Facet Joint Osteoarthritis in Adolescent Idiopathic Scoliosis: A Radiological Analysis

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Objectives

- Analyse preoperative CT images of Adolescent Idiopathic Scoliosis (AIS) patients to assess evidence of facet joint osteoarthritis (OA).
- Generate a novel facet joint OA grading system for the thoracic spine.

Introduction

AIS is one of the most common musculoskeletal diseases that affects children aged 10-16 years. It has a global prevalence of up to 3%, with a greater number of girls affected than boys (1). AIS creates spinal "instability" during rapid adolescent growth, and AIS patients have twice the prevalence of back pain than those without (1), with the underlying cause unclear. Evidence suggests that this pain continues after surgery (2) with a possible cause being facet joint OA.

Facet joints are paired synovial joints between the superior and inferior articular processes of two adjacent vertebrae. Their primary role is to prevent hypermobility of the spine, whilst also bearing up to 25% of compressive load (3). There is existing histological evidence that the facet joints of AIS spines show features of OA (4), but radiological evidence is limited.

There is currently only a grading system to objectify lumbar facet joint OA, not suitable for assessing the prevalence of OA of thoracic AIS curves.

Methods

- Acquired the list of AIS patients who underwent corrective surgery between January 2023 and December 2024 at Children's Hospital for Wales.
- Utilised Synapse5 radiology software to assess multiple features of each patient's spinal curve. These included: Cobb angle, curve apex and truncal shift.
- Generated a new three-level grading system for thoracic facet joint OA (Fig 1) and tested for inter-rater agreement and reliability.
- The facet joints assessed were those of the apical vertebra, the two above and two below. If the apex was at an intervertebral disc, then the two facet joints above and below that disc were analysed.
- Utilised the new grading system to objectify the degree of facet joint OA evident on CT.

Fig.1 The grading system produced to assess facet joint osteoarthritis in the thoracic spine

Osteoarthritis Grade	Facet Joint Features
Grade 0	Normal joint
Grade 1	Joint space narrowing/sclerosis
Grade 2	Osteophytes/subchondral cysts

Results

32 girls and 3 boys (N=35) were included in this study, with a total of 312 facet joints analysed. 90.1% of all facet joints had a degree of osteoarthritis, scoring a minimum of Grade 1. 60% of the facet joints were determined to be Grade 2, indicating more advanced degeneration (Fig.2). 33 patients had right sided thoracic curves, and the left sided (concave) facet joints demonstrated a slightly greater proportion of Grade 2 OA (Fig.3). This is consistent with the theory of asymmetrical loading in AIS, in which the concave facet joints may transmit more than 91% of the load (5) and therefore be subject to greater degeneration.

Fig.2 CT images from patients included in this study demonstrating Grade 2 facet joint OA

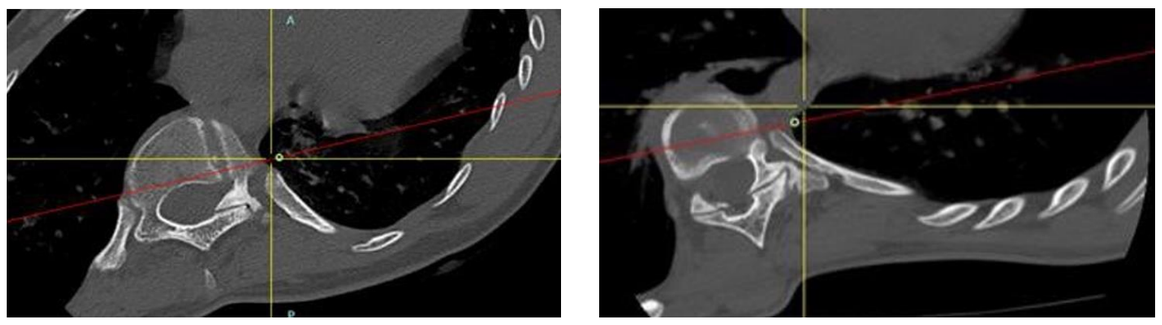
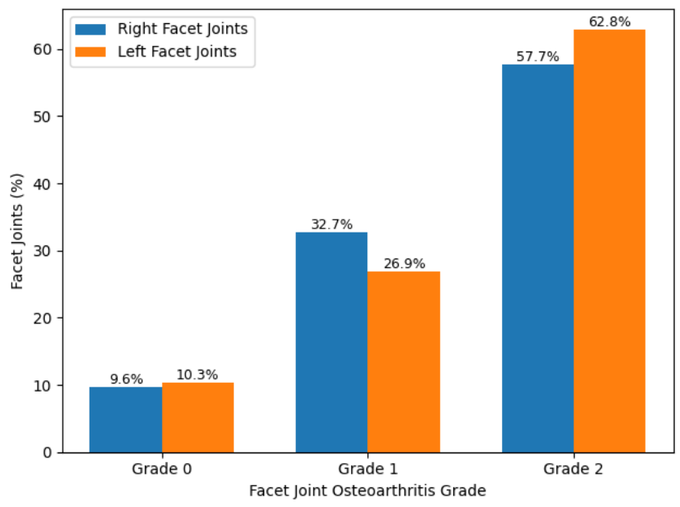


Fig.3 Percentage distribution of osteoarthritis grade across the right and left facet joints



The novel grading system developed for this study demonstrated excellent reliability, with perfect inter-rater agreement (weighted $\kappa = 1.00$, 95% CI 1.00–1.00, $p < 0.001$). This suggests that the grading criteria are clear and reproducible when applied to CT imaging of the spine. These findings support the use of this grading system for future studies investigating facet joint degeneration in scoliosis.

Conclusion

This study found strong radiological evidence of facet joint OA in AIS on CT imaging, with the majority of facet joints around the apex displaying moderate to advanced degenerative change. While previous studies demonstrate the biochemical and histological evidence of OA in AIS, this is one of the first radiological studies.

These findings are significant as they identify the presence of a degenerative disease in patients less than 16 years old. This highlights the potential role of altered spinal biomechanics and asymmetrical loading in AIS.

The novel classification system developed in this study demonstrated excellent reliability for grading thoracic facet joint OA on CT imaging. This can support future research investigating facet joint degeneration in scoliosis and other spinal deformities. Further studies with larger cohorts may help to clarify the relationship between AIS and facet joint degeneration.

Overall, this study contributes to the growing understanding of facet joint degeneration in AIS and introduces a reliable grading system that may facilitate future research into the relationship between spinal biomechanics and facet joint pathology.

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