# The Peak Site of Stone Distribution in the Upper Ureter is Unlikely the Ureteropelvic Junction: Computed Tomography Analysis of Stone Lodging Site With Respect to a Newly Identified Area of Constriction

**Minobu Kamo, Taiki Nozaki, Jay Starkey, Saya Horiuchi, Natsuka Muraishi, Kazunori Hattori, and Keiichi Akita**


**OBJECTIVE** To investigate the relationship between the upper urinary stone distribution and the "crossing point," an area of relative fixation within the upper ureter at approximately the level where the ureter crosses the gonadal vein.

**MATERIALS AND METHODS** We reviewed 298 consecutive patients presenting with acute renal colic, identified upper ureteral stones in computed tomography. For stones located at the "renal pelvis and upper ureter," we measured the vertebral level of each renal pelvis, crossing point, and stone. The distance between the crossing point and the stones (designated as positive if the stone was located above it) and the distance between the renal pelvis and the crossing point were measured.

**RESULTS** The average stone size at the "renal pelvis and upper ureter" was 6.0 ± 3.2 mm, at "middle ureter" 5.2 ± 1.9 mm, and at "lower ureter" 3.7 ± 1.8 mm. Lower location was significantly correlated with smaller size ($P$ <.001). The level of the crossing point and stone location were significantly lower on the right ($P$ = .019, $P$ = .033, respectively), whereas the vertebral level of the renal pelvis was not significantly different on both sides ($P$ = .225). The mean distance between the crossing point and the stones was −5.6 ± 18.4 mm (median: 0 mm) on the right and −4.7 ± 19.3 mm (median: 0 mm) on the left. The mean distance between the renal pelvis and the stones was significantly longer on the right (57.2 ± 18.5 mm and 48.2 ± 19.1 mm) ($P$ = .038).

**CONCLUSION** The crossing point is the peak site of stone distribution in the upper ureter and likely different from the traditionally identified obstruction site at the ureteropelvic junction. UROLOGY 107: 31–36, 2017. © 2017 Elsevier Inc.


The classic description of 3 areas of functional narrowing or constriction in the upper urinary tract dates back to an anatomy textbook in 1954, which was written without a reference.[1] A description of these 3 points of "narrowing," namely at the ureteropelvic junction (UPJ), the pelvic brim where the ureter crosses over the iliac vessels, and the ureterovesical junction (UVJ), has since permeated the literature and has been included in almost every textbook of anatomy or urology up to the present time.[2-4] However, several recent studies assessing upper urinary tract stone distribution on computed tomography (CT) have demonstrated that this well-known dogma is inaccurate[5-8]; these studies demonstrated lack of significant stone lodging at the site where the ureter crosses the iliac vessels. Instead, they revealed only 2 peak sites of stone distribution: (1) the UVJ and (2) the level of the upper ureter.[5-8] Although the UVJ site peak is well explained by the fact that the intravesical portion of the ureter is the most contracted part and has the narrowest diameter in the upper urinary tract,[9] it is not clear what factors account for lodging of stones at the level of the upper ureter and what relationship exists between the area and the UPJ.

In daily practice, urinary stones located slightly distal to the "UPJ" are often seen. However, in discussing the exact

**Financial Disclosure:** *The authors declare that they have no relevant financial interests.*

*From the Department of Radiology, St. Luke's International Hospital, Tokyo, Japan; the Department of Clinical Anatomy, Tokyo Medical and Dental University, Tokyo, Japan; and the Department of Urology, St. Luke's International Hospital, Tokyo, Japan*

*Address correspondence to: Minobu Kamo, M.D., Ph.D., Department of Radiology, St. Luke's International Hospital, Akashi-cho 9-1, Chuo-ku, Tokyo 104-8560, Japan. E-mail: kamomino@luke.ac.jp*

*Submitted: September 28, 2016, accepted (with revisions): May 25, 2017*



http://dx.doi.org/10.1016/j.urology.2017.05.045
0090-4295

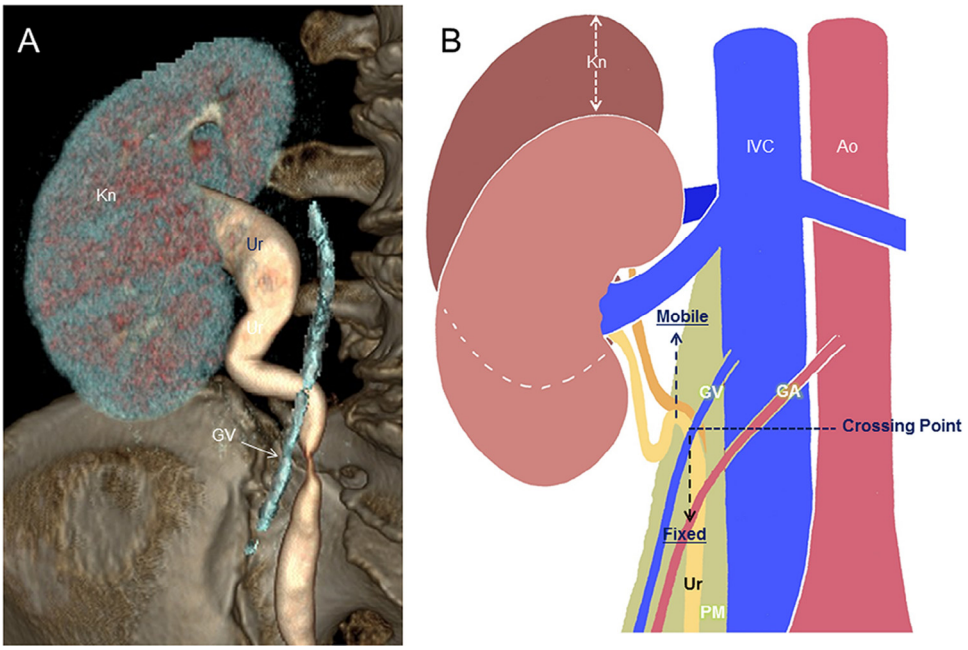


**Figure 1.** The "crossing point (CP)" where the ureter crosses the gonadal vein and the relatively fixed portion of the ureter. **(A)** Three-dimensional volume rendering computed tomography (CT) image. **(B)** Illustration of the upper ureter. The upper ureter is relatively mobile compared with its caudal portion, which is fixed firmly to the medial anterior aspect of the psoas muscle. We named the level where the ureter crosses the gonadal vein as "crossing point (CP)," and it was approximately at the level where the upper border of the firm fixation was seen. Kinking can occur here because of the difference in fixation of the ureter; the perirenal portion of the upper ureter kinks in when body motion causes kidney movement. Ao, aorta; GA, gonadal artery; GV, gonadal vein; IVC, inferior vena cava; Kn, kidney; PM, psoas major muscle; Ur, ureter. (Color version available online.)

location of these stones, the concept of the UPJ itself is called into question. The UPJ has been conventionally defined as the site where a difference in diameter between the renal pelvis and the ureter is found, because no histologic border exists between them. However, this morphologic but somewhat objective definition could be problematic, especially when lodging within the upper urinary tract occurs; the ensuing upstream ureteronephrosis can make it difficult to identify where the change in caliber defining the UPJ would have been. Consequently, in case of upper ureter stone obstruction, secondary dilatation of the upper ureter may be incorrectly identified as the UPJ.

Within the upper ureter, we recently identified an area of relative firm fixation. The upper ureter running in the perirenal fat slackens with kidney motion caused by physiological movements such as respiration. This is often manifested radiologically as "kinking" in the upper ureter. We previously investigated this finding by correlating CT urography with cadaveric examination and concluded that this kinking arises owing to relative mobility of the ureter in the perirenal space compared with the more caudal ureter (Fig. 1).[10] As the ureter transitions from the perirenal fat and then dives deeper, the ureter becomes relatively firmly fixed along the psoas muscle. We named the level where the ureter crosses the gonadal vein as "crossing point (CP)," and found that the CP approximately corresponds to the level where the fixation of the ureter changes.

We hypothesized that this level where the ureter's fixation changes might also correspond to the area of constriction and peak distribution that has been described in the upper ureter in cases of acute renal colic. The aim of our study was to investigate the relationship between the location of upper urinary tract stone distribution and the level where the ureter's fixation changes. We evaluated this by investigating the location of the CP, the radiological landmark of the ureter's fixation, in relation to upper urinary stone using CT images obtained for patients presenting with renal colic to the emergency department.

## MATERIALS AND METHODS

This study was approved by our institutional review board. Informed consent was waived because of the retrospective nature of the study. We reviewed 298 consecutive patients (237 male and 61 female patients, mean age, 49.0 years; range, 18-93 years) from January 2014 to June 2015 who presented to the emergency department in our institution with acute back pain and were diagnosed with acute renal colic, that is, upper urinary tract stone accompanying upstream hydronephrosis on abdominal CT. Contrast agent was used only when clinically required, and we do not routinely have patients ingest water before examination. The average elapsed time from the onset of the acute back pain to CT examination was 7.9 ± 14.5 hours. None of the patients were taking alpha blockers at the time of CT examination. Exclusion criteria were as follows: prior history of an open or