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REVIEW

Surgical Treatment of Urinary Calculi

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The current treatment of urinary calculi involves conservative, endoscopic and surgical methods. Advances in biochemical and pharmacological research have provided the possibility of attacking causative factors, such as hypercalciuria or urinary tract infection, thereby lessening the chances of recurrence. However, in spite of undeniable progress in conservative treatment of calculi, the majority of cases of urinary stones must still undergo surgical treatment. Sandegard reports that 24% of the cases of ureteric calculi required instrumental or surgical treatment (14). Calculi which cannot be passed, with the exception of uncalcified urate stones, require surgery. Before a therapeutic plan for the patient can be drawn up, it is necessary to make the distinction between stones which can be passed and those which cannot.

In this review some new techniques for the instrumental removal of ureteric calculi and the surgical treatment of renal stones will be described to indicate current trends.

In Germany chiefly the Zeiss loop is used for extraction of ureteric stones, while elsewhere the so-called Dormia or basket loop is preferred.

Extraction with the loop is usually restricted to stones in the lower third of the ureter. Stone extraction should not be forced in a single sitting. In general, the loop is left in position for several days and spontaneous ejection awaited. In this way atraumatic passage of the loop head with the concrement is obtained. Recently loops with elastic tips or double spirals have been made which have improved the catching capacity of the loop (18).

Fibrin pyelolithotomy is recommended for the removal of small, multiple renal pelvic calculi or calculi fragments. This is an older technique which has been reintroduced recently by Patel (13). He was able to produce a firm fibrin coagulum for the removal of multiple calculi.

The surgical technique for the removal of renal pelvic calculi or staghorn calculi has been considerably improved in recent years. Recent progress in surgery has included the application of perfusion techniques used in kidney transplantation. In addition pyeloscopy, intraoperative radiography, coagulum pyelolithotomy and the use of microsurgical techniques, including microcoagulation have become available.

For removal of larger renal-pelvic or staghorn calculi the procedure of Gil-Vernet (7) for preparation of the renal sinus with possible additional nephrolithotomy is available. (A staghorn calculus is defined as occupying the renal pelvis and at least two calices.) With the help of this technique it is possible to remove large calculi without parenchymal loss or opening any blood vessels (Fig. 1 a-c). A nephrotomy is especially recommended when the calculus is mushroom-shaped and extraction through the caliceal neck is not possible, provided that the renal parenchyma over the calices has been well preserved. The question arises which procedure for the separation of the renal parenchyma is more protective: multiple small radial nephrotomies or an extensive longitudinal nephrotomy (15).

The technique for opening of the parenchyma which takes into account the anatomical peculiarities of the renal arterial circulation is of particular interest. There is an avascular area in the middle two-thirds of the kidney between the dorsal and ventral segments. This is the area of contact between the dorsal and the anterior branch of the renal artery. It is possible, by injecting methylene blue into a branch to delineate the area supplied and to undertake the opening of the parenchyma. This "true" border of the vascular area is not at all congruent with the so-called "white line" of Brödel (3), but we must note here that a con-

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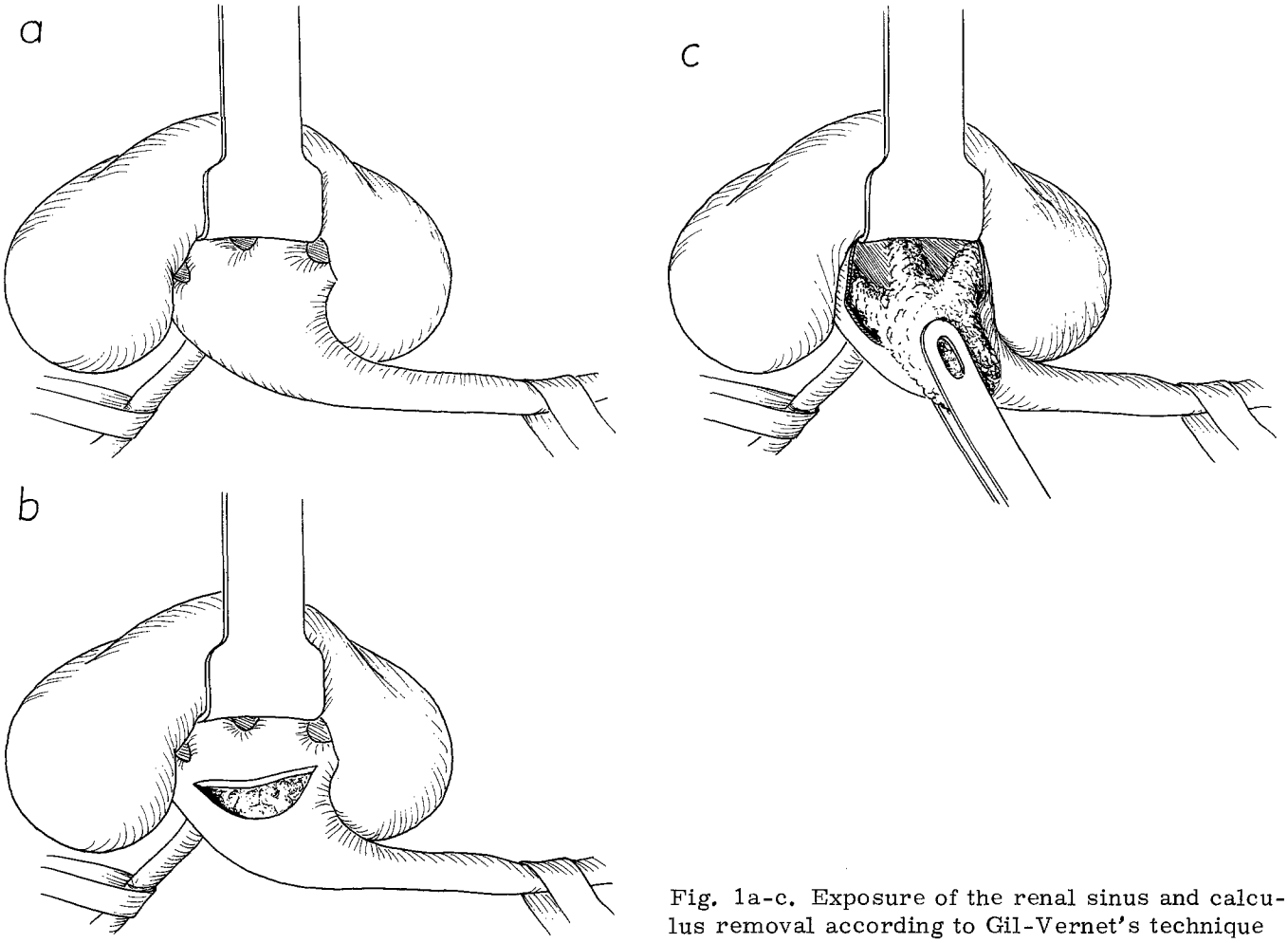

Fig. 1a-c. Exposure of the renal sinus and calculus removal according to Gil-Vernet's technique

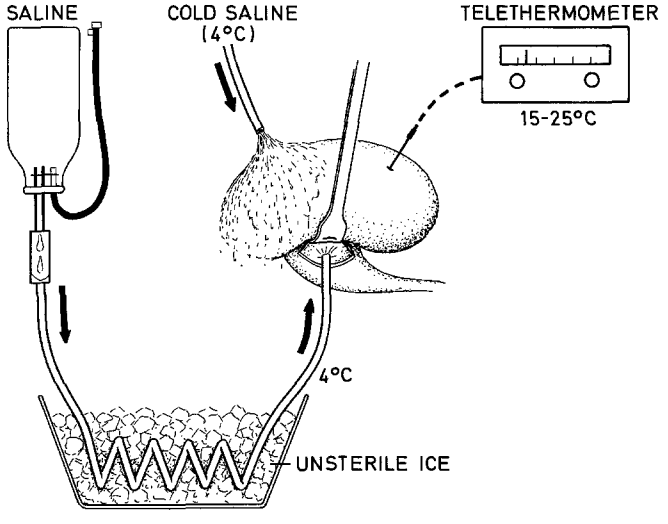

Fig. 2. External hypothermia with cold saline solution (method described by Blandy)

siderably serrated incision is obtained which can cause difficulty at closure. We have used an incision in the area of Brödel's line but restricted to the middle third of the kidney. The upper and lower kidney poles are thus not included in the incision. After separation of the renal capsule the parenchyma is opened with the back of the knife. In this way small vascular branches are preserved. The calices are opened systematically and carefully washed out. A splint from the renal pelvis through the ureter into the bladder (17) or a nephrostomy tube (15) is inserted. Closure of the renal pelvis is carried out with atraumatic chromic catgut (5-8/0). For this use of magnifying glasses and micro-surgical instruments is recommended. The renal parenchyma is not sutured, but the renal capsule is closed with either 3/0 or 4/0 atraumatic chromic catgut. Such extensive opening of the kidney should today be done only under hypothermia. Lowering of the organ temperature with or without perfusion has considerably

improved the removal of staghorn calculi (22). Hypothermia protects the renal parenchyma for ischaemia times of up to 30 minutes (21).

Various cooling techniques are available: 1. external hypothermia following partial or complete blocking of the renal artery, 2. hypothermia and perfusion of the renal artery with simultaneous occlusion.

With these techniques an organ temperature of 15-25°C can be obtained and ischaemia can be prolonged up to 90 minutes. External hypothermia should not be used for extremely long ischaemic times.

Some authors (1, 9, 17, 21) prefer external cooling. This method dispenses with the renal artery catheter. Cooling can be achieved by ice, with heat-exchange coils or washing the renal pelvis with chilled physiological saline solution and additional external cooling of the parenchyma (Fig. 2). Perfusion cooling of the kidney according to Marberger's technique (10) uses a special angiographic catheter. The renal artery is thus occluded and a hypo-osmotic Ringer-lactate mannitol solution is introduced into the kidney through a 5F-Swan-Ganz-Catheter (Fig. 3). Cooling to 22°C can be achieved in this way.

We have tried and tested preoperative introduction of the Swan-Ganz Catheter (19) and found it to be acceptable. The presence of only one renal artery is a requirement for this technique. If, for anatomical or technical reasons, perfusion cooling of the kidney is not possible, we prefer the hypothermia method described by Blandy (1) in which the renal pelvis as well as the renal surface are irrigated with chilled saline solution (Fig. 2). Perfusion cooling with arterial occlusion from the standpoint of hypothermia and total visibility of the surgical field, is the best method. It is especially recommended for longer ischaemia times (up to two hours) and results in the best preservation of kidney function (6, 10). An additional advantage is that the perfusion washes out all the blood constituents from the vessels and thus prevents the formation of microthrombi. The cooling of the kidney by the perfusion is easily controllable. One disadvantage of the method is the limited mobility of the kidney. The arterial catheter can also slip out due to manipulation of handling of the kidney pedicle. Furthermore, there is danger of pulmonary oedema when too much of the perfusion solution is used. The patient's cardiopulmonary functioning must be thoroughly examined before surgery and the intraoperative perfusion volume should be limited to 1 1/2 liters. In our experience this amount has been well tolerated.

Alternative techniques include the introduction of a renal artery catheter and closure of the vessel with a tourniquet (5) and the recent technique of Wilhelm and Sigel (23) in which regional renal hypothermia is achieved via transvenous perfusion. In this way the perfusate cannot get back into the circulation. Wagenknecht et al. (20) have reported on the technique of continuous perfusion by leading the catheter directly into the renal vessels.

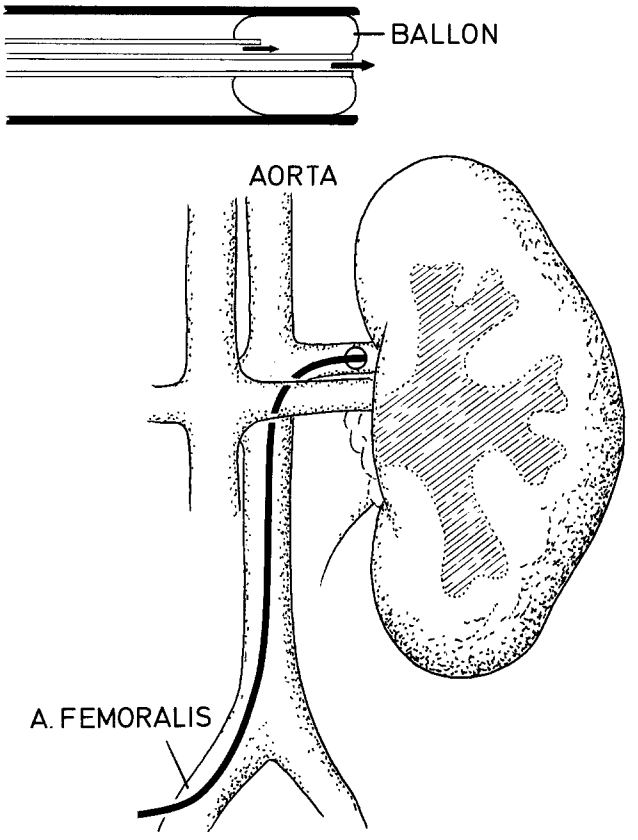

Fig. 3. Perfusion colling of the kidney with the Swan Ganz Catheter (method according to Marberger)

Intraoperative x-rays and pyeloscopy are of great importance for complete removal of concrements from the renal cavity (2, 8, 12).

With the use of these surgical techniques including hypothermia when necessary nearly every stone of whatever size can be removed. The question is always raised in connection with surgery for removal of large renal pelvic staghorn calculi as to whether this surgery is necessary. Until the introduction of the above mentioned surgical techniques with hypothermia of the renal parenchyma, urologists treated coral calculi conservatively. Blandy (1) has researched the problem of the usefulness of surgical removal. He was able to ascertain that a renal pelvic staghorn calculus which causes no symptoms is exceedingly rare (in 80% of cases pain and infection were present). Conservative treatment lead in 50% of cases to eventual nephrectomy and, in a high percent of cases, to shortening of the patient's life span.

The question of possible damage to the kidney from surgery must be taken into consideration

before the decision can be made to operate. Comparative studies of renal function following surgical removal of large, renal-pelvic calculi show that when consistent use is made of the intrasinus surgical procedure, hypothermia and a tissue-sparing stitching technique no change, or at least only negligeable change in function as compared to the preoperative state. Quite frequently considerable function improvement occurs, for example as a result of overcoming infection (10, 22).

Apart from the maintenance of renal function the question of the recurrence rate is of importance in deciding the success of the operation. Coe (4) found while evaluating 3,229 operations for the removal of calculi from the renal cavity a recurrence rate of 31% within ten years. It is a question here of the evaluation of literature in the period between 1915 and 1974. It was shown that in recent years with the use of modern surgical procedures and conservative prophylactic measures the recurrence of some isolated authors was less than 10% (22, 16). Wickham et al (22) found a recurrence rate of merely 8% subsequent to nephrolithotomy under hypothermia (follow-up period was 1-4 years).

In conclusion, surgical therapy of urinary calculi has been considerably improved through the introduction of improved surgical methods and modern technology. Critical selection of the various operative procedures and a judicious combination with conservative treatment or prophylaxis will result in greater success in the treatment of urinary calculi with a diminished recurrence rate.

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