Cervical mismatch: The normative value of T1S-CL and its use to predict ideal cervical lordosis

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Defining Sagittal Malalignment

- PI = LL ± 9
- No such equation in the cervical spine that elucidates a deformity and also suggests a goal for correction
Defining cervical sagittal malalignment

- cSVA < 4 cm
  - Does not tell you the driver of the deformity
  - Does not take in to account thoracic kyphosis
Restoration of Lordosis?

- Nearly 34% of people have kyphotic cervical spines at baseline.
- Reliance of cSVA or simple alignment parameters without an ideal CL makes deformity correction difficult.
T1 Slope

- The angle of a line drawn parallel to the superior T1 endplate and a horizontal line
T1 Slope

- The key to understanding cervical alignment
- Has been postulated to correlate with TIA and TK as well as cervical parameters including CL, cSVA, TS-CL
- Appears to be the lone variable linking the cervical and thoracolumbar spinopelvic parameters
Question to be answered

- Is there a normative value of T1S – CL?
- What is the expected cervical lordosis given a specific patient’s T1S?
Methods

- 2 databases:
  - Retrospective review of prospectively collected ASD data
  - Review of normative spine database

- Inclusion criteria for ASD database:
  - No previous cervical fusion
  - McGregor Slope between -5 and 15 degrees
  - Proportional change between T1S and CL pre and post op (Demonstrated a mobile cervical spine)
Methods

- Determine normative T1S-CL in ASD pts using preoperative imaging
- Validate results against ASD pts post op films
- Validate again against normative cohort
Results – ASD database

- 837 patients in the database
- 281 had sufficient data to be included
- 103/281 met inclusion criteria
- Mean age = 54.47 ± 16.6
- Mean T1S = 28.1 ±13.3
- Mean CL = 8.8 ± 14.7
Correlation analysis

- T1S and C0-7 lordosis (r=0.886)
- T1S and C2-7 lordosis (r=0.815)
- T1S-CL and C0-2 lordosis (r=0.732)
- T1S and cSVA (r=0.470). (moderate)
- T1S and T1S-CL (r = 0.153, p = 0.124). (no correlation)
  - Implies that TS-CL is a constant!
Linear Regression Analysis

- Strong correlation between T1S and CL
  - R-square = 0.664, p < 0.001

- Beta Coefficient
  - Nearly 1:1 ratio between T1S and CL (Beta = 0.901)
  - Implies a constant mismatch between T1S and CL
    - T1S – CL = 16.5 (p < 0.001)

- T1S – CL = 16.5 ± 2
Validation

- Original values all taken from preop images before thoracolumbar surgery
- Used to estimate post-op cervical alignment
  - Error = $1.5^\circ \pm 7.7$ with a mean abs error of $5.9^\circ$
2\textsuperscript{nd} Validation

- Normative cohort of 119 patients
  - Controlled for normative gaze
- The mean error in validation was -1.7°±8.3 with a mean abs error of 6.7°
Conclusion

- **T1S – CL = 16.5 ± 2**
- A kyphotic cervical spine can be normal
  - T1S less than 16.5
- T1 pso might make more sense than a C7 pso for restoration of CL as it resets the T1S
- We now have a goal for the alignment of the cervical spine