Partial nephrectomy: novel closure technique using bovine pericardium

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Partial nephrectomy (PN) has gained popularity over the past two decades as an alternative to radical nephrectomy (RN) in patients with small renal masses. Morbidity and mortality from PN have been shown to be lower than from RN, while oncologic outcomes have been shown to be equivalent for tumors < 7 cm. PN has become increasingly popular in academic centers, but the general urologic community continues to lag behind. The reason for this is not known, but may be related to the relatively high complication rate, including delayed complications associated with inadequate closure. Here we describe a novel PN closure technique that provides additional strength and hemostasis by incorporating bovine pericardium.

Key Words: bovine pericardium, renal cancer, partial nephrectomy, surgical techniques, novel closure

Introduction

Recent studies have demonstrated the merits of partial nephrectomy (PN) as the preferred alternative to radical nephrectomy for small renal masses.[1-3] Patients have been found to be at lower risk of developing chronic kidney disease,[3] lower risk of overall mortality[2] and oncologic outcomes are reported to be equivalent in those with tumors < 7 cm.[1] While PN has become increasingly utilized, especially at academic centers,[4] there continues to be a lag within the general urologic community.[5] One reason may be the risk of complications, both early and late, including urine leak, fistula formation, ureteral obstruction, delayed bleeding and pseudoaneurysm,[6] that are effectively absent with radical nephrectomy. Many of these complications are assumed to be, at least in part, a result of an inadequate closure.[7]

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Standard closure techniques

The classic teaching for PN closure involves ensuring repair of the collecting system and vasculature followed by reapproximation of the renal capsule with simple interrupted 3-0 chromic sutures. Perirenal fat or a hemostatic agent, such as Surgicel (Ethicon, Somerville, NJ, USA) may also be inserted into the defect.[8] Recently, a number of additional closure techniques have been described. Ozkan et al recently described the "lipocorticoplasty" method, in which perirenal fat is wrapped in Surgicel and sutured into the defect without capsule closure.[9] Hayn and colleagues reported success with a single layer closure using a "slightly straightened CPX needle."[10] Gorin and associates discussed a closure with sliding clips, similar to those used in laparoscopic and robotic approaches, while Sammons and colleagues reported success with a closure using barbed sutures in patients undergoing robotic PN.[11] Here we introduce and describe a novel closure technique in which bovine pericardium is used to reduce tension on the site of closure following PN.

Novel closure technique

The key to any PN closure is a delicate combination of hemostasis from tissue compression while maintaining a suture line with as little tension on the renal capsule as possible to prevent tearing through renal parenchyma. Our experience using bovine pericardium (Synovis Surgical, Saint Paul, MN, USA) (BP) to bolster the edges of the tumor defect has resulted in both effective closure and limited major postoperative complications.

In each case, the renal hilum is dissected out, the renal artery and vein isolated, and vessel loops placed around them. The lesion is then isolated, taking care to preserve the perinephric fat where possible. The site of incision in the renal capsule is then marked circumferentially, approximately 1 cm from the tumor, using cautery, in an effort to allow a negative margin.

Next, a 6 cm x 8 cm rectangle of BP is prepared for use as a renal capsule bolster for closing the tumor excision site. Typically, the BP is divide into two, 3 cm x 8 cm sections, each of which is further prepared by splitting it in a pantaloon fashion with 1.5 cm wide "legs". The "legs" may be selectively shortened depending on the size of the defect after tumor removal, Figure 1.

The authors typically use one or two doses of Mannitol, 12.5 grams, to encourage diuresis prior to clamping. Next, bulldog clamps are placed on the renal artery and vein, followed by an ice slush bath to create cold ischemia. Alternatively, both the artery and vein may be occluded with a single vascular clamp (e.g. Wylie). Following adequate time for ischemia to occur, the lesion is sharply excised, taking care to preserve a negative margin on all sides. An argon beam may be used to cauterize any parenchymal bleeding. Collecting system defects and segmental arteries and veins are rapidly oversewn with absorbable suture (typically 3-0 Monocryl of Vicryl on an SH or RB needle). The legs of the BP segment are then assessed to ensure they span the extent of the defect, Figure 2.

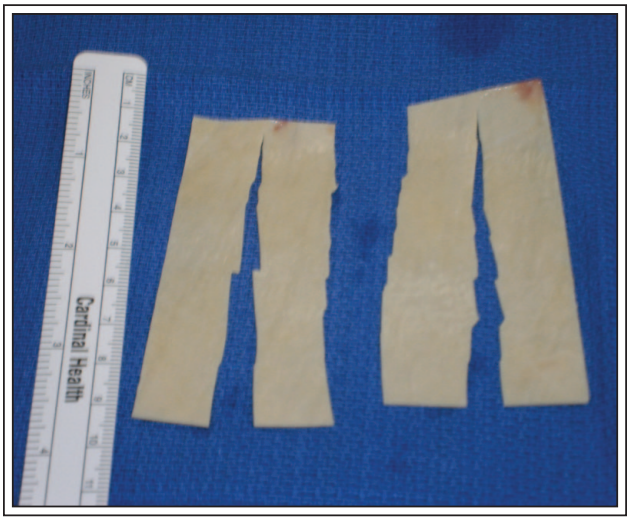

Figure 1. Bovine pericardium prepared in pantaloon fashion.

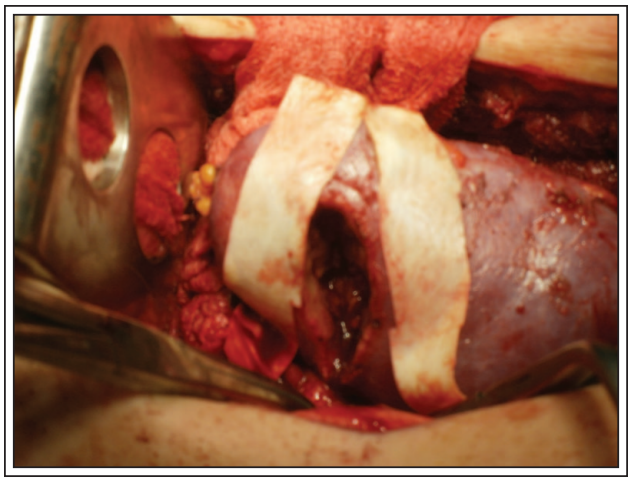

Figure 2. Bovine pericardium "legs" approximating defect.

A No.1 PDS suture on a CPX needle is then inserted through the superior half of one leg portion of the BP, roughly 1 cm beyond the defect edge and1.5 cm wide horizontal mattress suture performed, with all four passes of the needle through the renal parenchyma traversing the pericardium. Additional horizontal mattress sutures, typically one or two, are placed as necessary in close juxtaposition to the first suture (2 mm-3 mm between sutures), with the entrance and exit sites on alternating legs, Figure 3. Up to five horizontal

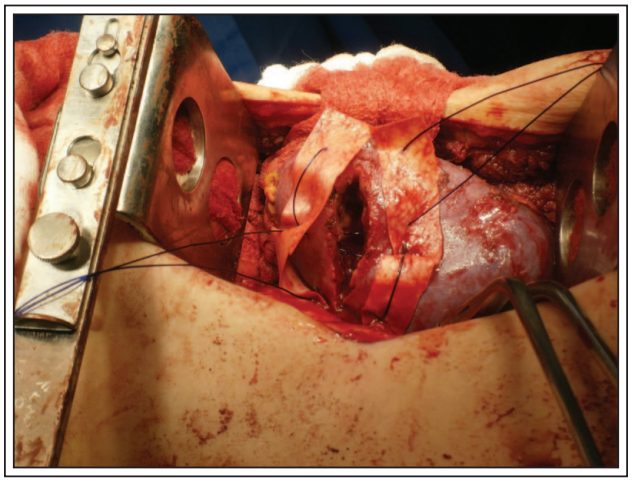

Figure 3. Horizontal mattress stitches using PDS with a CPX needle, with bovine pericardium bolstering the edges.

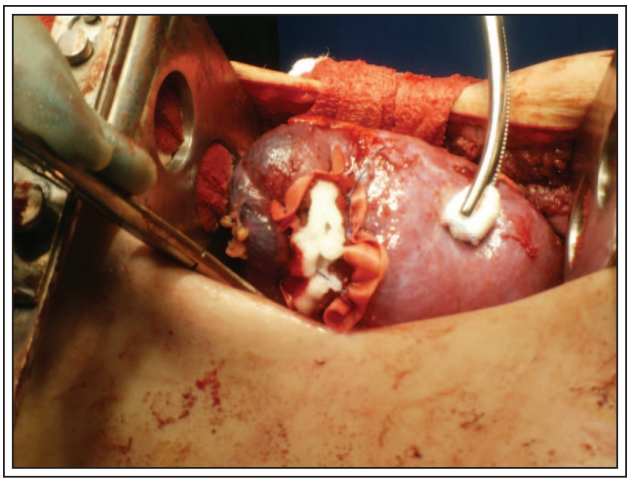

Figure 4. Floseal injected onto the raw surface of the partial nephrectomy.

mattress sutures may be necessary, depending on the size of the defect; however, in our experience two or three will suffice in the majority of cases. The intra-defect sutures are then elevated using a large right angle clamp and several 3 cm x 3 cm squares of Surgicel (Ethicon) are placed across the base of the defect after injecting Floseal (Baxter, Deerfield, IL, USA) onto the raw surface, Figure 4. Finally, the sutures are tied securely, using a surgeon's knot to create tension and gather the defect together, Figure 5. After the parenchymal defect is successfully closed, the clamp is removed and perinephric fat is secured over the top of the surgical site. A Jackson-Pratt drain is placed in the perinephric space, the wound is closed and the procedure terminated.

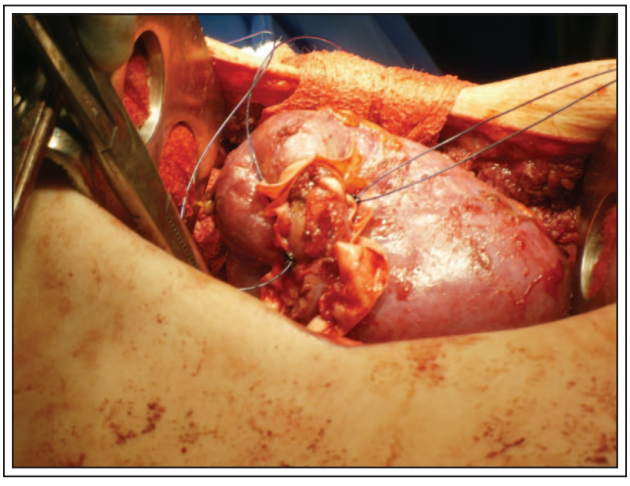

Figure 5. Completed horizontal mattress stitches gathering together and closing the defect.

Discussion

Bleeding following partial nephrectomy can be a devastating complication and can occur early or in a delayed fashion. Patients may present with increasing flank pain, gross hematuria, flank mass,[12] or constitutional signs representative of hypotension including malaise, dizziness, lightheadedness, or in rare cases, hypovolemic shock. Large series have shown the rates of postoperative bleeding following open PN to be less than 5%.[13-15] Swift action including fluid resuscitation, hemodynamic monitoring, judicious administration of blood products when needed, and, in cases of hemodynamic instability, embolization of the bleeding area are all necessary to ensure patient safety. Urinary extravasation following PN is another troublesome complication. It necessitates prolonged drain utilization, may lead to development of an abscess or the need for ureteral stent placement. Results from a review by Van Poppel showed rates of urine leak varied widely (0.7%-17.4%), but pooling results demonstrated an overall rate less than 4%.[15]

Previous reports have discussed the use of Gore-Tex mesh to bolster partial nephrectomy closures,[16] while others have reported the use of Polyglycolic Acid Mesh (PGA).[17] Both reports cite positive results with small cohorts. Wainstein et al argue that PGA is superior due to it being absorbed over time and thus causing less scarring. In our experience, the use of bovine pericardium results in low amounts of scarring in the operative region, very little artifact on follow up CT, and is easier to manipulate during preparation and while operating. Furthermore, the cost of BP is significantly lower than Gore-Tex. At our institution, the cost of an acceptable piece of BP (4 cm x 4 cm – 6 cm x 8 cm) is $261-$412 (Synovis Peri-guard Bovine) versus a cost of $757-$1715 (Mesh Dual Gore-Tex and Mesh Dual Plus Gore-Tex) for a comparable mesh product that incorporates Gore-Tex. While both BP and Gore-Tex mesh are biocompatible, BP causes minimal distortion on CT and ultrasound, where Gore-Tex is seen on imaging and can obscure ultrasound after surgery.[18] Additionally, given the ease of use of the BP and the generally straightforward nature of the procedure, we find trainees and new users have few problems learning to work with the material. To date, we have only utilized BP in open surgical cases, but given the increase in laparoscopic and robotic procedure volume, the material may have additional utility in this arena.

Results of our use of bovine pericardium to bolster the renal capsule during defect closure following PN

have been positive. We believe the inclusion of this material works to markedly reduce the shearing force of the sutures on the renal capsule and parenchyma, ultimately allowing a significantly tighter closure that provides excellent hemostasis and prevents urinary extravasation. Further study is needed to determine the absolute rates of postoperative complications, though our experience has not demonstrated an increased rate of complications. □

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