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Beyond the curve: Preoperative detection of inferior vena cava agenesis prevents high-risk thoracic kyphosis correction

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Abstract
A 20-year-old male presented with progressive mid-to-upper back pain, fatigue, and psychological distress related to posture and self-image. Radiographs demonstrated severe, flexible thoracic kyphosis (87°, apex T_9-T_{10}). Cross-sectional imaging unexpectedly revealed congenital agenesis of the inferior vena cava (IVC) with extensive collateral venous channels and epidural venous engorgement. Planned elective spinal deformity correction was cancelled after multidisciplinary review due to prohibitive bleeding risk. This case illustrates that beyond spinal alignment, meticulous evaluation of vascular anatomy and individualised risk stratification are essential in deformity surgery. Early detection of vascular anomalies enables safer decision-making while ensuring the patient's functional and psychosocial needs are balanced against operative risk.

Keywords: Thoracic kyphosis, inferior vena cava agenesis, vascular anomaly, spine surgery, preoperative imaging, mental health, case report

Introduction
Severe thoracic kyphosis in young adults, typically defined as hyperkyphosis exceeding 40°, is associated with pain, impaired function, and increased mortality risk [1-3]. Beyond physical symptoms, visible spinal deformities have profound psychosocial consequences including anxiety, self-consciousness, and depressive symptoms, which often motivate young patients to pursue surgical correction. However, surgery for deformity driven primarily by quality-of-life goals must be balanced against anatomical and vascular safety considerations. Congenital vascular anomalies such as agenesis or atresia of the inferior vena cava (IVC) occur in approximately 0.005-1% of the population [4, 5]. Although often asymptomatic, IVC agenesis may lead to extensive paravertebral and epidural venous collateralization, which markedly increases the risk of intraoperative hemorrhage during spinal exposure [6-9]. Preoperative identification of these anomalies is therefore essential. This case highlights the intersection of surgical ambition, psychological wellbeing, and vascular anatomy in determining safe management.

Case Presentation
Patient Information
A 20-year-old male presented with a two-year history of progressive upper and mid-back pain and persistent fatigue. He expressed growing concern about his posture and self-image. He had previously undergone evaluation for Marfan syndrome, which was negative, and was otherwise healthy, taking only minocycline for acne. There were no known allergies.

Clinical Findings
Examination revealed tall stature, mild left shoulder elevation, and a flexible but pronounced thoracic kyphosis with skin pressure marks over the apex. Neurological examination was normal. There was no spinal tenderness, sensory deficit, or reflex abnormality. Gait and tone were normal.

Timeline
2022: Spine X-ray showed 70° thoracic kyphosis, apex T_9-T_{10}.
May 2025: Repeat X-ray showed progression to 87°, mild lumbar scoliosis (16°) and left pelvic tilt (13°).
July 2025: MRI revealed large paravertebral collaterals and epidural venous plexus engorgement.

August 2025: CTA was performed which revealed absent IVC with multiple collateral venous pathways spanning the thoracolumbar paravertebral and epidural spaces.
Planned deformity correction was cancelled following multidisciplinary evaluation.

Diagnostic Assessment
Radiography confirmed severe, flexible thoracic kyphosis with an apex at T_9-T_{10} and mild compensatory lumbar curvature. MRI excluded spinal cord tethering or vertebral bony abnormality, but revealed extensive collateral venous pathways. A subsequent CTA was performed which revealed agenesis of the IVC with multiple collateral venous pathways.

Therapeutic Intervention
Elective posterior deformity correction was initially planned. Upon discovery of the IVC anomaly, vascular surgery consultation confirmed high risk for massive hemorrhage due to engorged epidural and paravertebral collaterals. The surgical team therefore cancelled the procedure and redirected management toward conservative care comprising physiotherapy, postural re-education, analgesic optimization, and psychological support.

Follow-Up and Outcomes
The patient continued conservative treatment without complications. He reported symptomatic improvement and reduced anxiety following physiotherapy and counselling. No further surgical interventions were pursued. Ongoing follow-up focused on pain control, posture management, and mental wellbeing.

Discussion
This case exemplifies the critical importance of preoperative vascular assessment in spine surgery and the ethical responsibility to balance patient motivation with procedural safety. While deformity correction may improve posture and self-perception, it carries substantial risks when vascular anomalies exist. IVC agenesis, though rare, predisposes to the formation of fragile venous collaterals throughout the paravertebral and epidural spaces, which are highly vulnerable to injury during posterior spinal exposure [6-9]. Yoon *et al.* [6] described vertebral venous collaterals secondary to IVC agenesis producing 'holey pedicles' on imaging—a hallmark of epidural venous engorgement. Similarly, Yigit *et al.* [7] reported lumbar pain as the presenting symptom of IVC agenesis due to venous congestion, underscoring that vascular anomalies may present with nonspecific spinal symptoms. Wang *et al.* [8] documented catastrophic IVC tear during posterior spinal fusion, reinforcing the potential lethality of undetected venous anomalies. From a psychosocial perspective, visible kyphotic deformity can significantly impair self-esteem and mental health. Addressing these concerns requires a multidisciplinary approach that integrates psychological assessment and counselling as part of preoperative planning [10-12]. When imaging reveals prohibitive vascular risk, non-surgical management—focusing on physical rehabilitation, posture optimization, and mental wellbeing—is ethically sound and clinically justified.

Fig 1: Standing lateral radiograph showing severe thoracic kyphosis (87°, apex T_9-T_{10}).

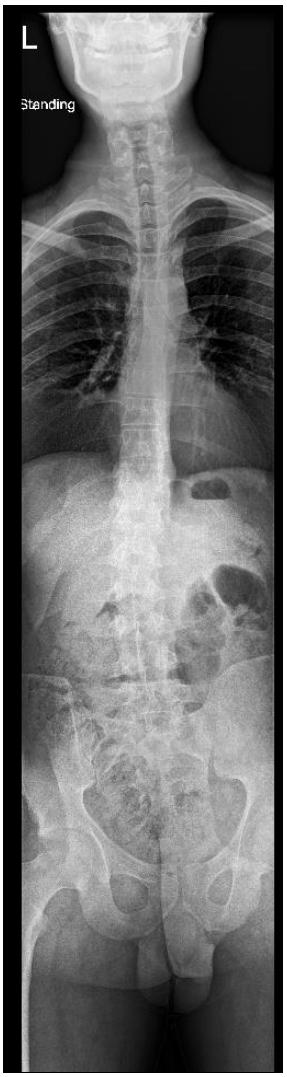

Fig 2: Standing anteroposterior radiograph showing mild scoliotic deformity.

Fig 3: Sagittal MRI demonstrating a large aberrant paravertebral vein (red star) and a large segmental vein (yellow arrow).

Fig 4: Axial MRI showing extensive paravertebral collateral venous channels (yellow arrow = segmental vein; red star = aberrant paravertebral vein; green star = engorged epidural vein).

Fig 5: Coronal CTA demonstrating complete inferior vena cava agenesis (blue star).

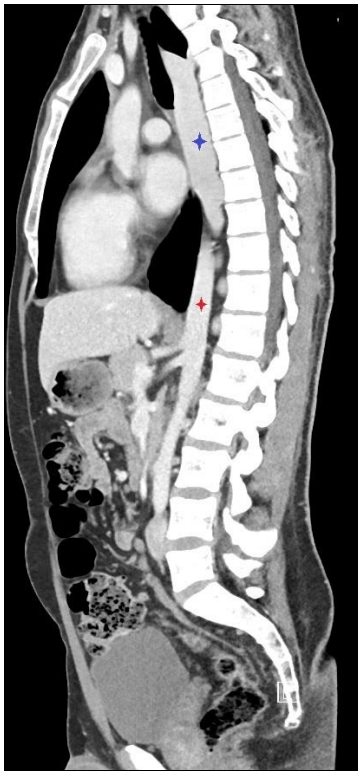

Fig 6: Sagittal CTA showing enlarged azygos system (blue star) and aorta (red star) for comparison.

Conclusion

This case underscores the essential need to evaluate vascular anatomy—not only spinal deformity—prior to proceeding with corrective surgery. Congenital IVC agenesis poses a prohibitive bleeding risk, making conservative management the safest approach in such patients.

Patient Consent

Written informed consent for publication of this anonymised case was obtained from the patient.

Conflict of Interest

The authors declare no conflicts of interest.

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