Evaluation And Follow-Up Of The Complications Of Urinary Tract Surgical Procedures: CT Urographic Patterns

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Learning objectives

To review the most frequent urinary tract postoperative complications

To illustrate MDCT-Urographic patterns of urinary tract postoperative complications

To describe the usefulness of MDCT-Urography in the diagnosis and follow-up of urinary tract postoperative complications
**Background**

The most frequent urinary tract postoperative complications result from disruption of the urinary collecting system, such as uretero-vesical anastomosis dehiscence, ureteral perforations, uretero-cutaneous fistulas, displacement or migration of ureteral stents, peritoneal and retroperitoneal fluid collections. The ureteral extravasation produces urine leak and urinomas. Urinomas may be initially clinically occult and may manifest themselves with delayed complications such as hydronephrosis and abscess. Urinary tract dilation due to post surgical strictures, secondary to kinks, cloth, edema or inflammations, are less common (1,2,3,4,5).

Conventional Urography and conventional Computed Tomography (CT) have been considered over the years as the standard techniques studying the patients with post-surgical urinary tract injuries. In particular, CT has been considered the gold standard as it is able to simultaneously visualize the urinary tract, the renal parenchima as well as the surrounding soft tissues (6). The recent development of the Multi-Detector row CT (MDCT) let a strong reduction of the acquisition time and the possibility to obtain high resolution images with respect to conventional CT, enabling 3D urographic acquisition (CT-urography) (7,8,9).

Based on our clinical experience on more than 25 patients, herein we described the MDCT patterns in the evaluation and follow-up of complications occurring after urinary tract surgery, combining conventional morphologic scan and CT-urographic acquisitions. Advantages and disadvantages of the technique were also illustrated.
PROCEDURE DETAIL

A basal morphologic evaluation of the abdomen, i.e. a post-contrast study during nephrographic phases, has to be performed studying the urinary tract via MDCT. This "standard" examination is combined with the urographic acquisition (CT Urography) acquired in the late post-contrast phase.

All the examinations were performed with a multi-detector equipment (Aquilion Multi 4, Toshiba).

CONVENTIONAL MORPHOLOGIC STUDY

The basal MDCT study of the pelvis-abdomen region was obtained with the following parameters: collimation = 4x3mm, pitch = 5.5, kW = 120 and mA = 300. Images were reconstructed every 5 mm with 5 mm thickness. Subsequently, the patients were injected intravenously with 150 ml of contrast medium (Ultravist 350, Shering) with a power injector at a rate of 2 ml/sec, after an intravenously administration of a diuretic (furosemide) without any abdominal compression technique. "Nephrographic-phase" images were then obtained from the diaphragm through the pelvis with a 80 sec delay after the contrast agent injection, with the following parameters: collimation = 4x3mm, pitch = 5.5, kW = 120 and mA = 300. Images were reconstructed every 5 mm with 5 mm thickness.

UROGRAPHIC STUDY (CT UROGRAPHY)

The urographic images were obtained from the upper pole of the kidneys through the pelvis with a 300 sec delay after the contrast agent injection, with the following parameters: collimation = 4x2mm, pitch = 3, kW = 120 and mA = 300. Images were reconstructed every 1 mm with 2 mm thickness. The mean examination time was about 15 minutes.

The urographic images were subsequently post-processed with an independent workstation (Vitrea 2, Vital); for all the patients MultiPlanar Reconstructions (MPR) as well as 3D reconstructions using Maximum Intensity Projection (MIP), Average Intensity Projection (AIP) and Shaded Surface Display (SSD) algorithms were obtained. Both axial source CT images and MPR, MIP, AIP and SSD reconstructions were evaluated in all the patients.

IMAGING FINDINGS

URETERO-VESICAL ANASTOMOSIS DEHISCENCE
Uretero-vesical anastomosis dehiscence may occur as a result of either bladder or distal ureter neoplasm excision.

In the majority of the cases conventional MDCT images showed hypo- or iso-dense fluid retroperitoneal collection on the un-enhanced and "Nephrographic-phase" images, whereas the direct visualization of the extravasation of hyperdense contrast medium on the urographic MDCT images allowed a better evaluation of urine leak, retro- or intra-peritoneal urinary collections and of the site of ureteral injury (Fig. 1), although in some cases MDCT images failed to directly demonstrate the lesion. In one case, uretero-vesical anastomosis dehiscence resulted associated to a uretero-cutaneous fistula, with cutaneous excretion of intravenous contrast material through the surgical scar on the Urographic CT images (Fig. 1a).

In all cases, delayed contrast enhanced urographic MDCT images allowed a better delineation of urine leak, urinomas and ureteral injury site. Conventional and urographic MDCT images resulted helpful in the follow-up of ureteral fistulas, with elevate accuracy in the evaluation of restoration of ureteral integrity (Fig. 1b).

**URETERAL PERFORATIONS**

Ureteral perforations may occur as a result of either diagnostic endoscopic procedures or endoscopic removal of ureteral calculi.

Conventional MDCT images showed hypo- or iso-dense retroperitoneal collections, whereas delayed contrast enhanced urographic MDCT images showed the enhanced lumen of the ureter surrounded from hyperdense collections, due to intravenous contrast material excretion into the retroperitoneal spaces (Fig. 2, 3, 4, 5, 6).

Urinary collections related to ureteral perforations resulted localized on CT images around the ureter into the infrarenal retroperitoneal space (Fig. 2). Major collections surrounded the ileo-psoas muscle to the pelvis (Fig. 3).

Urographic MDCT images allowed a better evaluation of urinary collections and site of ureteral injury.

Urine leak related to ureteral perforations or fistulas were treated with ureteral stent placement (Fig. 5, 6). Conventional and urographic MDCT images resulted helpful in the follow-up of ureteral injuries, with elevate accuracy in the evaluation of ureteral lumen integrity after ureteral stent removal (Fig. 7a-b).

**DISPLACEMENT OF URETERAL STENT**

Displacement of ureteral stent is an incorrect position of the stent relative to initial placement.
Hyperdense ureteral stents are easily recognizable on un-enhanced and "Nephrographic-phase" CT images. Nevertheless, delayed contrast enhanced urographic MDCT images allowed a better topographic evaluation of stent position respect to urinary tract lumen and a good evaluation of concomitant retroperitoneal or intraperitoneal urinomas (Fig. 7a).

Conventional and urographic MDCT images resulted helpful in the evaluation of repositioning of ureteral stent and in the follow-up of ureteral injury (Fig. 7b)

**MIGRATION OF URETERAL STENT**

Migration of the stent within the urinary tract may occur, despite the presence of a proximal and distal pigtail, due to peristalsis or inadequate stent length.

Hyper-dense ureteral stent position is recognizable on un-enhanced and "Nephrographic-phase" CT images. Nevertheless, delayed contrast enhanced urographic MDCT images confirmed the conventional CT patterns, with a better panoramic evaluation of the urinary tract (Fig. 8)

**POST SURGICAL URINARY TRACT STRICTURES**

Early post surgical obstructions of the urinary tract may be secondary to kinks, cloth, edema or inflammations.

Conventional MDCT allowed an accurate imaging of both the entire course of the ureter and presence of periureteral diseases.

Nevertheless delayed contrast enhanced urographic MDCT images allowed a better anatomic evaluation of the collecting system due to the acquisition of volumetric high resolution images of the urinary tract (Fig. 9).

Conventional and urographic MDCT images resulted helpful in the evaluation of the progressive reduction of the urinary tract dilation during the follow-up (Fig. 9)
Fig. 1: FIG. 1a (Uretero-vesical anastomosis dehiscence occurred after bladder neoplasm excision, with ureterocutaneous fistula) Conventional MDCT images showed isodense fluid retroperitoneal collection on the un-enhanced (A) and ce "Nephrographic-phase" images (B, red arrow). Direct visualization of the extravasation of hyperdense contrast medium on the urographic source axial (C, red arrow) and MIP (D, red arrow), AIP (E, red arrow) and SSD (F, red arrow) 3D reconstruction MDCT images, with better evaluation of urine leak and urinary collection. The urographic source axial images showed also the presence of ureterocutaneous fistula through the surgical scar (C, white arrow).

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**Fig. 2:** FIG. 1b (Uretero-vesical anastomosis dehiscence occurred after bladder neoplasm excision, with ureterocutaneous fistula: 5 months follow-up after surgery) Urographic MDCT MPR (A) and 3D SSD (B) reconstructions showed the restoration of the ureteral integrity.

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**Fig. 3:** FIG. 2 (Perforation of the proximal left ureter after endoscopic lithotripsy for ureteral stones) Conventional MDCT images showed isodense fluid retroperitoneal collection on the un-enhanced (A) and ce "Nephrographic-phase" images (B, red
Direct visualization of the enhanced lumen of the ureter (white arrow) and extravasation of contrast medium (red arrow) on the urographic source axial (C,D) and MPR reconstruction (E), with better evaluation of the ureteral lesion and retroperitoneal urinary collection. MIP (F), AIP (G) and SSD (H) 3D reconstructions showed a good panoramic urinary tract evaluation.

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Fig. 4: FIG. 3 (Perforation of the proximal left ureter after endoscopic lithotripsy for ureteral stones) Better visualization of the enhanced lumen of the left ureter (white arrow) and extravasation of contrast medium (red arrow) in the retroperitoneal spaces on the urographic source axial images (B,D,F) and on MPR reconstruction (G) respect to conventional ce "Nephrographic-phase" images (A, B,C). SSD (H) 3D reconstruction showed a good panoramic urinary tract evaluation.

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**Fig. 5:** FIG. 4 (Perforation of the distal left ureter after radical prostatectomy) Extravasation of contrast medium (red arrow) in the retrovesical space, with left obturator urinary collection on the urographic source axial image (A) and on MPR reconstruction (B,C). SSD 3D reconstruction (D) showed a good panoramic urinary tract evaluation.

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**Fig. 6:** FIG. 5 (Perforation of the proximal left ureter after Percutaneous Nephrolithotripsy) Left calico-pyelic dilation, with endoluminal cloth, on the urographic source axial image (A). Visualization of the enhanced lumen of the left ureter (yellow arrow) and extravasation of contrast medium (red arrow) in the retroperitoneal spaces on MPR reconstruction (B,C). SSD (D) 3D reconstruction showed a good panoramic urinary tract evaluation.

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**Fig. 7:** FIG. 6 (Perforation of the proximal right ureter after Percutaneous Nephrolithotripsy) Extravasation of contrast medium (red arrows) in the retroperitoneal spaces on the urographic source axial image (A) and on MPR reconstruction (B). SSD 3D (C,D) reconstruction showed a good panoramic urinary tract evaluation.

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Fig. 8: FIG. 7a (Displacement of left ureteral stent after endoscopic lithotripsy for ureteral stones) Urographic source axial MDCT images (A,B,C,D). Visualization of the ureteral stent migrated in the intraperitoneal space (white arrow), before the bladder, with extravasation of contrast medium at the Douglas (red arrow). Simultaneous contrast enhancement of the lumen of the left ureter and bladder lumen. MIP (E) and SSD (F) 3D reconstructions showed a good panoramic urinary tract evaluation.

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**Fig. 9:** FIG. 7b (Displacement of left ureteral stent: follow-up) Ureteral stent repositioning on source axial (A), MPR (B) and MIP (C) urographic MDCT images. Source axial (D), MPR (E) and MIP (F) reconstructions of the urographic MDCT acquisition showed the restoration of the ureteral integrity 6 months after ureteral injury.

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**Fig. 10:** FIG. 8 (Bladder migration of left ureteral stent) Visualization of the ureteral stent migrated in the bladder lumen (white arrow) on urographic source axial MDCT images (A). MIP (B), AIP (C) and SSD (D) 3D reconstructions showed good panoramic urinary tract evaluation.

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Fig. 11: FIG. 9 (Post surgical urinary tract stricture) Stricture of pyelo-ureteral junction after pyelo-ureteral plastic surgery, with pyelo-caliceal dilation and partial loss of excretory function.

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Conclusion

DISCUSSION

MDCT has been recently described and recommended as a quick and accurate technique for the study of urinary tract diseases (7,8,9). Herein we report our experience in the evaluation of MDCT urographic acquisitions for the study of the complications of urinary tract surgical procedures.

Combination of source axial images and MPR and 3D reconstructions of the urographic acquisitions, obtained with a MDCT equipment, permitted an optimal evaluation of the urinary tract anatomy in patients with normal renal excretory function.

In our experience, the most frequent urinary tract postoperative complications were uretero-vesical anastomosis dehiscence, ureteral perforations, ureterocutaneous fistulas, displacement or migration of ureteral stent, peritoneal and retroperitoneal fluid collections and post-surgical urinary tract stricture.

In all the cases of uretero-vesical anastomosis dehiscence and ureteral perforations, delayed contrast enhanced urographic MDCT images allowed a better delineation of urine leak, urinomas and site of the ureteral injury, due to the better evaluation of the extravasation of contrast medium, related to the action of diuretic and the acquisition of high resolution images in the late phase after contrast medium administration (Fig. 1,3,4). Urographic MDCT images resulted also helpful in the follow-up of ureteral injuries (Fig. 2,6). In the case of displacement or migration of ureteral stents, despite ureteral stent position is recognizable on un-enhanced and "Nephrographic-phase" CT images, delayed contrast enhanced urographic MDCT images allowed a better topographic evaluation of stent position respect to urinary tract lumen and a good evaluation of concomitant retroperitoneal or intraperitoneal urinomas (Fig. 5,7). In the case of post surgical urinary tract strictures, delayed contrast enhanced urographic MDCT images allowed a better anatomic evaluation of the collecting system due to the acquisition of volumetric high resolution images of the urinary tract (Fig. 8), with good anatomic and functional evaluation of the urinary tract dilation in the follow-up (Fig. 9).

The source axial images of the urographic acquisition, combined with MPR reconstructions, let a better identification of the urinary tract wall lesions, whereas some small lesions of the collecting system were not found visible on the 3D urographic reconstructions due to partial volume effects, making mandatory the evaluation of the source axial images of the urographic acquisition for all the patients (Fig. 3,4). However, the 3D urographic reconstructions were found useful in all the cases to summarise the numerous urographic axial images in few projections, providing a view of the urinary tract similar to that obtained with the conventional urography (Fig. 1-8).
CONCLUSION

Ureteral lesions with urinary fluid collections were the most frequent urinary tract postoperative complications

Urographic acquisition combined with conventional MDCT imaging allowed an accurate diagnosis and follow-up of urinary tract postoperative complications

Source axial images and MPR reconstructions of the delayed contrast enhanced urographic acquisition showed a better identification of urinary tract lesions and perilesional urinomas

3D reconstructions were found useful in summarising urographic axial images
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