Abstract
Multidetector computed tomography (MDCT) and advances in CT urography techniques have enabled vast improvements in the depiction of the ureter. Studies of the ureter can find a wide variety of conditions including congenital defects and anatomic variants (anomalies in the origin, distribution, and distal insertion of the ureter) as well as all benign and malignant causes of focal and diffuse wall thickening (inflammatory and infectious processes, and neoplasms, as well as iatrogenic thickening and postsurgical changes). Other benign processes like ureteral kinking and stenosis due to extrinsic compression of the iliac vessels are also well characterized by MDCT. The aim of this article is to show the spectrum of ureteral variants and disease apart from common entities related to stones.

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KEYWORDS
Multidetector computed tomography; Urography; Ureter; Urinary tract

PALABRAS CLAVE
Tomografía computarizada multidetector; Urografía; Ureter; Tracto urinario

Uréter: hallazgos en tomografía computarizada multidetector
Resumen
Con la aparición de la tomografía computarizada multidetector (TCMD) y el perfeccionamiento en las técnicas de urotomografía (UT), la evaluación del tracto urinario ha adquirido otra dimensión, obteniendo cada vez una mejor representación del uréter. Cuando el uréter es evaluado podemos encontrar una gran variedad de entidades, que incluyen anomalías congénitas y variantes anatómicas (alteración en el origen, distribución e inserción distal del uréter), todas las causas benignas y malignas de engrosamiento focal y difuso de la pared ureteral, incluyendo procesos inflamatorios e infecciosos, neoplasias, iatrogenia y cambios posquirúrgicos. Otros procesos benignos, como el asa ureteral y la estenosis por compresión extrínseca de vasos...
Introduction

In recent years, CT urography has become one of the most important methods for the diagnosis of urinary tract pathology, providing better characterization and more accurate diagnoses of the ureter. The main use of CT urography is the evaluation of patients with a high suspicion of transitional cell carcinoma, that is to say, patients over 40 years of age with macroscopic hematuria. However, this diagnostic method is being increasingly used for characterization of benign conditions such as congenital anomalies, anatomic variants, ureteral kinking and stenosis from iliac vessels, among others. 1

CT urography offers several advantages that have pushed other diagnostic modalities into the background. These advantages are: complete evaluation of the urinary tract in one single study; higher sensitivity to detect calculi and focal renal lesions; assessment of both the lumen and wall of the ureter and renal urinary tract; ability to stage the tumoral lesions found in the same study; identification of diseases out of the urinary tract and better visualization of bladder lesions. 2 CT urography main drawback is the high radiation doses to the patient, for this reason this technique must be used only following established recommendations. 1,3

Tecnique

Over time, different CT urography protocols and techniques have been proposed. However, there is always agreement on the four fundamental characteristics of CT urography: 1. it must be a diagnostic modality optimized for kidney, ureter and bladder evaluation; 2. it must be performed by using MDCT, providing high spatial resolution images (thin sections/low collimation); 3. it requires intravenous injection of a contrast agent and 4. imaging in the excretory phase, essential to assess the urothelium, is also a basic requirement. 1

CT urography was initially described as a three-phase technique (triphasic) that uses a single bolus of intravenous contrast agent (CA). 1 Initially, an unenhanced phase is carried out; this phase is very useful for a preliminary visualization of anatomic variants of the ureter, presence of stone disease in the collecting system, detection of hematomas, attenuation measurements and thickness wall anomalies of the ureter. These precontrast images are followed by the venous administration of the CA bolus (100-150 ml), injected at a rate of 2-3 ml/sec, and two additional image phases are then obtained. Nephrographic phase enhanced CT scans are typically obtained 70-120 seconds after intravenous administration of CA. Nephrographic phase offers better characterization of the enhancement and abnormal thickening of the urothelial wall, particularly in inflammatory processes and neoplasms. Excretory phase imaging is obtained at least after a 180-second delay after injection of CA (although the usual practice is to perform the study at 6-15 min). This phase is useful for the assessment of ureter opacification with CA, of the ureteral tract in case of anatomic variants and congenital anomalies, and filling defects due to tumoral, inflammatory or infectious processes. In some cases, particularly in patients with a suspicion of vasculature anomalies, a corticomedullary phase CT scan can be obtained 25-35 seconds after CA administration. 1,3,5-7 However, some institutions prefer to carry out a two-phase technique, also called “split”, in which nephrographic and excretory phase images are obtained during the same acquisition in order to reduce radiation exposure. 1,3

Additional techniques, including administration of furosemide, moving the patient to obtain different projections and the use of compression bands are still controversial issues and are applied depending on each institution’s experience. 4,8-10

In our institution, patients are given 1000 ml of water to drink over a 1-hour period before image acquisition. First, unenhanced phase images are obtained and then we inject 100 ml of CA. Nephrographic phase imaging is obtained at 80 seconds and excretory phase at 8 min after CA injection.

The main parameters for MDCT image acquisition are slice collimation and pitch, which in combination with tube voltage (Kv) and tube load (mA) determine the raw data. In all CT equipments, tube voltage for average-sized patients is typically 120 Kv. While low Kv settings are recommended in order to reduce radiation dose, this is not always follow in the clinical practice. Tube load settings vary significantly among groups, continents and equipments, from 50-300 mA on 4-detector CT scanners and from 65-200 mA in 16-detector CT scanners. 1,4,6

For 4-detector CT scanners, 2.5-3.75 mm collimation is used for the unenhanced and nephrographic phases, and either 1.25 mm or 2.5 mm collimation for the excretory phase.
phase. For 16-detector CT scanners collimation is smaller, usually 1.25-1.5 mm for unenhanced and nephrographic phases, and 0.5-0.75 mm for excretory phase. Using 64-detector systems, collimation decreases to 0.5-0.625 mm for all phases. In order to avoid excessive noise, tube load (mA) may have to be increased. The use of thin collimation requires high pitch values of at least 1.5, while pitch values for thicker collimations have varied from 0.75 to 1.5. In 16- to 64-detector scanners relatively high pitch settings of 1.2-1.4 remain in use.\cite{1,2}

MDCT provides the possibility of multiplanar reconstructions (those in the coronal plane are the preferred ones), curved planar reformat, average intensity projection, maximum intensity projection (MIP) and volume rendering 3D images. These modalities offer, in some cases, additional information to that provided by the axial slices and help, in other cases, to elucidate diagnosis.\cite{2,4,6}

Below, we describe the most frequent ureteral diseases that can be best characterized using CT urography.

**Anatomic variants and congenital anomalies** (figs. 1-7)

MDCT and CT urography are techniques that allow characterization of a wide variety of congenital anomalies and urinary tract variants where the origin of the excretory system, distribution and distal insertion of the ureter might be altered. These techniques provide a detailed anatomic evaluation that allows not only the identification of pathological conditions related to the anomalies, but also facilitate an adequate surgical planning if needed. Often, congenital anomalies are diagnosed in adulthood and CT urography plays a very important role in their characterization, since excretory phase is the most relevant phase for detection of excretory system anomalies.

Below, we summarize the most frequent congenital anomalies and anatomic variants affecting the course, caliber, morphology and insertion of the ureter.

**Duplicated ureter and duplicated collecting system** are the most common anomalies (1 out of 160 born alive) with family related risk factor. Partial duplications, where the two ureters fuse to form a single ureteral orifice, are more frequent than complete or double duplications associated with double distal ureteral meatus. According to the Weigert Meyer law, in complete duplications, the ureter draining the upper pole inserts in a more medial and distal (inferior) position than the lower pole ureter. In these cases, the upper pole ureter often ends in ureterocele, whereas reflux is typically seen in the ureter draining the lower pole (fig. 1).\cite{11-13}

**Ureterocele** is a cystic dilation of the intravesical segment of the ureter. Seventy-five percent of ureteroceles are associated with complete duplications of the ureter and are located in the ectopic insertion of the ureter draining the upper pole of the kidney (fig. 1). Ureteroceles occur more frequently in girls and are associated with pyelocaliectasis and ureterectasis, whereas single-system ureteroceles are most often found in boys.\cite{11,13} Single-system ureteroceles can show an insertion located in a normal position within the bladder or in an ectopic location. Regardless their location, ureteroceles are usually associated with ureterovesical junction obstruction or with multicystic dysplastic kidney. The “simple” non-obstructive ureterocele that appears in adults is rare in children.\cite{12}

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**Figure 1** Duplicated collecting system associated with an infectious process. Weigert Meyer law. Coronal reconstruction CT in the excretory phase (a). Sagital reconstruction in the nephrographic phase (b) in a patient with urinary symptoms and fever. A complete duplicated collecting system is identified, with ureterohydronephrosis of the excretory system and ureter draining the upper pole of right kidney, secondary to an obstructive process that arises from the ureterocele (b), located medial and inferior to normal insertion of the ureter draining the lower pole. Images demonstrate thickening and abnormal enhancement of the renal pelvis and ureter walls due to inflammatory process of infectious type (a, b). In the excretory phase, there is an adequate opacification of the excretory system and ureter draining the lower pole of the right kidney and ectasia secondary to vesicoureteral reflux previously diagnosed (a), according to the classic characteristics of Weigert Meyer law.

**Figure 2** Pyeloureteral stenosis. Coronal reconstructions. Maximum intensity projection (MIP) (a) and 3D reconstruction of CT images (b) in the excretory phase show left hydronephrosis, a transitional area at the UPJ, and an abrupt reduction in calibre due to primary pyeloureteral stenosis.
Ectopic ureterocele can be simple, but in > 70% of cases arise from duplicated collecting systems.\textsuperscript{10} Ectopic ureteroceles are generally located in a more caudal insertion point than normal. In females, the insertion can be located in the inferior part of the bladder, urethra, vestibule, or vagina and less frequently into the uterus. In males, ectopic ureters may terminate in the inferior portion of the bladder, posterior urethra, seminal vesicles, deferens and ejaculatory ducts. The main difference between ureteral ectopia in females and males is that in females, ectopic ureters can terminate distally to the continence mechanisms that the bladder neck and external sphincter provide; therefore, this fact can result in incontinence.\textsuperscript{11}

Ureteropelvic junction (UPJ) obstruction is the most common cause of fetal/neonatal hydronephrosis and is found predominantly in males. Although obstruction of UPJ is twice more common in the right kidney, approximately 10-20% of obstructions occur bilaterally (fig. 2).\textsuperscript{12,14} The causes of this condition can be primary, including intrinsic or functional factors, and extrinsic such as aberrant vessels, adventitial bands, renal cysts and aortic aneurysm. UPJ obstruction can also be secondary to inflammatory processes, calculi, ischemia and iatrogenic trauma. CT images will show a significant stenosis of UPJ associated with dilation of the proximal collector system.\textsuperscript{12,15}

Congenital anomalies and variants of the ureter can be very close linked to anomalies of the kidney, since both structures are related from an embryological point of view. Ureters of ectopic kidneys (e.g. pelvic and intrathoracic kidneys) may show variable length, abnormal course and may or may not insert in the normal location into the bladder.\textsuperscript{12,16} Crossed renal ectopia and horseshoe kidney probably belong to the same spectrum of anomalies in the upward migration, position and fusion of the kidneys. Crossed ectopic kidney locates caudally and medially to its normal position, in the midline or completely in the opposite side of the abdomen. Generally, ectopic kidney fuses with the orthotopic kidney; this condition is known as “crossed fused renal ectopia”. Crossed non-fused ectopia occurs in less than 10% of cases. However, crossed renal ectopia, solitary or bilateral, are very rare conditions (figs. 3 and 4). In both fused and non-fused ectopias, the ureter of the ectopic kidney crosses the midline and enters the bladder on the contralateral side, inserting into its normal position into the bladder trigone.\textsuperscript{12,17} The axis of the collecting system of horseshoe kidneys is deviated inward at the lower poles, located medially to the upper poles. Horseshoe kidneys are in an anteriorly rotated position that favors the anterior position of the pelvis and UPJ, in turn, the ureters may be displaced anteriorly over the isthmus. UPJ obstruction occurs in 30% of patients with horseshoe kidney and may result from intrinsic stenosis, high ureteral insertion, extrinsic obstruction from the isthmus or aberrant vessels.\textsuperscript{12}

CT urography is a very useful diagnostic tool, since it allows not only the proper characterization of congenital anomalies, but also of abnormal ureteral course, caliber and insertion related to these anomalies.

Megaureter is a generic term that refers to a dilated ureter, with or without concomitant dilation of the upper collecting system. Primary megaureter is due to a congenital idiopathic anomaly of the ureterovesical junction. Primary obstructive megaureter appears dilated above a short and aperistaltic segment of the juxtavesical ureter that shows the typical “beak” shape. Ureteral orifice and submucosal tunnel appear normal. The normal segment of the ureter, proximal to the aperistaltic segment, dilates due to partial obstruction.\textsuperscript{11}

Retrocaval ureter is a rare anomaly secondary to abnormal embryogenesis of the inferior cava vein (ICV), Incidence of retrocaval ureter is 1 to 1000, accounting for 0.1% of all ICV anomalies.\textsuperscript{18,19} Usually, ICV originates from supra and subcardinal veins, located above and below the kidney respectively. Retrocaval ureter results from the persistence of the subcardinal vein positioned anterior to the ureter.\textsuperscript{18,19} Diagnosis of most adult patients occurs when investigating infectious diseases such as...
pyelonephritis. CT urography shows how the right ureter swings medially and passes behind the ICV, over the confluence of iliac veins. The ureter exits between the ICV and aorta to pass over the anterior surface of the ICV before descending to the bladder. Right retrocaval ureter typically swings over the superior and medial margins of the fourth lumbar vertebral pedicle, where it is compressed behind the ICV, resulting in a variable degree of proximal obstruction and dilation (fig. 5). Among the most common variants, we found the ureteral kinking and stenosis due to compression of the ureter by the iliac vessels. Occasionally the ureters may have a tortuous course. This is most frequently found in breath-hold imaging studies (diaphragm and kidneys are in a more caudal position), in patients with renal ptosis or those with previous urinary tract obstruction. In some instances, ureteral kinking can result in filling defects that might be confused with small urothelial neoplasms (fig. 6). Wrong diagnosis may be avoided by identifying tortuous courses of the ureter. Post-processing of images can be also very useful since ureter anatomy is better rendered using 3D images in the coronal or sagittal planes. Additionally, an arterial phase can be integrated into the conventional CT protocol in order to obtain a better characterization of the vasculature and a more accurate identification of the causes of the anomaly. On the other hand, it is not rare to find iliac and ovarian vessels close to the course of the ureter causing indentation or obstruction of the ureter due to extrinsic compression (fig. 7). This finding is better visualized in the excretory phase of CT urography, where a sort of filling defect is seen associated with an adjacent vascular structure that it might be sometimes difficult to see. This condition occurs more frequently in the infundibulum of the upper pole of the kidney, but also in the renal pelvis, UPJ and ureter.

Inflammatory processes

They encompass inflammatory conditions of the ureter mainly caused by infection, mechanical irritation secondary to lithiasis or surgical procedures. In the former case, infection generally comes from the kidneys or bladder. The most common findings are diffuse thickening of the ureter and abnormal enhancement of the urothelial walls (fig. 1). Thickening and diffuse enhancement of the ureter can be caused by ureteral inflammation or ureteral neoplasms (fig. 8). It might be impossible to differentiate between these two conditions using CT urography, even in the presence of multifocal tumors. In addition to the most common bacterial infections, where gram-negative bacteria play the most important role, fungal and mycobacterial infections are also relatively frequent, and are therefore described below.
Fungal diseases of the kidney and ureter appear as opportunistic infections occurring in patients with abnormal host resistance, such as patients with diabetes mellitus, antibiotic therapy, immunosuppressive and chemotherapeutic agents, intravenous and urinary catheters, acquired immunodeficiency and renal transplantation. Several types of fungi have been identified in the urinary tract such as Candida albicans and other Candida spp. but it has also been reported the association with Coccidioides immitis, Cryptococcus neoformans, Torulopsis glabrata and Aspergillus fumigatus. Fungal infections can also occur after bacterial colonization. Findings provided by CT urography may not be distinguishable from other causes of ureteral inflammation associated with ureteral thickening and abnormal contrast-enhancement. Fungal infection of the upper urinary tract is not infrequent; however, formation of mycetomas (fungus ball) within the course of the renal pelvis or ureter is rare (fig. 9). This type of disease, described in very few patients, causes inflammatory processes, sometimes obstructive, in the excretory system and adjacent ureters. Candida tropicalis and Aspergillus flavus are some of the germs associated with this disease.25-27

The urinary tract is the most common site of extrapulmonary tuberculosis (TB). TB of the urinary tract affects 8-15% of patients suffering from pulmonary TB. The development of genitourinary TB usually arises from the hematogenous spread of pulmonary TB first to the kidney and then to the ureters and bladder. People of all ages may be infected, but TB is more common in males in their fourth-fifth decade of life.29,30 Lesions caused by urinary TB may be indolent with very few symptoms until diffuse affection of the urinary tract appears, associated with lower urinary tract symptoms such as frequent urination, dysuria and nocturia. Gross hematuria is seen in almost 25% of patients and less than 10% show constitutional symptoms. Around 10% of patients are completely asymptomatic, but may have the classic laboratory findings of TB such as sterile pyuria.30,31 Radiologic findings depend on the extent of the disease.31 MDCT can be very helpful at identifying the extent of the renal involvement and spread to extrarenal structures.

**Figure 8** Ureteritis. Axial CT urography (a) and coronal reconstruction (b) in the excretory phase show a circumferential thickening of the renal pelvis wall and proximal and middle third of the right ureter, in a patient with fever, urinary symptoms and positive urine culture.

**Figure 9** Micetoma in left renal pelvis with inflammation of the proximal ureter. Axial CT (a) and coronal reconstruction (b) images in the excretory phase show wall thickening and dilation of the left renal pelvis, with increased attenuation of the adjacent fat associated with an oval filling defect oval with soft tissue density. Images also show thickening of the proximal third of the left ureter due to inflammatory disease.

**Figure 10** TB with renal, perirenal, adrenal glands, pelvic and ureteral involvement. Axial abdominal CT in the corticomedullary phase (a, b) and coronal reconstruction images in the nephrographic phase (c) show thickening and abnormal enhacement of the right adrenal gland, associated with adjacent fat stranding due to inflammatory involvement (a). Hypodense pseudonodular lesion with irregular contour affecting the upper pole and middle third of the right kidney with inflammatory changes of the perirenal fat (b, c). Granulomatous inflammatory process also reaches the proximal third of the ipsilateral ureter, with thickening and abnormal enhacement of its wall (c).
including the ureter. During the active phase of the disease, findings in the excretory system and ureters may not be distinguishable from other inflammatory diseases associated with thickening and abnormal enhancement of the renal pelvis and proximal ureter secondary to adjacent renal infection (fig. 10). In some cases dilation and urethelial irregularity may occur due to ureterovesical junction obstruction secondary to urethritis. As disease progresses, ureteral shortening and stricture can appear, in some cases associated with ureterohydronephrosis of the proximal ureter, filling defects in the excretory phase or even ureteral wall calcifications. During CT evaluation is important to assess the findings suggestive of renal involvement that permit diagnosis of TB of the urinary tract. One of the earlier findings is the alteration in the calyceal outline. In later stages, renal mass, parenchymal scars and renal cortex atrophy, papillary necrosis, parenchymal calcifications, infundibular stricture and autonephrectomy can be also found.

Associated radiological findings, apart from those in the urinary tract, may suggest TB. Approximately one third of patients show findings such as involvement of the retroperitoneal lymph nodes — sometimes calcified —, changes in the spleen, liver and adrenal glands, and bone, affecting hip, sacroiliac joints and spine — with or without paraspinal abscess.

Ureteritis cystica is a rare disorder characterized by small cysts containing a proteinaceous fluid that appear in the submucosa of the ureter. When the intrarenal collecting system is involved, the term pyelitis cystica is used. The etiology of this disorder is uncertain, but it seems to be related to lithiasis and chronic infection of the urinary tract. Imaging findings are multiple, smooth, oval filling defects that protrude into the lumen of the ureter.

Neoplasms (fig. 11)

Transitional cell carcinoma (TCC) is the most common infiltrative neoplastic disease of the ureter. TCC is more frequent in men than in women (male-female ratio, 2:1), and the incidence peaks in the seventh decade of life.

In recent years, the incidence of upper urinary tract TCC has increased, perhaps because of improved diagnostic techniques and survival rates of patients with bladder cancer — who have high risk of developing upper urinary tract tumors. These TCCs occur in 2-4% of patients with bladder cancer, for this reason, patients with bladder cancer need to undergo upper urinary tract imaging. In addition, 40% (range 20-70%) of patients with upper urinary tract TCC will develop TCC of the lower tract.

Primary ureteral tumors are relatively rare and account for approximately 1% of upper tract neoplasms. Around 73% of all urothelial tumors are located in the distal ureter, 24% occur in the mid ureter and only 3% in the proximal ureter. Seventy-five percent of all primary urothelial neoplasms arise from the epithelium. The most common epithelial neoplasm is TCC, which divides into a papillary subtype and a non-papillary subtype. Eighty to eighty-five percent of TCCs are papillary tumors, which have higher tendency to be multifocal than the non-papillary. Squamous cell carcinoma is the most aggressive epithelial tumor, however, it accounts for less than 10% of primary epithelial neoplasms in the ureter. Adenocarcinoma is extremely rare.

Unlike other diagnostic techniques such as excretory urography, CT urography allows assessment and differentiation of structures that may overlap the distal ureter (bladder, intestinal gas or bone). In the unenhanced phase, circumferential thickening in the urothelial wall is the most common finding. Nephrographic phase images show abnormal enhancement and intraluminal lesions and in the excretory phase TCC is typically seen as filling defects (fig. 11). As we mentioned before, in some instances these radiologic characteristics can be difficult to differentiate from inflammatory processes. Differential diagnosis of TCC includes benign urothelial tumors, which account for approximately 20% of all ureteral tumors. Two of the most common benign tumors of the ureter are papilloma — which appears as a solitary filling defect connected to the ureteral wall through a stalk —, and fibroepithelial polyp — a non-epithelial lesion whose size varies from a few millimeters to several centimetres. Generally, polyps are smooth and cylindrical in shape, and usually have a long stalk that allows mobility in some cases. Unlike primary malignant tumors, these polyps are more commonly found in the proximal third of the ureter and in patients aged 20-40 years. According to our experience, this condition is difficult to differentiate from TCC and thus a definite diagnosis is based on histology.

TCC also needs to be differentiated from other conditions that cause intraluminal filling defects. Some of these conditions are uric acid calculi (that, unlike tumors, show acoustic shadowing on the ultrasound study and appear denser than soft tissue on CT), ureteral clots (denser than soft tissue and resolve spontaneously) and detached papilla (fragments that can appear in the urine and whose origin can be visualized on CT urography images).
Iatrogenic injuries and post-surgical complications (figs. 12-15)

Iatrogenic ureteral injuries can occur during a wide variety of abdominal, pelvic, gynecologic and urologic surgery. The incidence of ureteral injuries during major pelvic surgery is reported to be 0.1-1.5%. Some endourologic procedures such as ureterolithotomy and ureteroscopy, although less invasive, are not completely innocuous and may cause different levels of ureteral injuries: from ureteral stenosis after upper tract endoscopy — with a reported incidence of 1-11% — to ureteral perforations resulting in urinoma (fig. 12). Gynecologic surgery has a particularly high risk, accounting for more than half of all iatrogenic ureteral injuries. Urologic and general abdominal surgery account for 30% and 5-15% respectively. Radical hysterectomy is the gynecologic procedure most commonly associated with ureteral injury, occurring in 10-30% of cases, related to unnoticed ligation of the ureter with a suture and blood flow compromise of distal ureters during dissection of periureteral lymph nodes. Patients may present with ureteral necrosis, urinoma and late stenosis.

In case of bilateral ureteral injury, anuria is the first clinical sign that appears right after surgery (fig. 13). Unilateral ureteral injury can go unnoticed initially and remain unnoticed for 10-30 days. Fever and pain in the ipsilateral flank are the most frequent symptoms; however, in a significant number of patients, diagnosis can be delayed until a ureterovaginal or ureterocutaneous fistula appear.

There is a wide variety of surgical procedures involving the ureter, which are performed according to the experience of each institution. CT urography plays a more and more important role in the follow up of these surgical procedures and diagnosis of their complications. Some examples of these procedures are: ureteral reimplantation, ureterolithotomy, ureteroscopy, neobladder evaluation, among others. Although this paper is not aimed to describe these surgical procedures, it is important for radiologists to be familiar with the main aspects of these techniques in order to better interpret CT images to avoid early and late complications, and to assess in detail uretero-intestinal anastomosis, fistulas, collections, ureterohydronephrosis, etc. (figs. 14 and 15).

Figure 12 Iatrogenic rupture of the left ureter in a patient with a previous history of endoscopic lithotomy. Nephographic phase axial MDCT image (a) shows thickening and abnormal enhacement of the proximal third of the left ureter, increased atenuation of the perirenal and periureteral fat. Coronal MIP of CT urography in the excretory phase (b) shows CA extravasation and urinoma formation.

Figure 13 Post-surgical complication. Coronal reconstruction in the excretory phase shows an accidental ligation of the distal third of the two ureters in a 25-year-old patient with a history of cesarean section. Bilateral hydronephrosis with abrupt amputation of the ureters.

Figure 14 Transverse ureteroureterostomy. Patient with a history of cervix cancer with infiltration of the distal third of the right kidney. 3D reconstruction of CT urography in the excretory phase shows permeable anastomosis from the right ureter to the distal third of the left ureter.
The ureters: Findings at multidetector computed tomography

Conclusion

Nowadays, MDCT and particularly CT urography are fundamental tools for identification and diagnosis of a wide variety of pathological conditions of the ureter.

Authors’ contribution

Jorge Mejia Restrepo: supplying the MDCT images collected over the last years. Critical reviewing of the manuscript.

Juan Esteban López: writing and critical reviewing of the manuscript.

Carlos Nicolau Molina: writing and critical reviewing of the manuscript.

Alejandro Zuluaga: writing and critical reviewing of the manuscript.

Mauricio Mazzaro: critical reviewing.

All authors have read and approved the final version of the article.

Conflict of interest

The authors have no financial relationships to disclose.

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