

Abstract: 470

In vivo versus in vitro Normal Cervical Sagittal Plane Biomechanics

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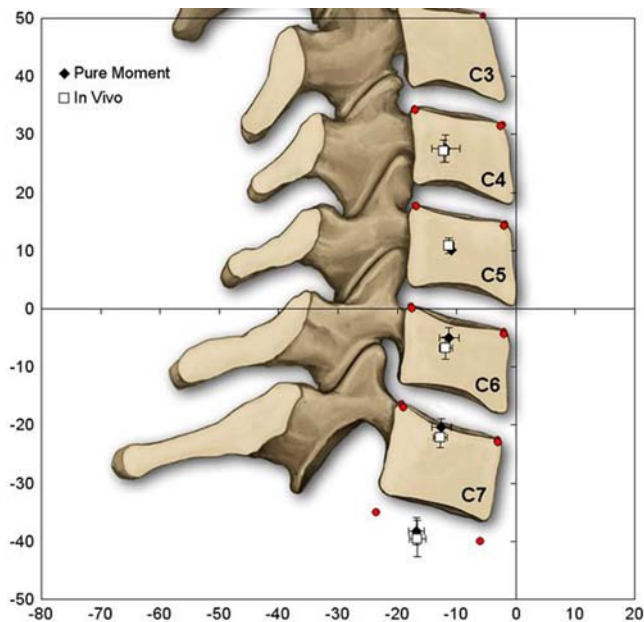
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Introduction: It is assumed that data from in vitro biomechanical studies of cervical arthroplasty are clinically relevant, representing how the device would behave in vivo. However, pure moment flexibility testing has been criticized for not accurately replicating the loading that occurs in vivo. This study was undertaken to determine the validity of pure moment flexibility testing by assessing whether segmental angles and axis of rotation from cadaveric tests of intact specimens matched radiographic findings from healthy volunteers.

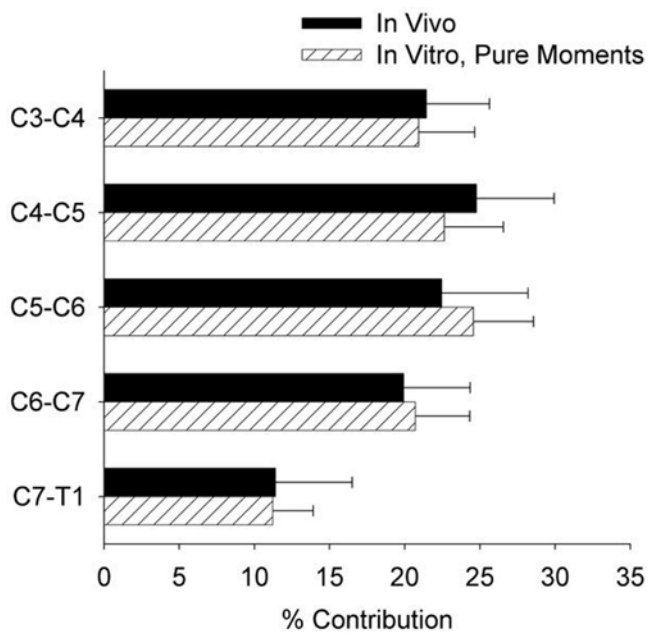
Methods: Flexibility tests were performed using 30 human cadaveric C3-T1 specimens (23 male, 7 female, mean age±standard deviation 54±11 years). Nonconstraining pure moments (1.5 Nm maximum) were applied quasistatically using strings and pulleys in conjunction with a servohydraulic test frame to induce flexion and extension. Vertebral motion was tracked optoelectronically at each level. Segmental angles and axis of rotation were determined at each level from marker data using 3D vector techniques. Elsewhere, sagittal plane cervical fluoroscopy images were recorded in 10 healthy volunteers (5 male, 5 female, age 38±9 years) in fully flexed and fully extended positions. Segmental angles and center of rotation were determined at each level using 2D image correlation techniques.

Results: Agreement between position of in vitro and in vivo centers of rotation was excellent (Fig. 1), differing by less than 1.8 mm at any level. Angular motion in vitro averaged 22% less than in vivo, but in terms of percent contribution, the segmental angle breakdown by level agreed to within 2.1% in vivo and in vitro (Fig. 2) and was not significantly different at any level (non-paired 2-tailed t-tests, p>0.11).

Conclusions: Pure moment flexibility testing gave sagittal plane segmental angle breakdowns and centers of rotation that matched in vivo data very well. The magnitude of angular motion in vitro was less than in vivo, partially explained by younger age of living volunteers than cadaveric specimens but indicating that greater than 1.5 Nm may be needed to replicate in vivo ranges. These findings support that in vitro flexibility testing using pure moments provides data that are representative clinically.



[Fig. 1. Mean center of rotation (SD error bars)]



[Fig. 2. % contrib to C3-T1 angle (SD error bars)]