# Study of pelvicaliceal anatomy by helical computerized tomography

## *Is it feasible?*

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## ABSTRACT

**Objectives:** To evaluate the role of 3-dimensional images produced by computerized tomography (CT), using intravenous contrast to study pelvicaliceal anatomy. This might be of help in endourological procedures.

**Methods:** The study was conducted in King Fahd Hospital of the University, King Faisal University, Dammam, Kingdom of Saudi Arabia. The study took place from July 2002 through to October 2002. Helical CT was carried out for patients who were investigated using excretory urography for any reason, after obtaining a written consent. A CT was carried out to the kidneys only within 10 minutes (between the 5 and 15 minute films of excretory urography). Images were reprocessed by 3-dimension construction after subtracting all structures except for the pelvicaliceal system. Thirty-six normal kidneys were studied.

**Results:** The upper pole was drained by a single caliceal infundibulum in all 36 (100%) kidneys. The middle segment of the kidney was drained by 2 infundibula in 32 (89%) kidneys. Four (11%) kidneys had no middle caliceal infundibula. The lower pole was drained by 2 caliceal infundibula in 23 (64%) and a single infundibulum in 13 (36%) kidneys. The minor calices draining each renal segment were seen clearly.

**Conclusion:** Three-dimensional images derived by helical CT are feasible for evaluating the anatomy of pelvicaliceal system, and, can be of help in endourological procedures.

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The anatomy of the pelvicaliceal system is important for the urologist who is going to perform endourological procedures. Antero-posterior views in excretory urograms do not give enough details about the number and direction of the calices.[1,2] A better understanding of the pelvicaliceal anatomy can be achieved through 3-dimension construction.[1,2] Some investigators used endocasts in cadaver kidneys to study the pelvicaliceal anatomy, and, its relation to intra-renal arterial and venous systems.[3,4] However, these studies were carried out on cadavers, and, endocasts can change their shape on hardening. Recently, computer methods have been developed that allow reprocessing of standard computerized tomography sections to produce 3-dimensional surface images.[5] These 3-dimensional images allow for better imagination of the anatomy of the pelvicaliceal system.[6] Three-dimensional imaging study of the pelvicaliceal system has been tried by Heyns and Gelderen.[6] However, the author injected the contrast

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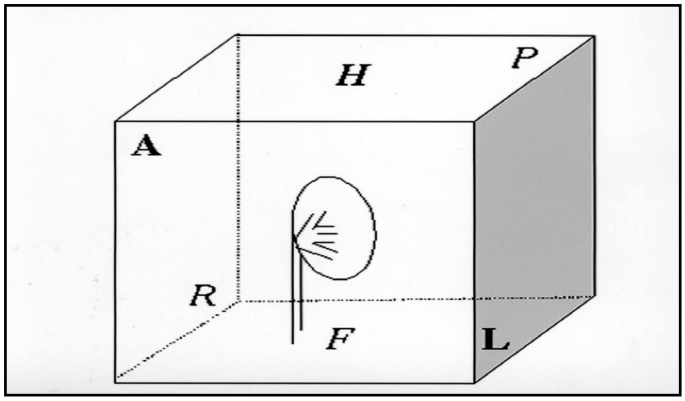


**Figure 1** - A diagram indicates the different views in a 3-dimension image of left pelvicaliceal system. A - anterior, P - posterior, R - right, L - left, H - horizontal, F - frontal.


**Figure 2** - 3-D computerized tomography scan of the left pelvicaliceal system. **(a)** posterior view revealing one upper, U - one lower, L - and 2 overlapped middle (M) caliceal infundibula. **(b)** Right view confirming single upper, single lower and 2 middle caliceal infundibula.

through a ureteric catheter, which might have a distention effect on the pelvicaliceal system, beside being an invasive method. Our objective was to study the feasibility of 3-dimensional images produced by helical CT, using intravenous contrast, in the evaluation of pelvicaliceal anatomy, which might be of help in endourological procedures.

**Methods.** Patients referred from the Urology Clinic to the Radiology Department for examination by excretory urography because of any urological problem, were studied after obtaining written consent. The study was in the form of limited computerized tomography (CT) on the kidney, carried out during the interval between the 5 and 15 minutes films of excretory urography. The contrast used was 50 ml of a nonionic compound "Omnipaque," in a concentration of 300 mg/ml. The study was carried out using the Balance Somatom-Siemens CT machine. Sections were taken at 5mm distance. The obtained pictures of the kidney were reprocessed in 3-dimensional surface images after subtraction of renal parenchyma and other surrounding structures. The images of pelvicaliceal system were studied from different views **(Figure 1)** allowing better visualization of the pelvicaliceal system. The study included 36 normal kidneys.

**Results.** The present study included 18 patients (16 males and 2 females) between the age of 18 and 64 years (mean=36.2 ± 12.23 years). These patients had normal kidneys on excretory urography. A total of 36 normal kidneys (18 right and 18 left) were studied. The

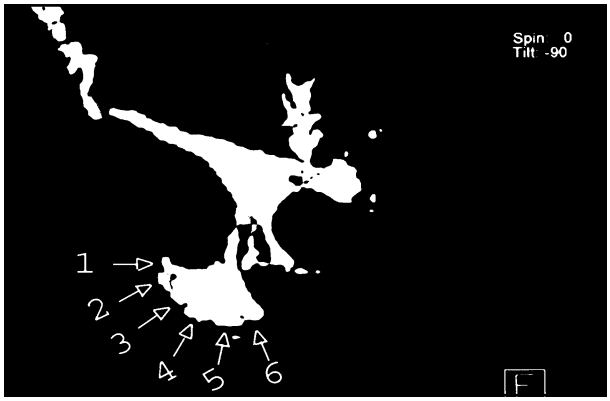


**Figure 3a**

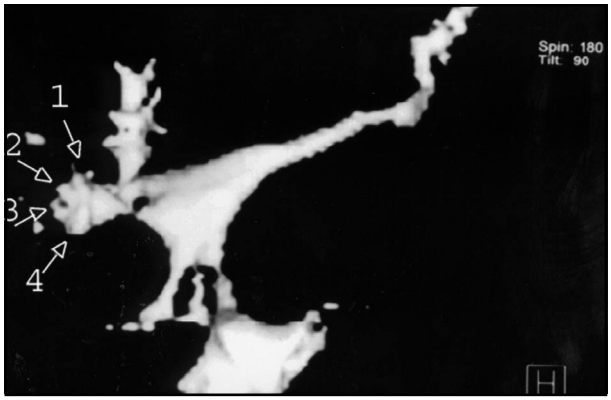


**Figure 3b**

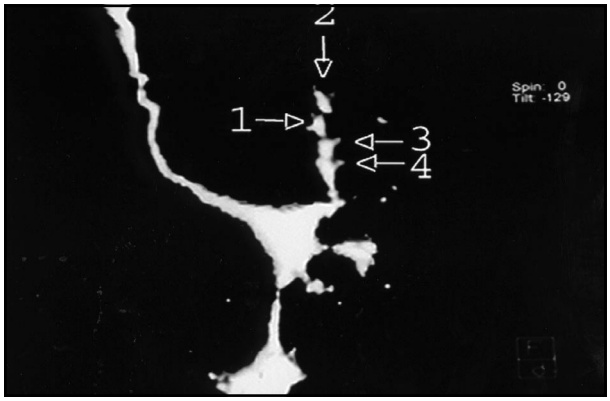


**Figure 3c**

**Figure 3 -** 3-D computerized tomography scan of the left pelvicaliceal system. **(a)** - Frontal view showing minor calices of upper renal segment (arrows). **(b)** Horizontal view showing minor calices of middle renal segment (arrows). **(c)** Posterior-frontal view showing minor calices of lower renal segment (arrows).

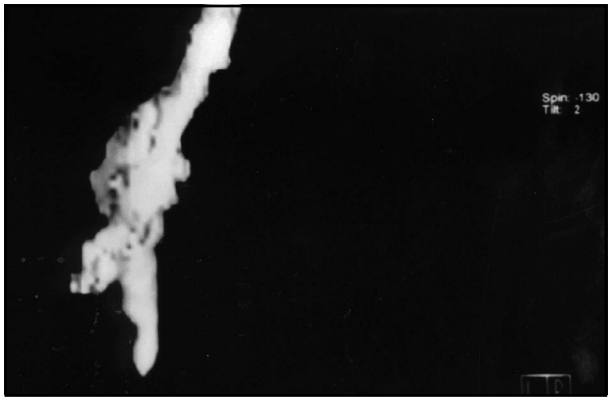


**Figure 4 -** 3-D computerized tomography scan of the left pelvicaliceal system revealing absence of middle caliceal infundibulum **(a)** left view, **(b)** left-posterior view.

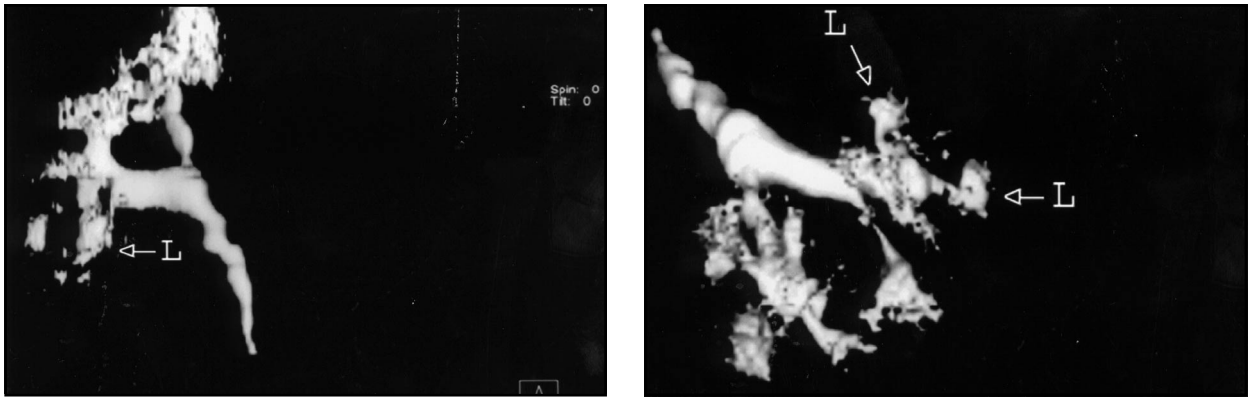


**Figure 5 -** 3-D computerized tomography scan of the right pelvicaliceal system **(a)** there is apparently one lower caliceal infundibulum (arrow) in anterior view, **(b)** The two superimposed calices (arrows) are seen clearly in horizontal view.

upper segment of the kidney was drained by a single caliceal infundibulum in all 36 (100%) kidneys **(Figure 2)**. The mean number of minor calices draining into it was 6.3 ± 1.8, range 4-10 calices **(Figure 3a)**. The middle segment of the kidney was drained by 2 caliceal infundibula in 32 out of 36 (89%) kidneys **(Figure 2)**. The middle caliceal infundibula were absent in 4 (11%) kidneys **(Figure 4)**. The mean number of minor calices of the middle segment was 3.8 ± 1.6, range 0-8 calices **(Figure 3b)**. The lower segment of the kidney was drained by 2 caliceal infundibula in 23 (64%) kidneys **(Figure 5)** and by a single infundibulum in 13 (36%) kidneys **(Figure 2)**. The mean number of minor calices draining the lower segment was 4.6 ± 1.02, range 4-8 calices **(Figure 3c)**.

**Discussion.** During percutaneous nephrolithotomy, the operator must be able mentally to construct an accurate 3-dimensional image of the pelvicaliceal anatomy.[1,7] Recently, computer methods have been developed that allow producing 3-dimensional surface images.[5] However, the optimal technique of obtaining 3-dimensional images of the pelvicaliceal system by CT has not been established.[6,8] In the present study, good quality 3-dimensional images of the pelvicaliceal system were produced. The quality of images was near to that obtained by endocasts in other studies.[1,3,4] The contrast medium used in the present study was given by intravenous route, while in other studies the authors had introduced the contrast via ureteric catheters.[6] The latter has the disadvantage of being invasive and in addition it might has a distension effect on the pelvicaliceal system.

Regarding the caliceal drainage of the polar regions of the kidney, most authors affirm only one caliceal infundibulum draining each pole.[1,9-12] In the present study, the upper pole had one caliceal infundibulum in all kidneys, and 2 caliceal infundibula for the lower pole in 64% of the kidneys. Our results were almost similar to those of another study using endocasts and pyelograms in cadaver kidneys.[1]

In conclusion, this study has shown that 3-dimensional images produced by helical CT are feasible for the study of pelvicaliceal anatomy. This could be of help for endourological procedures.

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