Section: Radiology

Review Article

ABDOMINOPELVIC VASCULAR COMPRESSION SYNDROMES: DIAGNOSTIC INSIGHTS USING MULTIDETECTOR CT AND MULTIPLANAR RECONSTRUCTION

Ajay Adhithya A[1], R Ramesh Kumar[2], B Venkata Giri Srinivas[3], Vyshnavi Gantasala[1], Soujanya B[1]

[1]Junior Resident cum Post-Graduate, Department of Radio-Diagnosis, PES Institute of Medical Sciences and Research, Kuppam, Chittoor, Andhra Pradesh, India
[2]Professor & HOD, Department of Radio-Diagnosis, PES Institute of Medical Sciences and Research, Kuppam, Chittoor, Andhra Pradesh, India
[3]Assistant Professor, Department of Radio-Diagnosis, PES Institute of Medical Sciences and Research, Kuppam, Chittoor, Andhra Pradesh, India

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Corresponding Author:
Dr. Ajay Adhithya A,
Email: dr.ajayadhithya@gmail.com

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ABSTRACT

Abdominopelvic vascular compression syndromes (AVCS) are rare yet clinically significant conditions arising from extrinsic compression of vascular or adjacent structures by normal anatomical variants. These syndromes present diagnostic challenges due to nonspecific symptoms and complex anatomic relationships. Computed tomography (CT), particularly with multiplanar reconstruction (MPR), has revolutionized their detection and characterization. This article explores the diagnostic role of CT with MPR in the comprehensive evaluation of AVCS, including both vascular and vascular-induced urologic compression phenomena.

INTRODUCTION

Abdominopelvic vascular compression syndromes (AVCS) encompass a range of disorders caused by the compression of vessels or adjacent structures by normal anatomical elements.

These syndromes include:

- Median Arcuate Ligament Syndrome (MALS)
- Nutcracker Syndrome (NCS)
- May-Thurner Syndrome (MTS)
- Superior Mesenteric Artery Syndrome (SMAS)
- Ureteropelvic Junction Obstruction (UPJO) by Crossing Vessels
- Retrocaval Ureter

Although infrequent, these syndromes are important differential diagnoses in patients presenting with chronic abdominal pain, hematuria, unexplained venous thrombosis, or hydronephrosis.

With the advent of multidetector computed tomography (MDCT) and high-resolution multiplanar reconstruction (MPR), radiologists are now better equipped to detect these subtle yet clinically significant conditions.[1]

Aims And Objectives

Aim: To evaluate the diagnostic utility of CT and multiplanar reconstruction (MPR) in detecting and characterizing abdominopelvic vascular compression syndromes.

Objectives

- To review key abdominopelvic vascular compression syndromes and their CT imaging features.
- To demonstrate the role of MPR in enhancing anatomical assessment and diagnostic accuracy.
- To highlight the clinical significance of early and accurate radiologic diagnosis for guiding management.

MATERIALS AND METHODS

A retrospective study conducted based on the data of 25 patients with imaging findings indicative of abdominopelvic vascular compression syndromes in the Department of Radio-Diagnosis, PES Institute of Medical Sciences and Research, Kuppam, Chittoor, Andhra Pradesh, India between October 2022 to April 2025. These patients had variable clinical indications such as abdominal pain (epigastric and flank regions), weight loss, nausea, vomiting, hematuria and abdominal bloating. CT scan of the abdomen and pelvis were performed using GE Revolution 32 slice CT scanner. Informed consent was obtained from all the patients. Detailed imaging findings were recorded for each patient.

RESULTS & DISCUSSION

1. Median Arcuate Ligament Syndrome (MALS)

MALS is caused by the compression of the celiac artery by the median arcuate ligament of the diaphragm. Patients typically present with postprandial abdominal pain, weight loss, and epigastric bruit.[2]

CT Findings

- "Hooked" appearance of the celiac artery.
- Proximal narrowing with post-stenotic dilatation.
- Enhanced visualization during expiration, as diaphragmatic crura descend during inspiration.

MPR Utility

- Sagittal reconstructions are essential to identify the celiac artery compression and measure its angle.
- Helps distinguish MALS from atherosclerotic stenosis.[3]

Figure 1: Median Arcuate Ligament Syndrome - Compression of the celiac artery by the median arcuate ligament of the diaphragm

2. Nutcracker Syndrome (NCS)

NCS is due to compression of the left renal vein (LRV), resulting in left renal venous hypertension, hematuria, and flank pain.

A. Anterior Nutcracker Syndrome (ANCS)

ANCS is caused by LRV compression between the aorta and the superior mesenteric artery (SMA).

CT Findings

- Narrowed aortomesenteric angle (<22°).
- Reduced aortomesenteric distance (<8 mm).
- "Beak sign" and pre-stenotic LRV dilatation.[4]

MPR Utility

- Sagittal MPR allows precise measurement of the aortomesenteric angle.
- Visualization of venous dilation and compression segment.[5]

B. Posterior Nutcracker Syndrome (PNCS)

PNCS is a less common variant, where the LRV courses retroaortically and is compressed between the aorta and vertebral body.

CT Findings

- Retroaortic LRV with posterior compression.
- "Reverse beak" sign and reduced flow through the compressed segment.[6]

MPR Utility

- Coronal and axial MPR confirm posterior ureteral course and compression site.
- Differentiates from anterior variant and guides treatment.[7]

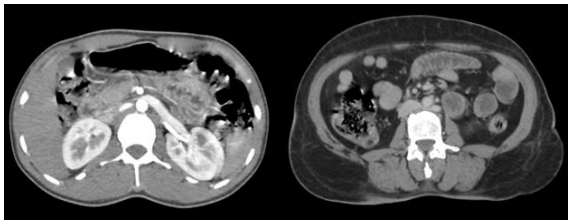

Figure 2: A - Anterior Nutcracker Syndrome - Compression of left renal vein between the aorta and the superior mesenteric artery (SMA)
B - Posterior Nutcracker Syndrome - Left renal vein courses retroaortically and compressed between the aorta and vertebra

3. May-Thurner Syndrome (MTS)

MTS is caused by the compression of the left common iliac vein (LCIV) between the right common iliac artery (RCIA) and lumbar vertebrae, resulting in venous stasis and thrombosis.

CT Findings:

- Narrowing of LCIV and presence of pelvic collaterals.
- Thrombus formation in cases of deep vein thrombosis (DVT).[8]

MPR Utility:

- Axial MPRs highlight the crossing anatomy.
- Coronal and sagittal reconstructions show exact compression level and extent.[9]

4. Superior Mesenteric Artery Syndrome (SMAS)

SMAS results from compression of the third portion of the duodenum between the SMA and the aorta, leading to duodenal obstruction.

CT Findings:

- Dilated stomach and proximal duodenum.
- Abrupt narrowing at the aortomesenteric angle.
- Aortomesenteric distance <8 mm confirms diagnosis.[10]

MPR Utility:

- Sagittal MPR allows measurement of the aortomesenteric angle and visualization of duodenal compression.
- Helps in differentiating SMAS from mechanical obstruction.[11]

5. Ureteropelvic Junction Obstruction by Crossing Vessels

Extrinsic compression of the ureteropelvic junction (UPJ) by crossing renal vessels - often lower pole segmental arteries or veins - can cause intermittent obstruction and hydronephrosis.

CT Findings

- Hydronephrosis with abrupt narrowing at UPJ.
- Identification of crossing vessels compressing the ureter.

MPR Utility

- Oblique and sagittal MPRs precisely delineate vessel-ureter relationships.

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- 3D reconstructions aid in surgical planning, especially in minimally invasive pyeloplasty.[12]

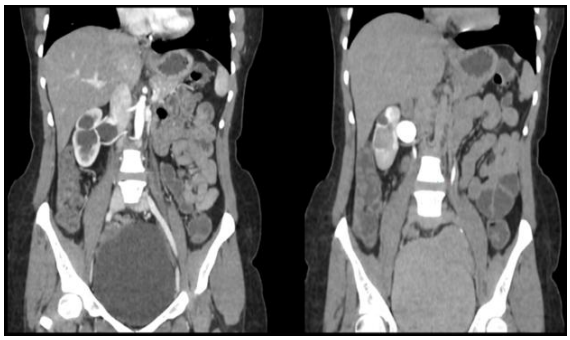

Figure 3: Ureteropelvic Junction Obstruction by Crossing Vessels - Extrinsic compression of the ureteropelvic junction (UPJ) by crossing renal vessels causing hydronephrosis

6. Retrocaval Ureter

Retrocaval ureter is a congenital anomaly where the ureter courses posterior to the inferior vena cava (IVC), causing ureteral obstruction.

Figure 4: Retrocaval Ureter - Ureter courses posterior to the inferior vena cava (IVC) causing ureteral obstruction.

CT Findings

- "Reverse J" or "fish-hook" shaped ureter.
- Hydronephrosis proximal to the obstructed segment.
- Medial deviation of the ureter behind the IVC.[13]

MPR Utility

- Coronal and axial MPR confirm the abnormal ureteral course.
- Facilitates differentiation from other secondary causes of ureteral obstruction.[14]

CONCLUSION

Multidetector CT with multiplanar reconstruction is the gold standard imaging modality for diagnosing abdominopelvic vascular compression syndromes. MPR enables accurate depiction of anatomical relationships and identification of subtle vascular and ureteral compressions that are often missed on axial images alone. Familiarity with the varied presentations - including vascular, gastrointestinal, and urologic syndromes - is essential for radiologists to provide accurate, clinically relevant diagnoses that can guide timely intervention.

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