# Quantifying paraspinal muscle fibre architecture (a)symmetry in adolescents with and without scoliosis.

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## Summary

Adolescent idiopathic scoliosis (AIS) is an atypical 3D spinal curvature that develops between ages 10-18 [1]. Here, we use diffusion-tensor imaging (DTI) to quantify differences in paraspinal muscle fibre architecture and line of action in adolescents with AIS and those with typically developing spines.

## Introduction

AIS affects ~3% of otherwise healthy adolescents [1]. To date, most AIS research has focused on the changes in bone shape and orientation or surgical outcomes. Recently, there has been growing evidence of asymmetries in paraspinal muscle morphology and activation in AIS [2]. Understanding the line of action of muscular forces on the growing spine may provide insights into the potential contribution of the paraspinal muscles to the bony changes observed in AIS. This study aimed to quantify paraspinal muscle fibre architecture and line of action in adolescents with scoliosis and typically developing age-matched controls.

## Methods

T1-weighted and diffusion-tensor imaging (DTI) MRI scans were conducted on 26 female adolescents with primary-right-thoracic scoliosis [Cobb angle: 38±16°; age: 13.7±1.5 years] and 16 controls [age: 13.6±1.9 years]. Using anatomically constrained fibre tractography [3], multifidus and longissimus muscle-fibre architecture was reconstructed between vertebral levels T5-L3. To allow for vertebral level-specific measures of muscle fibre architecture, regional reference points were determined at the centre of the upper laminar border (ULB) for vertebrae T5 to L4.

The muscle-fibre orientation was then calculated as the angle formed between the direction vector of two consecutive vertebrae's ULB reference points and (i) the muscle fibres end-to-end direction vector and/or (ii) the average fibre direction vector. The end-to-end fibre orientation is defined as the direction vector formed between superior and inferior endpoints of a fibre track. The average fibre orientation vector was determined as the mean direction vector across all points composing the fibre track. Muscle fibres were then further grouped by the vertebral location of a fibre's superior-end. The end-to-end fibre orientation outcomes are presented below.

## Results and Discussion

Comparing multifidus and longissimus muscle fibre angles, AIS participants showed greater fibre angles on both the left and right-sides of the spine, at most vertebral levels than the controls. The AIS group's multifidus muscle fibres had marked between-side asymmetry, with greater fibre angles on the right-side at vertebral levels T5-T7 and on the left-side at T8-L2 ($p<0.05$, Figure 1A).

In contrast, while the AIS group's longissimus muscle on both sides of the spine had significantly greater fibre angles than the control group ($p<0.05$), its fibres were more symmetrical. This resulted in smaller between-side asymmetry compared to multifidus, with only small between-side asymmetries observed at vertebral levels T7-T9, T12-L2 (Figure 1B).

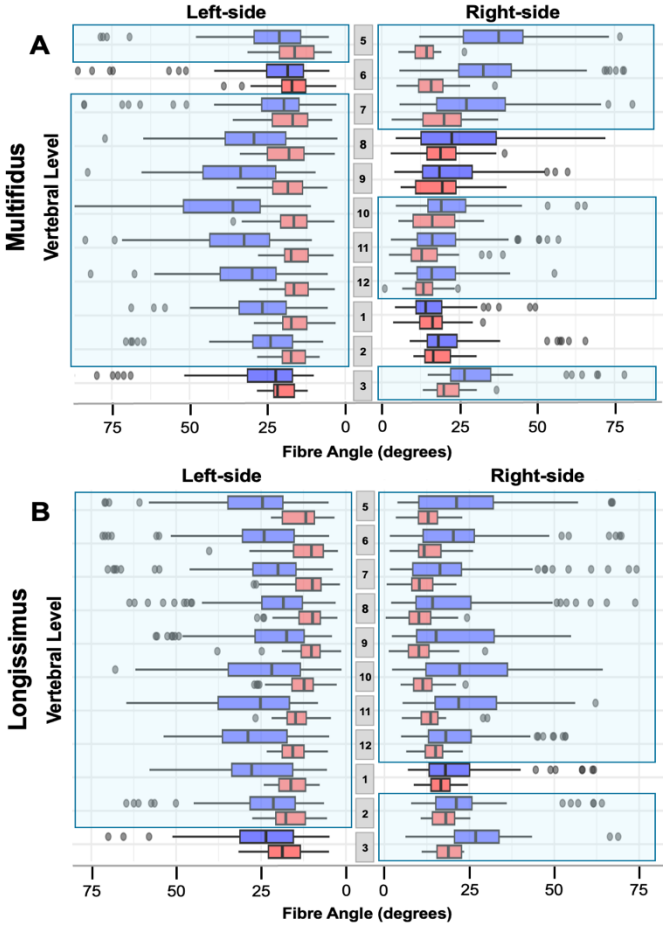


**Figure 1**: Multifidus and Longissimus fibre orientation from vertebral levels T5-L3 for adolescents with scoliosis (Blue) and controls (Pink). Boxplot: Median and IQR. n=16-26. Significant between-group asymmetries are highlighted in blue shading, $p<0.05$.

## Conclusions

Adolescents with AIS demonstrate significant asymmetries in multifidus and longissimus muscle-fibre architecture, with greater relative fibre angles on the left-side of the spine. These findings suggest an asymmetry in the paraspinal muscles' line of action, which may contribute to asymmetrical loading and development of the spine.

## References

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