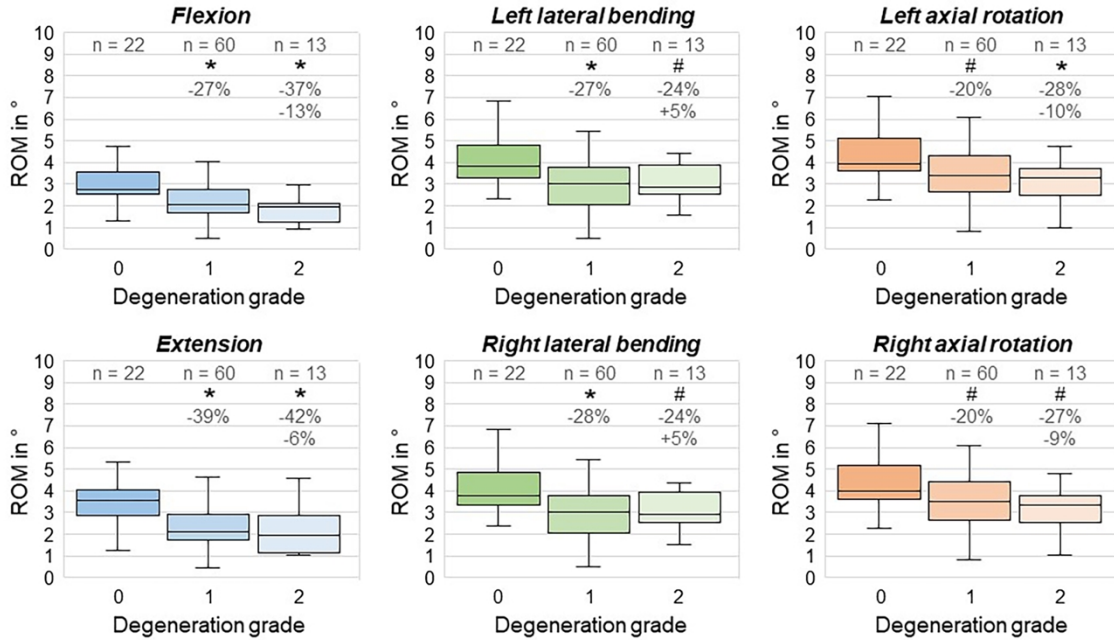


**Introduction** The effect of degenerative changes of the intervertebral disc on spinal flexibility was predominantly studied for the lumbar spine in the past, generally exhibiting a reduction in flexibility in flexion/extension and lateral bending as well as a slight increase in axial rotation with increasing degeneration grade [1]. In the thoracic spine, however, solely influences of disc degeneration on the kinematics were shown so far [2]. The aim of this study therefore was to investigate the effect of the degeneration grade on the flexibility of the thoracic spine. **Methods** 95 human thoracic spinal motion segments (min. n = 4 per level from T1-T2 to T11-T12) from 33 donors (15 female / 18 male, mean age 56 years, age range 37-80 years) were loaded with pure moments of 5 Nm in flexion/extension, lateral bending, and axial rotation in order to determine range of motion and neutral zone values. Degeneration grades of all single intervertebral discs were assessed using a recently developed and validated grading scheme for the radiographic determination of thoracic intervertebral disc degeneration (0 = no, 1 = mild, 2 = moderate, 3 = severe degeneration) [3]. Statistically significant differences were evaluated using the Kruskal-Wallis test with Dunn-Bonferroni post-hoc correction together with the Mann-Whitney-U test, each with a significance level of 0.05. **Results** The 95 specimens exhibited degeneration grades between 0 and 2. In all six motion directions, the range of motion significantly decreased for grade 1 as well as grade 2 compared with grade 0, respectively. The strongest decrease was found in extension comparing grade 2 with grade 0 (-42%, Fig. 1). No significant differences were detected between grades 1 and 2 in all motion directions. Neutral zone was significantly reduced for grade 1 compared with grade 0 in flexion, extension, and lateral bending, as well as for grade 2 in extension, where the strongest decrease of the neutral zone was found (-47%). Donor age did not significantly affect the range of motion ( $p > 0.05$ ), whereas the range of motion was significantly reduced in specimens from male donors ( $p < 0.05$ ), since the mean degeneration grade was significantly increased in male donors compared with the female ones ( $p < 0.05$ ). **Discussion** The results of this study revealed that even mild intervertebral disc degeneration reduces the range of motion of the thoracic spine, whereas progressing degeneration does not further affect the flexibility. This is in contrast to the lumbar spine, where a gradual decrease was reported [1]. These disparities, especially in axial rotation, might be explained by morphological differences between thoracic and lumbar intervertebral discs and the additional stabilizing effect of the rib cage. **References** [1] Kettler et al. (2011). *Eur Spine J* 20(4):578-584. [2] Liebsch et al. (2020). *Spine J* 20(3):488-498. [3] Liebsch et al. (2021). *Eur Spine J*. doi: 10.1007/s00586-021-06970-6.



\* Significantly different ( $p < 0.05$ ) from grade 0 (Kruskal-Wallis test with Dunn-Bonferroni correction and pairwise Mann-Whitney-U test)

# Significantly different ( $p < 0.05$ ) from grade 0 (solely pairwise Mann-Whitney-U test)

**Fig. 1** Box-and-whisker plots outlining effects of the degeneration grade on the range of motion (ROM) of the thoracic spine.