Intradiscal pressure at L4L5 level in adolescent idiopathic scoliosis: A computational study based on musculoskeletal modelling approach

Tito Bassani¹, Noemi Barba², Dominika Ignasiak³, Tomaso Maria Tobia Villa², Fabio Galbusera¹

¹ IRCCS Istituto Ortopedico Galeazzi, Milan, Italy. LABS, Laboratory of Biological Structures Mechanics
² Department of Chemistry, Materials and Chemical Engineering “Giulio Natta”, Politecnico di Milano, Milan, Italy
³ Institute for Biomechanics, ETH Zurich, Zurich, Switzerland

Contact: tito.bassani@grupposandonato.it
none of the authors has any potential conflict of interest
Introduction

- **adolescent idiopathic scoliosis (AIS)** occurs in the general population with prevalence between 2 and 3%.

- Investigating the relationship between scoliosis and **intradiscal pressure (IDP)** at lumbar level could provide valuable information for the understanding of the pathomechanics of the AIS spine.

- IDP cannot be obtained *in vivo* due to the **invasiveness** of the measurement procedure. An alternative strategy is represented by **musculoskeletal modelling simulation**, which allows for calculating the biomechanical loads in assigned posture by the means of **inverse static analysis**.

**Aim of the study:** investigate the relationship between the **severity and type of scoliosis** in the thoracolumbar/lumbar region and **IDP calculated at L4L5 level**.
Methods

- 92 AIS subjects (age 8-18 years) with mild (Cobb angle 10-25°, 44 cases) and moderate (25-45°, 48) scoliosis. Lenke type 3, 5, and 6.

- Coronal and sagittal radiographic images acquired with EOS system (EOS Imaging, Paris, France); 3D reconstruction of the spine by sterEOS software.

- Spinal alignment replicated with musculoskeletal model developed in AnyBody software (AnyBody Technology, Denmark); intervertebral load (F) calculated at L4L5 level.

\[
IDP = \frac{F_{\text{comp}}}{A} \times CF
\]

- \( F_{\text{comp}} \), compression component of F.
- A, upper endplate area (manually measured on the radiographic images).
- CF, correction factor from experimental studies.

---

the relation between IDP and scoliosis severity was evaluated by Pearson correlation coefficient (ranging from 0 to ±1) and differentiated by Lenke type

- correlation
  - overall: 0.29*  
  - Lenke 3: 0.27  
  - Lenke 5: 0.34  
  - Lenke 6: 0.35*

N = 92  
Lenke 3 = 40  
Lenke 5 = 15  
Lenke 6 = 37

* significantly different from zero (p<0.05)
• mean IDP in mild (Cobb angle 10-25°) and moderate (25-45°) cases was compared

mean(SD)

pressure [MPa]

mild (10-25°)  moderate (25-45°)

44 cases  48 cases

#, significant difference between groups (p<0.05)
Discussion

- **weak correlation** between IDP and scoliosis severity in each Lenke type, although mean IDP was slightly larger in the moderate cases compared to the mild ones (0.93 and 0.83, respectively)

- the range of IDP was **generally comparable** to that observed in literature for **adult healthy subjects***(ranging from 0.4 to 1 MPa), but the larger values found in AIS (>1 MPa) were not dependent on scoliosis severity*

Conclusion

Scoliosis at thoracolumbar/lumbar level demonstrated to have a weak impact on IDP, independently on the type of deformity
Summary points

- 92 AIS subjects with mild and moderate scoliosis at thoracolumbar/lumbar level were considered
- the spinal alignment was replicated with musculoskeletal modelling approach
- the intradiscal pressure (IDP) at L4L5 level was calculated by inverse static analysis
- IDP was put in relation with the scoliosis severity
- scoliosis severity demonstrated to have a weak impact on IDP, independently on the type of deformity