The Location of Instant Center of Rotation in the Cervical Spine during In Vivo Dynamic Flexion-Extension

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Introduction: The locations of the instant center of rotation (ICR) in cervical spine at each segment were conventionally measured using plain lateral radiographs collected at the ends of the range of motion (ROM). This study is to find and to compare the location of the ICR at each cervical segment in vivo dynamic flexion-extension in voluntary subjects.

Material and Methods: Three asymptomatic controls were performed cervical flexion-extension while biplane fluoroscopy was evaluated. Dynamic flexion/extension images were collected from two oblique views aligned horizontally and angled approximately 55°. The minimum change of degree to detect the significant movement in calculating helical axis model was set 2°. The anterior-posterior (AP) and superior-inferior (SI) location of each ICR was defined with respect to the inferior bone anatomic coordinate system, and zero setting was center of the upper end plate of lower cervical vertebra. The ROM was started neutral position, then to the flexion, to the full extension, and finally neutral position. The mean AP and SI coordination of ICR was defined as the center of ICR. To evaluate the possible distribution area of the ICR, the distance between each AP and SI coordination of ICR and the center of ICR was calculated. The circle with the radius of calculated distance was drawn with the mean AP and SI locations of ICR as its center.

Results: The mean ROM curves were shown in Figure 1. The mean AP and SI locations of the ICR are -5.81 mm(SD : 5.9) and -8.31mm(SD : 4.5) in C2/3, -4.47mm(SD : 8.7) and -8.03mm(SD : 7.5) in C3/4, -2.61mm (SD : 8.1) and -4.24mm(SD : 8.8) in C4/5, -2.19mm (SD : 5.3) and -6.34mm(SD : 4.0) in C5/6, -1.76mm (SD : 10.5) and -3.15mm(SD : 6.9) in C6/7. The mean distance for radius of circle was 6.3mm(SD : 3.7) in C2/3 segment, 9.7mm(SD : 5.7) in C3/4 segment, 11.2mm(SD : 3.8) in C4/5 segment, 5.7mm(SD : 3.3) in C5/6 segment 10.8mm(SD : 6.2) in C6/7 segment. The circle was made using the radius of calculated distance with the mean AP and SI coordination of ICR as its center (Figure 2).

Conclusion: The mean AP and SI location of the ICR became progressively more superior and anterior from the C2/C3 motion segment to the C6/C7 motion segment. The statistical difference was found in the mean SI location of the ICR ($p = 0.015$) and significant difference was found between the ICR in C2/3 and C6/7. However, the mean AP locations of the ICR were not significantly different. Moreover, to evaluate the distribution border, the circle was made by calculated distance of AP and SI coordination. By the distribution area, the ICR would be located more closely to center of lower vertebral body at corresponding cervical segment, and overlapped with disc space.

If the goal of cervical arthroplasty is to replicate in vivo motion, they should be designed to account for level-specific differences although further study needed.

Figure 1.

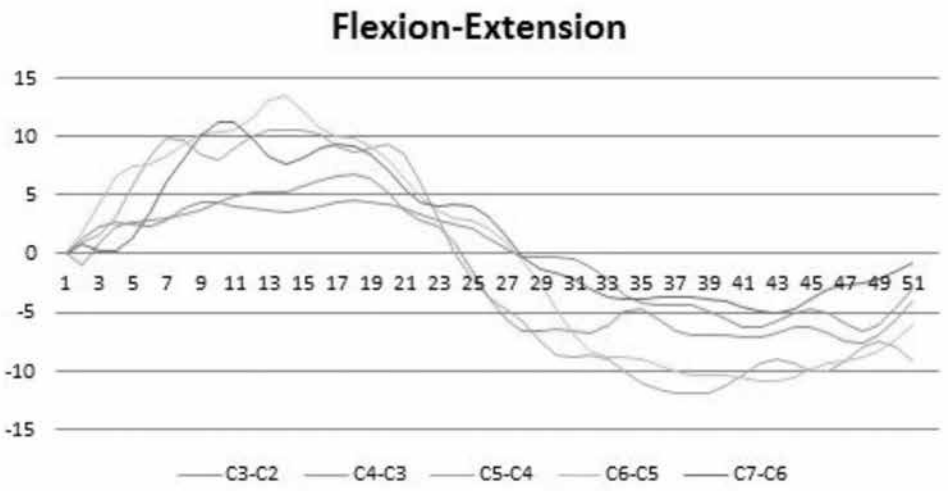
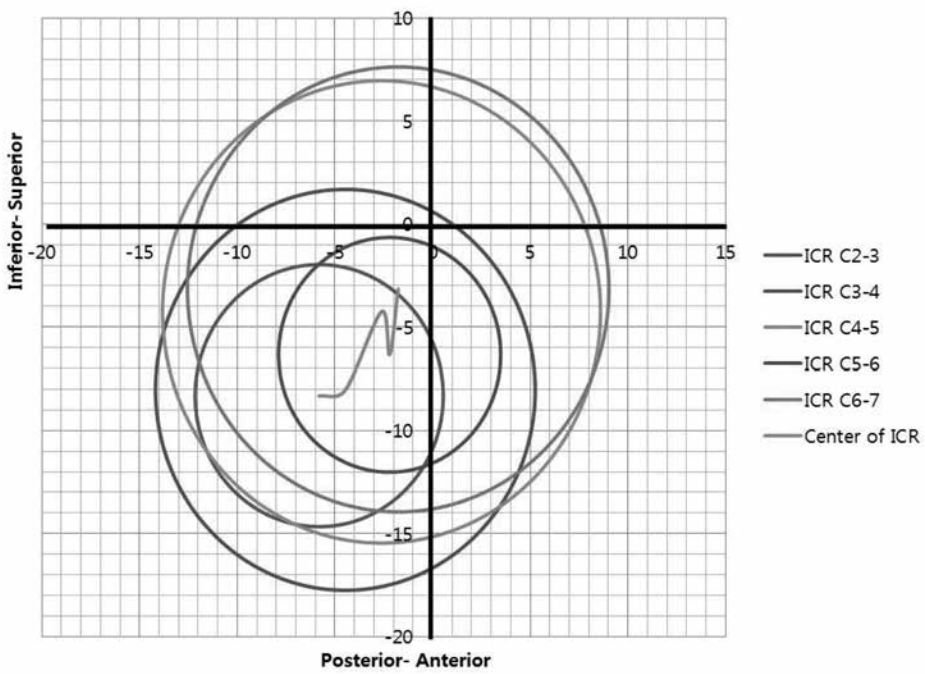


Figure 2.



See Disclosure Index pages 40–88.