INTRODUCTION: Considering that cervical spine fixation screws are small in diameter, short in length, traverse only the thin anterior cortex of the vertebra, and are located in low density cervical vertebral cancellous bone, it is not surprising that complications occur related to fixation loosening. Interlocking screws have been used with intramedullary rodding in fixation of long bone fractures. McKoy, et al (1) recently described the use of a K-wire to interlock a conventional screw in the lumbar vertebral body. In this study we determined the cyclic mechanical properties of an anterior cervical plate with an interlocking screw design, Figure 1, in comparison to 5 other widely used anterior plating systems.

METHODS: Ten fresh cadaveric specimens were chosen based on radiographic and visual screening. Five were used to load the interlocking device to failure, in flexion, extension, lateral bending, and axial torsion, and 5 were used for comparative cyclic testing of the interlocking device and other implants. For loading to failure, the interlocking device was applied across level C5-6 after the disc had been excised and a cortical bone graft placed between the vertebrae. The interlocking device was applied using a custom guide, first drilling and inserting the nonthreaded rod, then drilling and inserting the threaded screw through the rod until it was rigidly interlocked. The posterior soft tissues remained intact. The specimen was potted at C3 and at T1 in methylmethacrylate and attached to a loading frame. For cyclic loading, a total of 6 plates were tested, the interlocking device and 5 currently available plates (Synthes, Medtronic Atlantis, Medtronic Zephyr, Codman, Aesculap). In each of 5 cervical specimens, one currently available plate and one prototype plate were applied either across C6-7 or C4-5 with cortical bone graft after the disc was removed. This allowed 5 separate cyclic loading tests on the interlocking device and at the same time, using each specimen as its own control, a comparison with one of each of the plates currently in use. Flexion-extension stiffness was used as the measure of the implant's ability to stabilize the fusion in a worst case physiological setting. To conserve specimens and add to the severity of the test, we loaded the specimen first in combined flexion, extension, and lateral bending for 10,000 cycles, then applied 10,000 cycles of axial torsion. Peak load in cycling was approximately 75% of breaking load, based on the 5 load to failure...
tests. Comparisons were made of flexion-extension stiffness initially, after flexion-extension cycling, and after torsional cycling.

RESULTS: The following were the loads to failure for the interlocking device: flexion, 14.8 N-m, extension, 7.6 N-m, lateral bending, 16.8 N-m, and axial torsion, 8.4 N-m. The interlocking device was initially stiffer than the Synthes, Zephir, and Atlantis plates and less stiff than the Codman and Aesculap plates. All of the plates, except for the Atlantis plate, lost stiffness with cyclic loading. A common reason for loss of fixation stiffness was screw toggling and screw hole opening in the vertebra, a prelude to implant dislodgement. For two plates, screws began to back out. The interlocking device had no observed screw toggling or loosening.

CONCLUSIONS: The interlocking screws form a triangle encasing cancellous bone which loads the anterior cortex to resist pullout loading. In contrast, other plates rely on the screw threads resisting shearing in cancellous bone. During bending, the screws of currently used plates tend to "windshield wiper" gradually opening the holes in the vertebrae, and reducing fixation strength of the screw. If the graft compresses or displaces, increasing stresses on the screws, this effect is exacerbated.

The interlocking device, with screw crosslocking, performs as well as currently used plates initially and better than most of the others tested, in terms of maintaining fixation and lowering the potential for dislodgement.

REFERENCES:
Figure 1 A comparison of the attachment mechanisms used by (below) Aesculap plate, and (above) interlocking plate

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