Role of Multidetector Computed Tomography (MDCT) in Detection and Characterization of Ureteral Lesions

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Abstract

Background: The ureters may be affected by a variety of congenital, traumatic, inflammatory, neoplastic and extrinsic disorders. Congenital anomalies of the ureters include complete and partial duplication, ectopic ureteral insertion, and ureteroceles. Transitional Cell Carcinoma (TCC) is the most common malignant tumor of the ureter. Traumatic injury to the ureter is most frequently iatrogenic, but it may result from blunt or penetrating traumatic injuries. Extrinsic involvement of the ureter can result from a seemingly endless variety of pathologic processes that cause obstruction by direct invasion, pressure, or constriction. The differential diagnosis of ureteral obstruction include intra luminal (calculi, blood clots, papillary necrosis with sloughed papilla), intramural (tumour, infection diseases, post-surgery/instrumentation trauma, lesions after radiotherapy, ureterocoele, megaurete) and extrinsic abnormalities (rioperitoneal fibrosis, invasion or compression by extrinsic malignancy, lymphadenopathy, inflammatory diseases).

CT scanning plays a major role in imaging the ureter involving the confirmation or further characterization of causes of obstruction or deviation of the ureter by tumor masses or vascular abnormalities. Detection of urothelial carcinoma is arguably the primary role of CT urography, whether in patients with hematuria or those with a history of urothelial tumors of the bladder requiring surveillance of the upper tracts.

Objective: The purpose of this study is to evaluate the role of Multidetector Computed Tomography (MDCT) in detection and characterization of the different ureteral lesions.

Patients and Methods: This study was conducted on 52 patients over a period of 18 months from February 2014 to August 2015 referred from Urology Department of Kasr El-Aini Hospital. Patients were adequately prepared and MDCT Urography was performed consisting of three imaging phases: Unenhanced, nephrographic and excretory phases. Images were processed and finally the CT findings were correlated with surgical and pathologic findings.

Results: Fifty two patients having different ureteral lesions were examined by MDCT, 34.6% (n=18) of cases showed ureteric stones, 17.3% (n=9) of cases had post bilharzial sequelae, 17.3% (n=9) of cases had ureteric strictures (four cases secondary to inflammation, three cases secondary to radiation therapy and two cases secondary to hysterectomy), 11.5% (n=6) of cases had traumatic injuries to the ureter, 7.6% (n=4) of cases had retroperitoneal fibrosis causing ureteric obstruction, 7.6% (n=4) of cases had TCC of the ureter, 1.9% (n=1) of cases had ureterocoele and 1.9% (n=1) of cases had ureteric intra luminal blood clots.

Conclusion: MDCT is an excellent imaging modality in evaluating ureteral lesions and can clearly show the relationship between the ureter and the surrounding structures. Multiplanar (MP) and three-dimensional volume rendering (3D VR) technologies are particularly useful in diagnosing ureteral lesions and their complications. MDCT Urography is now described as a comprehensive test, which can be performed as a substitute “one stop” imaging test for a number of imaging studies, thereby saving time, hospital visits and cost, and potentially shortening the duration of diagnostic evaluation for urinary tract pathology.

Key Words: Ureteral lesions – MDCT.

Introduction

THE ureters may be affected by a variety of congenital, traumatic, inflammatory, neoplastic and extrinsic disorders [1].

Congenital anomalies of the ureters include complete and partial duplication, ectopic ureteral insertion, and ureteroceles Fig. (4) [2]. Transitional Cell Carcinoma (TCC) is the most common malignant tumor of the ureter Fig. (1). Fibroepithelial polyps are the most common benign tumors of the ureter; however, they are rare tumors that occur in younger adults (20–40 years old) more commonly than in children and older patients [3]. Traumatic injury to the ureter is most frequently iatrogenic, but it may result from blunt or penetrating traumatic injuries. Hematuria following traumatic injury may be an initial clinical clue [2]. Ureteral strictures may be the result of prior surgery or instrumentation, stone passage, primary urothelial neoplasms, penetrating injuries, prior radiation therapy, ische-
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mia, retroperitoneal fibrosis Fig. (3), endometriosis, metastatic tumor encasement, or an infectious disease (e.g., tuberculosis, schistosomiasis Fig. (2), etc.) [2].

Extrinsic involvement of the ureter can result from a seemingly endless variety of pathologic processes that cause obstruction by direct invasion, pressure, or constriction. Examples include pelvic neoplasms Fig. (5), extrapelvic neoplasms, inflammatory diseases, and miscellaneous disorders [4].

The differential diagnosis of ureteral obstruction include intra luminal (calculi, blood clots, papillary necrosis with sloughed papilla), intramural (tumour, infection diseases, post-surgery/instrumentation trauma, lesions after radiotherapy, ureterocele, megaureter) and extrinsic abnormalities (retroperitoneal fibrosis, invasion or compression by extrinsic malignancy, lymphadenopathy, inflammatory diseases) [4].

Imaging of the upper urinary tract has traditionally been the purview of Intravenous (IV) urography, but over the last decade, Computed Tomography Urography (CTU) has become the modality of choice in imaging the urinary tract [5]. CT has evolved from single-detector row scanners into multi-detector row helical volumetric acquisition techniques, and these advances have had a significant impact on imaging of the urinary tract [6]. Continuing improvements in the spatial resolution and speed of newer CT scanners, combined with advanced multiplanar and volume-rendered image reconstruction, have made CTU a comprehensive examination whereby the kidneys and upper collecting system, ureters, and urinary bladder can be evaluated in one setting. Indications for CTU continue to evolve [5]. The American College of Radiology rated CTU as the most appropriate imaging procedure in the evaluation of hematuria. Furthermore, extra urinary findings, some of them clinically important, can be found in a percentage of patients undergoing CTU [5].

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. CT urography main drawback is the high radiation doses to the patient, for this reason this technique must be used only following established recommendations [7]. CT scanning plays a major role in imaging the ureter involving the confirmation or further characterization of causes of obstruction or deviation of the ureter by tumor masses or vascular abnormalities. It is also useful in the evaluation of radiolucent filling defects found at urography and can help to delineate extra luminal extension of disease [8].

Contraindications to CTU are generally limited to those patients who cannot receive iodinated contrast because of renal insufficiency, prior severe reaction, or pregnancy [1].

Aim of the work: The purpose of this study is to evaluate the role of Multidetector Computed Tomography (MDCT) in detection and characterization of the different ureteral lesions.

Patients and Methods

Patients:
This study was conducted on 52 patients over a period of 18 months from February 2014 to August 2015. The cases included in the study belong to the age group ranging from 26-82 years with mean age of 45 years. The patients were 33 males and 19 females representing 63.4% and 36.6% respectively. Our source was the Urology Department of Kasr El-Aini Hospital. Clinical presentations were hematuria whether macroscopic or microscopic and/or loin pain.

The patients were subjected to the following:
• Detailed careful history taking before doing the study especially that of previous allergy or reactions to contrast material.
• Laboratory analysis including serum creatinine and urine analysis.

Methods:
Patient preparation:
Patients were kept on NPO (nothing by mouth) status for 6 hours. Then sufficient good hydration of the patients was achieved by oral administration of 500-1000mL water over a 15-20 minutes period before scanning. This avoids dehydration, induces mild diuresis and ensures ultimate distention of the collecting system. It also acts as negative contrast material in the bowel as well as volume load to the kidneys. No oral contrast was given.

Protocol of MDCT technique:
Examinations were performed using two MDCT scanners: 4-detectors GE Light Speed scanner (General Electric, Milwaukee, USA and 320-
detector row scanner (Aquilion ONE; Toshiba Medical Systems, Otawara, Japan).

All patients were placed on the scanner table in the supine position, and an intravenous 16/18-gauge cannula was inserted into an appropriate upper extremity vein. Automatic pump was used and connected to the machines. Approximately 100-120ml of a nonionic contrast material was injected at a rate of 3-4ml/sec. The range of scanning from D11 vertebra till the aortic bifurcation using 1.25-mm section thickness, pitch 1:1.5, table speed of 7.5mm per rotation, gantry rotation of 0.8 second and 140kVp, 200-300mA. The entire range was scanned during breath holding.

MDCT Urography consisted of three imaging phases: Unenhanced, nephrographic and excretory phases. 1) Unenhanced CT: Non contrast scans are obtained initially to visualize anomalies, evaluate for urinary tract calcifications including calculi. This phase was done in all cases but when UT stones were identified as the cause of clinical presentation no other CT phases were performed. This phase is used for detection of stones or calcification of the urinary tract and is also helpful in detection of soft tissue masses and ureteric hematomas. 2) Nephrographic phase: Was obtained at 80-100sec after the initiation of contrast material injection of 100ml of nonionic contrast material at a rate of 3ml/sec by using a maximum collimation of 2.5mm. This phase is employed to evaluate the renal parenchyma for masses, solid renal lesions and ureteric obstructive conditions where persistent dense nephrographic appearance is noted. 3) Delayed (excretory or urographic) phase: Was acquired 8-12 minutes after the initiation of contrast material administration. A longer delay may be necessary in patients with a urinary tract obstruction. It is marked by enhancement of the calyces, renal pelvis, and ureters. It is employed to evaluate the urothelium from the pelvicalyceal system to the bladder.

Imaging processing: After scanning, the image data were transferred to a workstation. For each CT examination, where coronal and sagittal, MIP and curved plane reformats were obtained for full assessment of the whole length of the urinary tract components.

Surgical pathologic correlation for the lesions were obtained and correlated with the CT findings.

Results

Fifty two patients having different ureteral lesions were examined by MDCT, 34.6% (n=18) of cases showed ureteric stones, 17.3% (n=9) of cases had post bilharzial squeal, 17.3% (n=9) of cases had ureteric strictures (four cases secondary to inflammation, three cases secondary to radiation therapy and two cases secondary to hysterectomy), 11.5% (n=6) of cases had traumatic injuries to the ureter, 7.6% (n=4) of cases had retroperitoneal fibrosis causing ureteric obstruction, 7.6% (n=4) of cases had TCC of the ureter, 1.9% (n=1) of cases had uretrocele and 1.9% (n=1) of cases had ureteric intra luminal blood clots.

Urolithiasis was the most common abnormality detected. Twenty calculi, mostly ureteral stones ranging from 4 to 20mm in maximal diameter, were identified on multi-detector row CT in 18 patients with attenuation ranging from 170 to 1490 HU. Some stones passed spontaneously and others needed surgical intervention. The majority of stones were detected at the upper third (45%, n=9), while the middle third was the least to be affected (20%, n=4) and the lower third was affected in (35%, n=7) of cases.

The second most common cause of ureteric lesions detected in this study was post bilharzial squeal found in 9 cases representing 17.3% of cases which is expected in our country where the study was performed due to prevalence of the disease.

Ureteric strictures detection was equal to bilharziasis found in 9 cases representing 17.3% of cases mostly due to post inflammatory process affecting the ureters in four cases or post radiotherapy as treatment for pelvi-abdominal primary or secondary neoplasm in three cases and finally secondary to pelvic adhesions after hysterectomy in two cases.

Traumatic injuries after motor car accidents or blunt traumas were found in 6 cases representing 11.5% of cases. The examination was performed the second day after the trauma in four cases and the third day in two cases when they developed hematuria.

Retoperitoneal fibrosis was diagnosed in 4 cases representing 7.6% of cases. All of them had unilateral ureteric affection with secondary proximal variable degrees of back pressure changes.

Transitional Cell Carcinomas (TCC) were found in 4 cases representing 7.6% of cases. Two cases showed urothelial growth confined to the ureters, one cases shows renal pelvic affection and one case showed extension into the urinary bladder passing the vesico-ureteric junction with no extra
luminal extension and with clear surrounding fat planes.

Congenital bilateral ureteroceles were diagnosed in one patient representing 1.9% of cases. One case showed intra luminal blood clot representing 1.9% of cases and the diagnosis was confirmed by complementary MRI examination the day after and follow-up study was performed ten days later revealing complete resolution of the blood clot.

Fig. (1): Female patient 55 years old with TCC A) Sagittal curved reformatted image in excretory phase, B,C) Coronal curved reconstructed images in excretory phase shows irregular right ureteric mural thickening with marled right side backpressure changes.

Fig. (2): Male patient 55 years old with Urinary tract bilharziasis A,B) Coronal curved reformatted image in non contrast phase, C) Axial images in non contrast phase shows urinary bladder and distal ureteric mural thickening, calcifications and distal ureteric stricture and marked right hydroureter and hydronephrosis.

Fig. (3): Male patient 35 years old with Retroperitoneal fibrosis A) Coronal curved reformatted image in non contrast phase, B,C) Axial images in non contrast phase shows retroperitoneal hypodense soft tissue sheets engulfing aorta and entangling both ureters with their medial deviation.
Table (1): Descriptive statistics of imaging findings in the study sample (n/\%).

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>(N)</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>Stones</td>
<td>18</td>
<td>34.6</td>
</tr>
<tr>
<td>Bilharziasis sequale</td>
<td>9</td>
<td>17.3</td>
</tr>
<tr>
<td>Strictures</td>
<td>9</td>
<td>17.3</td>
</tr>
<tr>
<td>Traumatic injuries</td>
<td>6</td>
<td>11.5</td>
</tr>
<tr>
<td>Retroperitoneal fibrosis</td>
<td>4</td>
<td>7.6</td>
</tr>
<tr>
<td>Transitional Cell Carcinoma (TCC)</td>
<td>4</td>
<td>7.6</td>
</tr>
<tr>
<td>Uretrocele</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Intra luminal blood clots</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td></td>
</tr>
</tbody>
</table>

Fig. (4): Female patient 22 years old with Bilateral uretroceles A,B) Axial and coronal images in non contrast phase, C,D) Axial and coronal images in excretory phase showing bilateral intra vesical cystic lesions filled by contrast at delayed phase.

Fig. (5): Male patient 45 years old with Ureteric entrapment A,B) Coronal curved reformatted images in non contrast phase, C) Sagittal images in non contrast phase showing entangled left ureter by enlarged left iliac lymph nodes with radio dense stone seen within.

Chart (1): Distribution of ureterolithiasis cases according to their site.
Discussion

This study was performed over a time interval aiming to show the wide range of MDCT applications in different types of lesions affecting the ureter.

Regarding the patient preparation, the patients in this study were given 500-1000mL water to drink over a 15-20 minute period before scanning began to avoid dehydration, promote diuresis and act as a negative contrast medium for the GIT. No oral contrast was given. This preparation agrees with preparation done by Sanyal et al., 2007 [9] and Maheshwari et al., 2010 [10].

Regarding patient position, the supine patient positioning was the standard with all cases in this study. This agrees with the studies done by McTavish and colleagues, 2002 [11] and Sanyal and coworkers, 2007 [9], who found that prone positioning did not reveal any advantage over supine positioning in distal ureteral opacification.

Regarding scanning technique, we used the single bolus technique in all patients to obtain two or three post contrast phases. Using this technique, we were following many authors who used the same technique including, Meindl and colleagues, 2006 [12], Dillman and colleagues, 2007 [13] and Maheshwari et al., 2010 [10] who stated that single bolus MDCT technique provides better overall UT distension than does split-bolus technique in which combined nephrographic/excretory-phase imaging was performed in a single acquisition.

Up till now, data concerning optimal delay time between I.V. CM injection and start of the excretory phase scan are very variable ranging from 2.5 to 16min. Longer delay times seemed beneficial for delineation of the distal ureter (10-16min), according to Kemper and colleagues, 2005 [14] but Meindl and colleagues, 2006 [12] stated that delay time greater than 28min was associated with higher number of non-opacified segments.

Raptopoulos and McNamara in 2005 [15] found that the best pelvicalyceal visualization was after 5 minutes using a low I.V. contrast dose. Caöili and colleagues, 2005 [16] demonstrated that scanning at 7.5 minutes rather than 5 minutes resulted in the greatest and most consistent opacification. They concluded that longer imaging delays improved distension of the proximal UT and aided in visualization of the lower segment of the ureter. However, the percentage of non-visualized distal ureteric segments remained 24% using a 7.5 minutes delay.

The findings in this study support the above mentioned conclusion by showing that delay times of 8-12min after IV contrast administration was favorable for complete opacification of the distal ureter and UB. The average scan delay in our patient group was calculated to be 10 minutes.

In this study with the use of thin collimation, we were able to depict the entire renal collecting system, the ureters and the urinary bladder in one acquisition in no more than 30 seconds, with a resolution we consider near to that of IVU, although no direct comparison of these two studies was performed. Multiplanar reformations and 3D reconstructions provided images with excellent anatomic details, as well as IVU-like images.

Concerning radiation exposure, as with other multiphasic abdominal CT protocols, MDCU exposes the patient to increased radiation exposure, which has to be weighed against the expected benefits from the examination [17].

Several steps were taken in this study in trying to limit the radiation exposure of the patients. Only one phase (non-contrast phase) was used if UT stones were identified as the cause of hematuria; the examination was terminated by this phase. This agrees with Maher and colleagues 2004 [18] and Kalra and colleagues 2002 [19] who decided that the incidence of urothelial cancer in patients who have hematuria and who are less than 40 years old is low; therefore, if urinary calculus is seen on an initial non contrast CT, the post contrast CT can be avoided, allowing a further, significant reduction in radiation dose.

It has to be noticed that, while the amount of radiation MDCT imparts into any given patient is not insignificant, the creation of coronal and curved-planar reformatted images comes at no additional radiation cost [20].

Regarding our cases ureterolithiasis was the most common, representing 34.6% of the cases. Although conventional radiography may help in detection of urinary calculi, it is not as sensitive as unenhanced CT [21]. Conventional radiography has a sensitivity of only 60% in detecting urolithiasis and in combination with US, the sensitivity increased to 70% [22]. While the sensitivity of unenhanced CT is greater than 95% for detecting ureteral stones in patients with acute flank pain [23]. Non contrast MDCTU has a number of obvious advantages for patients over the IVU including: No need for IV contrast, considerably shorter examination time, increased sensitivity, can identify.
and directly measure size of calculi and other extra urinary causes. It provides a considerable amount of additional information, such as reaction of the kidney (nephromegaly and “perirenal stranding”) or ureter wall thickening at the site of an obstruction (“soft tissue rim sign”), it is also helpful in detecting non obstructing calculi [24].

In this study, the unenhanced phase of MDCT examination provides optimal evaluation of all ureteral calculi as well as evaluation for secondary signs of obstruction. We were able to detect 20 stones in 18 patients. Hydronephrosis and hydrourere were readily recognized by axial, coronal or sagittal reformatted images as a dilatation of the collecting system and ureter. Calculi can be detected at any site of UT: Calyceal, renal pelvis, upper, middle, lower ureteric and UB. These results agreed with Cowan et al., 2006 [25], who stated that the unenhanced portion of their CT examination provides optimal evaluation of all urinary calculi as well as evaluation for the level of obstruction and demonstrate reliable secondary signs of obstructing calculi.

Our study also concluded 9 patients with history of Bilharziasis. The relative large number of patients (17.3% of cases) is most likely due to the prevalence of the disease in our country. All patients showed distal ureteric calcification using the unenhanced phase of MDCT. Our results agreed with Jorulf and Lindstedt, 1985 [26], who stated that fine ureteral calcification may be observed at an early stage of schistosomiasis, initially with areas of sparing but eventually coalescing until the entire length of the ureter is calcified, from the bladder to the kidney. The fine ureteral calcification is visible as a linear or parallel linear pattern on radiographs and as a circular pattern on axial CT images. These radiologic imaging findings are considered pathognomonic.

Ureteral strictures may be the result of prior surgery or instrumentation, stone passage, primary urothelial neoplasms, penetrating injuries, prior radiation therapy, ischemia, retroperitoneal fibrosis, endometriosis, metastatic tumor encasement, or an infectious disease (e.g., tuberculosis, schistosomiasis, etc.) [2]. In our study, we encountered 9 cases with ureteral strictures which were secondary to prior inflammatory process (ureteritis), radiation therapy and hysterectomy operation.

Traumatic injury to the ureter is most frequently iatrogenic, but it may result from blunt or penetrating traumatic injuries. Rupture or tear of the ureter is identified on excretory images as excreted contrast accumulates outside of the collecting system and ureter [1].

In our study, we encountered 6 cases of ureteral injuries all of them showed obvious ureteral laceration demonstrated by contrast extravasation on the delayed excretory phase.

The widespread availability of MDCT has allowed comprehensive evaluation of retroperitoneal fibrosis location, extent, and effect on adjacent organs and vascular structures. Retroperitoneal fibrosis most often manifests as a paraspinal, well-demarcated but irregular retroperitoneal mass that is isodense to surrounding muscle. Initial fibrosis tends to begin near the aorta and the iliac arteries, extending through the retroperitoneum to involve the ureters [27].

We also concluded 4 cases of retroperitoneal fibrosis, with unilateral ureteric affection and encasement of the aorta. The four patients were males. This also agrees with Miller and colleagues, 2003 [28], who stated that idiopathic retroperitoneal fibrosis is seen more commonly in men, with a 2:1 to 3:1 ratio compared with women.

Our study included four cases having TCC, two cases the lesion was confined to the ureter, one cases had renal pelvic extension and the last had urinary bladder extension. The diagnosis was confirmed pathologically in the post operative specimen. TCC is the most common malignant tumor of the ureter. Ureteral TCC is more common in men than women and typically occurs in the sixth and seventh decades of life. It is commonly multifocal and multicentric. With the advent of multislice CT, CT urography is now considered the standard for evaluating ureteral TCCs [3].

IVU is still used routinely by most urologists to evaluate the renal collecting system and ureter. Use of IVU for detecting urothelial abnormalities is not ideal, however, because it has limited sensitivity, failing to detect up to 40% of upper tract urothelial malignancies likely due to relatively suboptimal contrast resolution as stated by Dalla Palma et al., 2005 [29].

Finally, MDCT urography techniques have enabled vast improvements in the depiction of the ureteral lesions. 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 post surgical changes. Other benign processes like ureteral kinking and stenosis due to extrinsic compression of the iliac vessels are also well characterized by MDCT.

Conclusion:

MDCT is an excellent imaging modality in evaluating ureteral lesions and can clearly show the relationship between the ureter and the surrounding structures. Knowledge of the spectrum of imaging findings of the different ureteral lesions may help the interpreting radiologist to formulate appropriate differential diagnosis. Multiplanar (MP) and Three-Dimensional Volume Rendering (3D VR) technologies are particularly useful in diagnosing ureteral lesions and their complications. The 3D reconstructions aided in convincing urologists of the benefits of this technique over excretory urography as it allowed the production of coronal images similar to IVU images.

MDCT Urography is now described as a comprehensive test, which can be performed as a substitute "one stop" imaging test for a number of imaging studies, thereby saving time, hospital visits and cost, and potentially shortening the duration of diagnostic evaluation for urinary tract pathology.

The major concern, which may limit universal acceptance of MDCTU, is the radiation dose as it clearly exceeds IVU. However, radiation dose can be reduced by adapting scanning parameters for each phase of MDCTU or by reducing number of phases.

References


الملخص العربي

يكون الحال من أمراض الأشعة ضيقة تقوم بتوصيل البول من حوض الكلية إلى المثانة، توجد أعراض عديدة تصلح الحالة منها العوامل الخلقية والأعراض العامة والحوادث والمزمنة والأمراض المسببة لاضطباب الحال، منها ما هو داخل مثل الحصوات والأورام ومنها ما هو خارج مثل الأورام والليفات.

الأشعة المقطعية متعددة الكواشف هي الطريقة السائدة الممتازة للتصوير في تقييم أطفال الحالة ويمكن أن تظهر بوضوح العلاقة بين الحالة وما يحيط به وتساعد بطب الأشعة في التوصل وتسهيل تشخيصات ترقية مناسبة للتقنيات الحديثة في طب الأشعة المقطعي بما في ذلك اثاثت الأبعاد المفيدة في تشخيص أعراض الحال ومساعدتها كما سمحت أيضا لمرض الصدر بطرقية مباشرة للأشعة العادية بالصفيفة.

توصف الآن الأشعة المقطعية متعددة الكواشف كاختيار شامل، يمكن أن تكون كبد لعدد من الفحوصات الأخرى، وبالتالي تساعد في توفير الوقت والتكفيلة.

إن استخدام الأشعة المقطعية يعترض المريض لجرعة عالية من الأشعة والتي تتوفر بالتأكيد الجرعة التي يتم التعرض لها مع الفحوص الأخرى بالصيغة وإن كان يمكن تقليل هذه الجرعة من الأشعة وذلك بتغيير العوامل المستخدمة بدون التأثير على جودة الصور وكذلك بحذف تصوير المراحل الغير مؤثرة في تشخيص المرض.