ROLE OF NEW IMAGING MODALITIES IN MANAGEMENT OF MALIGNANT RENAL TUMORS

Essay
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Table of Contents

Abbreviations

ADC	Apparent Diffusion Coefficient
AUC	Area under the curve
C	Celsius
CE	Contrast enhanced
CEUS	Contrast enhanced ultrasound
Cm	Centimeter
CT	Computed tomography
CTU	CT urography
D	dimensional
DW	Diffusion Weighted
FDG	18F-Fluoro Deoxy Glucose
Fig	Figure
FLASH	Fast low angle shot
FNA	Fine needle aspiration
FNAC	Fine needle aspiration cytology
G6Pse	Glucose 6 phosphatase
Gd-DTPA	Gadolinium Di Ethyl Triamine Penta acetic acid
GRE	Gradient Recalled Echo
h	hour
HIFU	High intensity Focused US
HU	Hounsfield Unit
IVC	Inferior vena cava
IVU	Intravenous urography
Kg	kilogram
L	Lumbar
MBq	Mega becquerel
mci	millicurie
min	minute
mL	milliliter

MPR	Multiplanar reformation
MR	Magnetic resonance
MRI	Magnetic resonance imaging
MRU	MR urography
MSCT	Multislice CT
MW	microwave
PET	Positron Emission Tomography
PET/CT	Positron Emission Tomography/ computed tomography
PRF	Pulse Repetition Frequency
RCC	Renal cell carcinoma
RFA	Radiofrequency ablation
ROI	Region of interest
sec	Second
SMA	Superior Mesentric Artery
SNR	Signal to noise ratio
T	thoracic
T	Tesla
TAE	Transarterial embolization
TCC	Transitional cell carcinoma
TNM	Tumor-node-metastasis
TTP	Time to peak
US	Ultrasound

List of Figures and Tables

Role of new imaging modalities in management of malignant renal tumors

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Abstract:

Tumors of the kidney account for about 3% of all malignant tumors of the body. RCC is the most common primary renal malignant neoplasm in adults. It accounts for approximately 90% of renal tumors and 2% of all adult malignancies. One fourth to one third of patients present with metastatic disease. In recent years, tumors are being discovered at an earlier stage, possibly due to increased use of medical imaging in general. Other malignant renal tumors include TCC, lymphoma, metastases, sarcomas and Wilm's tumor (the most common malignant renal tumor in children).

Conventional radiography is rarely used to diagnose a renal mass. Accidentally, we may suspect the presence of a renal tumor in abdominal radiographs done for other causes (loss of the psoas margin, displacement of retroperitoneal fat, presence of calcification and presence of an expansile ball shaped mass extending from the kidney raise the suspicion). Picture of renal tumors on IVU are non-specific and include mass effect on the collecting system, distortion of the renal contour, enlargement of a portion of the kidney and calcification.

The widespread use of abdominal US has aided in the early detection of renal tumors discovered incidentally on US for other causes. It can differentiate solid masses from simple cysts. It is non invasive, painless and does not involve irradiation. However, it is still limited in staging and giving final diagnosis of the nature of the tumor. CEUS has become increasingly important because it can clearly resolve small tumor vessels; it is safe for patients with impaired renal function because of the absence of urinary excretion of the contrast agent. Moreover, the technique is not contraindicated for patients with pacemakers or arthoprostheses, is less expensive than CT and MRI, and does not entail use of ionizing radiation. But still the presence of bowel gas limits the effectiveness of US. Endoscopic ultrasound allows examination and biopsy of masses within the kidney, thus facilitating the diagnosis of early RCC.

CT plays a central role in the evaluation of a patient with a suspected renal mass; it can be used to detect and stage RCC and to provide information for surgical planning of renal tumors. Helical CT has improved the diagnosis of renal masses by decreasing the potential limitations of partial volume averaging and respiratory misregistration. Currently, the CT technique recommended for detection and staging of renal cell carcinoma is a multiphase protocol, which includes unenhanced CT followed by corticomedullary and nephrographic phase imaging of the kidneys. MSCT allows faster data acquisition times when compared with single-detector CT, with no loss in image quality thus helping reduce the motion artifact. CTU has demonstrated excellent sensitivity in detecting upper tract uroepithelial neoplasms. But still CT has two major disadvantages, the use of intravenous contrast media and the irradiation to the patient.

Most imaging modalities yield purely anatomic and morphologic tumor details without addressing tumor metabolism. The advent of PET and PET/CT has provided tumor-related qualitative and quantitative metabolic information critical to patient diagnosis and management. Its sensitivity for detecting metastatic lesions is better than for determining the presence of cancer in the renal primary site.

MRI is a powerful and versatile tool for single modality evaluation of potential renal malignancies. A well-planned high field MRI examination can simultaneously detect and characterize renal tumors. MRI generates the highest intrinsic soft tissue contrast of any cross-sectional imaging modality. The main MRI feature indicating potential malignancy of a renal tumor is enhancement after intravenous gadolinium administration. MRU has evolved to become a serious clinical alternative to conventional IVU and CTU. Analysis of tumor vascularity by MRA and MRV helps in recognition of all malignancies, including renal cancer. When IVC involvement is suspected, either inferior venacavography or MRI angiography is used. Diffusion weighted MRI is able to differentiate between normal and neoplastic renal parenchyma. MRI is limited by patient cooperation because MRI is more sensitive to motion artifact than CT.

Image-guided renal mass biopsy procedures can be performed using CT, US, MRI or less commonly, fluoroscopic guidance. The most common indications are tumors that do not have the typical radiologic features of RCC, Bosniak category III or IV cystic lesions, locally advanced or metastatic RCC and non-surgical tumors.

RFA is increasingly more being used for the treatment of renal lesions in patients who are poor surgical risks or who refuse surgery, also in patients with a solitary kidney and as an alternative to nephron-sparing surgery. The size of a renal tumor, its location within the kidney, and the proximity of adjacent structures should be considered when evaluating a tumor for possible ablation. The procedure can be performed laparoscopically under US guidance, open under US guidance or percutaneously under US, CT or MRI. Other ablation techniques include cryoablation, HIFU, microwave and laser ablation.

Transarterial embolization is an accepted therapeutic option for palliation of renal cancer with very high success rate and low complication rate.

Introduction

Tumors of the kidney account for 1 to 2% of all malignancies **(Yaqoob, 2009).** Renal cell carcinoma (RCC) is the most common primary renal malignant neoplasm in the adult. It accounts for approximately 85% of renal tumors. One fourth to one third of patients have metastatic disease at presentation **(Baumgarten et al., 2009).**

Wilm's tumor (nephroblastoma) is the most common childhood abdominal malignancy and represents 5% of all malignant renal tumors with an incidence of bilaterality up to 10% **(Arnold, 2009).**

Other malignancies include oncocytoma, collecting duct carcinoma, lymphoma, transitional cell carcinoma (TCC) and metastatic disease.

The prognosis is worst for patients with metastatic disease at presentation and best for patients with small masses confined to the kidney. Larger lesions tend to be of higher grade and metastasize more frequently **(Baumgarten et al., 2009).**

Today, the majority of solid renal masses that are ultimately proved to be renal cell carcinomas were incidental findings on imaging studies performed for non–urinary tract symptoms **(Dyer et al., 2008).**

With modern computed tomography (CT) and magnetic resonance imaging (MRI) equipment, the diagnosis of most renal

masses is usually straightforward and accurate. The major question to be answered is whether the mass represents a surgical or nonsurgical lesion or, in some cases, if follow-up studies are necessary. This usually can be accomplished with high-quality examination and awareness of the potential pitfalls and limitations of CT and MRI **(Israel and Bosniak, 2005).**

With introduction of multidetector technology, CT urography has emerged as the initial heir to intravenous urography (IVU). CT is the test of choice for many urologic problems including renal masses. CT urography provides detailed anatomic depiction **(Silverman et al., 2009).**

By diffusion weighted technique, T1 signal characteristics of a renal lesion appear to be related to the apparent diffusion coefficient (ADC) of the lesion. ADC may be helpful in characterizing and differentiating renal masses **(Zhang et al., 2008)**. MR urography can also be used to evaluate the urinary tract and has the advantage of not using ionizing radiation and the potential to provide more functional information than CT **(Silverman et al., 2009).**

Percutaneous renal biopsy, under ultrasound or CT guidance, has a low rate of complication and a high yield of definitive histopathologic diagnosis (**Samir et al., 2006**).

In the treatment of malignant renal tumors, percutaneous cryoablation using CT and ultrasound guidance is highly effective **(Farell et al., 2006).** Also, MRI guided percutaneous cryotherapy of renal tumors shows promise for treatment of selected small renal tumors and MRI can be used to monitor treatment

intraprocedurally (**Silverman et al., 2005**). Also radiofrequency ablation of renal cell carcinoma showed success rate of 90-95% with complete tumor necrosis and very few cases of residual disease (**Mylona et al., 2008**).

Urologic applications of Positron Emission Tomography (PET) have centered primarily in oncology using F-2-deoxy-D-glucose (FDG), although a variety of tracers and specialized applications have been approached in limited studies. Its application in renal cancer, as with other oncologic applications in the body, is for purposes of diagnosis and staging. PET potentially could aid non-invasive characterization of the malignant potential of small renal masses which is taking on great importance for reasons of the growing incidental detection of solid masses less than 3 cm in diameter and the conservative management of such cases **(Shreve, 2006).**

Today, the majority of new machines also have a CT scanner incorporated (PET/CT) which has more advantages **(Hilson, 2006).**