

THE ABC'S OF KIDNEY STONES



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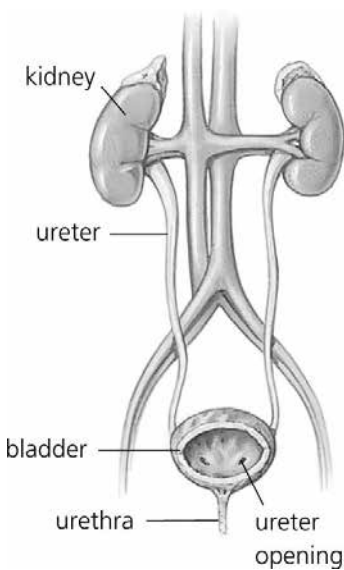
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INTRODUCTION

Kidney stones are a common urological condition that have been prevalent since ancient times. In fact, kidney stones have been found in an Egyptian mummy dated to be approximately 7000 years old! Men tend to be affected much more frequently than women.

A kidney stone is one of the most excruciatingly painful problems that a patient can encounter. Many women who have experienced both a kidney stone and natural childbirth without anesthesia will report that childbirth was less painful than the stone! Fortunately, most stones will ultimately pass on their own without any intervention by a urologist.

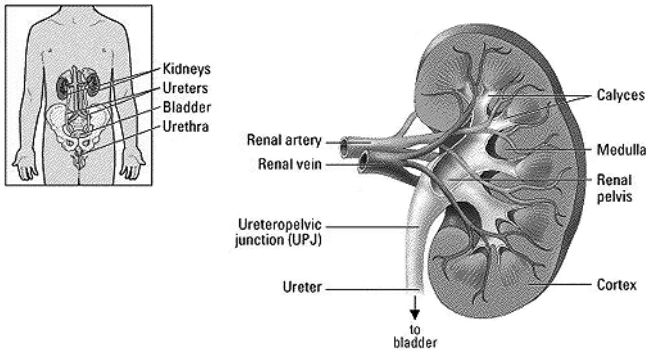
THE URINARY TRACT



The kidneys are paired, bean-shaped organs that function as the filters of our body, responsible for removing chemical waste substances and excess fluids as well as maintaining a stable balance of salts and other substances in the blood. The kidneys also produce hormones that help form red blood cells and build strong bones. The **renal artery** provides the blood supply that needs to be cleansed by the kidneys. This purified and filtered blood is then returned to the circulation via the **renal vein**. The chemical impurities and excess fluid that the kidneys produce is known as **urine**, which travels from the **calyx**, the cup-shaped part of the kidney, into the **renal pelvis**, the inner

aspect of the kidney that collects the urine. The urine flows down the **ureters**, thin tubes that conduct urine downward from the renal pelvis, to the **urinary bladder**, the balloon-like, muscular organ that functions to store and empty urine. The **urethra** is the thin tube that conveys urine from the bladder out the body.

The Kidneys



KIDNEY STONE FORMATION

Kidney stones form when certain minerals, normally dissolved in the urine, come out of their dissolved state to form solid crystals. Such **crystal formation** often occurs after meals or during periods of dehydration. These crystals must then **aggregate**, a process in which they join together to form stones. Dehydration causes very concentrated urine, which is a major risk factor for the formation of kidney stones. This is more apt to occur on a hot summer day or after exercise, but may also occur following diarrhea or vomiting.

There are many other factors that may contribute to kidney stone formation. Certain food items and beverages contain high concentrations of certain minerals that may increase the risk. Excess intake of some vitamins can promote kidney stone formation. Inflammatory bowel disease and small bowel resection/bypass engender an increased risk for stones. Some stones have a genetic basis, with a tendency to affect many family members. Kidney infections in the presence of certain bacteria may also impact stone formation by changing the acid balance of the urine. Parathyroid gland disease is yet another underlying cause of kidney stones.

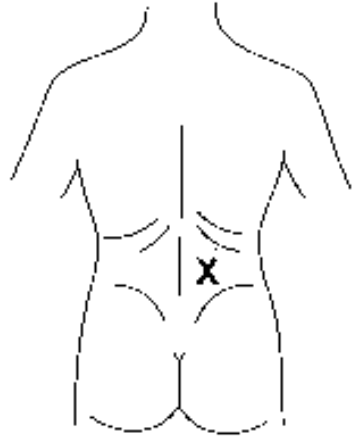
All kidney stones typically begin their formation in the calyx. They start out as a tiny grain of solid matter that grows over time as the grain is exposed to urine and more minerals are deposited and coalesce around the grain. Under certain circumstances, stones can get so large and branched as to form an actual cast of the renal pelvis; these are referred to as **staghorn stones** because their appearance resembles a stag's antlers.

SYMPTOMS OF KIDNEY STONES

Some stones, referred to as *silent stones*, cause no symptoms whatsoever and are found incidentally when imaging studies of the abdomen are performed for other health reasons. However, many stones can be very painful. The movement of a stone within the renal pelvis is responsible for stone pain known as *renal colic*.

Hematuria, defined as blood in the urine, can occur as the stone movement tears the delicate inner lining of the kidney. When a stone or piece of a stone moves into the ureter and becomes trapped and impacted, thereby obstructing the flow of urine, severe pain known as *ureteral colic*

occurs. The pain is intermittent, wave-like, and of great intensity, with an inability to achieve a comfortable position. The pain often radiates from the flank region to the groin. It is often accompanied by sweating, nausea and vomiting. If the stone is in the lower part of the ureter near the urinary bladder, it will often cause urinary symptoms such as *urgency*, the sudden and acute desire to urinate even if the bladder is empty and *frequency*, the need to urinate more often than normal. When the urinary tract obstruction caused by the stone gives rise to a urinary tract infection, fever and shaking chills may occur.



Whether a stone is likely to pass on its own or not is determined by the size and shape of the stone. Most small stones will pass spontaneously. However, the size of the stone does not correlate with the degree of pain, as a small stone can hurt just as much as a larger stone. The shape of the stone is also a factor, as round, smooth stones will pass more readily than jagged, irregular stones. There are three areas of the ureter where stones tend to get impacted: the *uretero-pelvic junction (UPJ)* where the ureter joins the renal pelvis; the pelvic brim, where the ureter crosses the iliac blood vessels; and the *uretero-vesical junction (UVJ)*, where the ureter joins the bladder.



TYPES OF KIDNEY STONES

- **Calcium** stones account for approximately 80% of kidney stones. The most common subtype is calcium oxalate followed by calcium phosphate. These stones may occur because of elevated oxalate levels or calcium in the urine, due to either increased intestinal absorption, decreased kidney reabsorption, or increased bone reabsorption.
- **Uric Acid** stones account for 5-10% of stones and often occur because of low urine volumes, acidic urine, and elevated levels of uric acid in the urine. These stones are not visible on a KUB, but are seen on sonograms and CAT scans.
- **Struvite** stones, also known as “infection stones”, are composed of magnesium, ammonium, and phosphate. Certain bacteria, including Proteus, Pseudomonas, and Klebsiella, are able to split urea and cause alkaline urine, which creates the environment that allow these stones to form. Patients with staghorn calculi, indwelling Foley catheters and neurogenic bladders (bladders that are functioning poorly as a result of a neurological problem) have a predisposition for this type of stone.
- **Cystine** stones are responsible for about 1% of stones. They occur because of an inherited defect in the ability of the kidney to reabsorb four important amino acids, including cystine.

EVALUATION OF THE STONE PATIENT

A detailed history is an important start to the evaluation of any stone patient. Certain conditions cause a predisposition to forming kidney stones:

- insufficient fluid intake
- occupations that require working in hot environments
- strenuous exercise without maintaining adequate hydration
- male gender—the male to female ratio of kidney stone incidence is 3:1
- a previous kidney stone—approximately 50% of people who experience a stone will have a recurrence
- family history of kidney stones
- renal tubular acidosis—a rare hereditary kidney disease
- a history of Proteus, Pseudomonas, or Klebsiella urinary tract infections
- urinary tract obstruction
- excessive intake of oxalate, salt, and protein
- excessive intake of Vitamin C
- intestinal malabsorption
- gout
- parathyroid disease

The following diagnostic tests are important in the further evaluation of a patient with a kidney stone:

- **Urinalysis** checks for hematuria (blood in the urine), which is present in up to 90% of patients with stones and is often microscopic (not visible). White blood cells and bacteria in the urine are often indicative of a urinary tract infection.
- **Urine culture** is a means to determine what specific bacteria is causing the infection and what the most appropriate antibiotic of choice is.
- **Kidney ultrasound** is an extremely useful tool in the diagnosis of kidney stones. By using sound waves (which do not carry the risk of radiation), kidney stones can often be detected. An ultrasound will determine if a kidney is obstructed by a stone. This resulting **hydronephrosis** (internal swelling of the renal pelvis), is often a tell-tale sign that there is an obstructing stone in the ureter.
- **K.U.B. (kidney, ureter, bladder) x-ray** provides a view of the abdomen, which will often show stones in the kidney or the ureter. The key limitation to this film is that the overlying intestines contain gas and fecal matter that can easily obscure visualization of kidney or ureteral stones. Although most stones contain **calcium** and are therefore **radio-opaque** (can readily be seen on an X-ray), some stones, such as **uric acid** calculi, are **radio-lucent** and will not show up on such an x-ray.
- **Computerized Tomography using a stone protocol** is a sophisticated study that takes multiple “slices” of the urinary tract. It is the best study to locate and identify a stone within the urinary tract. It can be done rapidly and does not require the use of intravenous contrast, while readily identifying the size and location of a stone regardless of whether it is radio-opaque or radio-lucent. It will also readily identify signs of obstruction and other abdominal and pelvic pathology.

CONSERVATIVE MANAGEMENT

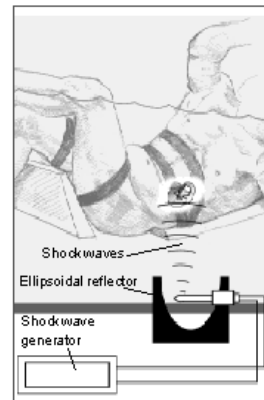
Most stones that are less than 5mm in size will pass spontaneously, without intervention. There is no correlation between stone size and symptoms; in other words, a very large stone may cause minimal pain, yet a tiny stone the size of a sand particle on the beach may cause excruciating colic. Conservative treatment entails hydration, a prescription for pain medication, straining the urine to capture the stone when it passes so that it can be submitted for chemical analysis, and careful follow-up with imaging. Hydration involves drinking sufficient volumes of water to keep the urine looking clear. The use of alpha blockers such as Flomax or Rapaflo will help facilitate stone passage. For radio-opaque stones, K.U.B. X-rays can be done at intervals to monitor the progressive movement of the stone down the ureter. Sonography will demonstrate the presence of the stone and the degree of obstruction. As long as the pain is manageable and there is progressive movement of the stone on imaging, conservative management may continue to be an option. Uric acid stones can be managed conservatively by using a medication that maintains the urine in an alkaline environment, which can help promote their dissolution.

Conservative management is not an option under the following circumstances:

- Large stones
- Intolerable pain
- Severe nausea and vomiting with dehydration
- Significant and prolonged obstruction of the kidney
- Urinary tract infection that does not respond to antibiotics
- High fever suggesting a kidney infection
- A solitary kidney
- Certain occupations that cannot risk impaired function, such as airline pilots

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL)

Extracorporeal shock wave lithotripsy is a revolutionary technique used for the treatment of kidney and ureteral stones. *Extracorporeal* means the shock waves come from “outside the body.” First performed in the United States in 1984, it is one of the greatest medical advances of all time, and has tremendously reduced the need for open, old-fashioned stone surgery.



ESWL uses high pressure shock waves directed at the kidney stone under x-ray guidance, which results in the crushing of the stone into tiny fragments that can then be passed through the urinary tract. This technique cannot be utilized in pregnant females, in the presence of a urinary tract infection, or bleeding disorders, and in patients who weigh more than 300 pounds.

Several factors will impact the results of ESWL: **size, location, and composition**. In general, the best results of ESWL are achieved with smaller stones. When stones are of a very large size or are multiple, the results from ESWL are less favorable. Location is another important factor. In general, stones located within the kidney itself have the best prognosis for treatment with ESWL and those in the ureter are typically more difficult to fragment. A third important factor is the composition of the stone itself. In general, uric acid stones, struvite stones, and calcium oxalate dihydrate stones fragment readily whereas cystine, calcium oxalate monohydrate stones, and calcium phosphate stones are more difficult to fragment.

ESWL is an outpatient procedure that is performed under intravenous sedation monitored by an anesthesiologist. After you are positioned on the lithotripter table, an x-ray monitoring unit is used to pinpoint the precise location of the kidney stone. High pressure shock waves are directed at the stone, causing it to disintegrate into small particles. The procedure usually takes 30 minutes and typically will involve approximately 2400 shocks. The disintegration of the stone is periodically monitored utilizing x-ray guidance.

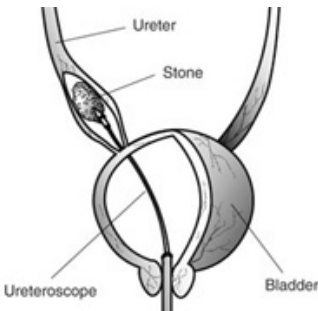
Following ESWL, you will go to a recovery area, and when you are fully awake and alert, you will be discharged. Although the treatment itself is painless, there may be some discomfort following ESWL, particularly as the stone particles are eliminated. You will be sent home with a prescription for pain medicine and sometimes a prescription for antibiotics. It is very common to have blood in the urine and a bruise in the area of the treatment. Typically, you may resume normal activities within only a few days. Careful office follow-up after ESWL is mandatory. You will be followed by K.U.B. X-rays or a renal ultrasound to ensure proper passage of the stone fragments and particles.

Although ESWL has provided a great number of patients suffering from stones with a wonderful alternative to the more invasive forms of therapy, there are definite limitations to this procedure. ***It is fundamental to understand that ESWL will result in the fragmentation of the stone into sand-like particles but that***

these particles must then pass down the ureter into the urinary bladder. It is not uncommon to have some retention of fragments in the lower calyx of the kidney and it may take up to three months to pass all the fragments. *It is important to know that some retained stone fragments may not pass spontaneously and may require a secondary ESWL or laser procedure.* During the passage of stone fragments, it is not uncommon to have colic-like pain that may require pain medication to control. Less than 5% of patients will develop a *steinstrasse*, a German word defined as “street of stones”. This is a condition in which multiple stone fragments line up in the ureter, sometimes requiring additional procedures. Although most patients will have transient blood in the urine, an occasional patient may have a significant amount of bleeding in the tissues surrounding the kidney. Despite these shortcomings, ESWL provides a means of successful treatment of most kidney stones and many ureteral stones in a very non-invasive fashion requiring no incision and no hospital admission.

URETEROSCOPY AND LASER LITHOTRIPSY

This non-invasive surgical technique, performed under anesthesia on an outpatient basis, involves the placement of a small telescope, called a *ureteroscope*, into the bladder and then into the ureter. In order to enter into the ureter, the opening to the ureter, the *ureteral orifice*, may need to be dilated. The ureteroscope is carefully manipulated



to the level of the obstructing stone.

Once the stone is identified, a *laser lithotripsy* is performed, a procedure in which a type of instrument called a Holmium laser fiber is used to fragment the stones. The largest fragments are then grasped with a special basket and removed. The technique of ureteroscopy used to be limited to stones that were in the ureter. However, with advanced techniques, the ureteroscope can be passed all the way into the renal pelvis in

order to treat stones within the kidney in a similar fashion to stones within the ureter. Therefore, stones that are resistant to breaking up with standard ESWL can now be fragmented using ureteroscopy. Additionally, patients who are not candidates for ESWL because the stone is too large or due to patient weight or non-visualization of the stone can now be successfully treated via ureteroscopy techniques.

A **ureteral stent** is left in place after ureteroscopic laser lithotripsy to allow the ureter to heal and prevent ureteral obstruction. This ureteral stent is a soft, hollow, narrow-caliber plastic straw that traverses the ureter with one end coiled within the renal pelvis and the other end coiled within the urinary bladder. The ureteral stent will remain in place for a week or so and is then removed using a **cystoscope**, a narrow flexible telescope that allows visualization and removal of the stent, a quick procedure that takes only a few minutes.

Staged Ureteroscopy

There have been tremendous advances in the equipment and techniques used for ureteroscopy and laser lithotripsy, and many large stones that used to require an incision to remove can now be treated with a staged ureteroscopy where a large stone can be broken in an initial procedure and then fragments removed in a secondary procedure after the ureter has been dilated with a stent. On occasion, a third procedure may be required. All procedures are outpatient with no significant recovery time since no incisions are made.

STONE MANIPULATION AND STENT PLACEMENT

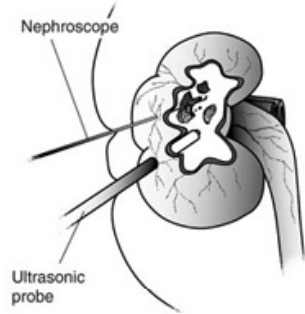
There are certain occasions where manipulation of an obstructing stone and stent placement is appropriate initial management. This will typically be done when a patient has a stone causing a high degree of obstruction and a urinary tract infection. Under these circumstances, a simple attempt at moving the stone out of its obstructing position and placing a stent to prevent further obstruction is the most expedient and safest means of managing the situation; ESWL or ureteroscopic laser lithotripsy is then reserved for a later date, after the infection is eradicated. Performing ureteroscopic laser lithotripsy under the condition of an acute febrile urinary tract infection is not desirable since it can cause **urosepsis**, a life-threatening systemic infection.

An alternative to stone manipulation and stent placement is placement of a **percutaneous nephrostomy tube** into the kidney by a physician called an “interventional radiologist.” Essentially, this is a small tube similar to an intravenous tube that, under local anesthesia, is passed using imaging guidance from the flank skin to the renal pelvis. By

diverting the kidney's urine output through the tube, it serves to temporarily bypass the ureteral obstruction. This is sometimes used as an alternative means of managing an obstructing stone, when placing a stent is mechanically impossible because of the complete obstruction caused by the stone.

PERCUTANEOUS LITHOTRIPSY

If a stone is too large for a staged ureteroscopy or shock wave lithotripsy, a **percutaneous lithotripsy** may be required. **Percutaneous** means "through the skin". A percutaneous nephrostomy tube is initially placed into the kidney by the interventional radiologist. Under general anesthesia, this tube is used to dilate a passageway from flank skin to renal pelvis that will create a tunnel for passage of a **nephroscope**. The nephroscope allows stone visualization, fragmentation (using a laser, ultrasound or electro-hydraulic techniques), and removal of the stone fragments. This is a significant improvement over the large flank incisions that were used in the past for sizable kidney stones. This type of technique is typically reserved for stones that are greater than 2-3cm (20-30mm) in size, staghorn calculi, or stones in the lower calyx that cannot be reached with ureteroscopy. After the stone has been removed, a percutaneous nephrostomy tube is left within the kidney to allow the kidney to heal properly. The hospital stay is typically 1-2 days. If a stone is very large, a "second look" procedure may be performed to ensure complete evacuation of all stone fragments.



OPEN SURGERY

With state-of-the-art techniques of minimally-invasive surgery, an open incision to remove kidney stones is an infrequent occurrence. Usually, this is required only for large staghorn calculi. This procedure involves a flank incision under general anesthesia and a several day stay in the hospital.

PREVENTING FUTURE STONES

The recurrence rate of kidney stones is approximately 50% within five years. An important part of any treatment involves preventing future stones. A key component to prevention is a **stone analysis** to identify the chemical constituents of the stone. Once the chemical makeup of the stone is identified, certain behavior modifications, including a change in diet, can be initiated.

In addition to the stone analysis, a **metabolic evaluation** may be prudent, particularly for recurrent stone formers. A 24-hour urine collection will be obtained to check the levels of “stone related chemicals,” including calcium, phosphate, magnesium, oxalate, uric acid, citrate, and total urine volume. Based upon the results, dietary adjustments or medications may be suggested.

Once the metabolic evaluation has been completed, certain lifestyle recommendations will be suggested. Staying well hydrated is the single best way to reduce the risk of future stones. A typical recommendation is eight 8 oz glasses of water daily, but this can vary, depending upon many other factors. Some people opt to simply observe the color of their urine to determine if they are diluting the urine enough. One should strive for a clear, water-like urine rather than a concentrated, amber appearing urine. A goal of 2 liters/day urine output is desirable. At times, medications may be prescribed to help diminish stone recurrence. Possible stone prevention medications include the following:

- **Potassium Citrate** is used to provide citrate to help prevent calcium stones and to alkalinize the urine to treat uric acid stones.
- **Allopurinol** is used when serum uric acid is found to be elevated.
- **Thiazide Diuretics** are used to treat elevated calcium levels in the urine.

CALCIUM OXALATE STONE PREVENTION

Calcium oxalate stones account for 70-80% of kidney stones. The following measures are advised when stone analysis demonstrates a calcium oxalate stone:

- **Hydration:** By drinking more liquids, the concentration of stone-forming minerals in the urine will be reduced. Remember, the goal

of hydration is very light urine as opposed to a dark amber color. If you live in an area where the water is “hard,” you may be drinking high concentrations of stone-forming minerals and, if so, it may be beneficial to drink bottled water.

- **Increase dietary citrate:** Citrate is a naturally-occurring stone inhibitor. Dietary citrate can be supplemented by consuming citrus fruits, particularly lemons and lemonade.
- **Eliminate medications and vitamins that can enhance stone formation:** Excessive Vitamin C, in particular, is a real risk factor for calcium oxalate stone formation as it is converted by the body into oxalate.
- **Restrict sodium intake:** Excessive dietary salt increases urinary calcium levels, so a moderate salt intake is desirable. Canned foods, soups, tomato juice, Chinese and Mexican foods have a high salt content.
- **Proteins in moderation:** A diet high in protein can increase the tendency for stone formation.
- **Fats in moderation:** A low-fat diet is desirable; this reduces the fatty acids that would otherwise bind with dietary calcium, thus allowing more oxalate to be absorbed into the body.
- **Dairy products in moderation:** Dairy is the main source of calcium and 2-3 servings of dairy products daily is considered desirable. It is important to have adequate calcium intake for many reasons and elimination of dairy products is counter-productive. Calcium will bind intestinal oxalate, and the calcium oxalate unit will be eliminated in the stool, so calcium intake paradoxically will help mitigate calcium oxalate stones.
The amount of calcium in your diet may be adjusted based on your twenty four hour urine collection. If you have been instructed to take a calcium supplement, use calcium citrate.

- ***Oxalate containing foods in moderation:***

Oxalate is a more important factor in calcium oxalate stone formation than calcium intake, Try to be careful with foods in the high and moderately high categories.

These foods are high in oxalate (greater than 10 mg per serving):

Beans in tomato sauce, Beer, Beets, Blackberries, Black and red raspberries, Blueberries, Celery, Chard, Chocolate, Cocoa, Coffee powder (Nescafe), Collards, Concord grapes, Crackers made from soy flour, Currants, Dandelion greens, Eggplant, Escarole, Fruit cake, Fruit salad (canned), Green bell pepper, Grits (white corn), Juices containing berries, Kale, Leeks, Lemon and lime peel, Nuts (especially peanuts and pecans), Ovaltine, Parsley, Pokeweed, Rhubarb, Rutabagas, Spinach, Strawberries, Summer squash, Sweet potatoes, Tea, Tofu, Tomato soup, Wheat germ

These foods are moderately high in oxalate (2-10 mg per serving):

Apple, Apricots, Asparagus, Bottled beer (12 oz [360 ml] limit/day), Broccoli, Carrots, Chicken noodle soup (dried), Coffee (8 oz [240 ml]), Cola beverage, (12 oz [360 ml] limit per day), Corn, Cornbread, Cucumber, Lettuce, Lima beans, Marmalade, Oranges, Orange juice (4 oz [120 ml]), Parsnips, Peaches, Pears, Peas (canned), Pepper (greater than 1 tsp [2 grams] per day), Pineapple, Plums, Prunes, Sardines, Soy products (most), Sponge cake, Tomatoes, Tomato juice (4 oz [120 ml]), Turnip, Watercress

These foods are low in oxalate (0-2 mg per serving); eat as desired:

Apple juice, Avocado, Bacon, Bananas, Beef (lean), Bing cherries, Brussel sprouts, Cabbage, Cauliflower, Cheese, Eggs, Grapefruit, Green grapes, Jellies, Lamb (lean), Lemonade or limeaid, (without peel), Melons, Milk, Mushrooms, Pork (lean), Poultry, Preserves, Nectarines, Noodles, Oatmeal, Oils, Onions, Peas (fresh), Plums, Radishes, Rice, Salad dressing, Seafood, Spaghetti, White bread, Wine, Yogurt

- **Medications:** Thiazide Diuretics are used when there are elevated levels of calcium in the urine. Urocit K or TheraLith is useful to provide supplemental citrate when dietary citrate is poorly tolerated or insufficient.

URIC ACID STONE DISSOLUTION AND PREVENTION

Uric acid stones are radio-lucent, meaning that they do not show up on x-rays because they do not contain calcium. Uric acid stone formation is ordinarily prevented by the increase in urinary alkalinity after meals, the so-called **alkaline tide**. This increase in uric acid alkalinization after meals is lost or diminished in uric acid stone formers. Many patients with this problem have recurrent episodes of passing **gravel** (tiny sand particles) accompanied by severe colic. Uric acid stones can sometimes be dissolved and their recurrence can often be prevented by paying careful attention to the following:

- **Hydration:** By drinking more liquids, the concentration of uric acid in the urine will be reduced. Remember, the goal of hydration is very light urine as opposed to a dark amber color.
- **Purines in moderation:** Uric acid is a by-product of the body breaking down dietary purines. By limiting purine intake, urinary uric acid levels will be diminished. Purine-rich foods include the following: Alcoholic beverages, Anchovies, Sardines in oil, Fish roe, Herring, Yeast, Organ meat (liver, kidneys, sweetbreads), Legumes (dried beans, peas), Meat extracts, Consomme, Gravies, Mushrooms, Spinach, Asparagus, Cauliflower

- **Medication:** Administration of alkaline potassium salts will increase urinary alkalinity and simulate the alkaline tide, thus helping reduce/dissolve uric acid stones, as well as to help their recurrence. Urocit K is often used to dissolve uric acid stones. Once the stone is dissolved, maintenance with Urocit is successful in preventing recurrent episodes. If serum uric acid levels are elevated, Allopurinol may be used. Allopurinol decreases serum uric acid.

UROLOGIC FOLLOW-UP

Regular doctor visits are of *extreme* importance in someone who has had a kidney stone. There is an approximately 50% stone recurrence rate in the first several years after a person's first kidney stone attack. A urological follow-up visit entailing a history, urinalysis, and imaging with ultrasound or K.U.B., is important in preventing future stones. Obviously, stones that are found early can be treated in a minimally-invasive way prior to their becoming severely symptomatic. For example, if a small stone can be imaged within the kidney, it may be able to be fragmented before it has a chance to drop into the ureter and cause severe colic. The patients who fare the best with regards to their kidney stones are those who have implemented all dietary recommendations and have continued with their routine urological preventive follow-up visits.

Dr. Martin Goldstein earned a Bachelor of Science degree with Honors from Yeshiva University in 1990. He was awarded a full four-year merit-based scholarship to attend the Rutgers New Jersey Medical School, where he earned an award given for excellence in research. Dr. Goldstein then completed two years of general surgical training at the University of Rochester. This was followed by four years of urologic training and research also completed at the University of Rochester.

Dr. Goldstein is a diplomate of the American Board of Urology and the National Board of Medical Examiners. He is a member of the American Urological Association, the New York Section of the American Urological Association, and the Society of Laparoscopic and Endo-Urological Surgeons.

Dr. Goldstein is recognized as a leader in the treatment of kidney stone disease. Complex kidney stone patients that other urologists find difficult to treat are frequently referred to Dr. Goldstein for his expertise in this field.

Dr. Goldstein has extensive expertise in the state-of-the-art techniques in urologic surgery, such as ureteroscopy and percutaneous approaches to the stone. In acknowledgement of his technical ability and experience he has been appointed Co-Director of Endourology and Kidney Stone Disease at Hackensack University Medical Center. Additionally, he has been named Co-Director of Hackensack University Medical Center's Kidney Stone Center.

Dr. Goldstein has been a speaker on many urologic topics and has published in peer reviewed scientific journals and urology text books. He is a Board-Certified Urologist practicing at Hackensack University Medical Center. He is actively involved in teaching residents and medical students while serving as Clinical Instructor of Urology at the Rutgers New Jersey Medical School.

Dr. Andrew Siegel earned a medical degree from the Chicago Medical School, Chicago, Illinois, where he was elected to the Alpha Omega Alpha Honor Medical Society.

He completed a two-year residency in general surgery at the North Shore University Hospital, Manhasset, New York, an affiliate of Cornell University School of Medicine. Dr. Siegel then went on to undertake residency training in urology at the University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania. Dr. Siegel completed a fellowship in voiding dysfunction, urodynamics, reconstructive and female urology at the UCLA School of Medicine, Los Angeles, California, under the direction of Dr. Shlomo Raz, prior to joining Bergen Urological Associates.

Dr. Siegel is a diplomate of the American Board of Urology and the National Board of Medical Examiners and is board certified in both Urology and Female Pelvic Medicine & Reconstruction Surgery. He is a member of the American Urological Association, the American Uro-Gynecological Society, the International Continence Society, the Society for Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction, and the Sexual Medical Society of North America.

Dr. Siegel has authored chapters in urology textbooks including *Current Operative Urology* and *Interstitial Cystitis*, and has published articles in numerous professional journals including *Urology*, *Journal of Urology*, *Urology Clinics of North America*, *Postgraduate Medicine*, *Neuro-Urology and Urodynamics*, and *International Urogynecology Journal*. He has presented papers at professional meetings for many medical societies including the Philadelphia Urological Society, the American Academy of Pediatrics, the American Urological Association, and the American College of Surgeons.

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