THE INFLUENCE OF PEDICLE SCREW DESIGN ON LOOSENING – A COMPARATIVE IN-VITRO STUDY

+*Biomechanics Section, Technical University of Hamburg-Harburg, Hamburg, Germany

Introduction

The positive effect of transpedicular screw fixation as support for spinal fusion is discussed controversially. This controversy might partly be due to differences with respect to primary stability and loosening between the internal spinal fixation devices used. The purpose of this study was to determine the influence of pedicle screw design on primary stability and loosening characteristics.

Methods and Material

A total of 18 human vertebral bodies was available for testing (male donors, L2-L5, age: 56.0±7.1 years, BMD: trabecular: 121±38mg/ml, cortical: 380±74mg/ml CaHA). Three different pedicle screw designs were compared (Tbl. 1; Fig. 1). One pedicle of each vertebral body was instrumented with a standard SCHANZ screw, the opposite pedicle with one of the 3 pedicle screw types. Six specimens were assigned to each of the 3 pedicle screw groups to achieve similar mean BMD. Screws were inserted according to manufacturer specifications by the same surgeon. Primary stability (at cycle 100) and loosening was determined using a toggle test on a material testing machine (Fig. 2). The screws were exerted to cranio-caudal sinusoidal loading for 1000 cycles (1 Hz) in each of 4 stepwise increasing load levels (LL): LL 1: ±50N, 2: ±75N, 3: ±100N, 4: ±125N. The movement of the rod/screw connection was analyzed. Testing was stopped if the movement amplitude of a pedicle screw reached 10mm. Movement of each pedicle screw was normalized to the movement of the respective SCHANZ screw in the same vertebral body. Failed screws were excluded from the analysis of the respective load level. ANOVA and \( \chi^2 \) tests were performed to compare the movement amplitude and failure frequency between screws and LL (a=0.05).

Results

Absolute movement magnitudes of the SCHANZ screw are reported in Tbl. 2, normalized movements of screws A to C in Fig. 3. Primary stability of screws B and C was higher than of screws A and SCHANZ (A vs. S: n.s.; B vs. S: p=0.04; C vs. S: p=0.04; Fig. 3; Tbl. 2). Movement of the SCHANZ screw increased within each LL (n.s.) and between LL (1 to 2: p=0.001, 3 to 4: p=0.02; Tbl. 2). Movement of screw A was larger than of SCHANZ screw for all LLs (LL1 and LL3: n.s., LL2 and LL4: p<0.001; Fig. 3) whereas screws B and C showed smaller movements than SCHANZ re. screw A in all LLs (p always < 0.001 re. p always < 0.005; Fig. 3). The movement of screw C was smaller than of screw B throughout (LL1 and LL2: n.s., LL3 and LL4: p <0.001; Fig. 3). Screw A showed higher loosening with increased loading than the SCHANZ screw (p=0.007; Fig. 3) and more failures than screws B and C (n.s.; Tbl. 2).

Discussion

Screw design was shown to play a major role for primary stability and loosening characteristics. A large core diameter and small pitch combined with a non symmetrical thread shape (rounded towards tip, sharp towards end) seems to be favorable. Screw A should only be used with additional anterior stabilization (as it is suggested by the manufacturer). Primary stability and loosening characteristics are not necessarily identical: screws B and C showed similar primary stability, however, screw B an increased loosening with loading cycles. This should be considered for further testing and might explain why intraoperative spine stiffness is not a good predictor for clinical outcome.

References


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++ Surgery Department, General Hospital St.Georg, Hamburg, Germany
*** Institute of Legal Medicine, University of Hamburg, Germany