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Combination of Quadruple Antegrade and Retrograde In Situ Stent-Graft Laser Fenestration in the Management of a Complex Abdominal Aortic Aneurysm

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1 **Combination of quadruple antegrade and retrograde in-situ stent graft**
2 **laser fenestration in the management of a complex abdominal aortic**
3 **aneurysm.**

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34 **COMBINATION OF QUADRUPLE ANTEGRADE AND RETROGRADE IN-SITU**
35 **STENT GRAFT LASER FENESTRATION IN THE MANAGEMENT OF A COMPLEX**
36 **ABDOMINAL AORTIC ANEURYSM**

37 **Abstract**

38 **Purpose:** We report a case of juxta-renal abdominal aortic aneurysm - anatomically
39 unsuitable for conventional endovascular repair because of narrow distal aorta - successfully
40 treated by endovascular repair facilitated by in situ laser fenestration.

41 **Case report:** An aortic stent graft was inserted to exclude a juxta renal aneurysm: under
42 image fusion guidance, antegrade in situ laser fenestration allowed to perfuse superior
43 mesenteric artery and both renal arteries. After complementary insertion of an extended
44 aorto-uni-iliac stent graft, retrograde in situ laser fenestration was performed to perfuse the
45 contralateral left iliac artery, in order to overcome a narrow distal aorta.

46 **Conclusion:** In situ laser fenestration seems to be an effective solution for endovascular
47 therapy of complex juxta renal aneurysms. In this case of narrow distal aorta it was a suitable
48 alternative to overcome EVAR anatomical restrictions and to prevent other additional open
49 surgical interventions.

50 **Keywords:** Juxta renal aneurysm, EVAR, narrow distal aorta, in situ laser fenestration.

51 **Introduction**

52 Open surgical aneurysm repair was the gold standard management for juxta renal
53 aneurysm (JRA) until Fenestrated / Branched – endovascular aneurysm repair (F/B-EVAR)
54 was proposed with a lesser mortality and morbidity rate upon short- and intermediate- term
55 follow-up.^[1]

56 Many limiting anatomical criteria must be considered before F/B-EVAR, in order to
57 prevent post-operative complications such as endoleak, aortic rupture or graft thrombosis.
58 Thus, alternative endovascular techniques, such as chimney techniques, home-made
59 fenestrations, and in situ fenestration were developed to overcome these anatomical
60 restrictions.

61 According to the European Society of Vascular Surgery, one of these criteria, i.e. aortic
62 bifurcation diameter less than 20 mm – known as narrow distal aorta (NDA) -, is considered
63 as a contraindication for conventional EVAR with bifurcated grafts, as it could lead to graft
64 kinking or thrombosis.^[2,3] Usually, surgeons rely on conventional EVAR using an aorto-uni-
65 iliac (AUI) stent graft followed by a cross over femoro-femoral bypass. More recently, new
66 techniques, such as AFX unibody bifurcated graft and “paving and cracking” technique were
67 proposed to avoid additional open surgery. Over the last decade, in situ fenestration (ISF)
68 provided another alternative for complex JRA, opening a new endovascular way to overcome
69 aortic anatomical restrictions.

70 We describe total endovascular repair of a case with JRA and NDA treated
71 successfully by combination of quadruple antegrade and retrograde in-situ laser fenestration
72 (ISLF) of an aorto-uni-iliac (AUI) stent-graft under image fusion guidance.

73 **Case report**

74 A 69 years-old male patient, smoker with a past medical history of chronic obstructive
75 lung disease, asthma, Klinefelter syndrome under hormonal therapy and type A hemophilia,
76 was followed for asymptomatic abdominal aortic aneurysm.

77 Thoraco-abdominal aortic CTA showed a JRA with an increasing diameter of 51-52
78 mm. Preoperative sizing showed a 4 mm short infra renal aortic neck length, a 14.8 mm
79 proximal healthy landing zone involving superior mesenteric artery (SMA) and both renal
80 arteries and a 12 mm circumferential calcified NDA diameter (Fig 1).

81 Conventional open surgery was refused by the patient for two reasons an increased risk
82 of hemorrhage because of hemophilia, and a risk of renal impairment because of suprarenal
83 aortic clamping.

84 FEVAR with bifurcated stent-graft was declined owing to NDA which could lead to
85 graft kinking or thrombosis. Even if “paving and cracking” technique could facilitate
86 introduction and deployment of the aortic stent-graft through the NDA, it was deemed at risk
87 of aortic rupture. Hybrid surgery consisting FEVAR with AUI model followed by crossover
88 femoro-femoral bypass was also declined because of the increased risk of wound/graft
89 infection and hemorrhagic complication as above mentioned. Chimney technique was not
90 preferred because we had had to use 3 chimneys stents for the superior mesenteric artery and
91 both renal arteries, thus increasing the risk of type 1A endoleak due to multiple gutters.
92 Finally, we could not use the AFX unibody bifurcated graft for the NDA because is not
93 reimbursed in France and is not available a fenestrated custom-made model of it.

94 The patient was thus considered for total endovascular repair using ISLF. Under
95 general anesthesia, We loaded pre-intervention CTA images with intraoperative unenhanced

96 cone-beam computed tomography (CBCT) images without contrast, in order to create a 3D
97 road map overlay on 2D fluoroscopy, providing landmark rings for each targeted artery.(Fig.
98 2).

99 After bilateral femoral and right brachial percutaneous access, we catheterized the
100 superior mesenteric artery via the brachial access as a rescue procedure in case of failure of
101 SMA fenestration. Catheterization of the abdominal aorta via the right femoral artery allowed
102 placement of a Lunderquist guidewire up to the thoracic aorta.

103 We then deployed a 30/100/30 Valiant Captivia aortic stent graft (Medtronic, Santa
104 Rosa, CA, USA) at the level of the celiac trunk, thus covering the superior mesenteric artery
105 and both renal arteries.

106 Via the right femoral access, we inserted a long steerable Aptus catheter (Medtronic,
107 Santa Rosa, CA, USA) to carry the Turbo Elite excimer laser catheter (Spectranetics,
108 Colorado Springs, CO, USA) at a precise point to perforate the stent graft opposite to the
109 SMA, guided by landmark rings previously created. We passed the guide wire into the SMA
110 through the opening after two attempts of fenestration (10 minutes). Then, we used a 1.5x2.5
111 mm cutting balloon followed by a 5x20 mm semi-compliant balloon to enlarge the perforated
112 opening. Next, we inserted a balloon expandable Bentley covered stent 7x27 (Bentley
113 Innomed, GMBH, DE). Maximum ischemia time was 21 mins. We used the same protocol
114 for right and left renal arteries: maximum ischemia time 50 and 72mins respectively.

115 Finally, we deployed an Endurant 32/104/14 aorto-uni-iliac (AUI) stent graft
116 (Medtronic, Santa Rosa, CA, USA) to the right iliac artery with 25 mm overlapping length
117 with the Valiant stent graft. Via the left femoral artery, we inserted the APTUS steerable
118 catheter (Medtronic, Santa Rosa, CA, USA) opposite to the AUI stent graft. We directly
119 perforated it using the same laser fiber as previously. After only one attempt of laser

120 perforation , we were able to pass the 0.014 wire smoothly through the laser catheter and the
121 opening .Then, we enlarged the opening with the same protocol as mentioned before and we
122 inserted a 10x59 mm Advanta V12 balloon expandable covered stent (Atrium Medical
123 Corporation, Hudson, NH). Maximum ischemia time for the left lower limb was 30 mins.
124 (Fig 3)

125 Additional covered iliac stent was necessary to fix a dissection of the homolateral right
126 external iliac artery. Final angiogram was satisfactory and showed patency of all stents
127 without evidence of endoleak. Total operating time was 150mins, amount of contrast 60 cc,
128 fluoroscopy exposure time 68 min, DAP 167138 mGycm².

129 Post-operative course was uneventful, and the patient was discharged at day 7 after a
130 post-operative CT scan showing good exclusion of the aneurysm. Stable baseline of
131 creatinine level was at 74 µmol/L and lactate level was at 1.8 mmol/L.

132 6 months follow up CTA showed patency of the aortic stent graft and of all inserted
133 stents and stable aneurysmal sac diameter at 52 mm. No endoleak was detected. (Fig 4).

134 **Discussion**

135 Open surgical aneurysm repair was the gold standard management for juxta renal
136 aneurysm (JRA) until Fenestrated / Branched – endovascular aneurysm repair (F/B-EVAR)
137 was proposed with a lesser mortality and morbidity rate upon short- and intermediate- term
138 follow-up.^[1]

139 The main challenge face surgeons during conventional EVAR for complex aneurysms
140 is anatomical restrictions. Other off-label endovascular techniques were developed to
141 overcome these anatomical restrictions such as chimneys techniques, home-made
142 fenestration, and in situ fenestration.

143 In the present case, we describe the first application of retrograde ISLF to preserve the
144 contra lateral common iliac artery following an antegrade ISLF of SMA and both renal
145 arteries in the management of JRA with a NDA .

146 First ISF was reported by McWilliams in the management of saccular thoracic aortic
147 aneurysm to maintain the left subclavian artery revascularization by retrograde way during
148 thoracic EVAR. Since then, many ISF cases were reported to perfuse the aortic branches by
149 two main methods; mechanical and physical fenestration and two main approaches;
150 retrograde and antegrade way.^[4,5]

151 Excimer Laser device, one of physical methods, was initially used by cardiologist to
152 revascularize atherosclerotic coronary arteries. Then, it was proposed as an alternative
153 technique instead of mechanical ISF to fenestrate the aortic stent graft by retrograde way for
154 aortic arch reconstruction.

155 Also, ISLF was developed to be used by ante grade way in the management of JRA to
156 perfuse reno-visceral arteries. Indication of the exact point of perforation during antegrade

157 ISLF is the corner stone of the procedure.^[6]Therefore, preliminary stenting of target vessels is
158 used to guide surgeons before laser fenestration until image fusion technique offered the
159 creation of landmarks rings to simplify perforation procedure without preliminary stenting of
160 target vessels as reported before by our team.^[7,8]

161 The retrograde ISF through the common iliac artery was previously reported by coscas
162 et al to convert an AUI to bifurcated endograft in the management of infra renal aortic
163 aneurysm and a NDA by using in situ mechanical fenestration by the Ross modified
164 Colapinto needle from the transjugular intrahepatic access set with satisfactory results. ^[9]

165 In the present case, using a retrograde ISLF through a calcified NDA had two main
166 challenges. On the one hand, the implantation of an iliac stent through a small laser
167 fenestration and a narrow circumferential calcified aorta may lead to stent stenosis and
168 inadequate perfusion to contra lateral limb. On the other hand, the damage made by the laser
169 fiber on the aortic stent graft fabric and the unreinforced fenestration could cause fenestration
170 instability, weakness, and sealing long term issue. In our case, we fenestrated a woven
171 Dacron stent graft by the laser fiber. Dacron stent graft showed more stability with laser
172 fenestration compared to polytetrafluoroethylene covered endografts which seems to be
173 unsuitable for laser fenestration.^[10] Furthermore, physical in situ Laser fenestration showed a
174 clean fenestration and less fabric fraying of the stent graft compared to mechanical needle
175 fenestration according to in vitro benchtop evaluations.^[11] Finally, the enlargement performed
176 with the cutting balloon and semi-compliant balloon before stent insertion helped us to easily
177 expand the iliac balloon expandable covered stent which reinforced the fenestration and
178 prevent iliac limb stenosis or kinking due to the NDA.

179 By using this technique under image fusion guidance, we avoided any surgical
180 intervention and we consumed less amount of contrast and less time of fluoroscopy exposure.

181 Conclusion

182 In situ laser fenestration offers an effective solution for endovascular therapy of complex
183 juxta renal aneurysms. In this case of narrow distal aorta, ISLF was a suitable advance to
184 overcome EVAR anatomical restrictions and to prevent other additional open surgical
185 interventions providing safe and rapid total endovascular reconstruction of abdominal aortic
186 branches and its bifurcation.

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228 **Figures quotations**

229

230 **Fig 1 :** pre-operative of Computed tomographic angiography (CTA) sizing. (A) 3D
231 reconstruction of 52 mm juxta renal aneurysm. (B) short infra renal landing zone measuring 4
232 mm, proximal healthy 14.8 mm landing zone involving superior mesenteric artery and both
233 renal arteries. (C) 12 mm Circumferential calcified narrow distal aorta

234

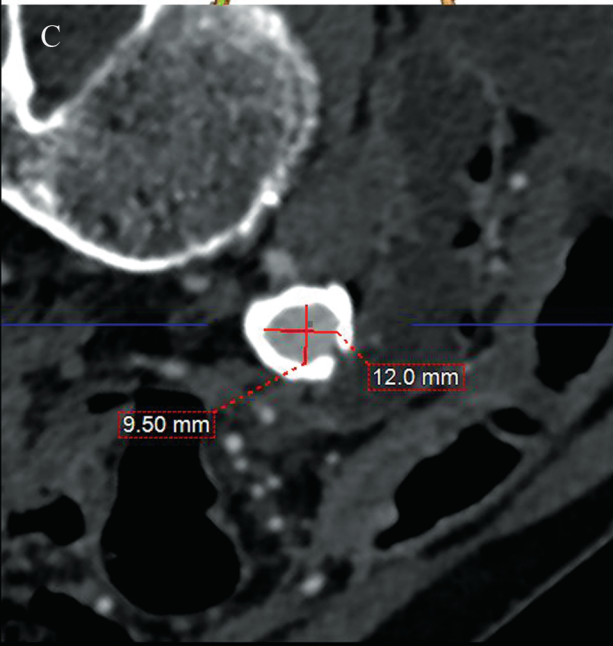
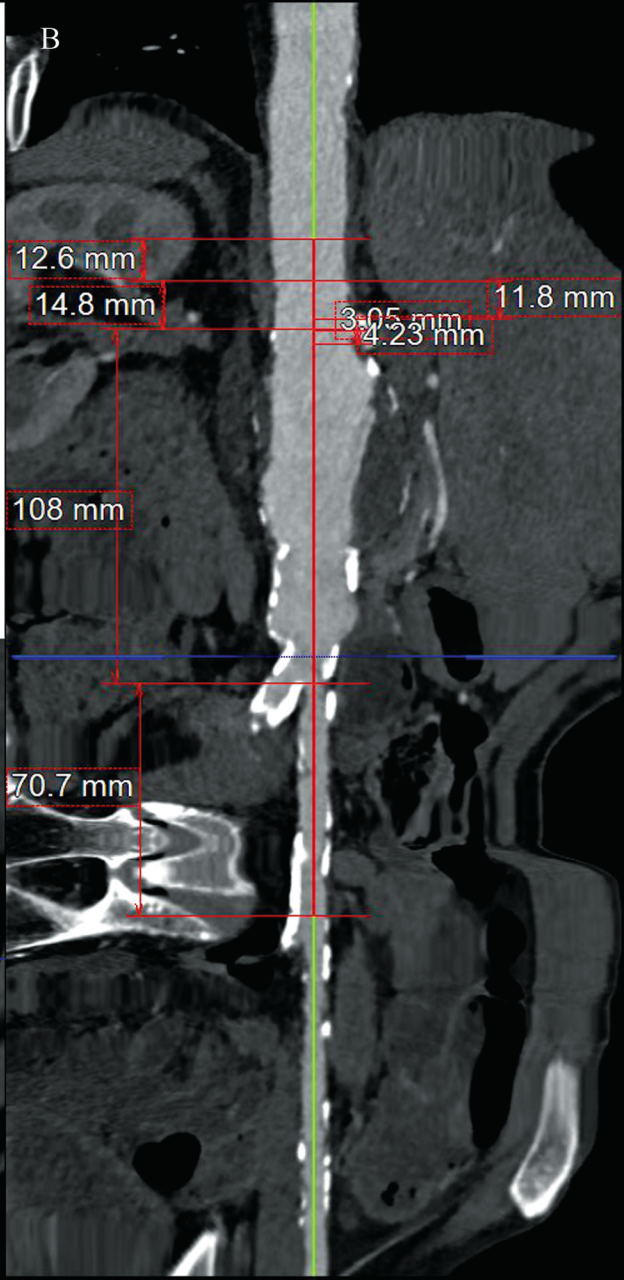
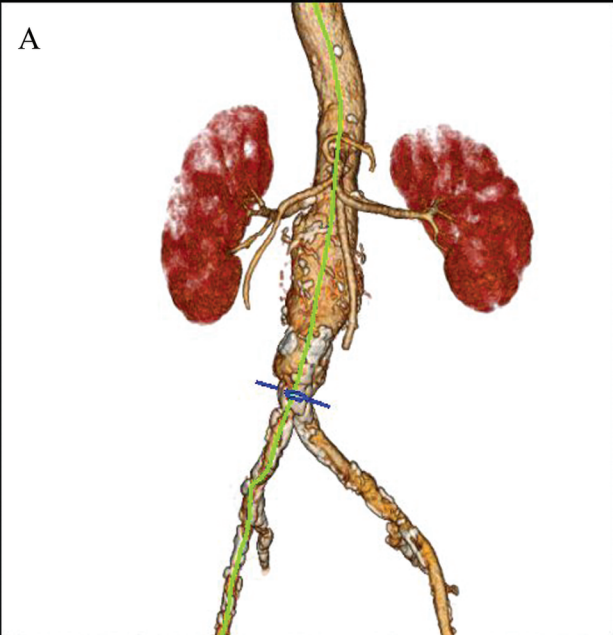
235 **Fig 2 :** 3D road map created by image fusion technique (A)created landmark rings of each
236 targeted vessels , superior mesenteric artery (SMA) and both renal arteries before the
237 antegrade laser fenestration (ISLF). (B) (SMA) catheterization with a guidewire after ISLF.
238 (C) created left contralateral common iliac artery landmark ring before retrograde laser
239 fenestration.

240

241 **Fig 3:** retrograde in situ laser fenestration technical steps. (A) Fabric hole enlargement using
242 a 2.5 x 1.5 cutting balloon after in situ laser fenestration was performed through the Aptus
243 steerable catheter using the Turbo Elite excimer laser catheter.(B) completion of the
244 enlargement procedure using a 5 x 2 mm semi compliant balloon. (C)Insertion of V12
245 balloon expandable covered stent (D) intra operative angiography showed intact stent
246 without stenosis or endoleak.

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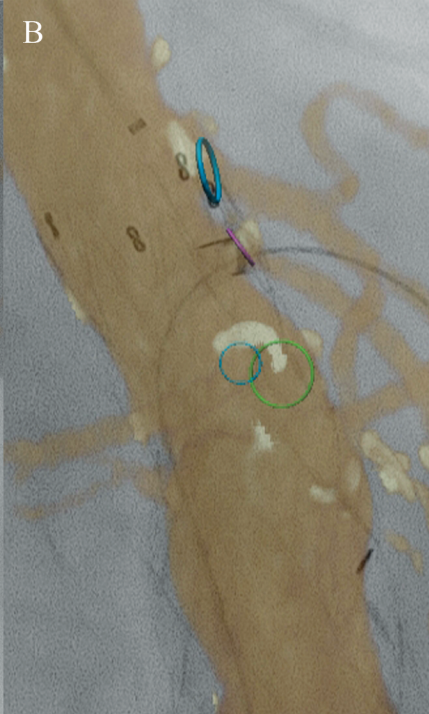
248 **Fig 4:** 6 months post-operative follow up. (A) 3D reconstruction CTA shows intact aortic
249 stent graft. (B)patent SMA stent. (C) patent both renal arteries stents. (D) Stable aneurysmal
250 sac diameter at 52 mm (E) patent common left iliac artery stent with no stenosis or
251 compression.



A



B



C

