Totally laparoscopic aortic repair: A new device for direct transperitoneal approach

Jérôme Cau, MD,[a] Jean-Baptiste Ricco, MD, PhD,[a] Amar Deelchand, MD,[b] Xavier Berard, MD,[b] Bernard Cau, MD,[a] Michel Costecalde, MD,[b] Xavier Chaufour, MD,[b] François Barret, BA,[b] André Barret, MD,[b] and **Jean-Pierre Bossavy, MD,[b]** *Poitiers and Toulouse, France*

On the basis of our experience with more than 71 cases of totally laparoscopic aortic surgery by the retrocolic approach, we have developed a new technique by a simple transperitoneal approach. The purpose of this report is to describe that technique and the novel laparoscopic bowel retractor used to ensure stable exposure of the aorta. (J Vasc Surg 2005;41: 902-6.)

Since the groundbreaking report published by Dion et al[1] in 1993, totally laparoscopic aortic repair has become a common procedure in many vascular centers in France.[2] More widespread use has been made possible by improvements in the aortic approach[2,3] and celioscopic instrumentation.[4,5] In our department, we have performed totally laparoscopic aortic surgery in 71 cases. The main difficulty for totally laparoscopic aortic surgery is achieving stable exposure throughout the procedure. For this reason, most practitioners have used the retrocolic route. The transperitoneal approach used in conventional open repair has been difficult to adapt for laparoscopic aortic surgery because of the lack of a simple, effective celioscopic device for retraction of the bowel loops. We have developed a novel celioscopic bowel retractor that enables totally laparoscopic repair of occlusive and aneurysmal lesions of the infrarenal abdominal aorta to be performed by the transperitoneal approach.

MATERIALS AND METHODS

Celioscopic bowel retractor. The bowel retractor used in this study consists of a net placed in racket-like fashion between two 30-cm-long preshaped flexible metal rods attached to an operating handle. The net is used to gather up and retract the bowel loops. The device is packed in a 10-cm-long, 1-cm-diameter sheath that passes easily through a 10-mm-diameter endoscopic trocar. Inside the sheath, the two blades are in contact on their convex edge. When the operator pushes the handle in, the rods exit the end of the sheath and assume their predefined shape (Fig 1). The net automatically deploys within the abdominal cavity.

A series of experiments were performed on 23 human cadavers to optimize retractor design, port placement, positioning of the operator and assistants, retractor deployment, and anatomic exposure of the abdominal aorta and iliac arteries. Findings showed that optimal retractor length and height were 20 and 15 cm, respectively.

Surgical technique. The patient is placed in the dorsal decubitus position with two bolsters on the left flank. The operator stands on the left side of the patient, as shown in Fig 2, *A*. In the open celioscopy technique that was routinely used and that is particularly suitable for patients with multiple adhesions, a total of seven trocars are inserted. The first 10-mm-diameter optical trocar is placed along the midline two finger widths above the umbilicus and is used to visually control placement of the other six trocars after insufflation of the abdomen to a pressure of 12 mm Hg, which is maintained throughout the procedure. The two operating trocars are placed 6 to 7 cm apart on the left anterior axillary line, parallel to the midline (Fig 2, *B*). The two trocars for the first assistant are then introduced: one at the level of the left iliac fossa and the other on the midline 5 cm above the pubis. The last trocar is positioned on the midline 2 cm below the xiphoid appendix (Fig 2, *B*). In this way, the colon is outside the operative field and cannot affect exposure of the aorta. As with the retrocolic approach, all instruments are introduced under visual control with the tips pointing toward the top of the abdomen to limit the risk of colon injury.

Before the bowel retractor is introduced, the operating table is tilted 30° to the right so that the bowel loops drop into the right side of the abdomen. The bowel retractor is then carefully introduced through the 10-mm-diameter trocar into the right iliac fossa under visual control (Fig 1). As soon as the two rods are pushed out, they assume their preformed S-shape, and the net deploys automatically without further manipulation. The exact shape of the retractor depends on the size of the net, which determines how far the rods can spread. Because the device is flexible, it adapts to the morphology of the patient. The handle of the retractor is held by using a self-locking system attached to the operating table. No other assistance is required. After placement of the bowel retractor, the operating table is tilted back to the left, and the patient is repositioned in the total dorsal decubitus position. However, the patient can be returned to the right lateral decubitus position at any

From the Vascular Surgery Department, University Hospital, Poitiers,[a] and the Vascular Surgery Department, University Hospital, Toulouse.[b]

Competition of interest: none.

Reprint requests: Jean-Baptiste Ricco, MD, PhD, Department of Vascular Surgery, University Hospital of Poitiers, 86000 Poitiers, France).(e-mail: j.b.ricco@chu-poitiers.fr

0741-5214/$30.00

doi:10.1016/j.jvs.2005.01.038

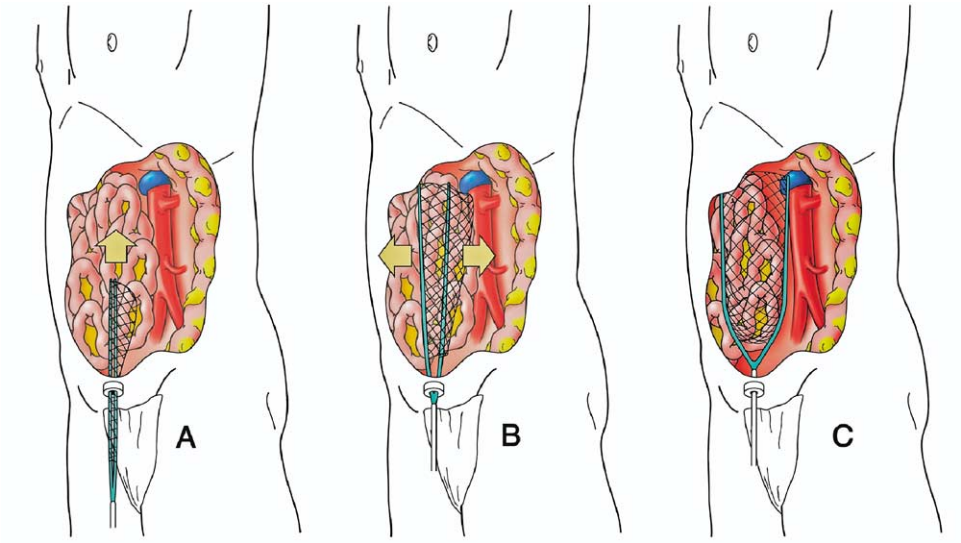


Fig 1. Front view of the retractor device (**A**). The retractor net provides a retaining barrier that holds the small intestine and fourth duodenum back throughout the procedure, thus enabling a direct transperitoneal approach to the infrarenal abdominal aorta. A major advantage of this retractor is automatic deployment in the abdominal cavity (**B** and **C**).

time if necessary. The retractor holds the bowel loops out of the operating field throughout the procedure (Fig 3).To prevent falling bowel loops in obese patients with voluminous mesocolon and omentum, an Endoretract retractor (Tyco, New Hampshire) can be used to support the net. As in conventional open surgery, exposure of the aorta begins by incision of the posterior parietal peritoneum and section of the ligament of Treitz. During this step, the retractor is pushed toward the diaphragm to mobilize the duodenum (Fig 4). After division of the preaortic lymphatics and dissection of the left renal vein, the infrarenal aorta is visualized (Fig 4). Use of a 30° telescope greatly facilitates exposure of the infrarenal aorta and its branches, including the inferior mesenteric artery and both common iliac arteries. After exposure is completed, the proximal aortic clamp (Aesculap; B. Braun, Melsungen, Germany) is introduced through the infraxiphoid trocar. The distal clamp is introduced through the suprapubic trocar (Fig 2, *B*).

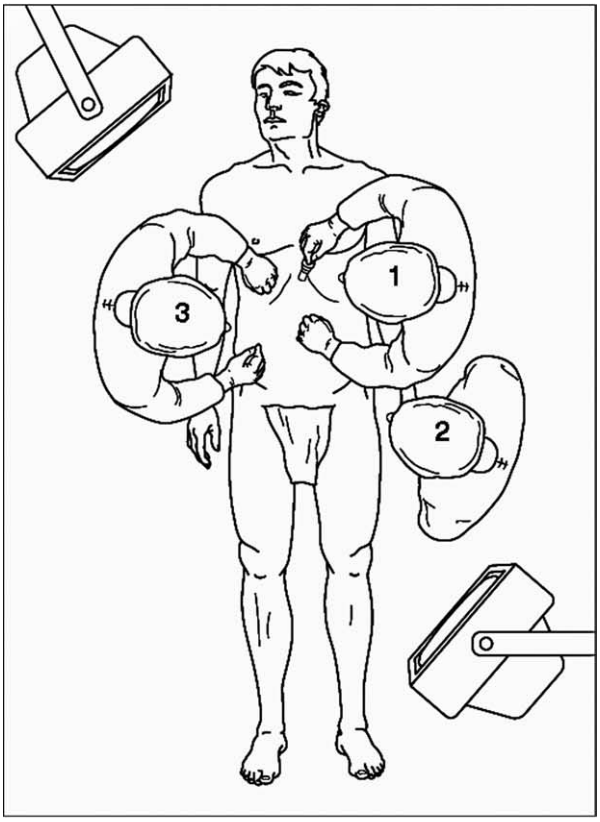
Before introducing the prosthesis into the abdominal cavity, we ligate the extremity of the left limb of the graft. Then, before aortic clamping, we tunnel the right limb of the prosthesis to the groin with a conventional DeBakey aortic clamp. In addition to stabilizing the graft and simplifying aortic suture, this technique, ie, tunneling only the right limb before aortic clamping, avoids gas leakage, because the pathway of the right limb of the prosthesis is long, and the weight of the bowel loops ensures sealing. A bolus of heparin is also administered before clamping.

Aortic bypass is performed by using two hemicircumferential running sutures according to the technique described by Coggia et al.[6] The free end of each running suture is held by a pledget to avoid tedious laparoscopic knot tying. For occlusive aortic lesions, we perform aortobifemoral bypass with an end-to-end or end-to-side anastomosis, depending on whether we need to preserve direct flow to the internal iliac arteries. In case of end-to-end aortic anastomosis, closure of the distal stump is performed by a running polypropylene suture held by pledgets to avoid having to tie the first knot. In our experience, staple closure of the distal aortic stump is unsatisfactory. For abdominal aortic aneurysm, we perform resection grafting with restoration of arterial flow by either aortoaortic bypass (Fig 5) or aortobifemoral bypass. In this case, iliac artery control is achieved by either by using releasable clamps (B. Braun) for the left iliac artery or by using standard laparoscopic clamps for the right iliac artery (this enhances exposure). In case extensive calcification prevents the use of releasable clamps, we use a laparoscopic clamp introduced through an additional trocar placed between trocar 5 and trocar 6 (Fig 2, *B*).

After the aortic anastomosis has been completed, the left limb of the prosthesis is tunneled down to the groin, and the duodenum is repositioned. Closing the posterior parietal peritoneum with 3-0 resorbable running suture is mandatory with this approach and can require epiploplasty in thin patients. The retractor is then removed by simply drawing the two rods back into the sheath. The net folds up automatically without any further manipulation. Femoral anastomoses are performed through a conventional approach.

DISCUSSION

By allowing totally laparoscopic aortic repair by a transperitoneal approach, use of a bowel retractor eliminates the time-consuming mobilization and dissection necessary for the transperitoneal left retrocolic, left retrorenal, or retroperitoneal approach.[2] The idea of using a net to retract the bowel loops to achieve direct transperitoneal exposure is



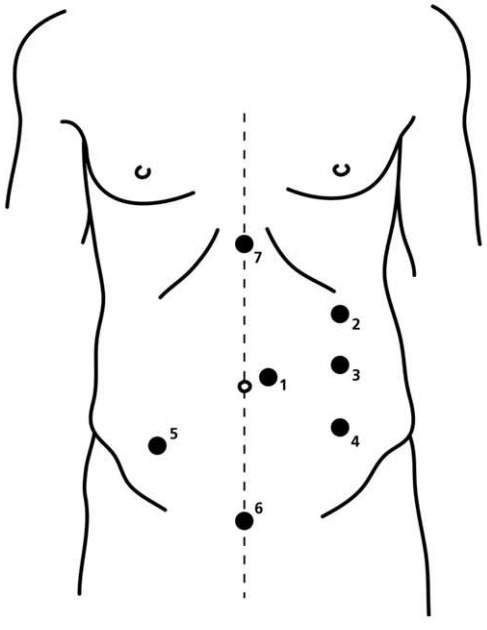


Fig 2. A, Position of surgical staff. 1, First surgeon; 2, first surgical assistant; 3, second surgical assistant holding the camera. **B,** Placement of the laparoscopic trocars. 1, Camera; 2 and 3, dissecting instruments and needle holder; 4, assistant operating channel (lavage-suction-fenestrated forceps); 5, bowel retractor; 6, distal aortic clamp; 7, proximal aortic clamp.

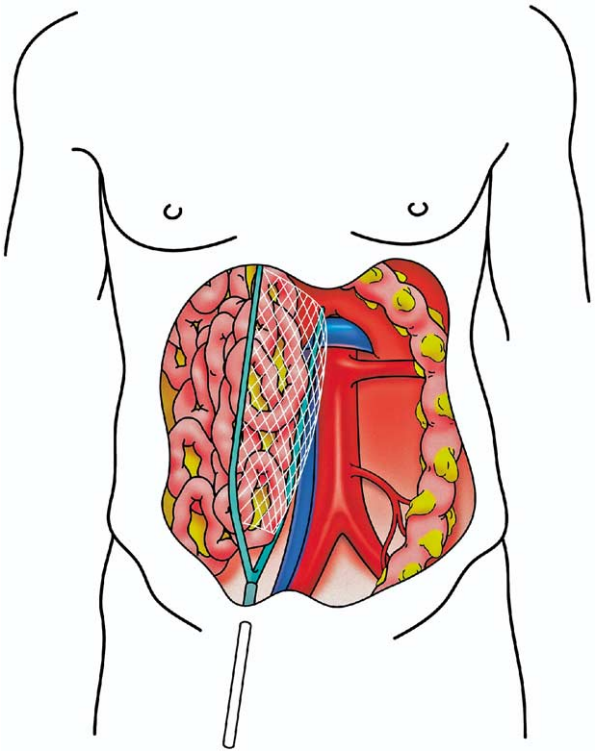


Fig 3. Transverse section showing the laparoscopic direct transperitoneal approach to the abdominal aorta. The bowel retractor device gathers the intestinal loops into the right side of the abdomen and provides a large cavity for endoanastomosis. This approach provides wide exposure of the right common iliac artery. The transverse colon, not seen here, is pushed upward by the retractor and by the proximal aortic clamp introduced through the infraxiphoid trocar.

not new. However, most retractors designed up to now are used for video-assisted procedures with minilaparotomy.[11] Only Barbera[12] has proposed a retractor specifically for totally laparoscopic use. The main disadvantages of Barbera's device are its bulky size and the need for assistants to hold it in place.

Our decision to design a retractor device that could reproduce the role of the mesocolon in the retrocolic route described by Coggia et al[6] arose from our 71-case experience with performing totally laparoscopic surgery for occlusive and aneurysmal disease by the left retrocolic route. Our retractor can be seen as the result of an effort to combine and improve the Barbera device[12] and the device described by Alimi et al,[11] which was difficult to deploy and poorly suited to totally laparoscopic aortic surgery.

Our technique presents several differences from the technique described by Alimi et al.[5,11] The main difference is that we perform aortic bypass by a totally laparoscopic technique without minilaparotomy. Trocar positioning is also different in our technique. The operator's trocars are located closer to the midline in a transrectal position to allow aortic suture, as well as dissection, and the proximal

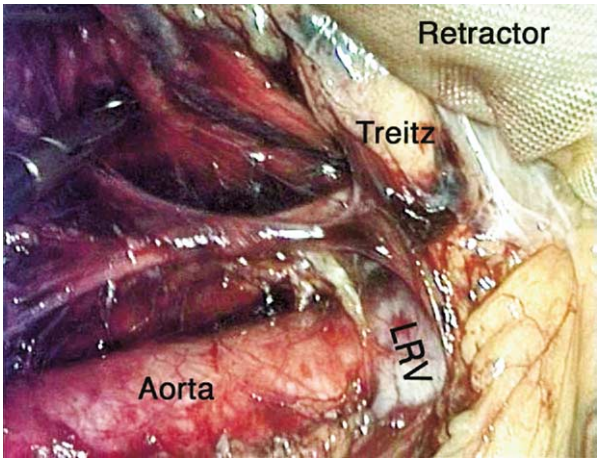


Fig 4. Exposure of the aorta. Operative view showing the laparoscopic exposure achieved after placement of the bowel retractor. The aorta and left renal vein *(LRV)* are fully exposed. The duodenum and ligament of Treitz are retained by the retractor.

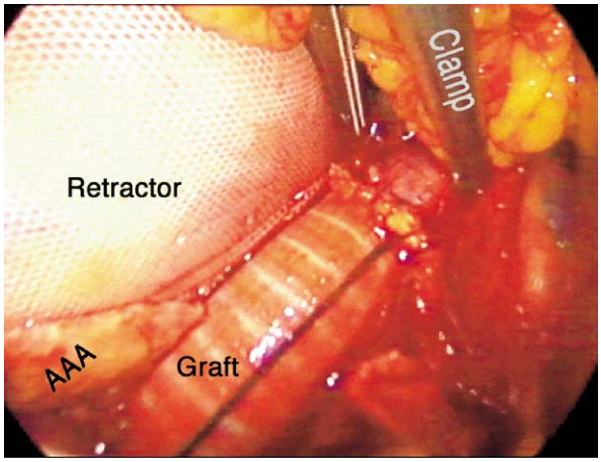


Fig 5. Proximal aortic anastomosis. Operative view showing an aortic bypass with the graft in place and the aneurysmal sac open *(AAA)*. The retractor acts as a retaining barrier that holds the intestinal loops and the duodenum out of the operative field. The transverse colon, not seen here, is pushed upward by the proximal aortic clamp introduced through the infraxiphoid trocar.

clamp is introduced through the infraxiphoid trocar. This has two advantages: it enables clamping of the infrarenal aorta and improves exposure by providing support for the retractor and pushing back the transverse mesocolon.

Our technique provides an alternative to the complex apron technique,[7] which requires transposition of the peritoneum and may be poorly reproducible without experience. We find that the retroperitoneal route, even if the inferior mesenteric artery is sacrificed, gives limited exposure on the right iliac artery.[8,9] As a result of these problems, the retrocolic approach has until now been the preferred route[2,3] for totally laparoscopic repair because it provides adequate exposure for aortobifemoral bypass.

However, the retrocolic route presents several drawbacks. Like the apron technique,[7] it needs left retrocolic dissection. Such dissection not only requires special training because it is rarely performed in conventional open surgery, but also can be difficult, especially in thin patients or in patients with previous left colon or kidney surgery, in whom there is a high risk of damaging the mesocolon.[6] The retrocolic approach is also associated with the same risk of hematoma at the colon dissection site[2,3] as the retroperitoneal approach and provides exposure of only a few centimeters of the right iliac artery because of the presence of the mesocolon. In this regard, the need for minilaparotomy to allow arterial control and right iliac anastomosis[2,3] in cases involving right iliac aneurysm cancels out the advantages of totally laparoscopic surgery.

So far, we have not the opportunity to perform right iliac anastomosis by the direct transperitoneal route in a patient with iliac aneurysm, but we have observed that our retractor provides much better right iliac exposure than the left retrocolic route. Because the retractor allows right iliac tunneling to be performed safely, there seems to be no reason to think that this would not be the case for right iliac anastomosis. Our transperitoneal approach does not allow exposure of the suprarenal aorta and revascularization of visceral arteries.[10] In such cases, we still use the retrocolic transperitoneal route.

CONCLUSION

The bowel retractor described in this report allows aortic repair to be performed by a totally laparoscopic transperitoneal approach. This safe technique is easier and quicker than retrocolic dissection. Although the left retrocolic approach remains the standard technique for abdominal aortic repair, this new transperitoneal approach, providing a view that is already familiar to vascular surgeons, is an attractive alternative in terms of simplicity and reproducibility.

REFERENCES

1. Dion YM, Katkhouda N, Rouleau C, Aucoin A. Laparoscopy-assisted aortobifemoral bypass. Surg Laparosc Endosc 1993;3:425-9.
2. Coggia M, Javerliat I, Di Centa I, Colacchio G, Cerceau P, Kitzis M, et al. Total laparoscopic infrarenal aortic aneurysm repair: preliminary results. J Vasc Surg 2004;40:448-54.
3. Kolvenbach R, Schwierz E, Wasilljew S, Miloud A, Puerschel A, Pinter L. Total laparoscopically and robotically assisted aortic aneurysm surgery: a critical evaluation. J Vasc Surg 2004;39:771-6.
4. Alimi YS, Di Molfetta L, Hartung O, Dhanis AF, Barthelemy P, Aissi K, et al. Laparoscopy-assisted abdominal aortic aneurysm endoaneurysmorraphy: early and mid-term results. J Vasc Surg 2003;37:744-9.
5. Alimi YS, Hartung O, Cavalero C, Brunet C, Bonnoit J, Juhan C. Intestinal retractor for transperitoneal laparoscopic aortoiliac reconstruction: experimental study on human cadavers and initial clinical experience. Surg Endosc 2000;14:915-9.
6. Coggia M, Bourriez A, Javerliat I, Goeau-Brissonniere O. Totally laparoscopic aortobifemoral bypass: a new and simplified approach. Eur J Vasc Endovasc Surg 2002;24:274-5.
7. Dion YM, Thaveau F, Fearn S. Current modifications to totally laparoscopic "apron technique." J Vasc Surg 2003;38:403-6.
8. Edoga JK, James KV, Resnikoff M, Asgarian K, Singh D, Romanelli J. Laparoscopic aortic aneurysm resection. J Endovasc Surg 1998;5:335-44.
9. Said S, Mall J, Peter F, Muller JM. Laparoscopic aortofemoral bypass grafting: human cadaveric and initial clinical experiences. J Vasc Surg 1999;29:639-48.

10. Javerliat I, Coggia M, Bourriez A, Di Centa I, Cerceau P, Goeau-Brissonniere OA. Total laparoscopic aortomesenteric bypass. Vascular 2004;12:126-9.
11. Alimi YS, Hartung O, Valerio N, Juhan C. Laparoscopic aortoiliac surgery for aneurysm and occlusive disease: when should a minilaparotomy be performed. J Vasc Surg 2001;33:469-75.
12. Barbera L, Mumme A, Mentin S, Zumtobel V, Kemen M. Operative results and outcome of 24 totally laparoscopic vascular procedures for aortoiliac occlusive disease. J Vasc Surg 1998;28:136-42.

Submitted Dec 12, 2004; accepted Jan 29, 2005.

CORRECTION

In: "Endovascular stent-graft repair of pararenal and type IV thoracoabdominal aortic aneurysms with adjunctive visceral reconstruction" (Fulton JJ, Farber MA, Marston WA, Mendes R, Mauro MA, and Keagy BA. J Vasc Surg 2005;41:191-8).

On pages 193 and 194, the legends for Fig 1 and Fig 2 are transposed. The following are the correct figures:

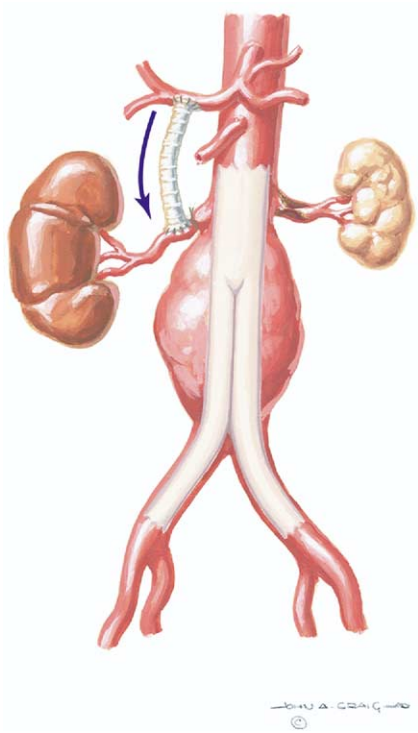


Fig 1. Hepatorenal bypass and stent graft.

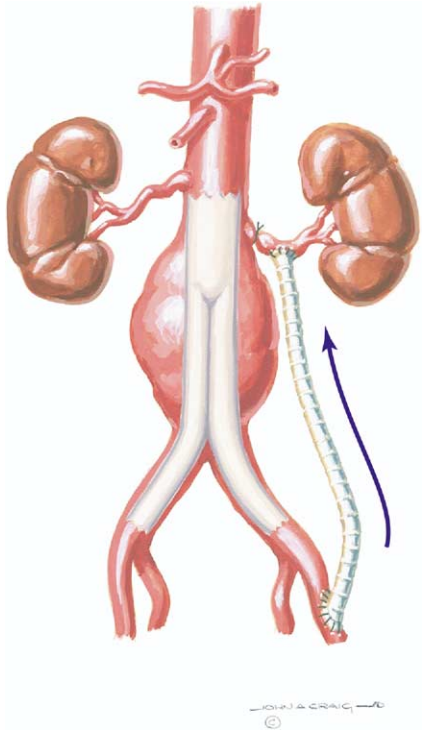


Fig 2. Left iliorenal bypass and stent graft.