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The Usefulness of 99m Tc Diethylenetriamine Pentaacetate (DTPA) or Mercaptoacetyltriglycine (MAG3) Renal Perfusion Scan in Assessing Chronic Renal Complications of COVID-19

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Abstract

Background: Imaging departments worldwide are exploring different ways to help manage chronic complications of COVID-19 after two years.
Objectives: Renal complications following acute kidney injury in the acute phase of COVID-19 or exacerbation of chronic kidney disease (CKD) are crucial.
Methods: This article presented the role of 99m Tc diethylenetriamine pentaacetate (DTPA) or mercaptoacetyltriglycine (MAG3) renal perfusion scan in managing chronic renal complications following COVID-19 by submitting the relevant techniques and available radiopharmaceuticals.
Results: Renal perfusion scan with 99m Tc DTPA and MAG3 could evaluate profusion and function in acute and chronic settings and manage these renal complications.
Conclusions: Based on the results, 99m Tc DTPA or MAG3 renal perfusion scan could detect, monitor, and evaluate response to treatment in COVID-19-related renal chronic damages and complications.

Keywords: COVID-19, Renal Complications, DTPA Renal Scan, Acute Kidney Injury

1. Background

The COVID-19 pandemic has caused substantial morbidity and mortality worldwide (1). COVID-19 can attack multiple organs, such as the lung, heart, kidney, and brain, and cause severe injury to these organs, leading to functional sequels (2). Multiple studies have shown an increasing number of late COVID-19 complications (66 - 87% of COVID-19 subjects) (3). The most common persistent symptoms in all grades of illness include fatigue, cough, dyspnea, anosmia, headaches, arthralgia, and chest pain (4). This virus binds to angiotensin-converting enzyme 2 (ACE2) receptors and leads to systemic inflammation and immune dysregulation in different organs (5).

2. Objectives

The multiorgan invasion of SARS-CoV-2 results from the wide distribution of ACE2 in the organs, and kidneys have the highest expression of ACE2. Mesangial cells, podocytes, parietal epithelium of the Bowman's capsule, and the collecting ducts in the kidney show ACE2 receptors. Several mechanisms have been proposed for the renal manifestations of COVID-19, including direct viral invasion of the kidneys and disturbance in renin-angiotensin-aldosterone system (RAAS) homeostasis (6).

COVID-19 causes renal complications, including acute renal injury and deterioration and progression of chronic kidney disease (CKD) in patients. Diabetes and high blood pressure are the most common causes of CKD. Many patients experience long-term renal consequences during follow-up after acute renal injury from COVID-19. An electrolyte disturbance (mainly hyperkalemia) accounted for 12.5% of renal complications, followed by acute kidney injury (AKI) with 11.0%. Populations with previous CKD had a higher incidence of AKI (7, 8).

3. Methods

Renal scintigraphy with Tc-99m MAG-3 and diethylenetriamine pentaacetate (DTPA) scan may help identify renal injuries by assessing the perfusion and function of kidneys

and evaluating the progression of disease and response to therapy.

A nuclear medicine renal scan was used to evaluate blood flow, function, and wash out of the kidneys. The radio-isotope, 99m-Tc, was bound to either DTPA or mercaptoacetyltriglycine (MAG3) to form the radiopharmaceutical.

Mercaptoacetyltriglycine was preferred over 99mTc DTPA in neonates, impaired renal function, and patients with suspected obstruction because of its more efficient extraction.

99mTc DTPA was filtered by the glomerulus to calculate the glomerular filtration rate (GFR).

This imaging was conducted to measure the percentage each kidney contributes to the total renal function.

A baseline study should be performed in the acute phase of renal injury in COVID-19 patients. Then, a follow-up study should be used to compare perfusion and function in acute and chronic settings to monitor any future loss of function requiring intervention and evaluation of response to therapy.

A DTPA or MAG3 renal perfusion scan may also be performed to evaluate urine flow. The size of kidneys and obstruction, as well as the relative function of a possibly injured kidney, is compromised to determine the renal function (9).

4. Results

Further data on the clinical course of the disease (baseline and follow-up renal scans) could help formulate effective treatment strategies. Understanding the perfusion and function of kidneys could assist in monitoring the course of illness and response to therapy (10).

An observational cohort study in 2020 found that 5.2% of COVID-19 subjects had previous CKD. The most common renal complication was electrolyte disturbance (mainly hyperkalemia), with an incidence of 12.5%, and AKI, with an incidence of 11.0%. US populations with a higher prevalence of CKD had a higher incidence of AKI (11). Acute kidney injury was the expected outcome of inpatients hospitalized for 2 to 28 days. However, electrolyte disturbance (hyperkalemia) was the most frequent renal complication, with an incidence of 12.5%, followed by acute kidney injury and renal transplanted therapy at 11.0 and 6.8%, respectively. Other reported complications included acidosis and alkalosis (4, 12).

5. Discussion

Generally, 99m Tc DTPA or MAG3 renal perfusion scans can be used to diagnose kidney function, manage renal injury progression, and respond to patients' treatment. There are few studies in this regard, and 99m Tc DTPA or MAG3 renal perfusion scan can be used in hospitalized patients with clinical and laboratory manifestations of renal injury for assessing renal perfusion and function of both kidneys. This baseline can be used to compare follow-up scans for evaluating recovery or disease progression after therapy to reduce morbidity and mortality and manage chronic renal complications in COVID -19 patients.

Footnotes

Authors' Contribution: Study concept and design: Raheleh Hedayati; analysis and interpretation of data: Hadi Malek; drafting of the manuscript: Mohammadjavad Yasemi; critical revision of the manuscript for important intellectual content: Raheleh Hedayati and Hadi Malek.

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