European Spine Journal (2020) 16:1965–2040
https://doi.org/10.1007/s00586-020-06630-1

ABSTRACT

screwdriver was developed and the corresponding adapters were manufactured. This screwdriver can also be used for intraoperative use under certain conditions and covers the amplitude of the torque values. Statistical analysis of the collected values of the variables (sigma plot) was performed.

Results: The maximum value of the insertion torque (Imax) in the polystyrene was 0.11 Nm and the smallest (Imin) 0.02 Nm (SD 0.02). In CRPF of 7.5, 10 και 12.5 pcf an Imax of 0.44Nm, 0.71Nm και 1.2 Nm and respectively an Imin of 0.06Nm, 0.08Nm και 0.14Nm was observed. The insertion and removal torque were statistical significantly ($p<0.05$) different in lower densities (polystyrene and 7.5 pcf) but not in higher densities (10 και 12.5 pcf). The insertion torques of the different densities are statistical significantly different.

Discussion: The cannulated screws used for this study can be cement-augmented if necessary. Based on the insertion torque, the quality of the bone and the bone purchase can be assessed and the biomechanical behaviour of the screws as well as the screw anchoring can be anticipated. For spine surgeons, the decision to augment the construct with cement can thus be made easier even intraoperatively.

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Misaligned spinal rods can induce high internal forces consistent with those observed to cause screw pullout and disc degeneration

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Introduction: Mismatches between the rod and the pedicle screw heads are generally reduced during a posterior fusion operation using dedicated reduction devices. The exerted forces by these devices, however, are uncontrolled and may lead to excessive internal forces. Such forces may result in decreased screw pullout strength [1], but can also alter the biomechanical behavior of the spine postoperatively. The aim of this study is to predict such loads and deformations in the instrumentation and surrounding tissue directly after the correction is applied and during physiological flexion following successful fusion.

Methods: A patient-specific, lumbar spine (L1-S1) finite element model was available [2,3]. The model consists of poro-elastic intervertebral discs (IVDs) with Pfirrmann grade dependent material parameters, linear elastic bone tissue with stiffness values related to the local bone density, and the seven major ligaments per spinal motion segment described with a hypo-elastic stress-strain relationship. Titanium instrumentation was implemented in this model to represent a bi-segmental L4- S1 posterolateral fusion. Next, a misalignment of 6 mm was introduced between the rod and the screw head at L4 in the coronal and sagittal plane respectively (Fig. 1). These misalignments were computationally reduced after which a physiological flexion movement of 15° was prescribed. Non-instrumented and well-aligned instrumented models were added as control groups.

Results: Pulling forces up to 1.0 kN were required for correcting the induced misalignment of 6 mm. These forces affect the posture of the total lumbar spine as motion segments are shown to rotate up to segment L1-L2. In addition, both IVD and bone tissue shows to be at risk for damage as a result of the correction procedure. These regions increased during the simulation of flexion. Also for the control case without correction, regions of high strains were found in bone and IVDs during flexion, but the total affected volume was lower than in the cases with reduction (Fig. 2).

Discussion: The estimated pulling forces calculated here for correcting the misalignment are expected to compromise the screw-bone interface and to induce a high risk of screw pullout. Although adverse tissue deformations are also found during flexion in the well-aligned fusion model, it should be emphasized that the deformations induced by correcting the misalignment are uninterruptedly exerted because the spine will be constrained in the enforced configuration. In conclusion, residual mismatches between spinal rod and screw head should be minimized as small deviations might result in screw loosening and tissue damage.

1. **References:** Paik et al, Spine J, 13(11):1617-26, 2013
2. Malandrino et al, Front Bioeng Biotechnol, 3:5, 2015
3. Rijsbergen et al, PLoS one, 13(8):e0200899, 2018

Fig. 1

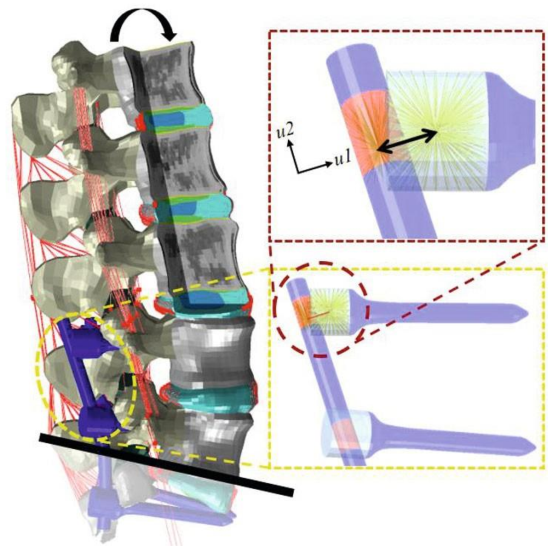
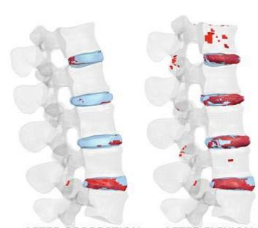


Fig. 2



	step	BONE	IVD
CONS	flex	0	209
PLF	flex	15	4866
COR	red	22	227
	flex	54	4908
SAG	red	3	4342
	flex	62	12840

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Muscular driven spine simulator simulating flexion-extension characteristics – an experimental study

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Introduction: The activity of trunk muscle forces to move and stabilise the thoraco-lumbar spine has only been partially evaluated. EMG measurements of the intramuscular activity is difficult to perform as well as a validation by 3D virtual models simulating ventral and dorsal muscles. A real, experimental model may visualise muscular forces for specific trunk muscles and is able to explain pathologies of spinal disorders – and in particular the role of the iliopsoas.

Published online: 19 October 2020