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1 *How to do it*

2 **Chunnel debranching for hybrid repair of thoracoabdominal aortic aneurysm**

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18 **Keywords:** thoracoabdominal aortic repair, debranching, hybrid repair

19

20 **Abstract**

21 Hybrid repair of a thoracoabdominal aortic aneurysm comprising thoracic endovascular
22 aortic repair and total renovisceral debranching is a feasible alternative to open repair,
23 especially for high-risk patients. However, transperitoneal debranching is a relatively
24 complicated procedure that requires deep dissection around vital abdominal organs.
25 Therefore, we developed a new debranching technique called Chunnel debranching,
26 which was characterized by transaortic tunneling using a covered stent between the target
27 artery and the prosthetic graft anastomosed on the aneurysmal wall using an inclusion
28 technique. This procedure increases the feasibility of renovisceral debranching with
29 fewer dissections than conventional transperitoneal debranching.

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31

32 **Introduction**

33 Open repair of a thoracoabdominal aortic aneurysm (TAAA) is a highly invasive
34 procedure and is associated with higher hospital mortality [1]. Thus, for high-risk patients,
35 thoracic endovascular aortic repair (TEVAR) with total renovisceral debranching through
36 a laparotomy is a feasible alternative [2]. However, this procedure has several concerns,
37 such as the need for a deeper dissection around the proximal segment of the renovisceral
38 arteries that are surrounded by vital abdominal organs, the difficult application in those
39 with severe intraperitoneal adhesions, the possible risk of graft infection [3], and
40 relatively high mortality and morbidity rates [4]. Therefore, for further feasibility of total
41 renovisceral debranching, we developed a novel debranching procedure named as
42 “Chunnel technique” using a covered stent.

43

44 **Technique**

45 The Chunnel technique is characterized by trans-aortic tunneling using an endoprosthesis
46 (Viabahn, W.L. Gore & Associates, Flagstaff, AZ) similar to the tunnel under the English
47 Channel. In this procedure, the Viabahn is placed from the renovisceral branch through
48 the intra-aortic cavity to the prosthetic graft that is anastomosed on the aneurysmal wall
49 (Figure 1). All procedures were performed using a retroperitoneal approach with an

50 oblique incision in the left lateral abdomen. After dissection around the thoracoabdominal
51 aorta, a 9–12 mm Dacron prosthesis was anastomosed as an inflow to the left common
52 iliac artery or a prosthetic graft used to replace the abdominal aorta in the presence of
53 severe atherosclerosis, such as an aortic aneurysm. Once the inflow was established, an
54 outflow graft for debranching with an appropriate size for the branch artery (7–9 mm
55 Dacron prosthesis) was anastomosed on the aneurysmal wall with an inclusion technique,
56 using 5-0 or 6-0 polypropylene sutures (Figure 1A). Then a 7F sheath was inserted into
57 the graft apart from the anastomosis, considering the length of the landing zone for the
58 Viabahn. Subsequently, the sheath was moved forward into the aorta by penetrating the
59 aortic wall in the anastomosis. A guidewire was inserted into the target artery using epi-
60 aortic echocardiography and fluoroscopy (Figure 1B). The Viabahn (8–9 mm × 100 mm)
61 was then inserted and deployed between the branch artery and the debranching graft
62 (Figure 1C). Post-ballooning using a balloon catheter was required because the Viabahn
63 should constrict after deployment at the crossing of the aortic wall. Then, the outflow
64 grafts were anastomosed to the inflow graft to complete debranching. The segmental
65 arteries were clipped externally as much as possible using this approach. After all the
66 target branch arteries were debranched, TEVAR was performed concomitantly with or
67 several days after debranching (Figure 1D). To date, this procedure has been performed

68 in two patients with a high risk of open TAAA repair; the operation time was 9–11 hours,
69 and the volume of blood loss was 1300–4900 ml. All the debranching were successfully
70 performed, and an ischemic time and fluoroscopic time for each branch were 15–20
71 minutes and 7–54 minutes, respectively. Both patients recovered uneventfully, and
72 successful debranching was confirmed on postoperative computed tomography images
73 (Figure 1E).

74

75 **Comment**

76 Transperitoneal debranching is a gold standard but relatively invasive because it requires
77 deep dissection around vital abdominal organs. The use of covered stents can simplify
78 this procedure and has previously been reported [5,6]. In such procedures, the deployment
79 of a covered stent in the target artery results in bypass grafting and proximal stumping
80 simultaneously, so that a direct access to the proximal segment of the artery was required.
81 However, these procedures may not be suitable for debranching the celiac trunk and
82 superior mesenteric artery through a laparotomy because of the inconvenient direction for
83 placement of the covered stent, although a laparotomy is required to access the proximal
84 segments of all the renovisceral branches directly and simultaneously. The Chunnel
85 debranching technique using the Viabahn covered stent is a novel procedure that can

86 resolve such dilemmas through a retroperitoneal approach. Although the debranching of
87 the right renal artery has not been performed because the artery was coincidentally
88 occluded in two cases we experienced, all renovisceral branches, including those located
89 on the opposite side of the aorta, can be debranched without intraperitoneal manipulations.
90 In contrast, we consider the debranching in the narrow aorta and penetration of the aortic
91 wall with a rich intraluminal thrombus are contraindications of this procedure. The former
92 would result in the interference between TEVAR and the Viabahn in the aorta, while the
93 latter is associated with a potential risk of embolic complications. In addition, a possible
94 occlusion of the debranched graft could be fatal. However, in the initial 2-year experience,
95 no procedure-related adverse events were not observed. So far, the use of Viabahn for
96 debranching is off-labeled and requires approval by the institutional review boards.
97 Nevertheless, the Chunnel debranching is a useful option for the hybrid repair of TAAA,
98 especially for high-risk patients for whom neither thoracotomy nor laparotomy would be
99 preferable because of lower respiratory function and history of the previous laparotomy.
100 To date, it requires a relatively long time to perform the procedure because of a highly
101 limited experience and disease complexity. Further improvement of the maneuver will be
102 required to reduce the invasiveness of the procedure.

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132 **Figure legends**

133

134 **Figure 1.** Schematic presentation of the Chunnel debranching: (A) anastomosis of the
135 graft on the aneurysmal wall; (B) guidewire engagement into the target artery; (D)
136 deployment of Viabahn across the aortic wall; (D) TEVAR after completion of
137 debranching; (E) inflow graft anastomosed on the iliac artery (white arrow) connected to
138 the CT and the SMA with the Viabahn and the LRA with direct anastomosis.
139 CT, celiac trunk; LRA, left renal artery; SMA, superior mesenteric artery; TEVAR,
140 thoracic endovascular aortic repair.

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