LOAD CARRYING CAPACITY OF THE HUMAN CERVICAL SPINE IN COMPRESSION IS INCREASED UNDER A FOLLOWER LOAD

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METHODS: A new technique was developed for applying a compressive follower load to a whole cervical spine specimen (C2-T2) fixed at the caudal end and free at the top. The load was applied bilaterally by cables that were attached to C2. The cables passed through guides secured to C3-T1, and were connected to a loading system underneath the specimen (Fig. 1). The location of the cables was determined by approximating the center of rotation of each segment from a lateral radiograph in the neutral posture. Since the guides moved with the vertebrae, the cable path approximated the tangent to the spinal curve as the spine deformed under load. After baseline measurements of range of motion were performed, a compressive vertical load was applied to simulate physiologic compressive loads during activities involving minimal to moderate exertion. The sagittal and lateral angular motions of C2 relative to T2 were measured. The spines were tested in the neutral posture (25°-30° lordosis) and in upright and flexed postures (at 15° and 30° flexion from neutral, respectively).

RESULTS: A compressive vertical load applied in the neutral posture caused large increases in cervical lordosis (15°-20°) and the specimens reached the extension limit at a load of only 20-40 N (Fig. 2). In sharp contrast, the cervical spines supported a load of up to 250 N in the neutral posture with small angular changes (<5°) in both the sagittal and frontal planes when the load path was tangent to the spinal curve. Under a vertical load applied in the upright and flexed postures, the specimens collapsed in flexion at a vertical load of 10-40 N, whereas under the follower load of 250 N the spines tended to extend, returning to the stable zone around the upright posture.

DISCUSSION: This is the first report of an ex vivo experiment on the load carrying capacity of the whole cervical spine when the load levels approximate those seen in vivo. Instead of applying the compressive load vertically, it was applied along the follower path, i.e., the path that approximated the tangent to the curve of the cervical spine passing through the centers of rotation of the segments. Because the follower load remained tangent to the spinal curve, the spine was loaded in nearly pure compression. This allowed it to support physiologic load levels experienced during activities of daily living without damage or instability. While previous studies have studied the response of the human cervical spine under primarily pure moments, this experimental study offers a novel method to test whole cervical spine specimens under compressive loads experienced during daily activities.