



Radiographic Analysis of Spino-pelvic Sagittal Alignment in Chinese Asymptomatic Subjects

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Objective

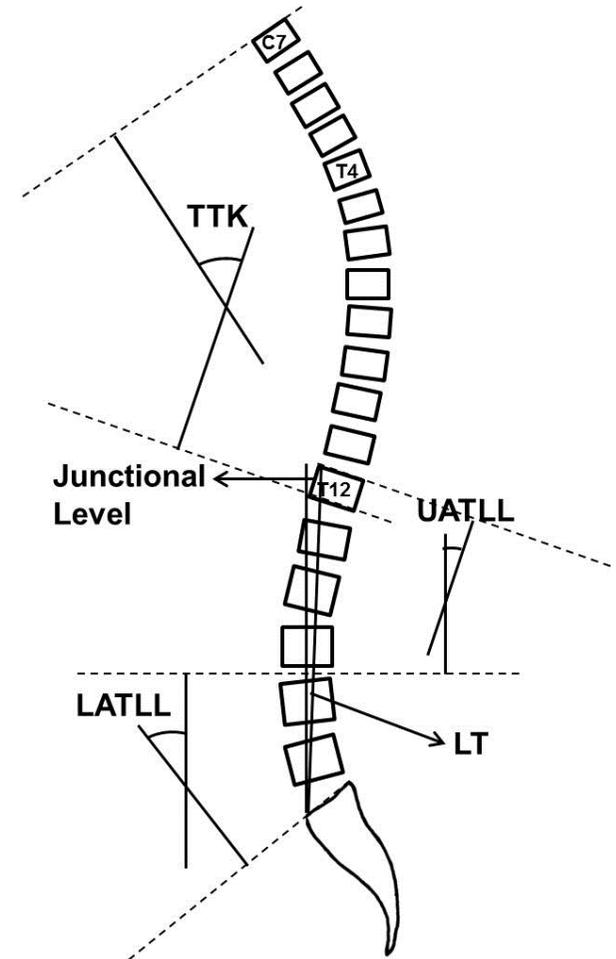
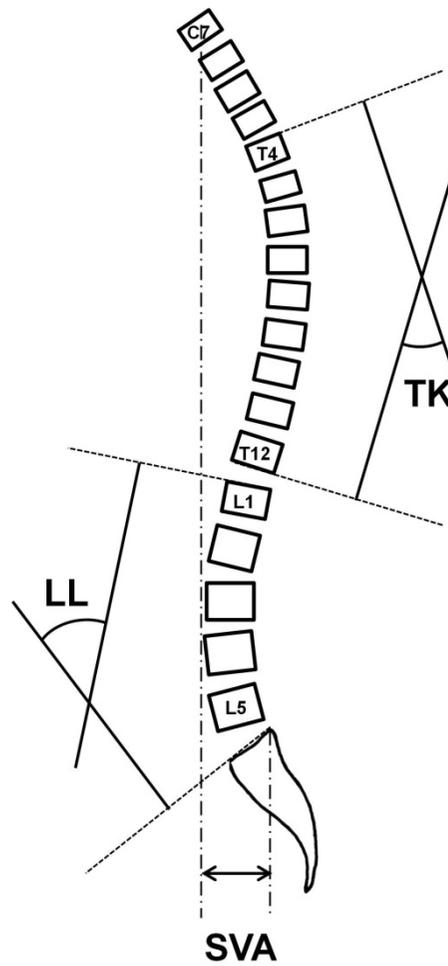
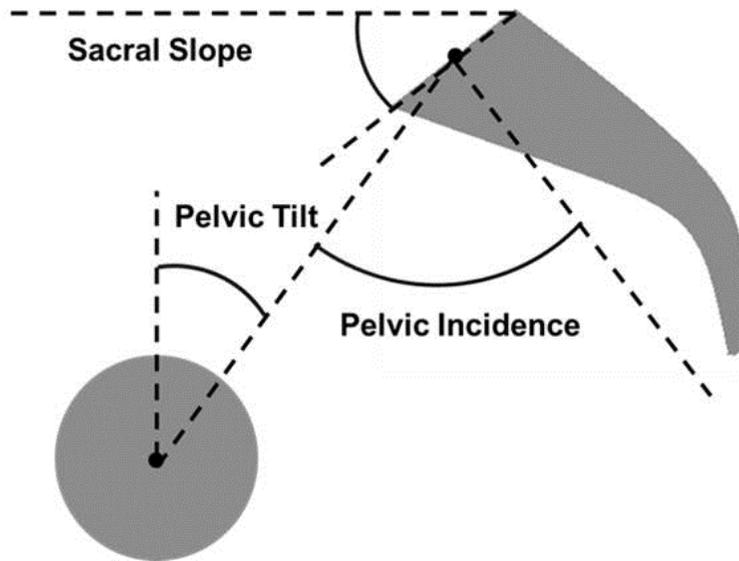
- To determine the physiological values of spinal-pelvic sagittal parameters in asymptomatic Chinese adults
- To describe the normal patterns of spinal-pelvic alignment in a Chinese population

Materials and Methods

- **Study Participants**
 - ✓ This is a prospective radiological analysis
 - ✓ Approval of ethics committee (No.IRB00006761-2012066)
- **Inclusion criteria**
 - ✓ age between eighteen and thirty years
 - ✓ no history of spinal disorder or surgery
 - ✓ no radiographic abnormality detected prior to or during the study
 - ✓ hip, knee, and ankle abnormalities were ruled out by clinical examination
 - ✓ provided informed consent
- **Study population consisted of 171 volunteers**
 - ✓ 77 women, 94 men
 - ✓ mean age 23.0 years, range 18 to 28 years
 - ✓ epidemiological and morphological characteristics: age, gender, weight, height and BMI
- **Lateral full standing radiographs of spine**
- **Measurements performed by means of imaging software ,
Centricity RIS/PACS, GE Healthcare**

Radiographic Measurements

- **Pelvic sagittal parameters**
 - *pelvic incidence (PI), sacral slope, pelvic tilt*
- **Spinal sagittal parameters according to anatomic location**
 - *lumbar lordosis (LL), thoracic kyphosis (TK), sagittal vertical axis (SVA)*
- **Spinal sagittal parameters according to geometric characteristics**
 - *junctional levels (JL), total lumbar lordosis (TLL), total thoracic kyphosis (TTK), apex of the total lumbar lordosis and total thoracic kyphosis, upper arc of total lumbar lordosis (UATLL), lower arc of total lumbar lordosis (LATLL), lordosis tilt (LT)*



Statistical Analysis

- ✓ SPSS software, version 17.0, Chicago, IL
- ✓ Mean value, standard deviation, standard error, and range of angular parameters
- ✓ PI was compared with those reported in historical normal subjects, student *t* test
- ✓ Investigated the relationship between the spinal and pelvic parameters, Pearson correlation test
- ✓ Patterns of spino-pelvic sagittal alignment were studied on the basis of the apex of total lumbar lordosis, Student-Newman-Keuls test

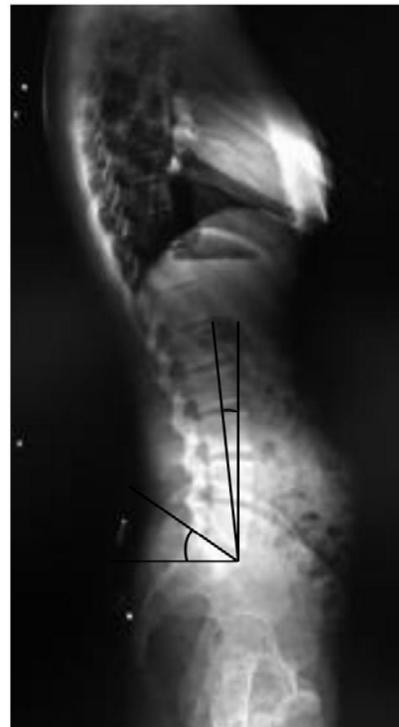
Results

- Mean PI was $44.6 \pm 9.5^\circ$, significantly less than that reported in historical subjects ($P < 10^{-4}$)
 - male $43.7 \pm 9.7^\circ$ VS female $45.9 \pm 9.2^\circ$, $P = 0.128$
- Strong correlations are found in both cohorts between PI-LL, SS-LL, PI-TLL, SS-TLL, PI-LATLL, SS-LATLL, PI-SVA, PT-SVA, LL-SVA and TLL-SVA ($P < 0.05$)
- Apex of total lumbar lordosis has the correlation with the largest number of parameters ($P < 0.05$)
- Participants were classified into four types according to apex of total lumbar lordosis as follows:
 - type I : at L₅ or L₄-L₅ (8.8%, 15/171), mean JL at L₁
 - type II: below 1/2 part of L₄ (40.3%, 69/171), mean JL at L₁
 - type III: upper 1/2 part of L₄ or L₃-L₄ (25.7%, 44/171), mean JL at L₁
 - type IV was above L₃ (25.2%, 43/171), mean JL at L₁-T₁₂
- Significant difference in the PI、 SS、 TLL、 LATLL and LT between the four types



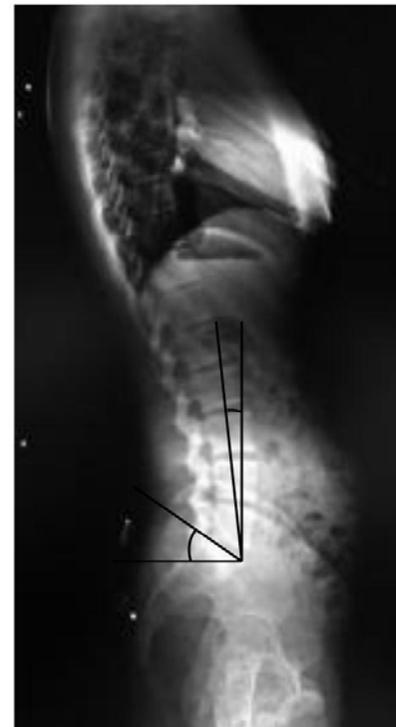
SS=31.8° , LT=-15.4°

Type I



SS=33.3° , LT=-7.9°

Type II



SS=30.1° , LT=-5.9°

Type III



SS=37.9° , LT=-1.2°

Type IV

As apex of total lumbar lordosis moved cranially, the LT decreased, whereas the TLL, LATLL, PI, and SS increased

Discussion

- This study yields a physiological standard for pelvic and spinal parameters, measured in a cohort of 171 asymptomatic Chinese adult volunteers
 - *PI in our study cohort was significantly less than that of normal western adults reported by Labelle, Boulay, Vaz, Vialle, even less than that of Korean adults reported by Lee*
 - *PI was somewhat different because of races and regions*
 - Vialle R, et al. J Bone Joint Surg Am, 2005, 87: 260-267.
 - Labelle H, et al. Spine, 2004, 29: 2049-2054.
 - Lee CS, et al. Spine (Phila Pa 1976), 2011, 36: 25: E1648-1654.
- Pelvic incidence played a predominant role in determining shape of the sagittal curvature, via *LATLL*
- In a spine-pelvis hinge structure, arc of total lumbar lordosis
 - *linked between pelvis and arc of total thoracic kyphosis, larger motion range, regulation by pelvis*
 - *A core in regulating the spinal sagittal balance*

Patterns of sagittal alignment

Roussouly

Lee

Current study

Differences

- Roussouly: magnitude of SS
- Lee: level of lumbar vertebra or disc space nearest to the horizontal line
- Current study: apex of the total lumbar lordosis

Similarity

- As apex of total lumbar lordosis moved cranially, LT ↓, whereas TLL ↑, LATLL ↑, PI ↑, and SS ↑

Conclusions

- The pelvic sagittal morphology of Chinese adults was significantly different from that of western and Korean
- Lumbar lordosis turned into a core in regulating spinal sagittal balance by pelvis
- As apex of total lumbar lordosis moved cranially, the lordosis tilt decreased, whereas the lower lumbar lordosis, pelvic incidence, and SS increased

Disclosure

**None of the authors has any potential
conflict of interest.**