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Correlation between computerized tomography density measurements of urinary bladder and urinalysis results

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ABSTRACT

Our aim was to investigate whether there is a correlation between computerized tomography (CT) density measurements of the urinary bladder and urinalysis results. Patients were subdivided into three groups with respect to urinalysis results: Group 1, no leukocytes or erythrocytes detected in urine (n=25); Group 2, erythrocytes detected in urine (n=50); and Group 3, leukocytes and erythrocytes detected in urine (n=98). In CT sections, densitometric measurements had been performed from three zones on each section and groups were compared in terms of densitometry results. Our results indicate that density measurements of CT views form the urinary bladder may provide valuable data on hematuria and leukocyturia.

1. Introduction

Urinary tract infections (UTIs) and urolithiasis mostly present in a straightforward or uncomplicated course. Such "uncomplicated" circumstances do not call for any emergency radiological investigations, and the diagnosis may rely on clinical criteria such as flank pain, fever, functional urinary signs, and laboratory results like positive urinalysis and culture results. However, potentially serious circumstances may exist in case there is an obstruction (urolithiasis, urinary system deformities, neoplasms, or neuropathy) or patients under risk for complications (e.g., immune supression, pregnancy) are affected [1,2].

UTIs usually spread via ascending or hematogeneous paths: In ascending route, the infected urine reaches the papillae and the collecting ducts from the lower urinary system. In the hematogenous route, the infection reaches the kidney as a consequence of a septic nidus, and urinalysis may be negative in some circumstances since there is no communication with the collecting system. This type of infection may occur as a pseudotumour, and the absence of bacteria in the urine may constitute a diagnostic challenge [2,3].

In such cases, imaging modalities may be utilized mainly to achieve 2 goals: (1) to look for any complications that would need specific therapeutic management (relief of obstruction of the collecting system, drainage of an abscess or perirenal fluid collection or change of antibiotic regimen) and (2) to identify rare forms of pyelonephritis in an atypical clinical presentation or with atypical laboratory results [4–6].

Our aim is to investigate whether there is a correlation between urinalysis results and computerized tomography (CT) density measurements of the urinary bladder. If any clues derived from CT scans of urinary bladder provide data on the presence of hematuria or leukocyturia, both unnecessary laboratory investigations may be avoided and clinically silent hematuric/leukocyturic patients who deserve to undergo further investigations may be selected easily.

2. Materials and methods

2.1. Study design

This study was approved by the local institutional review board (2012/70). Written informed consent was obtained from all subjects, a legal surrogate, the parents, or legal guardians. A total of 173

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patients, whose pelvic, abdominal, and urinary CT scans had been obtained after admission to the radiology department of our tertiary center between January 2011 and May 2012 were retrospectively reviewed. Urinalysis had been made within 2 days before noncontrast CT scanning of these patients. Patients with severe artifact caused by the movement of bowel were excluded from the study group.

Examinations were performed with a 128-section multidetector CT (Siemens Definition AS+; Siemens Medical Solutions, Forchheim, Germany). A workstation (Leonardo; Siemens AG, Erlanger, Germany) was used for interpretation of the image data. In CT sections without contrast, region of interest (ROI) measurements had been performed from upper axial (zone 1), middle axial (zone 2), and lower axial (zone 3) zones. ROI measurements have been made on a cross-sectional area of 100 mm^2 using an imaginary horizontal line passing through the mid-horizontal plane in every zone (Fig. 1). By measuring the ROI from a 100-mm^2 area in the midline, mean and standard deviation values were obtained in Haunsfield units (HU) (Figs. 2 and 3).

Patients were subdivided into three groups with respect to urinalysis results: Group 1, no leukocytes or erythrocytes detected in urine (n=25); Group 2, erythrocytes detected in urine (n=50); and Group 3, leukocytes and erythrocytes detected in urine (n=98) [7]. Cases with urine output less than 250 cc according to volumetric assessment on CT scan, those aged <18 or >70 years, and patients having antibiotics before urinalysis were excluded from the study.

Urine samples underwent centrifugation at 3000 rpm for 3 min and were observed under ×400 magnification. Hematuria is defined as observation of ≥3 erythrocytes per each field, while leukocyturia is described as observation of ≥5 leukocytes per each field. Patients with bacteriuria (presence of ≥5 bacteria per each field) were excluded from the study.

2.2. Statistical analyses

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software (version 19.0 for Windows). Normal distribution of quantitative data was analyzed using Kolmogorov–Simirnov and Shapiro–Wilk tests. Variables with normal distribution were assessed by parametric tests, while variables without normal distribution were evaluated with nonparametric tests. Independent multiple groups were compared with one-way analysis of variance test, and post hoc analyses were performed by Tukey HSD tests. Correlation of variables was evaluated with partial correlation test after the control of main variables. Quantitative variables were expressed in mean±standard deviation in tables. Data were assessed in 95% confidence interval, and a $P<.05$ was considered statistically significant.

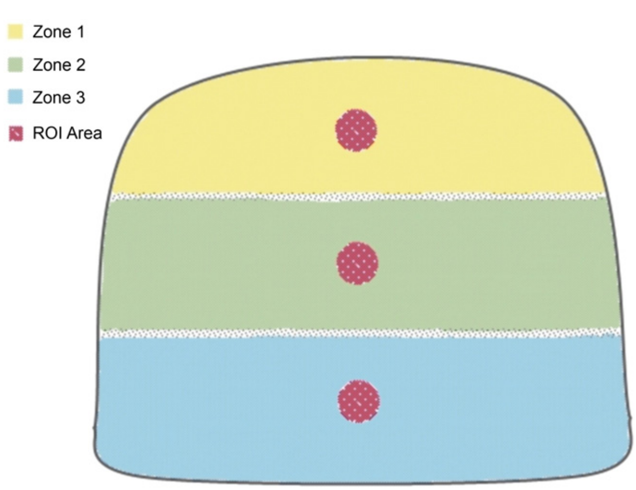

Fig. 1. Schematic representation of ROI measurements taken from three equal areas on the largest images of axial CT scans from the urinary bladder.

3. Results

Of the 173 (90 males, 83 females) patients included in the study, the mean age was 43.22±14.58 (range 18–65) years. In all three groups of patients, densitometric measurements from each zone were not statistically different from each other when compared between groups. However, there were noteworthy differences for zones 1 and 2 (P=.034) and for zones 1 and 3 ($P<.001$) in Group 2. Similarly, in Group 3, zones 1 and 2 (P=.045), zones 1 and 3 ($P<.001$), and zones 2 and 3 ($P<.001$) showed different densitometric results (Table 1).

4. Discussion

In the present study, we attempted to demonstrate whether there was a relationship between urinalysis results and density measurements form CT scans of urinary bladder. Our results showed that there was a difference between the three zones of urinary bladder in the hematuric group and hematuric and leukocyturic group regarding the densitometric evaluation.

Hematuria is described as macroscopic (frank) or microscopic (occult). Hematuria is a common finding in young adults, reported in 0.3%–38.7% of adults in population-based studies [5]. The prevalence of microscopic hematuria in asymptomatic individuals is reported to be approximately 2.5% [6,8]. Asymptomatic microscopic hematuria is mostly a benign incidental finding [9]. The appropriate strategy for imaging young adults with microscopic hematuria has therefore been controversial. Gross hematuria has a relatively high predictive value for malignancy and therefore requires a thorough urologic evaluation [6,9]. Hematuria may ensource from a number of causes like calculi, infections, neoplasms, trauma, and parenchymal diseases affecting the urinary tract [5,9]. Current guidelines from the American Urologic Association and American College of Radiology recommend upper urinary tract imaging of adults with excretory urography or CT urography [9,10].

UTIs are the most commonly reported bacterial infections, and patients usually present with uncomplicated cystitis or pyelonephritis. These infections occur in otherwise young, healthy, nonpregnant women and are expected to respond favorably to appropriate antibiotic therapy [11–14]. The diagnosis of pyelonephritis can often be made with a fair degree of certainty based on history, physical examination, and standard laboratory evaluation. Infections are often heralded by fever, flank pain, costovertebral angle tenderness, and/or nausea and vomiting [12,13]. Pyuria and bacteriuria are almost always present on urinalysis, sometimes accompanied by hematuria [15]. Positive blood cultures may support these findings, and diagnostic imaging modalities are usually not required for this population. However, in cases with complicated UTIs, radiologic evaluation can direct the appropriate medical or surgical therapy and prevent unfavorable or potentially catastrophic outcomes. At most institutions, available imaging modalities include ultrasound, intravenous urography (IVU), CT with or without CT urography, and magnetic resonance imaging each with their own potential benefits and limitations [14–16].

Despite increased cost, radiation exposure, and use of iodinated contrast, CT is often the preferred modality for evaluating complicated UTIs. It is a readily available and sensitive method for evaluating many of the potential complications of upper tract disease and can provide a global assessment of the extent of involvement within the abdomen or pelvis [11–13]. Furthermore, the development of the CT urography protocol with noncontrast, nephrographic, and pyelographic-phase imaging processed in multiple imaging planes with three-dimensional reconstruction capabilities has further improved sensitivity for detecting underlying renal abnormalities. This modality has largely