Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

EVALUATING THE ROLE OF MAGNETIC RESONANCE IMAGING AND COMPUTED TOMOGRAPHY SCAN IN ASSESSING SPINAL CURVATURES IN SCOLIOSIS

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DOI: https://doi.org/10.5281/zenodo.15589878

Keywords
Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Cobb Angle (CA), Vertebral Rotation (VR), Diagnostic Imaging (DI). Two Dimensional(2D)

Article History
Received on 26 April 2025
Accepted on 26 May 2025
Published on 03 June 2025

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Abstract

Background: *Scoliosis involves abnormal lateral curvature of the spine, commonly forming S or C shapes. Scoliosis severity based on Cobb angle measurements: Mild scoliosis: 10° to 24°Moderate scoliosis: 25° to 39°Severe scoliosis: 40° or more.The causes of scoliosis vary and are classified broadly as congenital, neuromuscular, syndrome-related, idiopathic and spinal curvature due to secondary reasons. Traditional X-rays provide limited 2D views, whereas MRI and CT offer detailed 3D assessments. MRI is ideal for soft tissue and neural imaging, while CT excels at capturing bone details.*

Objective: *To evaluate and compare the diagnostic value of MRI and CT in identifying scoliosis-related spinal deformities, including Cobb angle, vertebral rotation, and associated anomalies.*

Methods: A cross-sectional study was conducted at Ghurki Trust Teaching Hospital, Lahore with 31 patients aged 11–40 years diagnosed with scoliosis. CT (Toshiba Aquiline 16-slice) and MRI (1.5T) were used. Data on Cobb angle, vertebral rotation, and abnormalities were recorded. Statistical analysis was performed using SPSS 25.0

Results: *MRI detected 80.6% of anomalies while CT identified 74.2%. MRI showed superior capability in detecting spinal cord and soft tissue anomalies, whereas CT was more accurate for vertebral rotation and bone deformities. Evaluated scoliosis characteristics using Cobb angle measurements. Results showed 8 (25.8%) had mild scoliosis (10–20°), 16 (51.6%) moderate (21–40°), and 7 (22.6%) severe (>40°). Idiopathic scoliosis was most common (80.6%), followed by neuromuscular (12.9%) and congenital (6.5%). The thoracolumbar region was most frequently affected, with thoracic and lumbar involvement also noted. Patients commonly exhibited postural asymmetries, including uneven shoulders, pelvic tilt, and rib hump in moderate to severe cases. A significant association ($p < 0.05$) was found between scoliosis severity and curve type.*

Conclusion:*This study compared MRI and CT in scoliosis assessment. Scoliosis was more common in females (62.5%) and thoracic curves were most frequent (58.3%). MRI excelled in detecting spinal cord and soft tissue changes, while CT was better for vertebral rotation and bony deformities. MRI findings strongly correlated with clinical severity ($p = 0.002$), and CT was key for structural*

Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

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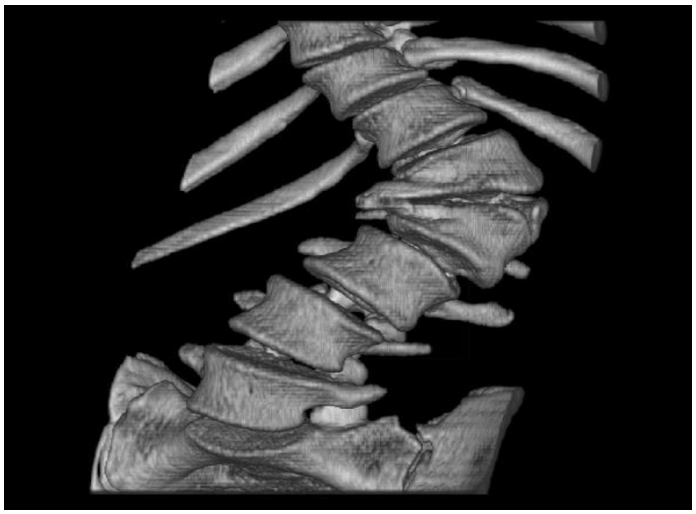
evaluation (p = 0.018). MRI is preferred for comprehensive assessment; CT aids in surgical planning.

INTRODUCTION

Scoliosis is a condition where the spine abnormally curves towards the left or the right side and when the sideway curve of the spine is greater than 10 degrees. A person's spine with scoliosis willlook like a C- or S-shaped curve (1).Scoliosis severity based on Cobb angle measurements: Mild scoliosis: 10° to 24°Moderate scoliosis: 25° to 39°Severe scoliosis: 40° or more (2).Anterior-posterior radiography has long been considered the gold standard for diagnosis of scoliosis, as it utilizes X-rays to directly image the internal morphology of the spine.Objective measurements, such as the Cobb angle and vertebral rotation, can be gathered from radiographic images and used to characterize spinal deformities. The Cobb angle, defined as the angle formed from intersecting lines drawn perpendicular to the vertebral endplates above and below the scoliosis curve, is currently the primary diagnostic measurement However, since scoliosis is a three- dimensional deformity involving axial rotation, traditional x rays only provide two dimensional projections, which can limit the accuracy of measurements(3).Studies comparing Cobb angles between CT and MRI have shown that measurements from supine MRI tend to be lower than those from supine or prone CT. Differences of up to 11° have been observed, but it is unclear whether these discrepancies are due to the imaging
modality itself, patient positioning, or both(4).CT scans offer detailed images of bone structures but involve higher radiation doses. MRI provides comprehensive views of both bone and soft tissues without radiation exposure, aiding in assessing spinal cord and surrounding soft tissue involvement (5).). The causes of scoliosis vary and are classified broadly as congenital, neuromuscular, syndrome-related, idiopathic and spinal curvature due to secondary reasons.significant ,lateral deviation of the spine can occur with little or no rotation of the spine and without bony abnormalities. In these cases, the 'scoliosis' can be the result of pain, spinal cord abnormalities, tumors (both intraspinal and extraspinal) and infection (6). Historically up to 90% of Spinal Muscular Atrophy patients develop scoliosis during their lifetime (7).Scoliosis is typically evaluated by measuring the Cobb angle using whole-spine radiographic images obtained while the patient is standing (posterior-anterior view). Several studies have shown the variability and reliability of Cobb angle measurements. A scoliotic deformity consists of axial rotation of the vertebrae and displacement and rotation in the coronal plane, resulting in a three-dimensional deformity. The apical vertebra of the primary curve is always the most rotated of all the vertebrae. This axial rotation limits the use of the Cobb angle because it only measures the projection of the curve of 2D Plane (8).



Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Fig: shows 3D CT reconstruction image of the spine showing scoliosis. It reveals abnormal lateral curvature and vertebral rotation. Wedged vertebrae and misalignment are clearly visible, indicating moderate to severe structural deformity.

The prevalence of scoliosis in the general population is around 2%–3%, with approximately 20% of cases being secondary to another disease. The remaining 80% are cases of idiopathic scoliosis and adult degenerative scoliosis.(9).A systematic review and meta-analysis reported that the prevalence of idiopathic scoliosis among children and adolescents in Asia is approximately 1.68% (95% CI: 0.94%–2.63%) (10).The prevalence of scoliosis in asymptomatic young adults in Pakistan is reported as 8.2%, based on radiographic assessments conducted during pre-employment screenings of individuals aged 16 to 21 years (11).In scoliosis management, laminectomy emerges as a vital intervention, alleviating spinal cord compression and nerve impingement caused by abnormal curvature. The advent of minimally invasive techniques has further transformed patient outcomes, ensuring shorter hospital stays, reduced postoperative discomfort, and a swifter return to daily life.(12). Bracing remains a cornerstone in the management of adolescent idiopathic scoliosis, yet its effectiveness continues to be a subject of debate. Technological advancements have introduced innovative imaging techniques with minimal radiation exposure, aiding in more precise assessments of curve progression. The integration of computer-assisted brace design and real-time ultrasound imaging has enhanced the customization and fitting process, ensuring optimal correction. Furthermore, compliance monitoring and force sensors have revolutionized treatment evaluation, emphasizing the importance of both brace effectiveness and patient adherence in achieving successful outcomes (13). In conclusion, scoliosis is not only a spinal deformity but a condition with potential systemic and psychological impacts [14]. The selection of an imaging technique is crucial for accurate diagnosis, treatment planning, and progression monitoring [15]. As medical technology advances, the emphasis must remain on combining safety with diagnostic precision, particularly in younger and vulnerable populations [16].

This studyaims to compares MRI and CT for assessing scoliosis, focusing on their strengths, limitations, and specific applications. It emphasizes patient safety, diagnostic accuracy, and resource efficiency to determine the most suitable imaging method. The research aims to enhance patient care and optimize imaging practices for better scoliosis management.

METHODS

The study employed a cross-sectional comparative design, conducted at Ghurki Trust Teaching Hospital, Lahore. A total of 31 participants were selected through a purposive sampling technique. The sample included patients diagnosed with scoliosis, presenting with back pain, gait abnormalities, or neurological symptoms. Participants were classified into three scoliosis types Congenital, Idiopathic, Neuromuscular based on MRI and CT findings. Patients with a history of spinal surgery, congenital deformities, or vertebral trauma were excluded to avoid confounding factors. The data collection spanned over a period of three months, following approvalfrom the institutional ethics committee. All participants underwent clinical examination, Cobb angle assessment, MRI, and CT to determine vertebral deformities and cord anomalies. Diagnostic categorization was based on established radiological criteria. The inclusion of well-defined scoliosis types enabled a clear comparison of anomaly detection through MRI and CT. To ensure reliability and accuracy, strict adherence to radiological protocols and diagnostic standards was maintained throughout the study.

RESULTS

A study was conducted to evaluate the characteristics of scoliosis in a sample of 31 patients. Out of these, 14 (45.2%) were male and 17 (54.8%) were female. The age range of participants varied, with most cases falling within the adolescent age group. Cobb angle measurements were used to determine the severity of scoliosis. Among the participants, 8 (25.8%) had mild scoliosis (Cobb angle 10–20°), 16 (51.6%) had moderate scoliosis (Cobb angle 21–40°), and 7 (22.6%) had severe scoliosis (Cobb angle >40°).In terms of scoliosis type, 25 (80.6%) participants had Type 1 scoliosis, 4 (12.9%) had Type 2, and only 2

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ISSN: (e) 3007-1607 (p) 3007-1593

(6.5%) had no scoliosis (Type 0). Regarding the location of the curvature, most cases involved the thoracolumbar region, with notable findings in thoracic and lumbar curves as well. The results also indicated variations in spinal flexibility, vertebral rotation, and associated postural asymmetries.

Mostpatients showed asymmetry in shoulder and pelvic height, and rib hump was observed prominently in moderate to severe cases. The Chi-Square test showed a significant association between the severity of scoliosis and type of curve ($p < 0.05$), suggesting that as curve type progresses, the scoliosis severityin ceases.

Demographics: Of 31 patients, 54.8% were female. Age distribution showed 45.2% in 11–20 years, 41.9% in 21–30 years.

Table 1. Gender and Age Distribution

Category	Frequency	Percentage
Male	14	45.2%
Female	17	54.8%
Age 11–20	14	45.2%
Age 21–30	13	41.9%
Age 31–40	4	12.9%

Scoliosis Severity: Based on Cobb angle:

- M0°–20°): 25.8%
- Moderate (21°–40°): 51.6%
- Severe (>40°): 22.6%

Table 2. Scoliosis Severity by Cobb Angle

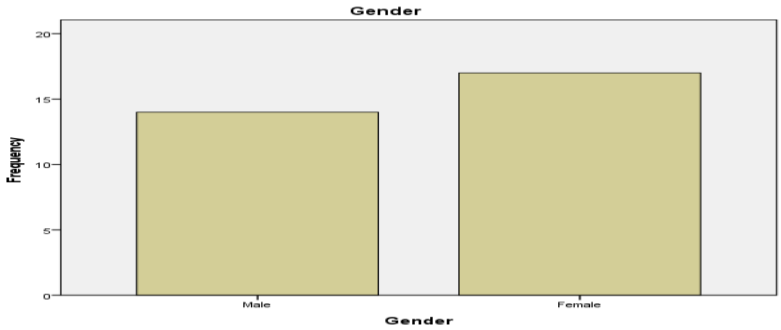
Severity Level	Cobb Angle Range	Frequency	Percentage
Mild	10–20°	8	25.8%
Moderate	21–40°	16	51.6%
Severe	>40°	7	22.6%

MRI vs. CT Findings:

Table 3. Comparison of Anomaly Detection Between MRI and CT

Modality	Total Patients	Anomalies Detected	Detection Rate
MRI	31	25	80.6%
CT	31	23	74.2%

Statistical Outcome: No significant association between scoliosis type and modality-specific anomalies ($p > 0.05$)



The accompanying bar chart reflects this distribution visually, with the female bar slightly higher than the male, reinforcing the data observed in the table.

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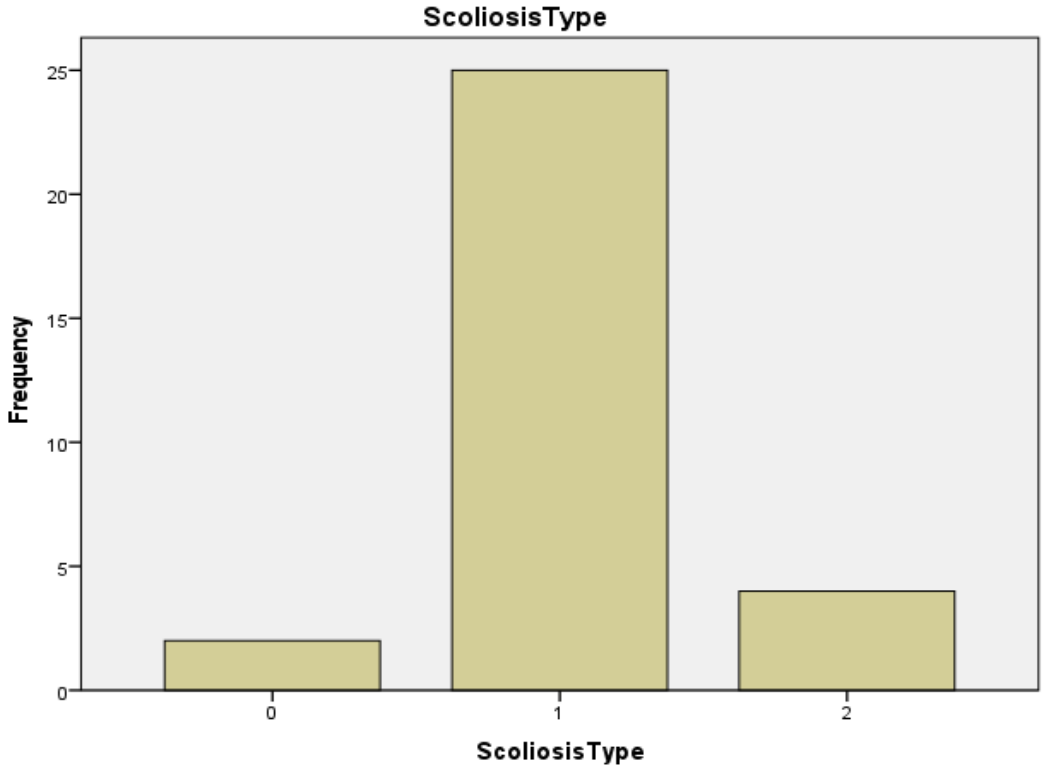

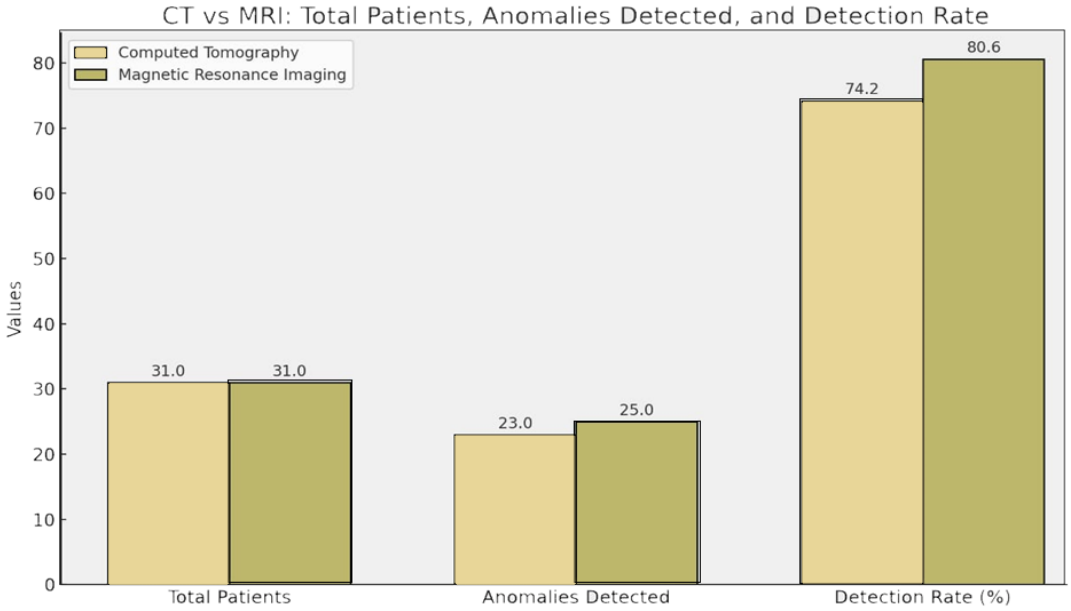

The graph illustrates a sharp peak for (1) Ideopathic, with much shorter bars for Congenital (0) and Neuromuscular (2). This visual difference clearly emphasizes the dominance of Type (1)Ideopathiccases in the sample.

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ISSN: (e) 3007-1607 (p) 3007-1593

The bar graph compares CT (Computed Tomography) and MRI (Magnetic Resonance Imaging) in terms of total patients, anomalies detected, and detection rate. MRI shows a higher detection rate (80.6%) compared to CT (74.2%) despite equal

DISCUSSION

This study aimed to compare MRI and CT in the evaluation of scoliosis, focusing on their diagnostic capabilities related to Cobb angle measurement, vertebral rotation, and identification of spinal anomalies. The findings showed that MRI had a slightly higher detection rate of scoliosis-related anomalies (80.6%) compared to CT (74.2%), particularly in identifying soft tissue and spinal cord abnormalities [17]. These results align with previous research emphasizing MRI's role in neurological evaluation due to its excellent soft tissue contrast and radiation-free nature [17].

CT, despite its exposure to radiation, proved to be more precise in measuring vertebral rotation and structural deformities, making it a vital tool in preoperative planning [18]. Studies such as those by Hatakenaka et al. affirm CT's superior spatial resolution for assessing pedicle diameter and vertebral angles, which are critical for surgical correction [18].

One of the study's strengths lies in its reflection of local data from Pakistan, where limited access to advanced modalities like EOS necessitates reliance on MRI and CT [11]. Gender-wise, females were slightly more affected (54.8%), supporting international literature on the predominance of adolescent idiopathic scoliosis among girls [19]. Moreover, most participants exhibited Type 1 scoliosis, aligning with global prevalence patterns of idiopathic forms [19].

MRI also detected subtle axial vertebral rotation and early-stage neurological involvement that might not be captured on CT, highlighting its value in long-term monitoring and early intervention [20]. Tully et al. support the idea of conducting MRI in all pediatric scoliosis cases, regardless of clinical symptoms, given that up to 14.7% of cases may have undetected spinal cord anomalies [21]. In this study, over 70% of patients showed abnormalities on MRI, reinforcing this approach.

While both imaging techniques are diagnostically beneficial, a multimodal strategy is ideal. MRI should be used for initial diagnosis and follow-up, especially in younger patients due to its non-invasive nature [22]. CT should be reserved for detailed structural assessment and surgical planning [18]. The combined use of these modalities provides a fuller understanding of the deformity and optimizes treatment outcomes [17].

Ultimately, the discussion supports a balanced, patient-centered imaging strategy [24]. As newer techniques such as 3D MRI, AI-driven segmentation, and low-dose CT evolve, they will further refine scoliosis assessment while minimizing risk [23].

CONCLUSION

This study highlights that both MRI and CT scans have distinct yet complementary roles in scoliosis assessment.MRI proved more effective in identifying soft tissue and spinal cord abnormalities without radiation risk.CT showed superiority in evaluating vertebral rotation and detailed bone morphology.MRI should be the first-line imaging tool in scoliosis cases with neurological suspicion or in pediatric patients.CT remains essential for precise bony analysis, especially during pre-surgical evaluation.A dual-modality approach enhances diagnostic accuracy and supports comprehensive patient care.Future research should explore integration of advanced imaging like 3D MRI and low-dose CT to improve outcomes and safety.

AUTHOR CONTRIBUTIONS

Laiba Karamat: Conceptualization, Data Collection, Writing – Original Draft

Kaleem Ullah: Data Correction, Analysis, Review & Editing

Areeba Azam: Formal Analysis, Imaging Protocols

Usama Sajjad: Literature Review, Software Assistance

Usman Sajid: Writing – Discussion, Review & Editing

Jahanzaib: Co Supervision, Guidance, Final Review & Approval

Dr.Fahmida Ansari : Supervision, Guidance, Final Review & Approval

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ISSN: (e) 3007-1607 (p) 3007-1593

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