3D Ultrasound vs. X-ray for Diagnosing Adolescent Scoliosis

INTRODUCTION

What is Scoliosis?

Scoliosis occurs when the spine curves sideways more than 10° and in some cases the spine twists. Doctors measure this curvature with the **Cobb angle.** This angle finds the most tilted vertebrae at the top and bottom of the curve, drawing parallel lines along their borders .

The Radiation Problem

X-rays work well, but they expose patients to ionizing radiation. Adolescents with scoliosis often need X-rays every few months for years. Over time, that radiation adds up and raises the risk of DNA damage. This is especially concerning for kids who are still growing.

A Safer Option

3D Ultrasound uses reflected sound waves instead of radiation. It can still show the shape of the spine in 3D, so no harmful exposure needed. Researchers have been working to find out if it's accurate enough to replace, or at least reduce, X-ray use.

OBJECTIVES

Compare 3D Ultrasound with standard X-ray imaging for Scoliosis. The goals are to:

- Check how closely 3D Ultrasound measurements match X-ray Cobb angles
- See if repeated scans give the same results (reliability)
- Look at safety and ease of use advantages
- Evaluate whether ultrasound could work in school screening programs

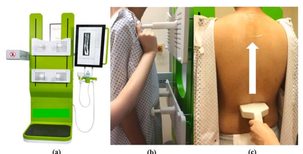
MATERIALS & METHODS

Who was studied: Teens with idiopathic scoliosis who received both 3D ultrasound and X-ray on the same visit.

Ultrasound: Free-hand or volume-projection systems (e.g., Scolioscan/SCN801) measured the Ultrasound Curve Angle (UCA).

X-ray: Standard standing radiographs provided the Cobb angle benchmark.

Analysis: Researchers compared UCA vs. Cobb angle for measurement agreement, reliability across operators, and practical scan efficiency.



(Lee 2021)

(a) The 3D ultrasound imaging system (SCN801) used for ultrasound scanning.
(b) The use of the supporters of the chest and hip boards to keep the body stable.
(c) Upward sliding of the ultrasound probe to scan the patient.

www.PosterPresentations.com

RESULTS

~5°
Average measurement difference between UCA and Cobb angle — within clinical tolerance

99%
Intra-operator similarity rate in repeated ultrasound scans, comparable to X-ray reliability

>50%
Reduction in unnecessary X-rays when ultrasound was used to pre-screen students

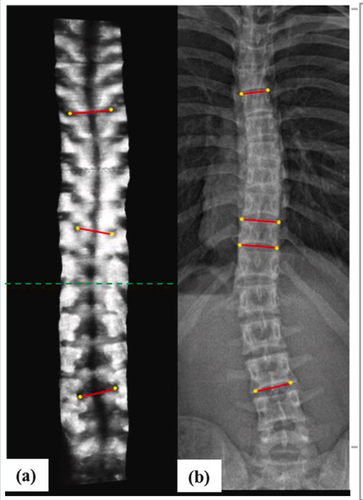
<60s
Scan time for some ultrasound systems, enabling fast high-volume clinic screening

Accuracy: Studies found strong agreement between 3D Ultrasound and X-ray measurements. The difference between them was usually within a few degrees, which doctors consider acceptable for tracking curve progression.

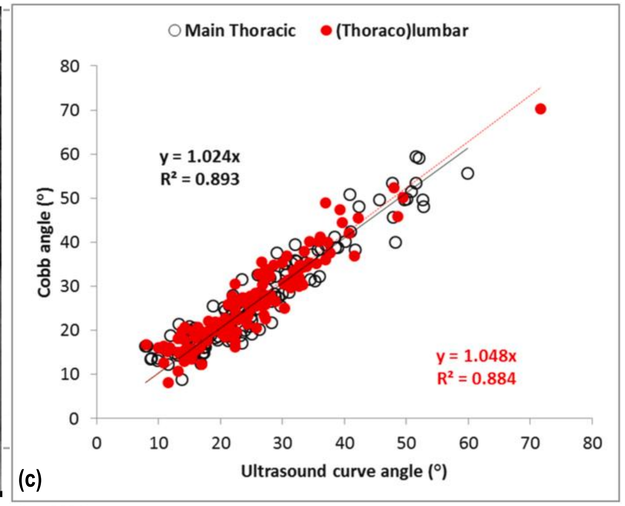
Reliability: Whether the same technician did the scan twice, or two different technicians did it, the results were highly consistent with about 99% agreement in angle measurements.

Safety: Ultrasound produces zero radiation exposure. In school-based screening studies, it cut the number of follow-up X-rays in half by ruling out kids who didn't need further imaging.

IMAGING COMPARISON: X-RAY VS. 3D ULTRASOUND



(Lee 2021)



(Lee 2021)

a) Ultrasound Curve Angle used on a patient.

b) X-ray Cobb Angles used on the same patient.

c) The correlation between the UCA and Cobb angle are shown with a very similar regression equation. Showing a strong correlation in degree of similarity between the two.

CONCLUSIONS

3D Ultrasound is a promising **radiation-free** option for diagnosing and monitoring scoliosis, especially for teenagers who need repeated scans over many years.

While X-ray is still the gold standard for precise Cobb angle measurement, ultrasound:

- Matches X-ray accuracy within a clinically acceptable range
- Delivers highly repeatable results across different operators
- Eliminates radiation risk for growing adolescents
- Can dramatically reduce unnecessary X-rays in large screening programs

As imaging technology evolves, 3D Ultrasound could become a routine part of scoliosis diagnosis and possibly replace many X-ray routines used today.

CLINICAL SIGNIFICANCE

Scoliosis affects roughly 2–3% of adolescents. Most of them require imaging checkups every 4–6 months during growth spurts. With X-ray as the only option, the radiation adds up fast.

3D Ultrasound could change the standard of care: kids with mild curves could be monitored without any radiation, and X-rays could be reserved only for cases where precise measurement truly matters.

REFERENCES

Du, H., Liu, C., Zhao, X., et al. (2025). Validity and reliability of 3D automatic ultrasound imaging for measuring coronal and sagittal angles in idiopathic scoliosis. Scientific Reports, 15, Article 33558. https://www.nature.com/articles/s41598-025-18538-1

Kwan, C. K., Young, J. H., Lai, J. C., Lai, K. K., Yang, K. G., Hung, A. L., Chu, W. C., Lau, A. Y., Lee, T. Y., Cheng, J. C., Zheng, Y. P., & Lam, T. P. (2025). Three-dimensional (3D) ultrasound imaging for quantitative assessment of frontal cobb angles in patients with idiopathic scoliosis - a systematic review and meta-analysis. BMC musculoskeletal disorders, 26(1), 222. https://doi.org/10.1186/s12891-025-08467-5

Lam, T. P., Pang, H., Wong, Y. S., Yip, B., Hung, A., Chu, W., Lai, K., Zheng, Y. P., & Cheng, J. (2021). Is ultrasound accurate for radiation-free quantitative assessment of spinal curvatures in patients with idiopathic scoliosis - a systematic review and meta-analysis. Studies in health technology and informatics, 280, 109–112. https://doi.org/10.3233/SHTI210446

Lee, T. T.-Y., Lai, K. K.-L., Cheng, J. C.-Y., Castelein, R., Lam, T.-P., & Zheng, Y.-P. (2021). 3D ultrasound imaging provides reliable angle measurement with validity comparable to X-ray in patients with adolescent idiopathic scoliosis. Journal of Orthopaedic Translation, 29, 51–59. https://pmc.ncbi.nlm.nih.gov/articles/PMC8144340/

Pang, H., et al. (2021). Using ultrasound to screen for scoliosis to reduce unnecessary radiographic radiation: A prospective diagnostic accuracy study on 442 schoolchildren. Ultrasound in Medicine and Biology. https://pubmed.ncbi.nlm.nih.gov/34210559/

Yang, D., Lee, T. T., Lai, K. K., Lam, T. P., Chu, W. C., Castelein, R. M., Cheng, J. C., & Zheng, Y. P. (2022). Semi-automatic ultrasound curve angle measurement for adolescent idiopathic scoliosis. Spine deformity, 10(2), 351–359. https://doi.org/10.1007/s43390-021-00421-4

Yang, X., et al. (2025). Three-dimensional ultrasonography: Advancing the clinical evaluation of adolescent idiopathic scoliosis. Ultrasonics Sonochemistry. https://pubmed.ncbi.nlm.nih.gov/40411987/

Zheng, Y.-P., Lee, T. T.-Y., Lai, K. K.-L., et al. (2016). A reliability and validity study for Scolioscan: a radiation-free scoliosis assessment system using 3D ultrasound imaging. Scoliosis and Spinal Disorders, 11, 13. https://scoliosisjournal.biomedcentral.com/articles/10.1186/s13013-016-0074-y