Introduction
Cages for the reconstruction of vertebral bodies together with additional anterior or posterior stabilization are used more and more for the surgical therapy of spinal metastases, post trauma mal-position, spondylitis as well as spondyloptosis (Fig. 1a) [1, 2]. In order to allow speedy mobilization, high primary stability as well as prevention of implant dislocation are required. The purpose of this study was to evaluate different vertebral body replacement systems in combination with a dorsal spondylodesis with respect to their primary stability in a human spine model (Fig. 1b).

Methods
A newly developed testing device on a material testing machine (MTS Bionix 858.2; Fig. 1c) was used to assess the movement range of human spine specimens. Fresh frozen human lumbar spines L3-L5 were screened for specimens with a spongy BMD>80mg/ml CaHA were included in the study. Specimens were embedded in PMMA and loaded successively in flexion/extension (±10Nm), lateral bending (±10Nm) and torsion (±7.5Nm) under displacement control (1.5%/s) with an axial pre-load of 130N. The angular movement achieved at 75% of maximum loading was used for analysis. Results of left/right lateral bending and left/right torsion were combined to ranges. Testing was performed in 5 conditions: all specimens were tested in the native state (Cond. 1) and after dorsal spondylodesis (Cond. 2; MOSS®Miami, DePuy, Leeds, UK); prior to the replacement of vertebral body L4, a laminectomy (Cond. 3) was performed on 50% of the specimens; final testing was performed after vertebral body replacement (Cond. 4: without prior laminectomy, Cond. 5: with prior laminectomy).

Results
Sixty lumbar spines (age: 25.8±11.3 years, BMD: 112.5±30.0mg/ml CaHA). Analysis of Variance with increased by 0.5°. Each cage type was tested in 6 spine specimens (age: 55.9±19.7years, BMD: 112.5±30.0mg/ml CaHA). Table 1: Principal movement ranges of the 3 cages in the different conditions and instrumentations.

Discussion
Dorsal spondylodesis in combination with vertebral body replacement reduced movement in flexion and extension loading effectively independent of cage design and whether laminectomy was performed or not. Stabilization potential in lateral bending and torsion loading, however, was influenced by cage design (slightly higher for the pre-loaded cages) and laminectomy (lower after laminectomy). Cage C performed better than cage B in lateral bending due to its larger diameter and worse in torsion due to poor torsion prevention of the small spikes anchoring the implant in the endplate. The possibility to spread the cage after implantation (i.e. pre-load) has a positive effect on stabilization if other design aspects are considered (e.g. fixation in endplates, cage diameter). However, none of the cages limited movement under torsional loading effectively [3]. Absolute movement ranges of the different spine specimens in torsion were quite variable; the torsion results, therefore, should be interpreted with caution.

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References

Figure 1: (a) X-ray of a dorso-ventral spondylodesis L3-L5 with vertebral body replacement on a spine specimen (cage B).
(b) The 3 vertebral body replacement systems investigated.
(c) The testing device in flexion-extension loading.