posterior inclination and increased angulation, shifting the lumbar apex to a more caudal position

  - Apex migration from its ideal position may be interpreted as another sign of mechanical pelvic and lower limb compensation, in both non-operated and operated patients.

Discussion

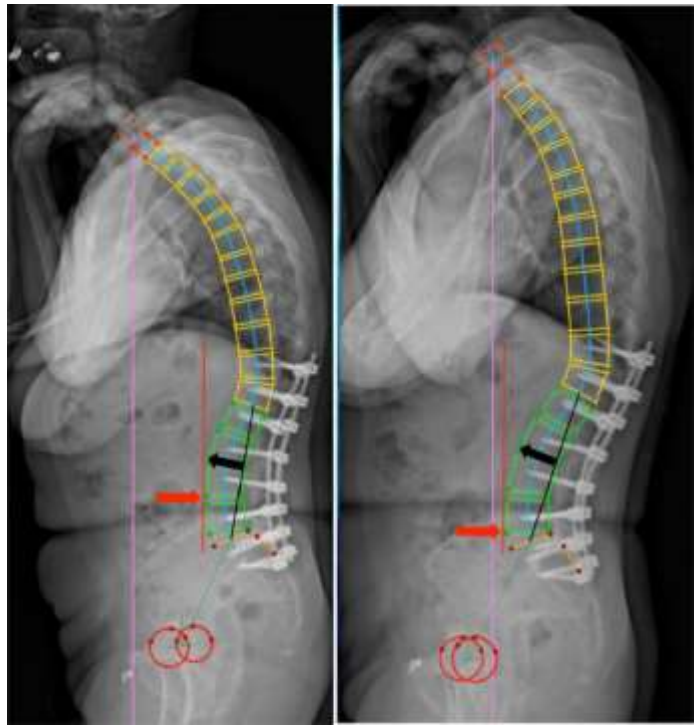
- Despite being interesting to understand sagittal harmony, this lumbar apex concept becomes poorly reliable when surgeons have to design the LL in a fused spine

- The method we propose in this study calculates the lumbar apex as the most distant level within the global LL curve when drawn by a line connecting the inflection point and the sacral plateau

Discussion

- The position of this apex characterizes the lumbar shape and remains constant regardless of postural changes or compensation mechanisms. Thus, this can serve as a fixed point to calculate the apex position when surgically molding LL

➢ The “dynamic” apex in red, which can be used as a parameter to assess compensation. The “static” apex in black, which is constant within the lumbar curve regardless of pelvic motion, representing the fixed point of an instrumented lumbar spine



Conclusion

- Postural changes can modify the location of the lumbar apex when understanding its location as the cornerstone of sagittal plane harmonic distribution
- This concept can be useful as an additional sign to assess compensation

Conclusion

- However, if the lumbar apex is calculated as the angular point of the global lordosis, its position remains stable regardless of postural changes

- This concept may help to mold lumbar lordosis in ASD surgery

- Disclosures

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