THE METHOD OF ANATROPHIC NEPHROLITHOTOMY USED IN CALCULUS REMOVAL AND PARTIAL NEPHRECTOMY

With the widely used extracorporeal lithotripsy, percutaneous nephrolithotomy, and endourologic methods for kidney stone surgery, the clinical use of the anatrophic nephrolithotomy procedure has diminished. However, because this operation clearly showed the advantages of using hypothermia in extensive kidney surgery and demonstrated maximal parenchymal preservation, it can still be useful. Anatrophic nephrolithotomy not only can be used for full staghorn calculus surgery but also can be adapted for complex kidney reconstructions and partial amputations in a solitary kidney.

If the surgeon chooses to induce kidney hypothermia for the operative procedure, intravenous infusion of mannitol (12.5 g) preoperatively as well as immediately before clamping the renal vasculature will allow the maximal ischemic time with the least renal damage.1,2

OPERATIVE PROCEDURE
Slush Preparation

FIG. 3-1. Slush should be used immediately after renal vasculature occlusion and is prepared easily by the following method3,4:

1. Dry ice is placed in a large basin.
2. An empty stainless steel bowl is placed in the middle of the large basin such that it is surrounded up to the rim with the dry ice (A).

When the inside of the stainless steel bowl becomes “frosty,” normal saline solution is slowly poured in while the solution is stirred (B).

Within 5 minutes, slush will form and will be ready for use (C).

Coagulum Preparation

The use of the most popular coagulum for trapping kidney stones was curtailed by the report of the associated development of a pulmonary embolus. The thrombin was identified as the culprit for the cascade of the fatal event.5

FIG. 3-2. A simpler method of forming a coagulum cast without thrombin was described by Klash, Campbell, and Young.6 Although this formula is rarely used, we have found it to be the most consistent and easiest to use:

1 Cryoprecipitate (250 mg/U) (12 U = 100 ml) is ordered the day before surgery.

2 The cryoprecipitate first is allowed to thaw in a 37˚C bath and then is left at room temperature for 30 to 40 minutes before use.

3 Using a 10% solution of calcium chloride (10 ml ampule, Elkin), the surgeon mixes a volume ratio of 1:20 of calcium chloride to cryoprecipitate (e.g., 1 ml of calcium chloride solution to 20 ml of cryoprecipitate). One to two drops of methylene blue can be added to distinguish this mixture from the stones.2

4 Either by estimating or by directly applying a No. 18 angiocatheter into the renal pelvis, the surgeon withdraws the volume of urine within the pelvis.

5 Correspondingly, the surgeon draws the same or greater volume of the cryoprecipitate mixture and injects it into the renal pelvis after the proximal ureter is temporarily obstructed with a vessel loop. The injection should fill the renal pelvis such that the mixture can flow into the multiple calyces. However, the surgeon should not overdistend the collecting system because this could lead to venous extravasation.5

6 The surgeon injects 5 ml of the mixture into a medicine cup to observe for coagulation to take place. It requires 15 to 20 minutes for the coagulum to form.

7 The surgeon then opens the renal pelvis and calyx and removes the solidified coagulum with the stone trapped within it.

Arterial and Venous Isolation

FIG. 3-3. To find the true avascular plane between the anterior and posterior renal arteries, Smith and Boyce7 first described isolating the renal artery from the renal vein and then occluding the anterior or posterior branch of the artery with a bulldog vascular clamp. An obvious avascular line can be defined if methylene blue is injected.

However, because this method is cumbersome and also has led to irreversible arterial injury, a simpler method described by Redman, Bissada, and Harper8 is more commonly used.

With this simpler method, the surgeon estimates the location of the avascular plane, which is slightly posterior to the midportion of the kidney. The surgeon occludes the renal artery and vein together as one unit instead of separating the artery, vein, and branches.

We prefer using vessel loops wrapped around twice and tied (en bloc ligation) rather than using bulldog vascular clamps. This vessel loop method lessens the vascular trauma and also permits the surgeon to loosen the loops intermittently to allow flow-through during the operation.
Bowel Bag Placement

**FIG. 3-4.** After the vessel loops have been placed loosely around the entire vascular pedicle, a bowel bag is placed over the kidney. Wrapping the kidney down to its pedicle, the surgeon ties umbilical tape around the base (A).

A small slit is made so the kidney can be extruded. The object of this maneuver is to prevent excessive leakage of slush into the retroperitoneum. Fluid in direct contact with the body may lead to excessive body hypothermia (B).

Once the renal vasculature has been occluded, slush is poured into the bowel bag (C).
Critical Operative Maneuvers in Urologic Surgery

**FIG. 3-5.** Using the simpler method of this operation, the surgeon first divides and preserves as much of the renal capsule as possible and then bivalves the kidney with a blunt knife handle along the estimated avascular line.

If coagulum is used, the precipitate is injected before opening the parenchyma.

After the surgeon has removed the bulk of the stones and has irrigated and flushed out each calyx, the most difficult part of the surgery is undertaken: the removal of residual stones.

The recurrence rate of infectious stones is proportionally related to the number of stones remaining in the kidney.

**FIG. 3-6.** With a needle placed on either pole, the surgeon can define remaining stones in the anterior as well as the posterior leaf of the bivalved kidney with the use of jaw or dental film. We prefer this method over the use of nephroscopy or sonography.

Jaw or dental film (Kodak catalog number 1566389) or 5 × 12 inch panoramic film is placed between intensifying screens (Lanex Regular; Kodak) and then placed within a pliable Gendex cassette. The cassette is covered with adhesive sterilized plastic or placed within a sterile plastic bag. The surgeon places the cassette between the bivalved kidney and obtains a radiograph of the stones in the anterior leaf. A second film is placed posterior to the whole kidney to define stones in both leaves of the kidney. By counting the stones in the first film and subtracting the number from the total number of stones detected in the second film, the surgeon can define the stones in the posterior leaf.

**FIG. 3-7.** A nephrostomy tube and a small-caliber irrigating stent are placed after the stones are removed (1 and 2).

Obvious, large defects of the collecting system and divided vasculature are closed with an absorbable stitch (4-0 chromic) (3), but it is not necessary to reapproximate all divided vessels or collecting systems.

The importance of reapproximating the renal capsule to create a tamponade cannot be overemphasized.

When the kidney is rewarmed and the vessel loop around the vasculature is released (4), there is usually minimal bleeding.

**PARTIAL NEPHRECTOMY FOR RENAL CANCER IN SOLITARY KIDNEY**

If partial nephrectomy is indicated, whether for cancer in a solitary kidney or for other reasons, the objective is to remove the diseased segment of the kidney and to preserve as much residual parenchyma as possible.

A preoperative selective arteriogram is useful.

In rare cases in which a branch of the renal artery corresponds to
the segment to be resected, the surgeon can simply ligate the branch and perform partial nephrectomy. In the majority of cases, however, this is not so. En bloc ligation of the renal artery and vein should be performed and then hypothermia should be induced.

**FIG. 3-8.** The capsule is opened, and the amputation of the kidney segment for a partial nephrectomy can be performed using the blunt end of a knife handle to divide the parenchyma.

The calyceal systems should be closed with a running stitch (2-0 or 4-0 chromic), and large-caliber vessels should be closed with figure-of-eight stitches.

The assistant should now loosen the vessel loop around the renal pedicle while the surgeon searches for obvious venous and arterial bleeding sites that require occlusion.

The argon beam coagulator (Bircher/Solos, Irvine, Calif.) can provide excellent hemostasis of the raw surfaces of the amputated kidney. The coagulator can also be used to obtain hemostasis of the spleen and liver.
FIG. 3-9. Mild hemorrhage can be tamponaded by pieces of fat or Surgicel with Avitene compressed within the reconstructed renal capsule.

The use of fibrin glue (Hemedeics, Inc., Malibu, Calif.) is also helpful.

FIG. 3-10. If there is still bleeding after the kidney is rewarmed and the temporary vascular ligation is released, the Teflon felt pledget sandwiching technique is another alternative for achieving hemostasis.

Using two Teflon felt pledgets (1 × 2 cm), the surgeon passes a mattress stitch (0 chromic) through the pledgets with the kidney in between as a “sandwich.” The Teflon pledgets prevent the stitch from tearing through because pressure is applied to compress the kidney. The same technique is used to repair lacerated spleens and livers.
**KEY POINTS**

**ANATROPHIC NEPHROLITHOTOMY**
- Mannitol (12.5 g) is administered intravenously.
- A vessel loop is twice wrapped around the renal artery and vein together. Alternatively, a single loop with a Rummel vascular tourniquet can be applied to the renal vessels.
- A bowel bag is placed around the kidney.
- Slush is poured into the bowel bag to induce hypothermia.
- The divided renal capsule is preserved for closure.
- The need for the use of coagulum should be considered.
- The renal stone is removed and the calyceal branches are irrigated.
- Cassette film radiographs of the anterior and posterior leaves of the bivalved kidney are obtained.
- A nephrostomy tube (Malecot 18 Fr) and stent (6 or 8 Fr) are placed for possible irrigation.
- Large open defects of the collecting system are reapproximated with an absorbable stitch.
- Capsular reapproximation is completed.
- The kidney is rewarmed and the vessel loops around the renal pedicle are released.

**PARTIAL NEPHRECTOMY**
- Vascular control is obtained with a vessel loop double-looped around the renal artery and vein together.

- Hypothermia is induced with the kidney in a bowel bag.
- Capsular division and kidney amputation are performed.
- A nephrostomy tube is placed.
- Open defects of the collecting system are reapproximated.
- Stitch ligation of large blood vessels is performed. *(Partial loosening of the vascular occlusion will reveal bleeding sites.)*
- The argon beam coagulator is used to obtain hemostasis of raw surfaces following amputation.
- A tamponade effect of capsular closure is achieved with Surgicel or fat compressed within the renal capsule or with fibrin glue *(Hemaedics, Inc.,)* applied to the wound.
- The Teflon felt sandwich technique can be used to control bleeding.

**POTENTIAL PROBLEMS**

**ANATROPHIC NEPHROLITHOTOMY**
- **Inability to remove small residual stones after radiographic location:** Perform nephrostomy → leave stent near the area of the stone to serve as the inflow port for later irrigation
- **Excessive bleeding after rewarming of kidney and releasing vessel loop around renal pedicle:** Use Teflon pledget sandwich technique to compress the bleeding site
REFERENCES


SUGGESTED READINGS


Kalash SS, Campbell EW, Young JD: Sources of fibrinogen for coagulum pyelolithotomy without thrombin, J Urol 12:486, 1983.
