**Introduction:** In patients with poor bone quality who require multisegmental fixations or corrections of deformities the current dorsal stabilization procedures in the subaxial cervical spine using lateral mass screw fixation are often insufficient. Screw loosening or avulsion have been described, particularly at the lower end of the instrumentation, where the lateral masses are often smaller resulting in a lower screw pull-out resistance. Cervical pedicle screw fixation has been suggested as an alternative fixation procedure to overcome these limitations (1). Because of higher risks of neurovascular injuries during screw insertion, only a small group of surgeons have made use of this technique. Even with the assistance of current computer navigation systems, there still seems to be a significant amount of screw displacements with injury to the vertebral artery or neurological structures (2). Therefore, it is important to know whether pedicle screw fixation in the cervical spine offers biomechanical advantages over the conventional technique of lateral mass screw fixation. The overall goal of this in vitro study was to investigate the biomechanical differences between pedicle screw and lateral mass screw fixation in the subaxial cervical spine. Using a human cadaver model, the biomechanical properties of the two different spinal constructs (fixation system based on pedicle screws versus fixation system based on lateral mass screws) were analyzed with respect to primary stability and stability after cyclic loading. To minimize differences based on incorrect screw positions, all screw insertions were performed with the assistance of computer navigation.

**Methods:** Eight human cadaveric cervical spine specimen (C2-C7) were prepared for mechanical testing. The mechanical properties of the intact specimen were determined by a flexibility test using a 6 degree of freedom spinal loading simulator. The intervertebral motion between C3 and C6 was measured by an opto-electronic motion measurement system (ProReflex, QUALISYS AB, Göteborgsvägen, Sweden). After a multilevel injury was created at C3/4, C4/5 and C5/6, we performed a dorsal stabilization from C3 to C6 using a modular screw-rod system (Starlock/Cervifix, Synthes, Paoli, PA, USA). To achieve a more reliable screw positioning, screw insertion (lateral mass (LM) or pedicle screws (PS)) was performed with the assistance of an optoelectronic navigation system (SurgiGATE, Medivision, Switzerland). The flexibility test was repeated and the instrumentation was changed to the alternative fixation type (LM to PS or PS to LM) with an additional flexibility test. Then the specimen were separated in two groups (LM or PS) randomized for bone mineral density (BMD). An additional potting was performed to include the cranial and caudal vertebrae of the instrumentation (C3 and C6). Then cyclic loading was applied with sinusoidal loads in flexion/extension (1000 cycles, +/- 1.5Nm, 0.1Hz). The mechanical properties of the specimen were determined by a flexibility test before and after the fatigue. For data analysis, characteristics of the hysteresis curves were analyzed for all three loading directions (flexion/extension, lateral bending and axial rotation) with respect to stiffness and the Range of Motion (ROM). For statistical analysis T-test and Boxplots were used.

**Essential Results:** All specimen (n=8) could be analyzed for primary stability. There were no significant differences between LM or PS screw fixation in all loading directions: The mean ROM was 7.42° for LM fixation (SD: 6.54°) and 6.46° for PS fixation (SD: 2.70°) in flexion/extension, 1.43° for LM (SD: 0.62°) and 0.86° for PS (SD: 0.31°) in lateral bending, respectively 2.66° for LM (SD: 1.76°) and 2.55° for PS (SD: 1.11°) in axial rotation. For cyclic loading four specimen were used in each group. The mean BMD was 0.364g/cm³ for the LM group (SD: 0.069) and 0.348g/cm³ for the PS group (SD: 0.047). In all loading directions the decrease in stability due to fatigue was less with PS fixation. These differences were statistically significant (p=0.022) in flexion/extension with a remaining stability of 93.5% for the PS group (SD: 11.32°) compared to 70.5% for the LM group (SD: 9.76°). PS fixation showed no loss of stability in lateral bending (102.6%; SD: 10.01°) and axial rotation (114.9%; SD: 29.55°), while there was some decrease in stability for LM fixation in lateral bending (84.2%; SD: 13.58°) and axial rotation (89.1%; SD: 21.78°). These differences were not statistically significant (p=0.072 and p=0.21).

**Discussion:** In this in vitro study we have shown that cervical pedicle screw fixation significantly increases the stability of the construct after cyclic loading although there were no significant differences with respect to primary stability between pedicle and lateral mass screw fixation. In a first biomechanical study on this topic Kotani et al. (3) compared different anterior and posterior cervical fixation methods. Although they showed that pedicle screws provided superior stability, an important limitation of the study was the different anatomy of cervical calf spines which allowed the use of pedicle screws with a diameter of 5.5mm. The current study was performed using a common implant and a realistic human injury model. Therefore, it can be concluded that the technique of subaxial pedicle screw insertion offers biomechanical advantages in patients with poor bone quality, need for multisegmental fixation or correction of deformity. This is why it seems worthwhile to enforce further development of surgical navigation techniques, so that pedicle screw fixation in the cervical spine becomes a more reliable and safer technique in this special group of patients.

**Literature:**