Range of Motion of the Upper Cervical Spine: flexion, extension, lateral bending, and axial rotation

Ana I. Lorente[1], César Hidalgo García[2], Jacobo Rodríguez Sanz[3], Mario Maza Frechín[1], Albert Pérez Bellmunt[3]

[1] Investigación y Desarrollo en Ergonomía (IDERGO)
Instituto de Investigación en Ingeniería de Aragón (I3A)
Universidad de Zaragoza, Mariano Esquillor s/n, 50018, Zaragoza, Spain.
Tel. +34-976762707, e-mail: analorente@unizar.es
[2] Unidad de Investigación en Fisioterapia, Universidad de Zaragoza
[3] Facultad de Medicina y Ciencias de la Salud, Universitat Internacional de Catalunya

Abstract

Instability is a serious and life-threatening diagnosis in the upper cervical spine (occiput-atlas-axis), and a depth understanding of normal range of movement is required for clinical manual evaluation. To improve this knowledge, ten upper cervical spine specimens have been tested in flexion, extension, lateral bending, and axial rotation.

Introduction

Neck pain and disability are common in the adult population [1]. Most of the mobility of the cervical spine occurs in its upper region. This region may show instability due to traumas, congenital conditions, or other scenarios, with symptoms varying from poor concentration and memory, nausea, tinnitus, headaches, and visual changes to fatal events [2].

Manual therapy plays a key role in the screening of instability in the upper cervical spine. Some tests such as side-bending test, passive upper cervical flexion test, and rotation stress test are used to detect upper cervical instability [3]. But with all these kinds of pre-manipulative tests, practitioners need to know which range of motion (ROM) should be expected. In the literature, a widespread possible ROM is available [4].

The present study aims to in vitro simulate clinical testing for upper cervical instability to show the relationship between the available ROM and the applied torque in the three planes of motion (flexion-extension, lateral bending, and axial rotation). In lateral bending and axial rotation, the results were studied for the right and left sides separately to see if dependency between the sides was detected because asymmetry can be observed in healthy individuals [4].

Materials and methods

Ten upper cervical spine specimens (74 years, range: 63-85 years) from cryopreserved cadavers (9 males, 1 female) were manually manipulated. A Research Ethics Committee approved the applied procedure.

The second cervical segment (axis) was fixed (in upright position) to a load cell (AMTI, USA). The head was manually manipulated from its neutral position to the maximum ROM in flexion-extension, lateral bending, and axial rotation. A motion capture system (Vicon, UK) tracked continuously the ROM.

The full information regarding the sample and the anatomical and biomechanical procedures can be found in our previous publication: *Hidalgo et al. (2020)* [5].

Statistical analysis

Paired t-tests were performed with a significance level of $p<0.05$. The software used was Minitab (Minitab Inc., USA).

Results

Flexion and extension

Flexion ROM was 19.8±5.3° (with a total load of 0.7±0.2Nm) and extension ROM was 14.4±7.7° (0.9±0.3Nm). The same torque was applied for flexion and extension movements (P-value = 0.190), and even though the flexion ROM was bigger than the extension ROM, there was no statistical difference between them (P-value = 0.173).

Lateral bending

Lateral bending of 4.7±2.3° (right side; applied torque of 0.8±0.2Nm) and 5.6±23.2° (left side, 1.0±0.3Nm) were measured. No differences between the right and left sides were detected neither in the range of motion (P-value = 0.523) nor in the applied torque (P-value = 0.608).

Axial rotation

A bigger difference than in lateral bending was detected between the right and left sides when the axial rotation was analysed (P-value = 0.058): 33.9±6.6° for the right side (applied torque: 0.6±0.1Nm) and 28.0±6.9° for the left side (0.6±0.2Nm). The applied torques to both sides were not different between the two sides (P-value = 0.359).

Further results

Currently, a more exhaustive analysis of flexion and extension is being conducted with the presented data set. However, for lateral bending and axial rotation, the continuous ROM-torque responses of these tests have been already published [5, 6].

Conclusions

Values for the mobility of the upper cervical spine in flexion, extension, lateral bending, and rotation are reported. Previous studies have reported these values testing the full cervical spine, but conducting these tests only with the upper cervical spine allows the simulation of a C2 stabilization as applied on manual therapy techniques to avoid the movement of C2. Furthermore, our tests were manually mobilized in order to have a more real feeling during the applied movements, simulating the performance of the clinical tests.

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