

Characteristics of Spinal Morphology According to the "Current" and "Theoretical" Roussouly Classification Systems in a Diverse, Asymptomatic Cohort: Multi-Ethnic Normative Alignment Study

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INTRODUCTION:

The Roussouly classification system is commonly used to classify spine morphology into distinct types. Recent literature suggests that the system could be applied to the adult spinal deformity (ASD) population and that restoration of parameters to a "theoretical" Roussouly type based on pelvic incidence (PI) may improve outcomes. We analyzed a large, multi-ethnic, asymptomatic cohort to classify spinal morphology using the Roussouly system and assessed sagittal alignment.

METHODS:

A total of 467 healthy volunteers without spinal disorders were recruited from spine centers in 5 countries as part of the Multi-Ethnic Alignment Normative Study (MEANS). Radiographic parameters were measured via the EOS imaging system. "Current" and "theoretical" Roussouly classification was assigned to 467 volunteers with sagittal whole spine imaging using sacral slope (SS) and PI, respectively, and the lumbar apex. One-way analysis of variance (ANOVA) was performed to compare subject characteristics across Roussouly types, followed by post hoc Bonferroni correction. The significance level was set to $p < 0.05$.

RESULTS:

In the MEANS cohort, "current" Roussouly Type 1 constituted 7.5% (35/467), Type 2 21.4% (100/467), Type 3 47.5% (222/467), Type 4 23.6% (110/467). A subgroup of Type 3 with anteverted pelvis (Type 3AP) constituted 11.1% (52/467). "Theoretical" Roussouly Type 1 comprised 5.8% (27/467), Type 2 18.6% (87/467), Type 3 55.9% (261/467), Type 4 19.7% (92/467) of the cohort. In total, 11.6% (54/467) of subjects had "theoretical" Type 3AP as a subgroup of "theoretical" Type 3. The mean PI in "current" Roussouly Type 1 was 40.8°, Type 2 43.6°, Type 3 52.4°, Type 4 62.4°, Type 3AP 43.7°. The mean PI in "theoretical" Roussouly Type 1 was 36.5°, Type 2 39.1°, Type 3 52.5°, Type 4 67.3°, Type 3AP 51.0°. The difference in PI between "current" and "theoretical" Roussouly types was significant for Type 1 ($p=0.02$), Type 2 ($p<0.001$), Type 4 ($p<0.001$), and Type 3AP ($p<0.001$) but not Type 3 ($p=0.85$). PI-LL mismatch did not differ significantly between any "current" types but did between "theoretical" types. The mean PI-LL mismatch of Type 1 (-7.5°) differed from Type 4 (2.2°) ($p<0.001$), Type 2 (-10.9°) from 3 (-6.1°) ($p=0.001$) and 4 ($p<0.001$), and Type 3 differed from Type 4 ($p<0.001$). Some 34.7% (162/467) subjects had a "current" Roussouly type different from the "theoretical" type. Type 3 theoretical shape had the most frequent mismatch, constituting 61.1% (99/162) of the mismatched subjects, where 51.5% (51/99) of mismatched Type 3 become "current" Type 4.

DISCUSSION AND CONCLUSION:

The Roussouly classification system applies to a large, multi-ethnic, asymptomatic cohort. The distribution of Roussouly types differs depending on whether the "current" classification using SS, or the "theoretical" using the PI are employed. A sizeable proportion of asymptomatic, non-pathologic subjects exhibit "current" and "theoretical" mismatch, highlighting the need to interpret the influence of spinal deformity on sagittal alignment cautiously when utilizing the Roussouly system.