STONE DISEASE

Rapid Communication: Relative effect of urinary calcium and oxalate on saturation of calcium oxalate

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Background: The study compared the effect of urinary calcium with that of oxalate on urinary saturation [relative saturation ratio (RSR)] of calcium oxalate.

Methods: A retrospective data analysis was conducted on urinary stone risk analysis from 667 patients with predominantly calcium oxalate stones. Urinary RSR of calcium oxalate was individually calculated using Equil 2. A "theoretical" curve of the relationship between urinary RSR of calcium oxalate and concentration of calcium or oxalate was obtained at two stability constants for calcium oxalate complex, while varying calcium or oxalate and using group mean values for urinary constituents.

Results: At the stability constant of 7.07 x 10(3), the increase in RSR of calcium oxalate was less marked with calcium than with oxalate. However, at the stability constant of 2.746 x 10(3) from the Equil 2 that is considered the "gold standard," calcium and oxalate were equally effective in increasing RSR of calcium oxalate. The above theoretical curves (relating RSR with calcium or oxalate) were closely approximated by the actual curves constructed with data from individual urine samples. Urinary saturation of calcium oxalate was equally dependent on urinary concentrations of calcium and oxalate ($r = 0.75$ unadjusted and 0.57 adjusted for variables, and $P < 0.0001$ for calcium; $r = 0.73$ unadjusted and 0.60 adjusted, $P < 0.0001$ for oxalate).

Conclusion: Among calcium oxalate stone-formers, urinary calcium is equally effective as urinary oxalate in increasing RSR of calcium oxalate.

Editorial Comment

It has long been held that urinary oxalate is a more important contributor to calcium oxalate stone formation than urinary calcium. This perception stems from work published in 1972 by Nordin, Peacock and Wilkinson (1) in which the relationship of urinary calcium and oxalate concentration on urinary saturation calcium oxalate was determined using the stability proposed by Robertson of 7.07 x 10(3). Their work showed that although urinary saturation of calcium oxalate initially increased with increasing urinary calcium concentration, saturation reached a plateau at moderate calcium concentration; in contrast, saturation of calcium oxalate continued to rise with increasing urinary oxalate concentration, thereby supporting a more pronounced effect of urinary oxalate than calcium on urinary saturation of calcium oxalate. Although Robertson later adjusted his stability constant, in line with a lower stability constant proposed by Finlayson (2), the relationships between urinary calcium and oxalate and urinary saturation of calcium oxalate were never re-assessed.

Pak and colleagues reexamined the relative contribution of urinary calcium and oxalate on urinary saturation of calcium oxalate using retrospective data from predominantly calcium oxalate stone formers in their stone registry. First, they constructed theoretical curves relating urinary calcium and oxalate concentrations to urinary saturation of calcium oxalate using average values for urinary analyses derived from the population of patients studied and varying the urinary calcium and oxalate concentrations from zero to 2 standard deviations above the mean of the patient-derived values. When the higher original Roberson stability constant was used, urinary saturation reached a plateau at relatively lower concentrations of urinary calcium than urinary oxalate. On the other hand, when the lower Finlayson stability constant was used (as is used in the Equil 2 computer program, considered the gold standard for calculating saturation of stone-forming salts), saturation increased with both urinary calcium and oxalate concentrations, with the 2 curves departing only at high concentrations, at which point the curves reached a plateau at relatively lower calcium than oxalate concentrations. Furthermore, when actual urinary saturations were plotted against urinary calcium and oxalate concentrations for the patients in the database using the 2 stability constants, the "actual" values closely approximated the "theoretical" values derived using the lower Finlayson stability constant. Of significance, the calcium and oxalate curves were nearly superimposable.

These findings suggest that urinary calcium and oxalate contribute equally to the tendency toward calcium oxalate stone formation. As such, recent studies downplaying the role of dietary calcium in stone formation and advising against calcium restriction for stone prevention should be viewed cautiously. Indeed, urinary calcium, among stone risk factors, has most consistently been shown to be associated with risk of calcium stone formation. Although these findings in no way minimize the contribution of oxalate to calcium oxalate stone formation, both dietary calcium and oxalate should be taken into account when recommending dietary measures for stone prevention and efforts to reduce both levels in the urine may result in reduced stone formation rates.

References

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Fluid absorption during ureterorenoscopy

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Background and Purpose: Ureterorenoscopy (URS) is a common minimally invasive diagnostic and therapeutic modality for ureteral and renal pathology. Fluid absorption during routine URS has not been studied prospectively, despite the fact that fluid absorption during other endoscopic urologic procedures can be substantial.

Patients and Methods: During URS in 15 male and 8 female patients with a mean age of 54 years (range 19 - 81 years), volumetric balance was performed by measuring all fluids instilled into the urinary tract (irrigation fluid and contrast medium) and fluids collected from the urinary tract (irrigation fluid, contrast medium, and urine output) and by estimating urine output from creatinine concentration in the urine and in the fluids collected from the urinary tract. Fluids from the urinary tract were assessed by measuring drainage fluid and the preoperative and postoperative weights of the drapes and bedsheets. Of the procedures, 11 were right-sided and 12 were left-sided. The indications for URS were urolithiasis (N = 18) and diagnosis (hematuria in 2, ureteral or renal filling defect in 2, flank pain and hydronephrosis in 1).

Results: The mean total operative time was 55 minutes (range 20 - 95 minutes), and the mean URS time was 37 minutes (range 8 - 83 minutes). The mean volume of irrigation fluid used was 2531 mL (range 552 - 5580 mL). The mean estimated urine output during the procedure was 62 mL (range 7 - 201 mL). The mean estimated systemic fluid absorption during URS was 54 mL (range 4 - 137 mL). There were two intraoperative complications (ureteral perforations) but no postoperative complications.

Conclusions: Routine URS is associated with minimal systemic fluid absorption, even if ureteral perforation occurs. Estimated absorption of as much as 137 mL was seen; however, evaporative losses and unaccounted for losses of fluid likely account for a substantial portion of this fluid discrepancy. This result suggests that irrigation with fluids other than normal saline, such as sterile water, during URS is likely safe.

Editorial Comment

As ureteroscope design and instrumentation have improved, ureteroscopic procedures have become more ambitious; it is increasingly common to treat larger and more complex renal calculi with ureteroscopy, particularly as the limitations of shock wave lithotripsy have become better defined. However, with more complex ureteroscopic cases have come longer operative times and greater potential for complications. Among the potential problems with lengthy ureteroscopic cases are sepsis and systemic absorption of irrigation fluid similar to that seen in TURP syndrome and that reported in some PCNL cases.

Cybulski and colleagues attempted to quantitate systemic fluid absorption during routine ureteroscopy (both diagnostic and therapeutic) by applying volumetric balance studies of input and outflow fluids, estimating urine output by creatinine concentration measurement of the urine and outflow fluid. Among 18 ureteroscopic cases with a mean ureteroscopy time of 37 minutes, mean systemic fluid absorption was only 54 cc, which correlated strongly with actual ureteroscopy time. Among 2 cases of ureteral perforation, fluid absorption was approximately twice the average. The authors concluded that fluid absorption during routine ureteroscopy is minimal and use of sterile water irrigation fluid may be safe, but deserves further study.

This is an important study, the first of its kind to quantitate systemic fluid absorption during ureteroscopy and show that the risk of significant fluid absorption and the associated consequences are minimal during routine cases. However, it is important to keep in mind that the average ureteroscopy time in this series was quite short, only 37 minutes. Most of the more complex ureteroscopic procedures performed today (for stones as large as 2 cm or more), are associated with lengthier ureteroscopy times. It is not known if fluid absorption is a linear process, correlating directly with ureteroscopy time, or if the rate of absorption may accelerate with time. Second, in the current series, a ureteral access sheath was used in all cases. It has been shown in both a cadaver study (1) and in a clinical series (2) that use of a ureteral access sheath reduces intrarenal pressure, which in all likelihood will reduce the chance of fluid absorption from the collecting system. Whether fluid absorption is greater in cases performed without an access sheath remains to be seen, but the use of a ureteral access sheath may increase the margin of safety for lengthy ureteroscopic procedure for exactly this reason. Thus, although this important study shows that fluid absorption during routine ureteroscopic cases is minimal, extrapolation to longer more complex cases is not advisable, and the use of water should be discouraged. Having personally reviewed several medicolegal cases of deaths due to use of sterile water irrigation during prolonged ureteroscopic cases, I suggest that the advantage gained in visibility with the use of sterile water irrigation is not worth the risk.

References

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