



# A Very Low-Positioned Aortic Bifurcation

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Anomalies of the aortoiliac arteries are rarely reported and are generally discovered incidentally on imaging performed mostly for investigation of other medical concerns. While aortic bifurcation is typically reported at the fourth lumbar vertebra, variations are possible. We present a case with very low aortic bifurcation, almost at the level of S2, with various other anomalies including a corkscrew left common iliac artery passing just anterior to the bladder dome with pulsation noted during cystoscopy. An ectopic right kidney was also noted. To our knowledge, these vascular anomalies have not been reported previously.

**Key Words:** Lumbosacral spine, Aortic bifurcation, Sacrum, Anatomy, Computed tomography

Received February 27, 2020

Revised April 2, 2020

Accepted April 6, 2020

Published online April 28, 2020

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Vasc Specialist Int 2020;36(2):112-115 • <https://doi.org/10.5758/vsi.200009>

## INTRODUCTION

Several variations in aortic branch origins and courses have been reported in the literature. These variations must be recognized by anatomists, radiologists, and surgeons, especially during laparoscopy, during anterior approaches to spinal surgeries, and while performing interventional radiological procedures [1]. Aortic bifurcation into two common iliac arteries commonly occurs at the L4 vertebral level. However, variations of this level have been reported [2]. Herein, we present congenital vascular anomalies including a very low aortic bifurcation at the S2 level, a left common iliac artery with corkscrew pattern coursing anterior to the urinary bladder with pulsation on cystoscopy, and an ectopic right kidney. Other minor anomalies were also noted. To our knowledge, these anomalies have not been previously reported.

## CASE

A 48-year-old woman with a history of microcytic anemia who was maintained on iron supplements presented with bilateral intermittent flank pain lasting for 6 months that radiated to the groin area along with urgency, urge incontinence, frequent, and painful urination. She was a nonsmoker and denied any previous gross hematuria. She also denied abdominal pain, nausea, fever, or chills.

Her general physical exam was unremarkable. Her lower extremities showed no delayed capillary refill and no pallor or varicosities. The arterial pulses at the femoral, popliteal, and dorsalis pedis arteries were all normal. She had no history of prior trauma or instrumentation of the lower extremity vessels.

All routine laboratory blood and urine tests were within normal ranges, with no signs of urinary infection. Initially, abdominal ultrasonography for evaluation of her loin pain revealed an ectopic small right kidney within the right lower quadrant and a normal left kidney with normal corticome-

dullary differentiation. Neither hydronephrosis nor stones were observed. All other visceral organs appeared normal.

For better imaging and characterization of this loin pain, a computed tomography (CT) scan with intravenous contrast and delayed phases (CT-urography) was performed. Her right kidney was small, measuring 8 cm in length, ectopically located at the L4-L5 vertebral levels and reaching the right hemipelvis. The kidney showed mild pelvicalyceal dilatation and multiple areas of cortical scarring. The contralateral left kidney was normal in size, located in the left hypochondrium at the L1, L2 and L3 vertebra level, with no focal lesions or pelvicalyceal dilatation. No stones were noted bilaterally. A single patent artery to each kidney was observed. The renal arteries were low in origin; the left one originated at the L2-L3 disc level, while the right originated at the level of the superior endplate of the L3 vertebra, without any lumbosacral anomalies. No filling defects in the collecting systems were noted on the excretory phases. The bladder looked unremarkable.

On the arterial phase, the celiac trunk originated at T12, the superior mesenteric artery originated at the level of the T12-L1 collapsed disc space, while the inferior mesenteric artery originated at the level of the inferior endplate of L2. The aortic bifurcation was very low, at the S2 level (Fig. 1). The left common iliac artery had a corkscrew pattern and coursed just anterior to the urinary bladder (Fig. 2), with a relative distal origin from the left external iliac artery at the upper border of the left femoral head. Reconstructive images are shown to better visualize these anomalies (Fig. 3, 4). The patient retrospectively denied any significant childhood events, any similar findings of anomalies within her

parents or siblings, or known genetic or congenital diseases in her family.

As these findings were not a convincing cause for her lower urinary tract symptoms, cystoscopy was performed under spinal anesthesia to rule out interstitial cystitis or bladder tumor. However, only a few bladder wall telangiectasias were noted and biopsied, with benign pathology findings. A pulsation was noted at the bladder dome that, in retrospect, corresponded to the left common iliac artery, just anterior to the bladder. Whilst the diagnosis most likely consistent with interstitial cystitis, the patient was advised to undergo supportive care including adequate hydration and non-steroidal anti-inflammatory drugs. She reported symptom improvement in follow-up visits.

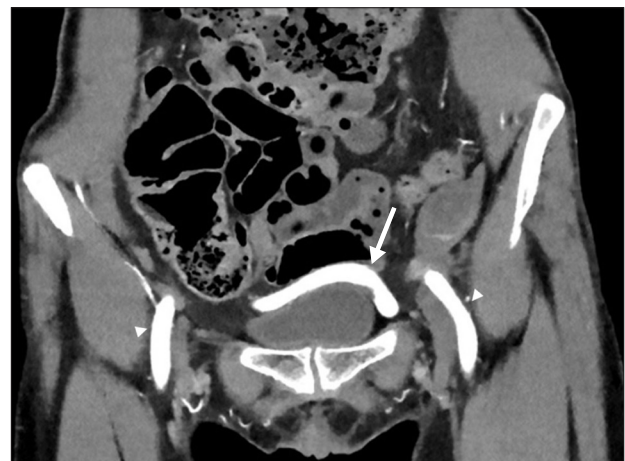
## DISCUSSION

The accurate description of the branches of the abdominal aorta and its bifurcation is for more than educational or academic interest; rather, its importance extends to the proper planning of surgical procedures such as anterior abdominal approaches for spinal surgeries, laparoscopic visceral operations, and interventional radiological procedures for precise interpretation of angiograms [3]. Acknowledging those variations may reduce complications [4].

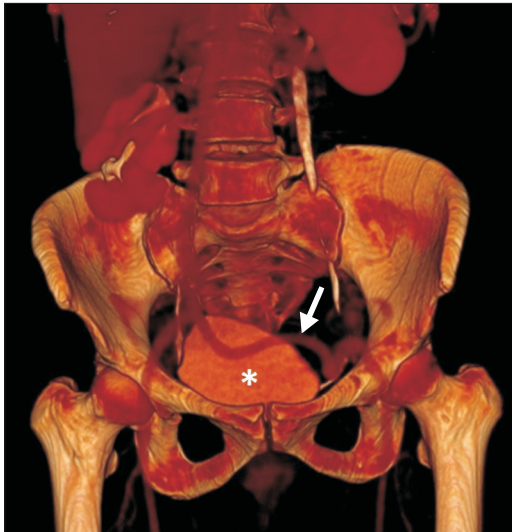
The optimal imaging modalities to identify those anomalies are CT scans with intravenous contrast administration and three-dimensional (3D) reconstruction or conventional digital subtraction angiography [5]. Those modalities can be utilized to investigate chronic lower limb ischemia or for other reasons such as ruling out pathological abdominal



**Fig. 1.** Sagittal cross-section of an enhanced computed tomography scan during the arterial phase, showing aortic bifurcation at approximately the S2 level (arrow).



**Fig. 2.** Coronal cross-section of an enhanced computed tomography scan showing the left common iliac artery coursing in a corkscrew pattern, just anterior to the bladder dome (arrow). Also noted are the bilateral common femoral arteries (arrowheads).

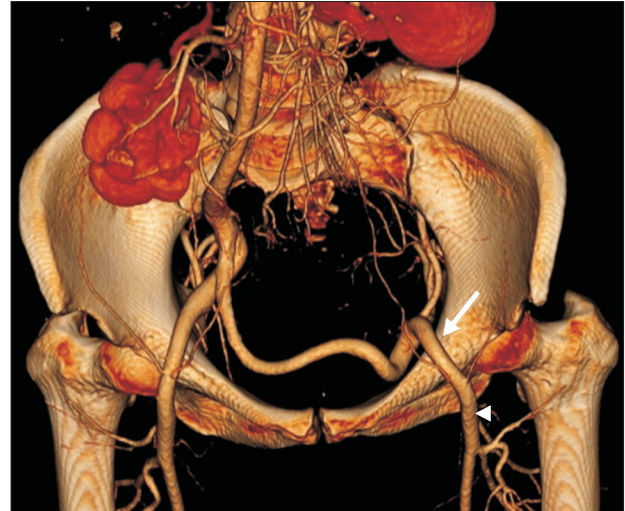


**Fig. 3.** Three-dimensional reconstructed image of a computed tomography scan showing the course of the left common iliac artery (arrow) anterior to the bladder dome (asterisk).

processes [4]. Another utility includes planning for radiation therapy in patients with International Federation of Gynecology and Obstetrics stage IIB to IVA cervical cancer [6], for which concurrent chemotherapy and radiation therapy are considered the standard of care. As such, the proper radiation field must be chosen, with its superior border set at the aortic bifurcation, to include the common iliac lymph nodes in radiation treatment, and minimize disease recurrence [7].

The abdominal aorta starts at the aortic hiatus of the diaphragm, anterior to the 12th thoracic vertebra, and proceeds cephalad to the lower border of the fourth lumbar vertebra (L4). It then divides into two common iliac arteries [8]. As reported by many anatomical textbooks, the most common site of bifurcation is the L4 vertebral level in 67% to 83% of cases [2,3]. Embryologically, aorta development begins in the third gestational week with the dorsal migration of two cell lines from the endocardial mesenchyme. These cells grow along the neural groove to eventually fuse into a single aorta. Numerous segmental arteries form and then regress. Only the 10th, 13th, and the 22nd persist to form the celiac trunk, superior mesenteric, and inferior mesenteric arteries, respectively. The common iliac arteries form by way of anastomoses between the allantoic and fifth lumbar dorsal intersegmental arteries [9].

The literature includes several cases describing variations in vertebral levels at which the aorta bifurcated. In their series of 210 patients who underwent lumbosacral magnetic resonance imaging (MRI), Lee et al. [2] reported that



**Fig. 4.** Three-dimensional reconstructed image, excluding the bladder, showing various vascular anomalies, including a deviated abdominal aorta to the right side with a very low bifurcation level at the sacrum; the left external iliac artery arises at the upper level of the femoral head (arrow), giving rise to the common femoral artery just below the inguinal ligament (arrowhead).

the commonest site of aortic bifurcation was at the level of L4 vertebra in 174 (83%) patients, the lower half of the L3 vertebra in four (2%) patients, and the upper half of L5 in two (1%) patients. A similar study by Chithriki et al. [3] also reported that the most common location was the L4 level (67% of cases), followed by the L3/L4 vertebral body (13% of cases) and the L3 level (9% of cases). In contrast, Inamasu et al. [10] reported a lower incidence of L4 bifurcation, at around 55%. Finally, a cadaveric study by Kawahara et al. [11] reported aortic branching at the L3 in one cadaver, L3-L4 in two cadavers, L4 in eight cadavers, L4-L5 in nine cadavers, and L5 in one cadaver.

With increasing age, the length of the spine decreases owing to reduced intervertebral disc thickness, resulting in caudal shifting of the aortic bifurcation [12]. As such, patient age should be considered. Similarly, lumbosacral anomalies are reported in 20% of patients [13] and may include either sacralization or lumbarization. Other abnormalities such as the presence of cervical ribs, hypoplasia of the 12th rib, or transitional vertebra [2] may result in inaccurate vertebra counts and must be considered when exact identification of the level of bifurcation is required.

In conclusion, our patient demonstrated unique vascular anatomy that, to our knowledge, has never before been reported. The most important anomaly was a very low aortic bifurcation at nearly the S2 level. Such anomalies usually go unnoticed if not discovered after investigating other

etiologies. CT scans with 3D-image reconstruction provide valuable information for those variations, the identification of which is important for both surgeons and interventional radiologists to properly plan procedures, in order to minimize complications and misinterpretation. Follow-up of such cases does not differ from that of individuals with normal vascular anatomy.

## CONFLICTS OF INTEREST

The authors have nothing to disclose.

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Concept and design: JAD, HM. Analysis and interpretation: JAD, TKY, MYRD. Data collection: JAD, MYRD, TKY. Writing the article: JAD, TKY. Critical revision of the article: JAD, TKY. Final approval of the article: JAD, HM, TKY, MYRD. Obtained funding: none. Overall responsibility: JAD, TKY.

## REFERENCES

- 1) Wamanrao MU, Ramakrishna KY. Anatomical study of abdominal aorta and its branches for multiple variations. *Int J Anat Res* 2016;4:2320-2327.
- 2) Lee CH, Seo BK, Choi YC, Shin HJ, Park JH, Jeon HJ, et al. Using MRI to evaluate anatomic significance of aortic bifurcation, right renal artery, and conus medullaris when locating lumbar vertebral segments. *AJR Am J Roentgenol* 2004;182:1295-1300.
- 3) Chithraki M, Jaibaji M, Steele RD. The anatomical relationship of the aortic bifurcation to the lumbar vertebrae: a MRI study. *Surg Radiol Anat* 2002;24:308-312.
- 4) Atalar MH, Salk I, Bozbiyik N, Cetin A. Diagnosis of high bifurcation of the abdominal aorta with associated vascular variations: case report with multidetector computed tomography. *Pol J Radiol* 2015;80:523-525.
- 5) Harb Z, Williams S, Rutter P. Bilateral congenital absence of internal iliac arteries, prominent lumbar arteries, and a ruptured mycotic aneurysm of the abdominal aorta. *Ann R Coll Surg Engl* 2006;88:W3-W5.
- 6) Mishra H, Hadi R, Sahni K, Mishra R, Ali M. Evaluation of level of aortic bifurcation in patients of carcinoma cervix. *Ann Int Med Dent Res* 2017;3:RT01-RT03.
- 7) Ponni TR, Avinash HU, Janaki MG, Koushik AS, Somashekar MK. Implication of bifurcation of abdominal aorta for Radiotherapy Planning for Cervical Cancers. *J Clin Diagn Res* 2015;9:XC01-XC03.
- 8) Salve VM, Ratanprabha C. Multiple variations of branches of abdominal aorta. *Kathmandu Univ Med J (KUMJ)* 2011;9:72-76.
- 9) Lin PH, Chaikof EL. Embryology, anatomy, and surgical exposure of the great abdominal vessels. *Surg Clin North Am* 2000;80:417-433, xiv.
- 10) Inamasu J, Kim DH, Logan L. Three-dimensional computed tomographic anatomy of the abdominal great vessels pertinent to L4-L5 anterior lumbar interbody fusion. *Minim Invasive Neurosurg* 2005;48:127-131.
- 11) Kawahara N, Tomita K, Baba H, Toribatake Y, Fujita T, Mizuno K, et al. Cadaveric vascular anatomy for total en bloc spondylectomy in malignant vertebral tumors. *Spine (Phila Pa 1976)* 1996;21:1401-1407.
- 12) Khamanarong K, Sae-Jung S, Supa-Adirek C, Teerakul S, Prachaney P. Aortic bifurcation: a cadaveric study of its relationship to the spine. *J Med Assoc Thai* 2009;92:47-49.
- 13) Peh WC, Siu TH, Chan JH. Determining the lumbar vertebral segments on magnetic resonance imaging. *Spine (Phila Pa 1976)* 1999;24:1852-1855.