Biomechanical Evaluation of the Craniovertebral Junction After Unilateral Joint-Sparing Condylectomy: Implications For the Far Lateral Approach

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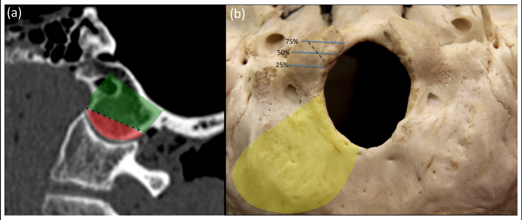
Figure 1



(a) Sagittal CT demonstrating occipital condyle anatomy with a rectangular-shaped main body (green) and concave-shaped articular surface (red). (b) View of the foramen magnum: yellow area indicates area of unilateral suboccipital craniectomy. Each condyle was divided along the anatomic transverse axis into 4 quadrants. Dotted line indicates approximate location of hypoglossal canal

Introduction

The far lateral transcondylar approach to the ventral foramen magnum requires partial resection of the occipital condyle. Early biomechanical studies suggest that occipital cervical (OC) fusion should be considered if 50% of the condyle is resected. However, in clinical practice, a joint sparing condylectomy has often been employed without the need for OC fusion. The biomechanics of the joint sparing technique have never been reported. We hypothesized that the clinically relevant joint sparing condylectomy would result in added stability of the OC junction as compared to earlier reports.

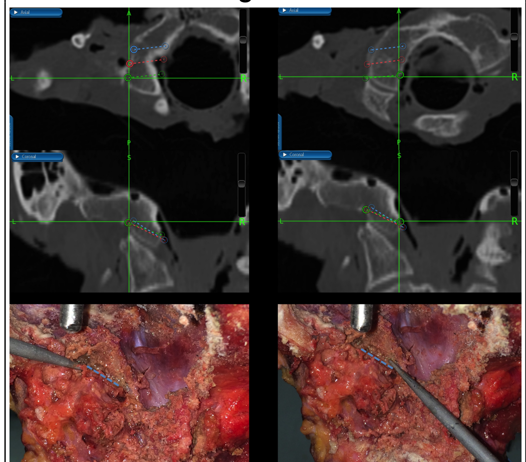
Methods

Multidirectional in vitro flexibility tests was performed using a robotic spine testing system on seven fresh cadaveric spines to assess the effect of sequential unilateral joint-sparing condylectomy (25%, 50%, 75%, 100%) in comparison to the intact state using a simulated head weight and follower load in cardinal directions and coupled motions.

Figure 2

Testing Setup. The specimen is rigidly fixed at the occiput and C3. A navigation reference frame and optoelectric sensors are placed for accurate condyle resection and ROM measurments, respectively

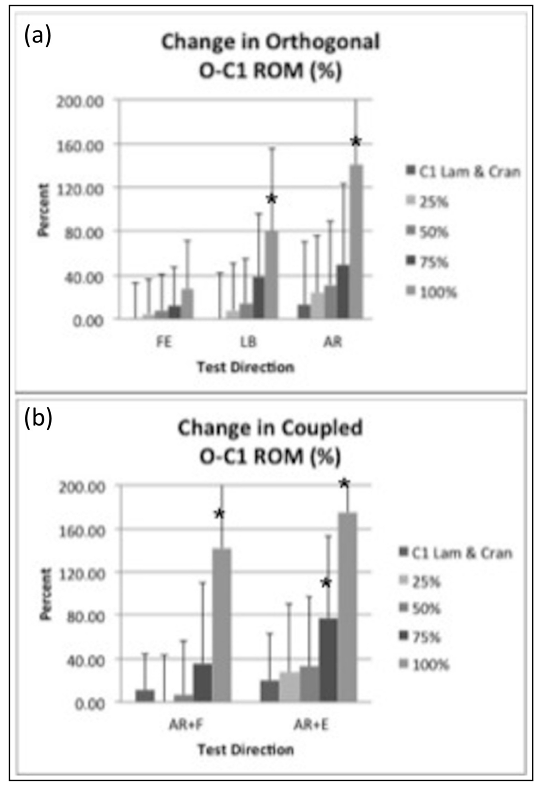
Figure 3



Stereotactic guided joint-sparing condylectomy. Navigation plan demonstrating 25% (green), 50% (red), and 75% (blue) resection lines. Lower panel: pointer on lateral (left) and medial (right) aspects of the 25% condylar resection line. Blue dotted line = posterior occiput-C1 joint

Results

We found the percent change in ROM (%ROM) following sequential condylectomy as compared to intact was 5.2, 8.1, 12.0 and 27.5% in flexion-extension (FE); 8.4, 14.7, 39.1 and 80.2% in lateral bending (LB); and 24.4, 31.5, 49.9 and 141.1 in axial rotation (AR). Only the values at 100% condylectomy were statistically significant ($p<0.05$). With coupled motions however, we found -3.9, 6.6, 35.8 and 142.4% increases in AR+F and 27.3, 32.7, 77.5 and 175.5% increases in AR+E. Values for 75 and 100% condyle resection were statistically significant in AR+E.



Conclusions

When tested in the traditional cardinal directions, 50% condylectomy sparing the OC joint did not create significant increased motion. Removal of up to 75% of the condyle while sparing the O-C1 joint might necessitate fusion as we found a statistically significant increase in motion when flexion-extension was coupled to axial rotation. Clinical correlation is ultimately needed to determine the need for OC fusion.

References

Vishteh AG, et al: Stability of the craniovertebral junction after unilateral occipital condyle resection: A biomechanical study. J Neurosurg 90:91-98, 1999