Introduction: Although ACDF has been effective for treatment of cervical spondylosis, a significant rate of adjacent level surgery in the years following cervical fusion has been reported. Total disc-replacement has theoretical advantages over performing a second fusion in treating a symptomatic level adjacent to a prior fusion. However, the levels adjacent to a fusion are likely to experience increased loads, creating a more challenging biomechanical environment for the disc-replacement. This study tested the following hypotheses: 1) The response of an disc-replacement placed adjacent to a single-level fusion is similar to its behavior as a stand-alone procedure, 2) The location of the fusion (cephalad or caudal) relative to the disc-replacement does not affect the behavior of the disc-replacement, 3) Non-operated segments experience less motion and lower loads adjacent to a hybrid construct (single-level fusion+disc-replacement) than adjacent to a two-level fusion.

Materials and Methods: Nine human cervical spine specimens (C3-T1) were tested in “load-controlled” and/or “displacement-controlled” modes with a compressive follower preload. Specimens were tested in the following sequence: i) intact, ii) single-level “reversible” fusion (using an external fixator) at C4-C5 and then at C6-C7, iii) stand-alone disc-replacement at C5-C6 using the Porous Coated Motion (PCM) device, iv) single-level fusion above or below C5-C6 disc-replacement, v) two-level fusion (C4-C6 or C5-C7).

Results: Disc-replacement performed at C5-C6 using the PCM disc prosthesis maintained the total flexion-extension ROM to the level of the intact controls (11.7±4.6 vs. 11.3±3.8 degrees, p>0.05). A small increase in extension motion of the prosthesis was observed when placed caudal (0.7±0.6 degrees, p>0.05) or cephalad (1.5±3.0 degrees, p>0.05) to a fusion when compared to the stand-alone disc-replacement. The location of the single-level fusion in the hybrid construct, whether above or below the disc-replacement, did not affect the motion response of the disc-replacement (p>0.05).

When both the stand-alone disc-replacement and hybrid constructs were required to achieve the same global flexion-extension end points (displacement-controlled test), the hybrid constructs increased the disc prosthesis flexion-extension motion by 2.5±0.9 degrees when the fusion was above the disc-replacement and by 2.1±0.4 degrees when the fusion was below the disc-replacement, as compared to a stand-alone prosthesis (p<0.05). However, the resulting motion of the prosthesis did not significantly exceed the motion of the stand-alone prosthesis under physiologic bending moments (p>0.05).

Performing a two-level fusion significantly increased the motion demands on the non-operated segments as compared to a hybrid construct when the spine was required to reach the same flexion-extension endpoints (p<0.05) (Table 2). The spine with a hybrid construct required significantly less extension moment (<1Nm) as compared to the spine with a two-level fusion (>2.5Nm) to reach the same extension endpoint (p<0.05).

Discussion: The PCM disc-replacement was able to maintain physiologic ROM at the treated level. When placed adjacent to a fusion, the motion of the PCM prostheses increased relative to a stand-alone PCM, suggesting this to be a more challenging environment. The hybrid (PCM+fusion) construct more closely approximated normal kinematics at adjacent non-operated levels than a two-level fusion construct during displacement-controlled testing, while the prosthesis motion remained within design limits. Therefore, disc-replacement adjacent to a prior fusion may be a better alternative to a two-level fusion in treating symptomatic adjacent level disease.