Influences of cervical structures on the kinematic behavior of the cervical spine

René Jonas, Robert Demmelmaier, Hans-Joachim Wilke

Presenter: Christian Liebsch

Institute of Orthopaedic Research and Biomechanics
Trauma Research Centre Ulm (ZTF)
Ulm University | Medical Center
Background

- **NECK PAIN**
  - ... is one of the most common disorders worldwide (Vos et al., 2015).
  - ... alters the kinematic behavior of the cervical spine (Ellingson et al., 2013).
- **NECK INJURY**
  - ... can cause instability of the cervical spine (White and Panjabi, 1990).
- **SURGICAL TREATMENT**
  - ... aims to maintain the physiological range of motion (Kettler et al., 2004).
  - ... requires resections of cervical structures.

Purpose of the study

In vitro analysis of the kinematic behavior of the cervical spine when resecting its anatomical structures
3 I Methods

Test setup

- 6 fresh frozen cervical spine specimen
  - C4-C5, 3♀/3♂, Ø age 48 years

- Quasi-static loading
  - Pure moments of 1 Nm
  - Angular velocity of 1°/s
  - 3.5 loading cycles

- 7 testing steps
  - Intact condition
  - **W/o supra-/interspinous ligaments**
  - **W/o flaval ligament**
  - **W/o facet capsule**
  - **W/o vertebral arch**
  - **W/o posterior longitudinal ligament**
  - **W/o anterior longitudinal ligament**
Three-dimensional helical axes analysis

- Motion tracking using Vicon MX13 motion capture device
- Matching of marker coordinates with x-ray images (Jonas et al., 2018)
- Calculation of three-dimensional helical axes (Söderkvist and Wedin, 1993)

Lateral bending
5 | Results

**Flexion/Extension** (coronal plane)

- Intact condition
- Vertebral arch resection

**Lateral bending** (sagittal plane)

- Intact condition
- Vertebral arch resection

**Axial rotation** (sagittal plane)

- Intact condition
- Vertebral arch resection
Interpretation of the results

- The **vertebral arch** predominantly affects the kinematic behaviour of the cervical spine.
- **Uncinate processes** substantially influence cervical kinematics, especially in **lateral bending**.
- **Flexion/extension** movement is **least** affected by ligamentous resection.

Conclusions

- **First time usage** of three-dimensional helical axes to investigate influence of tissue resection.
- **All structures** exhibit a non-negligible effect on cervical spine kinematics.
- Future development of **cervical disc replacements** should focus on **three-dimensional kinematics**, especially regarding **lateral bending**.
Thank you for your attention!