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A Review Study on Characterization of Renal Masses Using Computed Tomography

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KEYWORDS

Computerized tomography, Renal cell carcinoma, clear cell renal cell carcinoma; papillary renal cell carcinoma, EP (excretory phase).

ABSTRACT:

Introduction: Computed tomography (CT) is the most widely used imaging modality in the characterization of renal mass. A standard CT study protocol for both solid and complex cystic renal masses includes an unenhanced study for baseline density measurements in Hounsfield units (Hu) and a contrast-enhanced nephrographic phase acquisition to evaluate the presence of enhancement (HU nephrographic phase– HU unenhanced phase). The enhancement will be considered certainly absent if CT attenuation increases by not more than 10 HU and a renal mass will be considered as non-enhancing, usually a renal cyst, If CT attenuation increases by almost 20 HU, the enhancement will be considered certainly present and if no intralesional macroscopic fat is visible, an enhancing lesion such as renal cell carcinoma, metastasis or lymphoma must be considered.

Objectives: 1. "To diagnose different types of renal masses with the help of different phases" by using CT.

2. To identify the various staging of renal masses through a CT scanner.

Methods: This study evaluates the quality of previous research on the use of CT in characterizing renal masses through a literature review. We collected and reviewed data from 17 articles after examining the first 30 with the help of the PRISMA technique.

Conclusions: Among all 4 phases nephrogenic phase is best for renal parenchyma enhancement and the corticomedullary phase is adequate for clinical diagnosis of RCC.

1. Introduction

Computed tomography: Contrast-enhanced computed tomography (CT) scanning is routinely used to determine the stage of renal cell carcinoma in the abdominal and pelvic regions. CT scans have the potential to distinguish solid masses from cystic masses and may provide information on the localization, stage, or spread of the cancer to other organs of the patient.[1] The Hounsfield unit scale calculates the attenuation or volume of a tissue. Fat has very low attenuation (i.e., −100 to −10 HU), and

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masses containing fat are almost always benign angiomyolipoma. Homogeneous masses with low attenuation (−10 to +20 HU) can be identified as benign, fluid-filled, simple cysts. Structures that exhibit irregular form, septations, calcium deposits, as well as attenuation over 20 HU might be carcinogenic and need to be evaluated further. Lesions show connective tissue attenuation around 20 and 70 HU on non-contrast CT.

Larger lesions frequently have areas of necrosis. Approximately 30% demonstrate some calcification.[2] It is the seventh most common cancer in men and the ninth most common in women[3], on an annual basis it causes 140,000 patients' deaths worldwide from malignancies. Partial nephrectomy is established as the preferred treatment method for ccRCC; however radical therapy has been proposed for patients with high-risk tumors.[4] A computed tomography (CT) examination is employed to identify the site and structure of a kidney abnormality. The most accurate method for determining the HU of homogeneous kidney mass or masses comprising large fat is non-contrast imaging.

The corticomedullary phase is best to delineate subcategories of renal cell carcinomas further. The nephrogenic is best for optimal enhancement of the renal parenchyma, including the renal medulla, and will demonstrate enhancing components of a mass. The excretory phase will demonstrate enhancement of calyces, renal pelvis, and ureters. It takes about five minutes to exhibit the ureter transparency at many institutes.[5]

During the corticomedullary phase of enhancement, 25-40 seconds after administration of contrast, renal cell carcinomas demonstrate variable enhancement, usually less than the normal cortex. Small lesions might be hard to find and could improve significantly. The corticomedullary phase is also best for assessing vascular anatomy, both for renal vein involvement and for arterial variation if partial nephrectomy is being contemplated. A highly efficient period for detecting aberrant enhancement in contrast occurs during the nephrographic stage, which lasts between 80 and 180 seconds. Although less significant, the excretory stage is crucial for evaluating the structure of the collecting system, particularly if the patient may benefit from a minimal nephrectomy. [6]

The purpose of this study is "To evaluate the different types of renal masses with the help of different phases & also various staging of renal masses through CT scanner after careful consideration of various research papers.

2. Methods

All of the original research articles were explored to diagnose and identify different types of renal masses with the help of different phases in CT scans. A literature review analysis was carried out using several suggested platforms, including PubMed, Google Scholar, Scopus, Web of Science, etc.

PRISMA Technique (Flow Chart of Articles)[7]

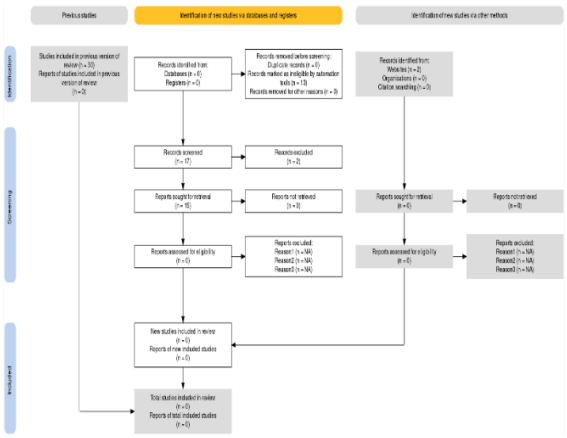

Fig: We followed the PRISMA guidelines to review 30 research papers on our topic. Out of these, we included 17 papers in our study because they had useful information. The whole process is shown in the figure.

3. Result/Discussion:

In this review, the Corticomedullary phase is useful for detection of the renal arteries and vascular anomalies. Although EP is commonly noted as the most critical stage for the identification and characterization of renal masses, the nephrographic period permits the maximum darkening of renal veins and the classification of renal illness. The medulla of the kidney showed a temporal rise with maximal amplification in the EP, although it was least boosted in the corticomedullary phase. The amount of increase during the corticomedullary phase is a useful metric for characterizing tiny renal tumors.[8] The degree of enhancement on the corticomedullary phase is a valuable parameter. Furthermore, the heterogeneous enhancement pattern and degree of enhancement on the nephrographic phase can provide information for

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differentiating small renal masses.[9] Enhancement of renal neoplasms is time-dependent and may not be evident in hypovascular tumors analyzed during the early corticomedullary phase. When internal criteria are not used as controls, relying solely on actual CT attenuation measures can result in the incorrect identification of neoplasms as cysts.[10] It is still possible to identify and characterize renal lesions using the usual four-phase renal CT methodology even if the nephrographic phase is skipped. In the assessment of enhancing minor solid renal masses free of fat, no CT criteria significantly aided in the distinction between lesions that were both benign and malignant.[11] Personal opinion and CT attenuation can be used to reasonably accurately characterize small hypoattenuating renal masses; tumors that seem solid upon inspection by eye or have an attenuation value of 50 HU or more are most likely to be renal cell cancer.[12] Dual-energy CT offers a fast and reliable interpretation of abdominal CT scans performed for the assessment of renal masses.[13] Dual-source DECT is a reliable imaging technique in the evaluation of complex cystic renal masses. True unenhanced images can be replaced by virtual unenhanced images with considerable radiation dose reduction.[14] Thus, with the benefit of reduced radiation exposure, a mixture of simple, corticomedullary, and EPs is sufficient to evaluate renal abnormalities. Renal masses can be quickly and precisely characterized with DECT in a single-phase acquisition. Interpretation of color-coded images significantly reduces interpretation time. Omission of a nonenhanced acquisition can reduce radiation exposure by almost 50%.[15] The use of a 64-slice MDCT scanner with the application of enhancement values correction gives promising results. The 64-slice MDCT scanner with the application of enhancement values correction allows diagnosis of clear cell carcinoma also AML could be identified easily with fat inside at the precontrast scan. 64-slice MDCT scanner with thin-slice sections that allows easy characterization of the cases of AML, with detection of fatty areas noted, and it correlated well with the post-biopsy histopathology results with 100% accuracy.[16] The analysis of contrast-enhanced dual-energy material attenuation significantly improves the specificity for characterization of small (1–4 cm) renal lesions compared with that of conventional attenuation measurements.[17] Personal impression and CT attenuation can be used to reasonably accurately characterize small hypoattenuating renal masses on contrast-enhanced CT; lesions that appear maybe solid upon inspection by eye or have an attenuation value of 50 HU or higher are likely to be renal cell carcinomas.[18] Based on reviewing the 30 articles that were found related to the studies rest all were excluded in which 8 best related articles discussion were taken to reach the final discussion. In my observation, it is found that in CT scans the corticomedullary and nephrographic phases are often considered the most important. The corticomedullary phase helps in distinguishing between enhancing and non-enhancing lesions, while the nephrographic phase allows better visualization of the renal parenchyma for assessing lesion characteristics. Kidney masses can be seen in several ways on computed tomography (CT) imaging, depending on the specific imaging method and slice thickness applied. Various CT scan modalities, including non-contrast, contrast-enhanced, and multiphase imaging, can be utilized to obtain multiple perspectives on renal masses.

4. Conclusion

In this review, different phases and different CT models were used to detect and identify renal cell carcinoma. Among all 4 phases nephrogenic phase is best for renal parenchyma enhancement and the corticomedullary phase is adequate for clinical diagnosis of RCC. From all the subtypes, ccRCC was the most common and had greater enhancement in all the different phases. However, CT criteria is not helpful in differentiating benign and malignant lesions.

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