

Original Research Article

Role of multi detector computed tomography (MDCT) in evaluation of renal masses

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ABSTRACT

Background: Due to rapid pace in development of imaging techniques and increasing number of investigations being done, more number of renal masses are discovered incidentally during evaluation of unrelated or unspecific symptoms. Hence it is vital to differentiate neoplastic and non-neoplastic masses. Among the neoplastic masses, there is a need to differentiate benign and malignant masses so that appropriate treatment strategies like nephron sparing surgery, radio frequency ablation etc. can be planned at an early stage and avoiding unnecessary radical treatments for improved patients survival.

Methods: A Cross-sectional Observational study was done in 35 patients. Patients of either sex in any age group who had presented with suspected renal mass by clinical signs and symptoms (palpable renal angle mass, renal angle pain, hematuria) confirmed on USG examination or an incidental Renal mass diagnosed on USG/CT examination were included in our study.

Results: Ultrasound is the initial imaging modality of choice since it is inexpensive, easy to perform and no radiation exposure. On USG, the renal lesions are classified as solid or cystic. Anechoic, thin walled cyst without any septations or solid components is usually Bosniak I cyst (simple cyst) and does not need any further evaluation. Rest of the cystic and solid lesions cannot be characterized by ultrasound and hence need further evaluation.

Conclusions: Multidetector Computed Tomography is the imaging modality of choice for further evaluation and characterization. CT is done in four phases viz., unenhanced, corticomedullary, nephrographic and excretory phase especially in cases of malignancy while in benign conditions like angiomyolipoma and abscess, evaluation with unenhanced and single phase post contrast in portovenous phase is sufficient.

Keywords: Multidetector computed tomography, Renal masses

INTRODUCTION

The kidneys are paired retroperitoneal structures that are normally located between the transverse processes of T12-L3 vertebrae. Several renal lesions are frequently encountered in clinical practice. Improvement in imaging modalities continues to have a large impact on the diagnosis and treatment of solid renal masses. Due to rapid pace in development of imaging techniques and

increasing number of investigations being done, more number of renal masses are discovered incidentally during evaluation of unrelated or unspecific symptoms. Hence it is vital to differentiate neoplastic and non-neoplastic masses. Among the neoplastic masses, there is a need to differentiate benign and malignant masses so that appropriate treatment strategies like nephron sparing surgery, radio frequency ablation etc. can be planned at an early stage and avoiding unnecessary radical

treatments for improved patients survival.¹ Various renal masses which are encountered are:

Neoplastic

Benign: Oncocytoma, Angiomyolipoma, Cystic nephroma

Malignant: Renal cell carcinoma, Transitional cell carcinoma, Squamous cell carcinoma, Wilms tumor, Renal sarcoma, Lymphoma, Metastasis

Non-neoplastic

Cyst, Malackoplakia, Abscess and pyonephrosis, Hydatid disease, Hematoma, Vascular malformation, Pseudotumour, Xanthogranulomatous pyelonephritis. The wide range of radiological investigations in evaluation of the renal lesions varies from the plain abdominal radiograph, excretory urography, ultrasonography, radionuclide imaging, angiography, CT and MRI. Historically excretory urography has been used as optimal screening test for evaluation of suspected renal mass. Computerized tomography (CT) has a major role in evaluation and characterization of renal masses.²

The ability of dedicated renal CT scanning and gadolinium-enhanced MRI to detect and characterize renal lesions greater than 1cm is similar. Because CT is more easily available, quicker, and less expensive than MRI, it is usually preferred to MRI for evaluating patients with suspected renal masses. Multidetector spiral CT have dramatically changed the diagnostic evaluation of renal pathologies by allowing rapid image acquisition through the entire kidney during various phases of contrast enhancement after the administration of a single bolus of intravenous contrast material.³ In general, multi detector CT serves as a single step investigation for suspected renal masses.⁴

Dedicated renal CT performed for the diagnosis and staging of renal cell carcinoma must include a combination of image data acquisitions, despite the added radiation exposure and cost, better detection and characterization of renal masses, as well as more accurate staging, are possible when the scanning protocol includes a combination of unenhanced CT and imaging in corticomedullary and nephrographic phases.⁵

METHODS

This Cross-sectional Observational study was conducted in the department of Radiodiagnosis, Post Graduate Institute of Medical Education and Research, Dr. Ram Manohar Lohia Hospital,

New Delhi, from November 2015 to March 2017. Approval from hospital and Institutional Ethical Committee was obtained prior to initiation of the study. Patients of either sex in any age group who had presented

with suspected renal mass by clinical signs and symptoms (palpable renal angle mass, renal angle pain, hematuria) confirmed on USG examination or an incidental Renal mass diagnosed on USG/CT examination were included in our study. Patients with Bosniak I and II cysts, patients who had history of allergy to intravenous contrast agents, patients with deranged kidney function tests, post-surgical patients, and pregnant women were excluded from our study.

A written informed consent was taken from all patients. A detailed history was taken with complete physical and systemic examination of the patient. Relevant biochemical investigations were done wherever required.

Ultrasonography

Ultrasound abdomen of patient was performed as an initial modality in patients with suspected renal mass. Ultrasound was performed using 3MHz convex transducer. Acoustic gel was used for skin transducer coupling.

Computed tomography

CT was performed on Philips 40-slice Multi-detector scanner (Brilliance). A plain tomogram was taken as a guide/reference from diaphragm to pelvis. Images were acquired with 1- to 3-mm collimation, and a pitch of up to 2:1 to allow coverage of the area of interest in single breath-hold. CT protocol for evaluation of the kidneys consists of both non enhanced and contrast-enhanced CT scans obtained in suspended respiration, to overcome the motion artifact. To avoid artifactual differences in attenuation values, the same peak kilovoltage, milliamperes-second setting, section thickness, and field-of-view were used for both pre contrast and post contrast scans.

After taking unenhanced CT scan, Intravenous contrast (non-ionic iodinated) was injected into an antecubital vein at a rate of 2-4ml/sec by power injector. Volume of contrast was calculated based on the age and weight of patient (approximately 1ml/kg).

Using bolus tracking by keeping the tracker at descending aorta, scanning for corticomedullary phase was acquired between 25 and 70 seconds after the start of contrast administration. The nephrographic phase was acquired between 80-180 seconds after the start of injection. Approximately 180 seconds after the start of contrast injection, the excretory phase scan was acquired.

RESULTS

The present study was carried out in the department of Radiodiagnosis, PGIMER, Dr. Ram Manohar Lohia Hospital, New Delhi. A total of 35 cases suspected of having renal masses on the basis of clinical profile, prior imaging profile underwent CT examination.

The cases encountered in our study were in the age range of 2-91years. Maximum cases were in age group 52-61 years of age (10/35 = 28.5%). Mean age was 46.8years.

Out of 35 patients included in the study, 23 (65.71%) were males and 12 (34.28%) were females with a Male:Female ratio of 1.91:1 In our study, hematuria was the most common (18/35=51.42%) presenting symptom followed by abdominal pain (12/35=34.28%) and palpable abdominal mass (8/35=22.85%). Fever was present in two patients. In our study, Renal cell carcinoma was found in 21 patients (60%) which makes it the most common renal mass encountered. This was followed by Transitional cell carcinoma, Wilm's tumour, and Angiomyolipoma which was found in 2 patients (5-6%). Bosniak III cyst, Bosniak IV cyst, Hydatid cyst, renal abscess, acute lobar nephronia, renal hematoma, lymphoma, metastasis was found in 1 patient (3%). In our study, most common age group for renal cell carcinoma was seen between 50 and 70 years (57.14%). Youngest patient was seen at 21 years of age with the mean age of 55.6 years.

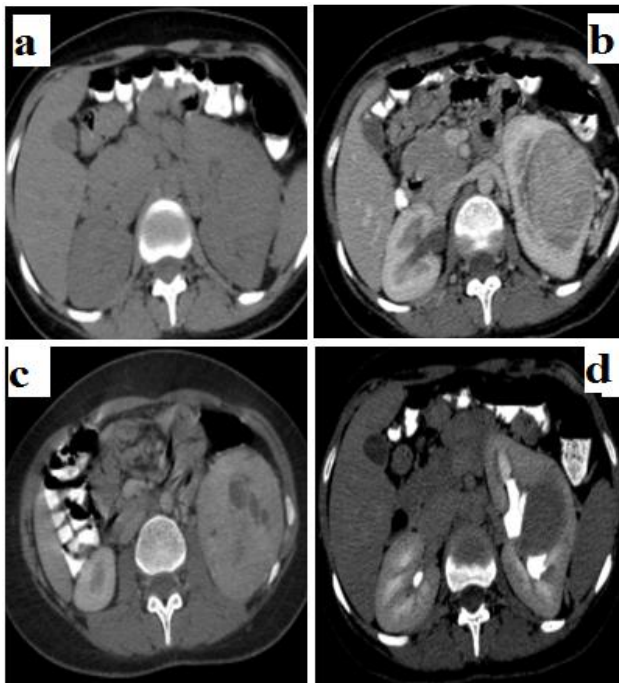


Figure 1: a) Axial unenhanced CT showing a isodense renal mass involving the midpole of left kidney. (b) and (c) axial corticomedullary and nephrographic image showing heterogenous enhancement of mass and cystic changes with pseudocapsule. (d) axial excretory phase showing mass extension up to pelvicalyceal system with splaying of calyces.

All the three complaints which are known as cardinal signs in renal carcinoma were seen only in 2 patients (9.5%). Calcification was present in 6 lesions (28.57%). Calcification pattern varied from punctate to amorphous nature. No fat attenuation was present in any of the lesions. Most of the lesion showed heterogeneous

enhancement on post contrast studies (20/21=95.23%). All the renal carcinoma cases showed altered renal contour (ball type mass) and showed enhancement in corticomedullary and nephrographic phase with wash out in excretory phase. In our study, perinephric space extension was seen in 13 patients (61.9%). Extension beyond perirenal fascia was found in 6 patients (28.5%). Ipsilateral adrenal involvement was seen in 6 patients (28.5%). Renal vein and IVC thrombosis was seen in 2 patients (9.5%) and both patients had malignant thrombosis. Lymph nodal involvement was seen in 12 patients (57.1%). Pelvicalyceal involvement was seen in 8 patients (38%).

Surrounding organ/viscera were involved in 9 patients in total (42.8%). Colon, duodenum, IVC, Psoas/paravertebral muscle involvement was seen in 2 patients (9.5%). Liver involvement was seen in 5 patients (23.8%). Ipsilateral adrenal involvement was seen in 6 patients (28.5%). Abdominal wall involvement was seen in 3 patients (14.2%). Distant metastasis was found in 9 patients (42.8%). Multiple sites of metastasis were found in 3 patients (14.2%). Lung was the most common organ of metastasis and found in 3 patients (14.2%) followed by bones and liver (9.5%).

Among the bony metastasis, osteolytic metastasis was the most common pattern observed in 3 lesions while sclerotic metastasis was found in 1 lesion. Among the solid organ metastasis, heterogeneously enhancing metastasis similar to parent organ involvement was the most common pattern observed in 7 lesions, homogeneously hyper enhancing metastasis was found in 1 lesion and hypodense metastasis was found in 2 lesions.

Regional lymph node metastasis was found in 11 patients (52.38%). Nodes along the renal vessels, para aortic, aortocaval nodes with the size of the lymph node more than 10mm in short axis diameter was taken as positive. There appeared to be a direct correlation between the lymph node involvement, metastasis and T staging. Higher T stage was associated with higher incidence of lymph node involvement and metastasis. Stage IV was the most common presentation seen in 10 patients (47.6%) followed by stage III and I (23.8%).

Renal Transitional cell carcinoma: Two cases of renal transitional cell carcinoma were diagnosed which comprised of 9.52% which were seen as infiltrative heterogeneously enhancing masses with maintained renal contour along with upper ureteral thickening. One of the patients had liver metastasis and one patient presented with synchronous renal and bladder carcinoma.

Bosniak cyst: One case of Bosniak IIF cyst was seen in 21-year male presented with left flank pain. On CECT there was a cyst with multiple coarse calcification and septae in left kidney involving mid and lower pole. No evidence of enhancement along the cyst wall or along the septae noted. On 6 months follow up, there was no

interval change in the lesion and was recategorized as Bosniak II cyst. Provisional diagnosis of Renal Hydatid cyst was made based on the appearance. One case of Bosniak III cyst was seen in 52-year female presenting with left flank pain. On USG, there was cystic lesion with multiple thick septations in interpolar region. On CECT there was a cystic lesion with multiple septations and foci of calcification.

On post contrast, there was measurable enhancement along the septations, suggestive of Bosniak III cyst. One case of Bosniak IV cyst was seen in 60-year male presenting with pain abdomen. On USG, there was a large predominantly cystic mass with solid components in lower pole of left kidney. On CECT there was enhancement of the septations and solid components. There was no invasion of renal vein or IVC. Features were suggestive of Bosniak IV cyst and diagnosis of Cystic renal cell carcinoma was made.



Figure 2: (a) Axial contrast CT showing Heterogeneously exophytic enhancing mass involving the right kidney. (b) and (c) Axial contrast CT showing multiple hyperenhancing lesions in liver in corticomedullary phase. (b) similar to parent lesion while the lesions are not distinct in nephrographic phase. (c) suggesting the importance of corticomedullary phase in assessing solid organ metastasis.

Angiomyolipoma: Two cases of sporadic Angiomyolipomas seen in middle aged female. In both the cases, the lesions were hyperechoic on USG with fat attenuation on CT. On post contrast, there was patchy nodular enhancement.

Acute lobar nephronia: One case of Acute lobar nephronia was seen in 18-year female who presented with fever and right flank pain. On USG, there was heterogeneously hypoechoic lesion in right kidney in the interpolar region. On CECT, there was a heterogeneously enhancing lesion in the interpolar region. In view of clinical complaints, patient was put on antibiotics and followed up by USG. On follow up there was a progressive diminution in size of lesion and periodic change in echogenicity. At 6 weeks, there was complete resolution of the lesion and diagnosis of Acute lobar nephronia was made.

Others: One case of renal abscess was diagnosed in 32-year female presenting with fever and right hypochondrial pain. On USG, there was a heterogeneously hypoechoic lesion with perinephric extension. On CECT, it showed peripheral enhancement with central low attenuation and extensive perinephric stranding suggestive of renal abscess. One case of lymphoma with renal involvement was seen in 4-year female child. On CECT there were bilaterally enlarged kidneys showing mild enhancement with maintained renal contour along with multiple non-necrotic bulky retroperitoneal and mediastinal lymphadenopathy. One case of renal metastasis was seen in known case of lung carcinoma in 40-year male. On USG, there were multiple heterogeneously hypoechoic lesions involving bilateral kidneys. On CECT, there were multiple heterogeneously enhancing lesions involving bilateral kidneys with bulky necrotic retroperitoneal lymph nodes. One case of large renal hematoma with grade IV renal injury was seen following blunt abdominal trauma. On CECT there was a large hyperdense collection suggestive of hematoma with parenchymal laceration involving renal cortex, medulla and collecting duct system.

DISCUSSION

Multidetector computed tomography (MDCT) remains the most widely available and most effective modality for the detection and characterization of renal masses. MDCT scanners with the improvement of spatial resolution and the ability to obtain multiplanar and 3D-reconstructions greatly improved the diagnostic performance of CT in characterizing RCC and estimating the extent of the disease. In our study, 35 patients suspected of having renal mass based on clinical complaints were subjected to ultrasound examination. Those who were positive for renal mass in USG and those patients with incidentally detected mass in any of the radiological investigations was further evaluated with Multidetector Computed Tomography. There was spectrum of both benign and malignant masses observed

in our study with malignant renal cell carcinoma being the most common diagnosis. To see the association of the disease at presentation and imaging findings, patients were divided into 10 age groups from 2 to 91 years.

Variables studied were gender, tumour size, USG appearance, TNM stage, Lymph node involvement, Renal vein and Inferior vena cava (IVC) thrombus. Age of the patients included in our study ranged from 2-85 years with mean age of 46.8 years. Maximum number of cases were between 52-61 years age group numbering 10 cases comprising about 28.5% of total. Out of 35 patients included in the study, 23 (65.71%) were males and 12 (34.28%) were females with a Male:Female ratio of 1.91:1.

Renal cell carcinoma: Renal cell carcinoma was the most common renal mass observed in our study accounting for 21 patients out of 35 (60%). Majority of renal cell carcinomas were seen between 50 and 70 years (57.14%) of life with the mean age of 55.6 years and median age of 55 years with definite male preponderance showing male to female ratio of 3.2:1. These results were comparable with other Indian studies.⁶ Shalini Agnihotri et al, in 2014 has shown that the mean age at diagnosis was 55.15±13.34 (median 56, range 14-91) years. Male preponderance was seen in patients of all age groups. In a study from Surveillance Epidemiology and End Results (SEER) database, majority of RCC cases at presentation were between 60-69 or 70-79 years of age and only 42 per cent of patients presented in < 60 years of age (68). In our present study, it was 61.9% in less than 60 years of age which was comparable with other Indian studies thus showing the relatively younger age group of occurrences of Renal cell carcinoma in India.

Imaging appearance: On ultrasound, renal cell carcinoma was predominantly solid with heterogeneous appearance in 47.6 % followed by solid mass with cystic areas in 38%. Renal cell carcinoma was equally in upper and lower pole in 6 patients (28.57%) with no predilection for either poles. Replacement of whole kidney by the mass was present in 2 patients (9.5%).

On CT, calcification was present in 28.57% of lesions with the pattern of calcification varying from punctate to amorphous in nature. No fat attenuation was present in any of the lesions. On post contrast, 95.2% showed heterogeneous enhancement having mixed areas of enhancement, necrosis and cystic changes. Difference of 15-20 HU between Unenhanced and nephrographic phase was taken as a significant enhancement.

Local extension: Perinephric space extension as defined by the presence of perinephric stranding or perinephric collaterals or presence of soft tissue component in perirenal space was seen in 61.9% of patients. Extension beyond Gerota's fascia as defined by presence of loss of fat planes with surrounding organ or surrounding organ invasion was found in 28.5%. Ipsilateral adrenal

involvement was seen in 28.5%. Renal vein and IVC malignant thrombus was seen in 9.5%. Lymph nodal involvement was seen in 12 patients (57.1%) and pelvicalyceal invasion in 38% of patients. P Hatimota et al has shown that Renal and IVC invasion was seen in 13.1% of patients which is comparable with our study.⁷

Staging: In our study, T4 was the commonest local stage accounting for 38.09% followed by T3 (33.3%) and T1(19.04%) leading to the higher presentation of stage 4 disease (47.6%). There was direct correlation between patients' clinical complaint and the stage of disease. Incidentally detected masses accounted for 23.8% of stage I and II disease while those with clinical symptoms accounted for only 4.7% of stage I and II disease. Also, there were no cases of T3/T4 local stage or stage 4 disease in incidentally detected lesions while those with clinical complaints accounted for 47.6% of stage 4 disease. These data indicate that the incidentally detected lesions were more confined to kidney locally with early stages of presentation which had significant impact on prognosis.

Metastasis: Distant metastasis was found in 42.8% at time of presentation in our study. Jemal Aet al, in 2006 showed, 25-30% of patients with RCC having metastases at the time of presentation which is comparable with our study.⁸ This indicates the need of effective methods for early diagnosis of renal cell carcinoma. Lung was the commonest site of metastasis accounting for 33.3% of metastasis followed by bones and liver (22.2%). Multiple sites of metastasis was found in 33.3%. B Sivaramakrishna et al in 2005 has shown Ten of the 39 patients (25.6%) developed multiple metastases with lung being the commonest site of metastases (37%), followed by skeletal system (22%), liver (19%) which is similar to our study.⁹ Osteolytic metastasis was the commonest pattern observed in 3 lesions among the bony metastasis. Among the solid organ metastasis, heterogeneously enhancing metastasis similar to parent organ involvement was the commonest pattern observed in 7 lesions, homogeneously hyperenhancing metastasis was found in 1 lesion.

In our study, small hyperenhancing solid organ metastasis in liver was seen only in the corticomedullary phase and became isodense with the liver parenchyma in nephrographic phase implying the need of triple phase CT in evaluation of renal cell carcinoma. Liver metastases can appear as ill-defined low-attenuation lesion that may show peripheral enhancement or appear hypervascular mass with or without central necrosis. The findings were comparable with our study.

Wilms tumour: Wilms tumor is the second most common intra-abdominal cancer of childhood and the fifth most common pediatric malignancy overall.¹⁰ Two case of Wilms Tumour were seen in our study in the age group of 2 and 4 years accounting for commonest pediatric renal mass which is similar with other studies. Both had

positive beak sign thus locating the organ of origin. There was no evidence of calcification or fat attenuation. On Post contrast, both lesions showed heterogeneous contrast enhancement with solid and cystic areas. There was no evidence of renal vein or IVC invasion or distant metastasis in our study.

Renal transitional cell carcinoma: There were 2 cases of transitional cell carcinoma who presented with hematuria. On US there was a mixed echogenic mass in the dilated renal pelvis of right kidney. On CT the mass was in central location with density greater than that of urine showing minimal heterogeneous enhancement. After contrast, centrifugal extension, invasion of renal parenchyma was seen but the shape of the kidney was well maintained. Raza SA et al showed six CT features which were diagnostically specific for identifying intrarenal TCCs: Tumor centered within the collecting system, Focal filling defect in the pelvicalyceal system, preserved renal shape, absence of cystic or necrotic change, homogeneous tumor enhancement and tumor extension towards the ureteropelvic junction (sensitivity 68-82%; specificity 79-89%).¹¹

Radiologically, intrarenal transitional cell carcinoma (TCC) presents as a centrally invasive renal mass, also referred to as “centrally infiltrating” or “intrarenal” Centrally located RCC is surgically treated with nephrectomy, whereas intrarenal TCC requires nephroureterectomy and often wider lymphadenectomy.¹²

Angiomyolipoma: Two case of asymptomatic sporadic Angiomyolipoma in middle aged female were seen with both the lesions appearing hyperechoic on USG and showing fat attenuation on CT. In one of the cases, there were multiple small lesions involving bilateral kidneys in a patient of known case of breast carcinoma who came for metastasis work up. Presence of fat attenuation in these lesions confidently allowed us to make the diagnosis of Angiomyolipoma and thus ruling out metastasis.

Renal metastasis: In our study there was one patient who had bilateral multiple renal mass in ultrasound who presented with nonspecific abdominal pain. On CECT, there were bilateral heterogeneously enhancing lesions. On further evaluation it was found to be advanced lung malignancy with renal metastasis Peter L Choyke et al has shown that lung is the commonest primary in renal metastasis. Also, he concluded CT had highest sensitivity in depicting renal metastasis with low specificity. In patients of known primary malignancy, renal metastasis outnumbered renal cell carcinoma by 4:1.¹³

The reported incidence of renal metastasis of extrarenal neoplasms varies 2-20%.¹⁴ On imaging, metastases are commonly small, multicentric, and bilateral, but less than 2% of renal cell carcinomas may also display this imaging pattern.¹⁵

CONCLUSION

Ultrasound is the initial imaging modality of choice in cases of renal masses since its inexpensive, easy to perform and there is no radiation exposure. Multidetector Computed Tomography is the imaging modality of choice for further evaluation and characterization. CT is done in four phases viz., unenhanced, corticomedullary, nephrographic and excretory phase especially in cases of malignancy while benign conditions like angiomyolipoma, abscess evaluation with unenhanced and single-phase post contrast in portovenous phase is sufficient. Presence of macroscopic fat attenuation in the lesion confidently allows to make diagnosis of Angiomyolipoma. Presence of Ball or bean type of lesion based on whether it alters the renal contour or not, respectively, helps to narrow the differential diagnosis. Presence of any exophytic enhancing solid lesion especially when associated with heterogeneous enhancement with areas of necrosis and cystic changes in the kidney are regarded as renal cell carcinomas. MDCT is the imaging modality of choice for evaluating local extension and staging of renal lesion.

Further, MDCT provides preoperative renal vascular status viz, renal artery anatomy, accessory arteries, normal variants, renal vein/IVC invasion and for evaluating the hyperenhancing metastasis in corticomedullary phase. While commenting on the IVC, care should be taken not to mistake unopacified lower extremity blood for filling defect and should be correlated with other phases. Local extension of the disease is done in nephrographic phase. Pelvicalyceal status is determined in excretory phase. Due to rapid advancement of Imaging techniques, there has been a sharp increase in the detection of incidental renal masses. Such incidental renal masses when show heterogeneous enhancement, necrosis, calcification is highly suggestive of renal cell carcinomas. The disadvantages of MDCT is that some benign masses like oncocytoma, lipid poor angiomyolipoma, show solid enhancement similar to Renal cell carcinoma and are unable to be differentiated from RCC, which needs further research and evaluation.

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