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Facet Joint Osteoarthritis in Adolescent Idiopathic Scoliosis: A Radiological Analysis

Background

Adolescent Idiopathic Scoliosis (AIS) is a musculoskeletal disease that affects children aged 10-16 years. It has a global prevalence of up to 3%, predominantly affecting girls.

AIS is a three-dimensional spinal deformity characterised by axial rotation, lateral curvature, and abnormal sagittal kyphosis/lordosis. AIS patients experience twice the prevalence of back pain than those without, with the underlying cause unclear. One study found that 12% of AIS patients who underwent corrective surgery continued to experience back pain after recovery, suggesting an element of permanent damage.

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. There is limited literature on the prevalence of facet joint degeneration in AIS. However, there is histological evidence that the facet joints of AIS spines show features of osteoarthritis (OA). This may explain why some AIS patients continue to experience back pain following surgery.

The primary objective of my research was to assess the radiological evidence of facet joint OA in AIS.

Design

A list of patients aged 10-16 who underwent surgery for AIS was obtained. These surgeries occurred between January 2023 and December 2024 at Children's Hospital for Wales. Patients with additional neuromuscular disorders were excluded, leaving 35 patients to assess.

Synapse5 radiology software was then used to assess Cobb angle (on erect XR and lying CT), curve apex and truncal shift. Pre-operative CT was also analysed, looking for evidence of facet joint OA in the two joints above and below the apex. A four-level grading system was used to quantify OA severity. The clinical notes were also reviewed to determine patients' pain.

Results

A new grading system (Fig.1) specifically for thoracic facet joint osteoarthritis was designed for this study.

A total of 312 facet joints were analysed (Table 1). 90.4% of all joints scored a minimum of Grade 1 OA. Furthermore, 31.4% of all facet joints were determined as Grade 3, suggesting severe osteoarthritis.

33 patients had right sided curves, reflected in the OA grade differences between right and left facet joints (Table 2). Overall, left sided facet joints displayed more severe OA. 37.8% of left sided joints were Grade 3, compared to 25.0% of right sided joints. This demonstrates the asymmetrical loading in AIS, where the concave side facet joints transmit more than 91% of the load.

22.9% of patients continued to experience pain post-operatively, despite curvature correction. It should be noted that 42.8% did not have documentation regarding pain postop, likely due to the proximity of the surgeries to the study period. These patients will be followed up in future appointments to assess if they experience pain beyond the recovery time.

Discussion

This study was significant because although previous literature demonstrates the biochemical and histological evidence of OA in AIS, this is one of the first radiological studies. Providing evidence of facet joint OA will help understand why AIS patients continue to experience postoperative pain, and how management can be modified to improve these symptoms. Further research is required to analyse whether pain increases with Cobb angle, as current literature shows limited evidence of a positive correlation.

Our future aims are to establish the proposed grading system for thoracic facet joints and follow up our cohort of patients to assess their pain.

Appendix

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

Osteoarthritis Grade	Facet Joint Features
Grade 0	No joint space narrowing, sclerosis or osteophytes
Grade 1	Joint space narrowing with differences between right and left sides
Grade 2	Significant joint space narrowing
Grade 3	Osteophytes, sclerosis or complete narrowing of joint space

Table.1 Results from CT analysis of facet joint osteoarthritis (OA) grade

Patient	Apex	Facet OA grades above and including apex		Facet OA grades below apex	
		Right side	Left side	Right side	Left side
1	T9/T10 IVD*	0, 2	0, 3	0, 0	3, 2
2	T8/T9 IVD	1, 0	3, 1	1, 1	3, 1
3	T9	2, 3, 3	3, 3, 3	3, 3	3, 3
4	T8	1, 1, 1	0, 2, 3	1, 2	3, 2
5	T9/T10 IVD	1, 1	0, 1	3, 1	3, 1
6	T8	2, 0, 0	2, 3, 2	0, 2	0, 2
7	T9/T10 IVD	0, 3	1, 3	1, 1	3, 0
8	T7/T8 IVD	2, 2	3, 3	2, 2	2, 2
9	T8	3, 2, 2	3, 3, 2	2, 2	3, 2
10	T9/T10 IVD	1, 0	1, 0	0, 0	0, 0
11	T8	3, 2, 1	3, 3, 0	1, 1	1, 1
12	T8/T9 IVD	2, 2 ,2	2, 3, 1	1, 3	0, 3
13	T9	1, 1, 2	2, 2, 3	1, 1	3, 2
14	T7/T8 IVD	1, 1	1, 3	2, 1	1, 0
15	T10/T11 IVD	3, 3, 3	3, 3, 3	3, 3	3, 2
16	T8	1, 1, 1	1, 1, 1	1, 1	1, 1
17	T8/T9 IVD	2, 0	2, 0	2, 2	1, 2
18	T8/T9 IVD	3, 2	3, 2	3, 3	3, 3
19	T8/T9 IVD	1, 3	2, 3	2, 2	2, 1
20	T9/T10 IVD	0, 0	1, 0	1, 2	0, 1
21	T8/T9 IVD	2, 2	3, 3	2, 2	3, 1
22	T10	2, 2	2, 3, 3	3, 2, 2	2, 3
23	T8/T9 IVD	3, 2	3, 3	2, 1	2, 1
24	T9/T10 IVD	1, 1	1, 3	3, 3	2, 2
25	T9	1, 1, 1	1, 2, 1	1, 1	1, 1
26	T8/T9 IVD	2, 3	3, 2	3, 3	3, 3
27	T9/T10 IVD	3, 3, 1	3, 1, 2	3, 3	3, 3
28	T9	3, 2, 1	3, 3, 1	2, 3	2, 2
29	T9	1, 1, 0	0, 1, 0,	1, 2	1, 1
30	T9/T10 IVD	3, 3	3, 3,	2, 2	2, 3
31	T11/T12 IVD	1, 1	1, 1	3, 2	3, 2
32	T8	3, 3	2, 3, 1	2, 2, 3	2, 1
33	T7/T8 IVD	3, 2	3, 3	2, 2	2, 1
34	T9/T10 IVD	1, 2	1,1	1, 1	1, 2
35	T8	1, 1, 2	2, 1, 1	2, 3	2, 2

*IVD = Intervertebral Disc

Table 2. The proportion of facet joints that were scored at each OA grade

Facet Joint OA Grade	% of right sided facet joints	% of left sided facet joints	% of total facet joints
Grade 0	9.60%	10.30%	9.90%
Grade 1	32.7%	26.9%	29.8%
Grade 2	32.7%	25.0%	28.8%
Grade 3	25.0%	37.8%	31.4%

Table 3. Patient Cobb angle and their mean facet osteoarthritis (OA) grades

Patient	PreOp Cobb Angle on XR (°)	Mean Right Facet OA Grade	Mean Left Facet OA Grade
1	80	1	2
2	80	1	2
3	70	3	3
4	60	1	2
5	70	2	1
6	65	1	2
7	65	1	2
8	90	2	3
9	80	2	3
10	40	0	0
11	50	2	2
12	75	3	2
13	70	1	2
14	55	1	1
15	60	3	3
16	70	1	1
17	55	2	1
18	70	3	3
19	70	2	2
20	60	1	1
21	75	2	3
22	95	2	3
23	40	2	2
24	60	2	2
25	55	1	1
26	70	3	3
27	60	3	2
28	60	2	2
29	50	1	1
30	95	3	3
31	80	2	2
32	50	3	2
33	50	2	2
34	55	1	1
35	60	2	2

AI Declaration

I declare that I have used Generative AI software to support me in producing parts of this work. I have used Gen AI in line with the usage defined by the assessment guidance and have maintained academic integrity throughout my work. I have validated any Gen AI content through using reliable independent sources.

I acknowledge my use of AI tools to:

1. Help understand core concepts or other preparatory activities:

I used ChatGPT to understand the pathophysiology of asymmetric loading in AIS and to explain the use of statistical analysis that I read during my literature review.

2. Write, rewrite, or paraphrase part of this submission

I asked ChatGPT to help me shorten phrases which were too wordy and help me fit the word count of the abstract. But the original text, writing and analysis is all my own work.

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Objectives

- Analyse CT images of Adolescent Idiopathic Scoliosis (AIS) patients to assess evidence of facet joint osteoarthritis (OA)
- Assess the prevalence of pain in AIS patients

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). However, the underlying cause is unclear. One study found that 12% of AIS patients who underwent corrective surgery continued to experience back pain after post-operative recovery (2). This suggests that there is an element of permanent damage created by AIS.

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 histological evidence that the facet joints of AIS spines show features of OA (4). This may explain why some AIS patients continue to experience back pain following correctional surgery.

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.
- Quantified the degree of facet joint OA evident on CT using a four-level grading system (Fig 1).
- Reviewed the clinical notes of the group to assess patient reported pain. Scored as either present, absent, or undocumented.

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

Osteoarthritis Grade	Facet Joint Features
Grade 0	No joint space narrowing, sclerosis or osteophytes
Grade 1	Joint space narrowing with differences between right and left sides
Grade 2	Significant joint space narrowing
Grade 3	Osteophytes, sclerosis or complete narrowing of joint space

Results

It was determined that a new grading system for thoracic facet joint osteoarthritis was needed for this study, as the existing system is based upon lumbar vertebrae. Fig.1 shows the grading system created.

A total of 312 facet joints were analysed across 35 patients' curves (32 girls, 3 boys). The facet joints of the apical vertebra, the two above and two below were assessed. 90.4% of all facet joints had a degree of osteoarthritis (scoring a minimum of Grade 1). 31.4% of all facet joints were determined as grade 3, suggesting severe osteoarthritis with features such as osteophytes and complete joint space narrowing.

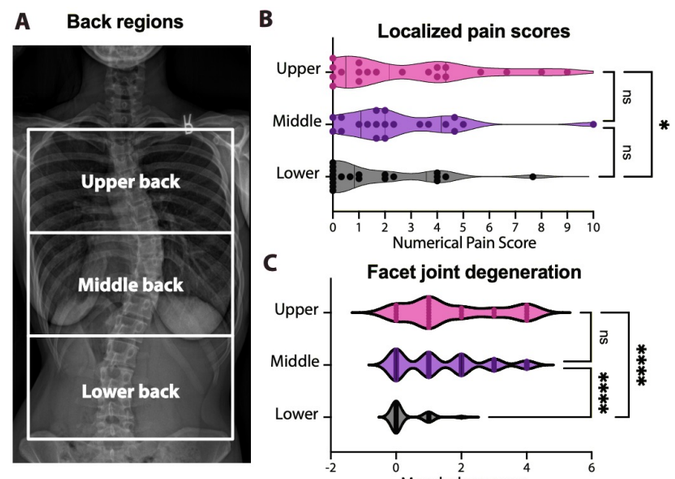
33 out of the 35 patients had right sided thoracic curves. This was reflected in the OA grade differences between right and left facet joints. Overall, the left sided facet joints displayed a greater severity of OA. 37.8% of left sided facet joints were Grade 3, compared to 25.0% of right sided joints. This supports the theory that there is asymmetrical loading in AIS, where the facet joints on the concave side of the curves have been shown to transmit more than 91% of the load (5).

68.6% of patients experienced pain preoperatively. Postoperatively, 22.9% of patients also reported pain. However, it should be noted that 42.8% did not have documentation regarding pain postoperatively, and this is likely due to proximity of the surgeries to the study period. These patients will be followed up in future appointments to assess if they experience pain beyond the surgery recovery time.

Discussion

This research was significant because although previous literature demonstrates the biochemical and histological evidence of OA in AIS, this is one of the first radiological studies. Figure 2 shows data from one of the previous papers. The results show increasing back pain with greater facet joint degeneration in the thoracic spine. Current theory is that increased rotational instability across AIS spines leads to asymmetrical forces across facet joints, contributing to joint degeneration. This is supported by evidence of cartilage degeneration severity in facet joint pairs positively correlating with increasing intervertebral axial rotation (3).

Fig.2 Back pain location associated with facet joint degeneration (3)



Providing further evidence of facet joint OA will help understand why AIS patients continue to experience postoperative pain, and how management can be modified to improve these symptoms. This is significant because pain after surgery has been shown to improve initially, but return over time, even back to preoperative levels (1). This suggests permanent damage to the spine which is not resolved by curve correction.

Greater research is required to analyse whether pain increases with Cobb angle, as current literature demonstrates limited evidence of a positive correlation. Our future aims are to establish the proposed grading system for thoracic facet joints and follow up our cohort of patients to assess their postoperative pain.

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