Research Article

CT imaging findings in vascular compression syndromes in abdomen and pelvis

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Abstract

Vascular compression syndromes are clinical conditions which occurs when vessels get entrapped between two surfaces which is rigid or semirigid, within a confined anatomic space. Vascular structures in the abdomen and pelvis can get compressed by anatomic structures or they can cause compression of hollow viscera adjacent to it. These conditions may be asymptomatic, but when it becomes symptomatic, can lead to many uncommon vascular compression syndromes. Diagnosis of these conditions is always based on imaging as well as clinical findings as these imaging findings may also exist as normal variants in healthy individuals. Hence, thorough understandings of these conditions are essential to make an accurate diagnosis and to identify the group of patients who will benefit from treatment. In this article, we describe clinical features, pathophysiology and typical radiological findings in these vascular compression syndromes.

Keywords: Compression syndrome, MALS, SMA, Retrocaval, Nut cracker, May Thurner.

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INTRODUCTION

Vascular compression syndromes are clinical conditions which occurs when vessels get entrapped between two surfaces within a confined anatomic space.[1] Vascular structures in the abdomen and pelvis can get compressed by anatomic structures or they can cause compression of hollow viscera adjacent to it. Diagnosis of the vascular compression syndromes is always based on imaging as well as clinical findings.[2] as normal individuals may also have similar imaging findings. We have studied the imaging findings of median arcuate ligament syndrome, superior mesenteric artery syndrome, retrocaval ureter, May Thurner syndrome and nut cracker syndrome and have described the same.

MATERIALS AND METHODS

Contrast enhanced CT abdomen was done in PHILIPS BRILLIANCE 16 and GE VCT LIGHT SPEED CT scan machines in 756 patients. Five cases of median arcuate ligament syndrome, two cases of superior mesenteric artery syndrome, six cases of retrocaval ureter, eight cases of May Thurner syndrome and one case of nut cracker syndrome were identified. We have described one representative case of each in our article. Water was used as an oral contrast in conditions where stomach or bowel needed to be distended to study the conditions.3D reformations and MIP images were studied as required.

OBSERVATIONS AND RESULTS

CASE 1

This is a case of 45 year old male who presented with history of significant weight loss since 6 months and came for evaluation of the same. Patient had complaints of postprandial abdominal pain, predominantly in epigastric region since 6 months. He didn't have any other medical illness or surgical history. His physical examination was unremarkable. Given his history of

significant weight loss with postprandial abdominal pain,ultrasound abdomen was performed which showed no significant abnormality. In view of persistent symptoms ,contrast enhanced CT abdomen was done.CECT abdomen demonstrated focal stenosis of celiac artery at the origin, giving a characteristic hook shaped appearance in sagittal images. The inferior aspect of the crura of the diaphragm on right side was found to be hypertrophied with compression at the site of origin of celiac artery causing post stenotic dilatation of the artery. With the clinical history and above imaging findings, a diagnosis of median arcuate ligament syndrome was made. Patient was treated with conservative management and he symptomatically improved and is being followed up.

CASE 2

A 38 year old female presented with history of recurrent episodes of vomiting and post prandial abdominal pain of 3 months duration. Her physical examination and routine blood investigations were normal. Ultrasound abdomen performed showed only a myometrial uterine fibroid. Hence, CECT abdomen was done which showed a grossly distended stomach and first and second part of duodenum along with a aortomesenteric angle of 20.2 degree and aortomesenteric distance of 5 mm. With these imaging findings and patient's symptoms, a diagnosis of superior mesenteric artery syndrome was given. Patient was treated consevatively and resolution of symptoms was seen.

CASE 3

A 9 year old male child was admitted to our hospital with history of abdominal pain in right lumbar region since 3 months. Patient also had recurrent episodes of vomiting, urinary tract infection and had been treated outside for symptoms of urinary tract infection. Physical examination revealed right renal angle tenderness. Urine analysis done was normal. Renal function tests done were within normal limits. Ultrasound abdomen done showed moderate dilatation of right proximal ureter and pelvicalyceal system. Left kidney was normal. Following this, CT urogram done displayed ureter crossing behind inferior vena cava at L3 vertebral level and getting compressed by inferior vena cava thereby resulting in dilatation of proximal ureter and pelvicalyceal system. Fish hook deformity (S shaped) deformity of right ureter was seen. With these imaging features, diagnosis of retrocaval ureter was made. Patient underwent ureteroureterostomy and had an uneventful post operative course.

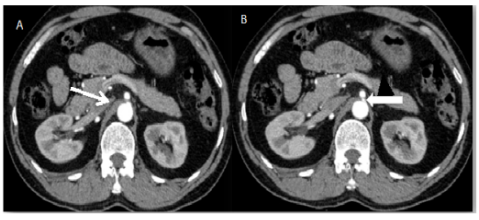
CASE 4

This is a case of 38 year old male who presented with recurrent episodes of pain and ulcer, swelling of left lower limb since 1 year. Patient gave a history of radiofrequency ablation for varicose veins 2 years back and previous history of recurrent episodes of deep vein thrombosis in left lower limb. In view of this clinical history, clinicians raised a possibility of iliac vein compression syndrome and hence CT venogram was done. CT venogram revealed compression of left common iliac vein by right common iliac artery and large abdominal wall collaterals between right and left common femoral vein. Left internal iliac vein was seen to get filled by the collateral veins. A focal non filling of left great saphenous vein was also seen due to thrombus. And an incidental finding of retroaotic left renal vein was present. Above imaging features helped in arriving at a diagnosis of May Thurner syndrome. This patient underwent endophlebectomy of common femoral vein and proximal superficial vein and endovascular stenting of distal inferior vena cava and left common iliac vein. Postoperatively, a Doppler ultrasound of iliac stent was performed which showed normal flow. Presently, patient is symptom free and doing well.

CASE 5

A 45 year old female presented with complaints of hematuria. Urine routine examination showed RBC in urine. Following this, ultrasound abdomen was performed which showed no significant abnormality. Since the patient's symptoms were persisting, CT abdomen was done which showed compression of left renal vein between SMA and aorta. Dilated left distal renal vein and ovarian vein and left ovarian varices were seen. With these imaging features, a diagnosis of anterior nut cracker syndrome was given. She was treated conservatively and on follow up, her symptoms had reduced.

Posterior nut cracker, i.e. retroaortic left renal vein was noticed in the previous patient who was diagnosed to have May Thurner syndrome and was an incidental finding.



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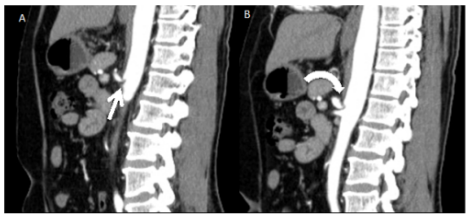

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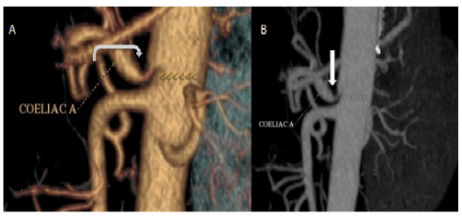

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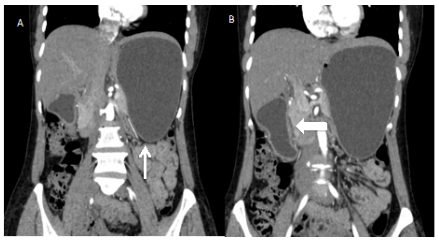

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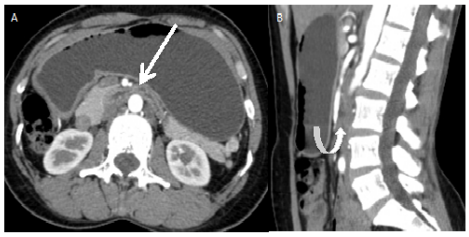

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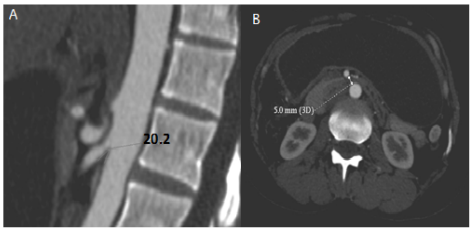

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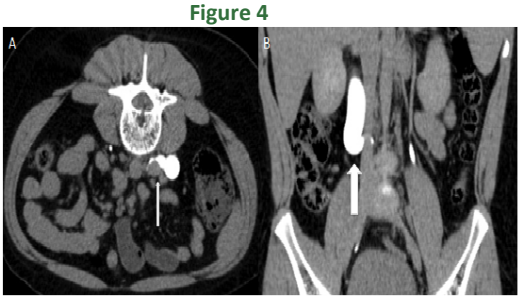

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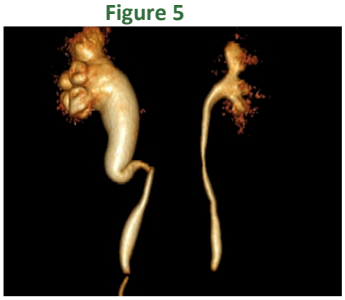

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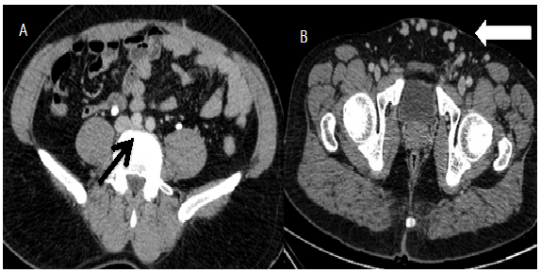

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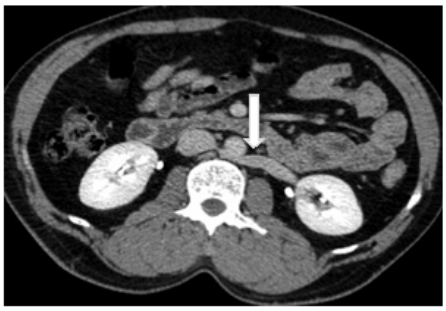

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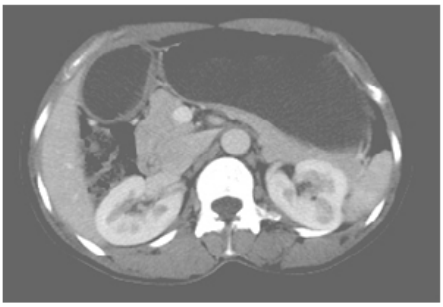

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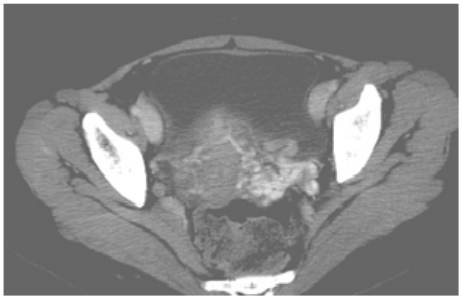

Figure 12

Legend

Figure 1: Contrast enhanced axial sections of CT abdomen of 45 year old male patient who presented with weight loss and epigastric pain since 6 months shows (A) hypertrophied crura of diaphragm on right side (thin arrow) and (B) stenosis of celiac artery at its origin caused by the hypertrophied crura of diaphragm. The patient was diagnosed to have median arcuate ligament syndrome.

Figure 2: Contrast enhanced sagittal sections of CT abdomen of 45 year old male patient who presented with weight loss and epigastric pain since 6 months shows (A) hook shaped contour of celiac artery (white arrow) and (B) post stenotic dilatation of celiac artery(curved white arrow).The patient was diagnosed to have median arcuate ligament syndrome.

Figure 3: 3D reconstructed and MIP sagittal images of CT abdomen of 45 year old male patient who presented with weight loss and epigastric pain since 6 months shows (A) hook shaped contour of celiac artery (curved arrow) and (B) post stenotic dilatation of celiac artery(straight arrow). The patient was diagnosed to have median arcuate ligament syndrome.

Figure 4: Coronal sections of contrast enhanced CT abdomen of a 38 year old female who presented with recurrent episodes of vomiting and post prandial abdominal pain shows (A) grossly distended stomach (thin white arrow) and dilated first and second part of duodenum (thick white arrow).

Figure 5: Axial and sagittal sections of contrast enhanced CT abdomen of a 38 year old female who presented with recurrent episodes of vomiting and post prandial abdominal pain shows (A,B) compression of third part of duodenum between superior mesenteric artery and aorta (thin white and curved arrows) .The patient was diagnosed to have superior mesenteric artery syndrome.

Figure 6: Sagittal and axial reconstructed images of contrast enhanced CT abdomen of a 38 year old female who presented with recurrent episodes of vomiting and post prandial abdominal pain shows (A) reduced aortomesenteric angle and (B) aortomesenteric distance .The patient was diagnosed to have superior mesenteric artery syndrome.

Figure 7: Coronal and axial images of CT urogram of a 9 year old child who presented with pain in right lumbar region, vomiting and recurrent urinary tract infection shows (A) ureter crossing behind the inferior vena cava (thin white arrow) and (B) the compressed ureter causing dilatation of proximal ureter (thick white arrow).Imaging features are suggestive of right retrocaval ureter.

Figure 8: 3D reconstructed image of CT urogram of a 9 year old child who presented with pain in right lumbar region, vomiting and recurrent urinary tract infection shows medial deviation of right ureter giving fish hook appearance and moderate to severe hydroureteronephrosis on right side. Imaging features are suggestive of right retrocaval ureter.

Figure 9: Axial images of CT venogram of a 38 year old male patient who presented with pain ,ulcer, swelling and recurrent episodes of deep vein thrombosis of left lower limb .(A)Note compression of left common iliac vein by right common iliac artery (black arrow) and (B)

large abdominal wall collaterals between right and left common femoral vein (white arrow).Imaging features are suggestive of May Thurner syndrome.

Figure 10: Note the retroaortic course of left renal vein ---posterior nut cracker syndrome. This was an incidental finding in the patient with may Thurner syndrome.

Figure 11: The left renal vein is compressed by the superior mesenteric artery

Figure 12: Dilated tortuous ovarian veins.

DISCUSSION

MEDIAN ARCUATE LIGAMENT SYNDROME (MALS)

Median arcuate ligament syndrome is also known as Dunbar syndrome or celiac artery compression syndrome. This condition is caused by extrinsic compression of celiac plexus by the median arcuate ligament or ganglionic tissue and was first described by Harjola in 1963 (3,4). The fibrous arch which connects the diaphragmatic crura on either side of aortic hiatus is termed median arcuate ligament and normally, is located superior to celiac axis at the level of L1 vertebra (1). The possibility of compression of celiac artery increases when the median arcuate ligament is in an abnormally low position or celiac artery has a more cephalad origin (5). But this may even occur as a normal anatomic variant and in upto 13%-50% of asymptomatic healthy patients may show angiographic features of compression especially during expiration, without causing any obstructive symptoms(6,7,8). There are no published studies regarding the exact incidence of MAL syndrome in general population. In a study of aortograms of 1500 patients done by Cornell *et al*,it was reported that 1% of patients had compression of the celiac artery severe enough to cause symptoms [9]. Lee *et al* in 2003, studied 97 patients who underwent MR upper abdomen with no symptoms of mesenteric ischemia and found proximal celiac artery narrowing of more than 60% in 16 patients (16.5%) at end expiration and 12 patients (12.4%) at full inspiration, thus confirming that compression occurs more during expiration (10).

Clinically, the patient may present with typical postprandial epigastric pain, nausea and weight loss. Two main theories explaining the pathogenesis include mesenteric ischemia occuring due to coeliac artery compression and neurogenic stimulation which is caused by celiac ganglion and plexus compression(11,12). Most of the patients with median arcuate ligament syndrome remain asymptomatic due to the collateral circulation from superior mesenteric artery(13). It occurs in young patients in the age group 20-40 years with a predominance in thin young women (14).

IMAGING FEATURES

Multidetector CT which provides excellent 3D images of vascular structures has superseded catheter angiography which was used in the past to diagnose median arcuate ligament syndrome (3). The typical imaging feature described in conventional, CT and MR angiography is the focal narrowing of proximal celiac artery with a characteristic hook shaped appearance which is more prominent in end expiration. This characteristic hook shaped appearance is best seen in sagittal MIP reconstructed images (15) and is due to the inferior displacement of celiac artery by the median arcuate ligament (16). This finding is considered significant if the focal narrowing is seen during inspiratory CT as transient compression of celiac artery occurs only during expiration (15). The other findings associated with MALS is post stenotic dilatation and collateral vessel formation from superior mesenteric artery branches (17). An important imaging finding described to differentiate from atherosclerotic stenosis is the absence of hook shaped appearance in atherosclerosis. Duplex ultrasound is occasionally performed which will show increased flow velocity in celiac artery at end expiration phase (18). Although catheter angiography was considered as the gold standard for diagnosing MALS, MDCT with the advantage of easy availability, non invasiveness and excellent post processing techniques like 3D volume rendered reconstructions and multiplanar imaging, is becoming the imaging modality of choice.

MANAGEMENT

Management of MAL syndrome is mainly surgical and it remains controversial. Surgical treatment involves median arcuate ligament transaction with celiac artery decompression and can be done laparoscopically (1). Surgical management is best preserved for young patients with postprandial epigastric pain and significant weight loss as they are seen to have better benefit from surgery (3).

SUPERIOR MESENTERIC ARTERY SYNDROME

Superior mesenteric artery syndrome which was first described by von Rokitanski in 1861 is also known as Cast syndrome, arteriomesenteric duodenal compression syndrome,Wilkie syndrome and chronic duodenal ileus (3,19,20). Later, in 1927, Wilkie named it chronic duodenal ileus and described the anatomy, clinical features and pathophysiology in detail (21). Superior mesenteric artery syndrome is a rare and unusual cause of proximal duodenal obstruction and occurs as a result of compression of third part of duodenum between superior mesenteric artery and aorta (3,22). The prevalence of

SMA syndrome in general population ranges from 0.013 to 0.3 % (23).

Normally, the retroperitoneal fat in the root of mesentery is the key factor which surrounds the third part of duodenum and help in maintaining a wide aortomesenteric angle and aorto mesenteric distance (3). The normal range which has been reported in various studies for AMA and AMD are 25-60 degree and 10-28 mm respectively (24,25,26). Thus, any clinical condition which results in reduction of this retroperitoneal fat can become a risk factor for SMA syndrome and these include any conditions leading to severe weight loss, corrective surgeries for scoliosis, anatomic variants like low position of superior mesenteric artery, high fixed position of Ligament of Treitz (27,28).

CLINICAL FEATURES

Main symptoms include postprandial epigastric pain, nausea, vomiting, weight loss and may also present with symptoms of reflux. There are various studies reporting a relief of these symptoms in prone or left lateral decubitus position (24,29,30). There is a female predominance with two thirds of the patients being in the age group 10-39 (30).

IMAGING FEATURES

Various imaging modalities preferred for diagnosing SMA syndrome include barium studies, ultrasound, mesenteric angiography and computed tomography. A dilated stomach and proximal duodenum with compression of duodenal arc, delayed gastroduodenal emptying, and relief of obstruction with change in position are the features described in Barium study (31). Mesenteric angiography and ultrasonography helps in showing the reduced AMA and AMD. CT and MR angiography are replacing these modalities because of its non invasiveness and its ability to provide high quality 3D reconstruction images (32,33).

According to a study done by Raman *et al* in 2012, various findings suggesting SMA syndrome include narrowing of aortomesenteric angle and reduction in aortomesenteric distance, grossly distended stomach and duodenum, dilated left renal vein with left sided venous collaterals (34). Various studies have reported a range for AMA and AMD as 6-22 degree and 2-8 mm, respectively for making a diagnosis of SMA (35-38). CECT with iodinated contrast helps in evaluating vascular anatomy, position of duodenum in vascular angle and in excluding other causes of obstruction.

MANAGEMENT

Initial choice of treatment is decompression of stomach and duodenum by insertion of nasogastric tube. If it fails, duodenojejunostomy (open or laparoscopic) is considered beneficial (39,40).

RETROCAVAL URETER

Retrocaval ureter which is also known as circumcaval ureter is a vascular compression syndrome which was first reported in 1893 by Hochstetter (41). It is a rare congenital anomaly in which the ureter courses posterior to inferior vena cava and is a result of embryological abnormality of inferior vena cava.

Abnormal persistence of right subcardinal vein which is positioned ventral to the ureter in definitive IVC results in this anomaly (41). Right side is almost always affected (42).

CLINICAL FEATURES

Clinical features described are right loin pain, recurrent urinary tract infections and hematuria, either gross or microscopic. Presence of calculi also has been reported in some cases. There is a slight male predominance and the patient usually presents in 3rd to 4 th decade. However, our case is a 9 year old male child.

IMAGING FEATURES

Two types of retrocaval ureter has been described. In type I, there is gross medial deviation of middle uretergiving a fish hook or S shaped deformity appearance and causes moderate to severe hydroureteronephrosis whereas in type II, medial deviation of ureter is less and results in mild or no hydronephrosis (43,44). In our case, we found type 1 retrocaval ureter.

Ultrasound abdomen is the initial investigation preferred and shows dilated proximal ureter and pelvicalyceal sytem. IVU helps in demonstrating dilated pelvicalyceal system, proximal ureter and reveals characteristic S shaped deformity of ureter. Spiral CT has become the investigation of choice as it can display the IVC and ureteric anomalies. MRI also helps in demonstrating the relation between ureter and IVC and the course of ureter (45). Isotope renal scan is helpul in assessing degree of obstruction and differential renal function (46,47). Two important conditions which will mimic retrocaval ureters are retroperitoneal fibrosis or retroperitoneal mass both of which can be distinguished with cross sectional imaging like CT or MRI.

MANAGEMENT

Patients with mild pelvicalyceal system dilatation and no significant symptoms are followed up whereas in patients who are symptomatic, surgical treatment is preferred. Ureter is divided and repositioned anteriorly to IVC and ureteroureteric anastomosis has to be done (48). In our case, ureteroureterostomy over DJ stent was done.

MAY THURNER SYNDROME

May Thurner syndrome, first described by Virchow in 1851 (49), is a condition where left common iliac vein gets compressed between right common iliac artery and spine resulting in deep vein thrombosis in left lower limb thereby leading to chronic insufficiency(50). This

condition is also known as iliac vein compression syndrome or Cockett syndrome. The pathogenesis have been explained by two mechanisms; the first involves physical compression of left common iliac vein by right common iliac artery and the second mechanism is the production of intimal hypertrophy with synechiae which develops as a result of repeated pulsatile impact(51). In patients with ileofemoral thrombosis of left lower extremity, prevalence of venous spur reported is around 49-62% which is quite high (52). Hence, there should be a high degree of suspicion to arrive at an accurate diagnosis.

CLINICAL FEATURES

The most common presentation is with swelling and pain of left lower limb. Risk factors include recent surgery, prolonged immobility and pregnancy. In chronic cases, due to venous stasis, patient can also present with varicose veins, discolouration of skin and ulceration. A middle age (20-40 years) and young female predominance has been described. Our patient is a 38 year old male who presented with recurrent episodes of deep vein thrombosis, pain and ulcer in left lower limb.

IMAGING FEATURES

Contrast venography is considered as the gold standard in diagnosing May Thurner syndrome. But being a time consuming invasive procedure and suboptimal for visualization of central veins, CT venography, which is non invasive and able to rule out extrinsic compression, is increasingly advocated in making an accurate diagnosis (53,54). It also helps in assessing the extent of thrombosis in ileofemoral veins. Imaging features described include compression of left common iliac vein by right common iliac artery, tortuous venous collateral veins which crosses the midline and drain to contralateral vein and thrombus within the veins. Doppler ultrasound has limitations since iliac veins lie deep in the pelvis.

TREATMENT

Surgical management is the main stay in order to relieve the mechanical compression. In addition, anticoagulation therapy is also started. In acute stage, surgical approaches like thrombectomy has been advised but the reocclusion rate reported is high (73%) (52). Catheter directed thrombolysis followed by angioplasty and iliac vein stenting has been reported to have high rate of success and helps in providing long term patency (55,56). Reocclusion rate reported with this procedure is only 13%(52).

NUT CRACKER SYNDROME

The term nutcracker syndrome is a rare entity which was first reported in 1950 by El Sadr and Mina(57). Nut cracker syndrome is the term used when a patient develops symptoms as a result of elevated venous pressure in left renal vein due to outflow obstruction to inferior vena cava. This elevated venous pressure will result in formation of multiple venous collaterals. When the left renal vein is compressed between the aorta and superior mesenteric artery, and when patient presents with symptoms, the term anterior nut cracker syndrome is used.

When left renal vein takes retroaortic or circumaortic course, it is called posterior nut cracker syndrome. This condition remains a diagnosis of exclusion as normal variants also can occur without clinical symptoms and it is essential to correlate the imaging findings with clinical history for making a proper diagnosis.

Two possible etiologies explained in literature are reduced aortomesenteric angle and aorto mesenteric distance as described in superior mesenteric artery syndrome and posterior renal ptosis which results in stretching of left renal vein over aorta (58).

CLINICAL FEATURES

The usual clinical feature is hematuria, abdominal pain and rarely proteinuria.Very rarely, patient can present with varicocele and gonadal vein syndrome which occurs as a consequence of formation collateral vessels.

IMAGING FEATURES

Doppler ultrasound has got limited usefulness in diagnosis although it helps in demonstrating left renal vein diameter and peak velocities. Demonstration of venous collaterals further helps in diagnosis (59). CT and MR angiography are the other non invasive imaging modalities which help in making an accurate diagnosis. These studies will help in depicting the course of left renal vein, the compression point and the collaterals which have developed as a result of elevated venous pressure. Sagittal images help in calculating the aortomesenteric angle and aortomesenteric distance. However, for definitive diagnosis, retrograde venography has been advised which will demonstrate an elevated left renal vein to inferior vena cava pressure gradient(> 3 mm Hg) and the collateral vessels(60). In our case left renal vein compression between superior mesenteric artery and aorta was depicted in CECT abdomen.

TREATMENT

For mild hematuria, conservative management is the proposed treatment as the development of venous collaterals later will alleviate the symptoms. If the patient presents with recurrent and persistent hematuria, surgical management is advised, namely, renocavalreimplantation, left renal vein bypass surgery, endovascular left renal vein placement, nephrectomy etc (61,62,63).

CONCLUSION

Vascular compression disorders are a group of conditions which can be present even in normal individuals and may be asymptomatic. When symptomatic conservative

management may help in resolution of the symptoms most of the times. In situations conservative management fails surgical techniques need to be considered.

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