CORONAL IMAGING TO ASSESS URINARY TRACT STONE SIZE

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ABSTRACT

Purpose: Urinary tract stones are typically measured using axial images from computerized tomography (CT). Such images provide a precise measurement of stone length and width. However, cephalocaudal dimensions can be difficult to determine from axial images. Coronal reconstructions, which can more accurately measure cephalocaudal dimensions, are seldom used to measure stones. We determined if coronal reconstructions could aid in more precisely determining stone size.

Materials and Methods: CT in patients who had undergone CT to evaluate urolithiasis at our institution during the 9-month period of January 2001 to September 2001 were reviewed. Length and width were measured using axial images, and cephalocaudal length and width were measured using coronal reconstructions. Cephalocaudal length was also estimated from axial images. Total area was calculated from axial and coronal reconstructions. The paired t test was used to assess statistical significance.

Results: The CT images of 102 patients with a total of 151 stones had undergone coronal reconstructions and, thus, were included in the study. Mean area in the axial and coronal reconstruction groups was 22.23 and 31.29 mm$^2$, respectively. Mean greatest axial dimension (length or width) was 4.87 mm and mean greatest coronal dimension (cephalocaudal length) was 6.51 mm. Cephalocaudal length estimated from axial images was 8.8 mm. Differences for all 3 of these comparisons (axial vs coronal area, greatest axial vs coronal dimension and estimated vs actual cephalocaudal length) proved to be statistically significant (p <0.0001).

Conclusions: While urinary tract stones have typically been measured using axial images, coronal images provide a different impression of stone size. These data demonstrate that examining only axial images provides an inaccurate measure of stone size. We suggest that coronal images should also be used to measure more accurately stone size, which is critical for clinical decision making.

KEY WORDS: urinary tract; calculi; tomography, emission computed

The accurate detection and measurement of renal calculi are critical steps in the care of patients with urolithiasis. Until the advent of computerized tomography (CT), excretory urography was the mainstay for evaluating the patient with suspected urinary lithiasis. However, excretory urography provides incomplete information about stone size. More recently urinary tract stones have been measured using axial CT images. Such images give a more precise measurement of stone length and width. However, cranio-caudal dimensions can be difficult to determine from axial images. Coronal reconstructions, which can more accurately measure cranio-caudal dimensions, are seldom used to measure stones. We determined if coronal reconstructions could aid in more precisely determining stone size.

MATERIALS AND METHODS

We retrospectively reviewed the CT images of patients who had undergone CT to evaluate urolithiasis at our institution during the 9-month period of January 2001 to September 2001. All images were obtained using a LightSpeed multidetector scanner (GE Medical Systems, Milwaukee, Wisconsin). The technical factors were 5 mm image reconstruction, 120 kV, 220 mA, 0.8 mm rotation, 7.5 mm per rotation table speed and HQ mode (pitch 3).

Following routine abdominal imaging protocols retrospective 2.5 mm reconstructed images were obtained at the scanner by the technologist from the raw data set and used to create 3 mm contiguous coronal images. The 5 mm axial images and coronal images were sent to the GE PathSpeed Picture Archiving and Communications System (GE Medical Systems). Stones were measured electronically using the clinical picture archiving and communications work station. Images were viewed with standard soft tissue settings with a level of 60 and a width of 400. Length and width were measured using axial images, and cranio-caudal length and width were measured using coronal reconstructions. Cranio-caudal length was also estimated from axial images by counting the number of images on which the stone was seen. Total area was calculated from axial and coronal reconstructions using the region of interest polygonal tool. The paired t test was used to assess statistical significance.

RESULTS

The CT images of 102 patients, comprising a total of 151 stones, underwent coronal reconstructions and, thus, were included in the study. A total of 84 patients had 1, 16 had 2, 9 had 3 and 2 had 4 stones. The stone location was upper pole (18 cases), renal pelvis (47), lower pole (44), ureteropelvic junction (4), proximal ureter (13), mid ureter (5) and distal ureter (20).

Axial height of the 151 stones was 1.3 to 33.3 mm. Axial width was 1.3 to 30.9 mm. Cranio-caudal length was 2.0 to 39.4 mm and cranio-caudal width was 2.0 to 31.9 mm.

Mean area in the axial and coronal reconstruction groups was 22.23 and 31.29 mm$^2$, respectively (fig. 1). Mean greatest...
axial dimension (length or width) was 4.87 mm and mean greatest coronal dimension (craniocaudal length) was 6.51 mm (fig. 2). Estimated craniocaudal length from axial images was 8.8 mm (fig. 3). Differences for all 3 of these comparisons (axial vs coronal area, greatest axial vs coronal dimension and estimated vs actual craniocaudal length) proved to be statistically significant ($p < 0.0001$).

DISCUSSION

Three-dimensional image reconstruction has an increasing role in preoperative planning, most recently for renal surgery.\(^2\) Traditionally stone dimensions on CT are analyzed only by axial dimensions. Although we presented our initial data in an abstract,\(^3\) to our knowledge this is the first publication documenting the usefulness of coronal reconstructions to aid in more accurately measuring stone size.

Axial images consistently underestimated stone size compared to coronal reconstructions (figs. 1 and 2). Moreover, it is clear that using axial images to estimate craniocaudal length consistently overestimates true coronal length (fig. 3). Precise volumetric information has a pivotal role in formulating appropriate management plans for stone cases. Indeed, knowing stone size is critical to determine whether to recommend ureteroscopy, extracorporeal shock wave lithotripsy, percutaneous nephrolithotomy or conservative management.\(^4\)–\(^7\) Narepalem et al compared CT to plain radiography.\(^8\) Their findings were consistent with ours, in that their axial CT images overestimated craniocaudal length.

At our institution coronal reconstructions are performed routinely on all abdominal CT examinations. The use of thinner images with multidetector scanners as well as rapidly improving software and hardware make this practical. Little processing time is required and images are created as the technologist calls for the next patient. While the clinical standard for stone measurement has been the abdominal x-ray, this method has limitations. Chief among these limitations is magnification. Because the distance from stone to film is unknown and varies with patient size, even cumbersome calculations are of limited value. The routine use of coronal images allows measurement in the craniocaudal plane, eliminating the need for additional imaging to measure stone size (fig. 4).

CONCLUSIONS

While urinary tract stones have typically been measured using axial images, coronal images provide a different im-
pression of stone size. These data demonstrate that examining only axial images provides an inaccurate measure of stone size. We suggest that coronal images should also be used to measure more accurately stone size, which is critical for clinical decision making.

REFERENCES