Introduction: In vitro nondestructive flexibility testing of a constrained, semi-mobile total disc replacement (TDR) was performed (Titania disc; Meteor Medical, Istanbul, Turkey). It was hypothesized that the TDR would not significantly alter biomechanics relative to normal, whereas rigid fixation would cause significant changes. Biomechanical assessment included a wide array of kinematic parameters for thorough characterization of the device.

Methods: Eight unembalmed human cadaveric C3-T1 specimens were tested intact, after TDR, and after anterior plating. Flexion, extension, lateral bending and axial rotation were induced by pure moments; flexion-extension was then induced by a simplified muscle force model with 70-N follower load and dead weight representing the head. Finally, 70N, 110N, and 150N were applied to specimens in static upright posture. Optical markers measured 3D vertebral motion and 8 points of laminar surface strain were recorded for assessing C5-C6 facet loads. Biomechanical parameters studied included Range of Motion (ROM), Lax Zone (LZ), angular coupling pattern, sagittal Instantaneous Axis of Rotation (IAR), and facet loads normal to the facet joint plane. Mean values of parameters were compared statistically using RM-ANOVA/Holm-Sidak tests.

Results: TDR reduced ROM during all loading modes to an average of 52% of intact (p< 0.001) while plating reduced ROM to an average of 35% of intact (p< 0.001, Figure 1). Similarly, TDR reduced LZ during all loading modes to an average of 27% of intact (p< 0.001) while plating reduced LZ to an average of 18% of intact (p< 0.001, Figure 1). After TDR, sagittal IAR shifted insignificantly relative to normal by 4.7 mm (Figure 2, p>0.18). However, after plating, IAR shifted 9.4 mm relative to the intact position, which represented a significant rostral shift (p=0.008). Coupled axial rotation per degree lateral bending was 69% of normal after TDR (p=0.027), but 22% of normal after plating (p=0.001). Coupled lateral bending per degree axial rotation was 76% of normal after TDR (p=0.029), but 62% of normal after plating (p=0.002). According to output from strain gauge arrays, neither TDR nor plating significantly altered facet loads during bending or twisting; loads were significantly reduced relative to normal by both constructs in the upright posture with 70N, 110N, or 150N applied (p< 0.03).

Conclusions: Although this TDR is not as mobile as other commercial cervical TDRs, with regard to ROM, LZ, IAR, and coupling, deviations from normal biomechanics were less substantial after TDR than after plating. Facet load alterations were minimal with either construct. Our results show that this particular TDR permits moderate mobility and maintains some desirable kinematic patterns in a cadaver model.
[Fig 1. Mean ROM and LZ. SD error bars.]
[Fig. 2. Mean sagittal IAR shift. SD error bars.]