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### Disc Height Distraction Increases Range of Motion and Impingement Risk in Fixed and Mobile Bearing Total Disc Replacements

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**Introduction:** Disc height distraction during total disc replacement (TDR) is essential for relieving compressed nerve roots, but will also alter the relative facet orientation. Excessive distraction will cause facet separation, and limit the segment's ability to resist anterior translation and extension. This increased laxity may allow implant impingement, which has been associated with unintended device wear. The objective of the current study was to evaluate both a fixed and mobile bearing TDR with disc height distractions of 0 mm and 3 mm during simulated standing and bending in the sagittal plane. We hypothesized that disc height distraction would increase RoM and the risk of impingement.

**Methodology:** A previously validated finite element model of L4-L5 was used. The intact model was altered to create a degenerative disc disease (DDD) model and implanted models with either a mobile (MTDR) or fixed bearing (FTDR) TDR. DDD was simulated by decreasing the disc height 3 mm and reducing the nucleus bulk modulus. Implanted models were created by implementing either a MTDR or FTDR into the disc space. Disc height distraction was set to 0 or 3 mm with 0 being equal to the intact healthy height. All models were subjected to compression and anterior shear characteristic of upper body weight during standing. Bending was simulated by progressively increasing the erector spinae force from 0 to 125 N. This force was applied between the spinous processes approximately 5.5 cm posterior of the joint center and normal to the disc's shear plane. Facet contact forces, RoM, and endplate impingement were evaluated.

**Results:** Distraction resulted in impingement scenarios for both the MTDR and FTDR during maximum extension. Impingement consisted of two-sided contact between the metallic foot plates and polyethylene core for the MTDR and anterior lift off with posterior focal contact for the FTDR. Total flexion-extension RoM was 4.8° for the intact, 4.2° for DDD, 5.7° for the MTDR-0mm, 5.4° for the FTDR-0mm, 9° for the MTDR-3mm, and 12.9° for the FTDR-3mm. Distraction resulted in a general decrease in resultant facet reaction forces, but anterior-posterior forces increased during extension for the MTDR.

**Discussion:** The results from the study supported the hypothesis that distraction results in increased RoM and impingement risk. Specifically, distracting the disc height prevented facet contact during extension which allows for excessive rotation and subsequent implant impingement. Interestingly, while the resultant facet contact force was reduced during extension for the MTDR, the anterior-posterior force component increased resulting in posterior shear of L4 relative to L5. This posterior shear resulted in a characteristic downward bending of the posterior polyethylene rim during impingement which has been observed in our retrieval collection. The results from the current study suggests that excessive disc height distraction may be partly responsible for cases of implant impingement documented clinically. Clinicians should consider this data when deciding how much distraction to use during TDR procedures. Additionally, designers should consider the effects of distraction and facet contact contribution when performing pre-clinical testing of new TDR designs.