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## Endovascular aortic repair of a postdissecting thoracoabdominal aneurysm using intraoperative fusion imaging.

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1 Endovascular Aortic Repair Of A Post-Dissecting  
2 Thoracoabdominal Aneurysm Using Intraoperative  
3 Fusion Imaging.

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21

1 **Abstract**

2 Computer-aided imaging can aid complex endovascular repair of aortic dissections in locating  
3 the narrow true lumen and identifying perfusion of visceral vessels by the true and/or false  
4 lumen. While these anatomical data are available for analysis during planning, they are not  
5 readily available during the procedure with conventional imaging systems.

6 We report the use of “Fusion Imaging” to facilitate the treatment of a post-dissection  
7 thoracoabdominal aneurysm. The preoperative computer tomography angiography was  
8 processed and the true and the false lumens individually colour-labeled. These data were then  
9 superimposed on the fluoroscopy images in order to facilitate deployment of a fenestrated  
10 endograft.

11

## 1 **Introduction**

2 The endovascular aortic repair of complex aortic aneurysms with fenestrated or branched  
3 grafts requires accurate planning and therefore, high quality imaging. Computer tomography  
4 angiography (CTA) volume data are interrogated and manipulated with an appropriate  
5 workstation to provide multiplanar reconstructions and thereby accurately size and plan  
6 bespoke endografts. Most operative imaging systems provide only two-dimensional  
7 fluoroscopy images with various refinements such as subtraction and roadmapping to  
8 facilitate positioning of the endograft. Conventionally, none of the pre operative CTA data  
9 (position of the aortic branches, true and false lumen location, thrombus or calcifications) are  
10 directly available to the operating surgeon. Current developments in image guided therapy  
11 and computer aided surgery in vascular surgery<sup>1</sup> are being combined to provide the pre-  
12 operative data to the surgeon during the operation. This case report describes the use of fusion  
13 imaging (3D preoperative CTA overlaid onto the 2D live fluoroscopy image) during the  
14 endovascular repair of a post-dissection thoracoabdominal aneurysm using a four vessel  
15 fenestrated endograft.

16

## 17 **Report**

18 A 46 year-old woman with a systemic lupus erythematosus presented with aneurysmal dilation  
19 of a chronic thoraco-abdominal aortic dissection. Previous aortic procedures included  
20 ascending aortic replacement, aorto bi-iliac inlay grafting and replacement of a segment of  
21 descending aorta with patch reimplantation of the origin of the distal intercostal arteries. The  
22 presenting thoracoabdominal aortic aneurysm (TAAA) included the visceral artery origins,  
23 which had not been previously treated. Given the multiple previous aortic operations,  
24 endovascular surgery was the preferred treatment option. The preoperative CTA was analyzed  
25 using an Aquarius workstation (Tera Recon Inc., SanMateo, CA, USA.). It showed a 60 mm

1 diameter dilated dissection with a Crawford type III anatomical distribution (Fig. 1A and 2A).  
2 There was evidence of a communication between the true and false lumen at the level of the  
3 LRA origin (Fig. 1B). The true lumen was narrow (7×16 mm) at the level of the visceral  
4 bearing aortic segment. Endovascular exclusion using two tubular components was planned :  
5 a proximal thoracic component to be positioned in the previously surgically placed  
6 descending thoracic aorta graft with its distal margin 20 mm proximal to the CT origin; a  
7 distal fenestrated component to be positioned with 3 stent overlap in the proximal thoracic  
8 component, and in the main body of the previously surgically placed infra-renal bifurcated  
9 bypass distally. The distal component included two large fenestrations for the CT and SMA  
10 and two small fenestrations for the renal arteries. The small fenestrations were planned with  
11 preloaded guidewires<sup>2</sup>. The procedure was performed in the TheraImage platform angiosuite  
12 at CHU de Rennes. A first image processing (Fig. 2A) was performed before the intervention  
13 using the Endosize<sup>3</sup> workstation (Therenva, Rennes, France) in order to label on the CTA the  
14 true and false lumen with different colors (Fig. 2B). This post processed aortic volume data  
15 was then imported into the Syngo software. To construct the fusion image, this software needs  
16 to match the preoperative CTA with an intraoperative CT performed with a c-arm digital flat-  
17 panel detector cone beam CT (CBCT) (Artis zeego, Siemens Healthcare, Forchheim,  
18 Germany). This acquisition is performed with a dedicated program allowing an automatic  
19 200° rotation without injection limited to the abdomen. A total of 350 images are created and  
20 then reconstructed with the Syngo software, producing CT-like images. The bony structures  
21 between the CT like images and the preoperative CTA are manually aligned. When the  
22 alignment is accurate, the vascular structure can be superimposed onto the 2D live  
23 fluoroscopic images. The color labeled process allowed an accurate real-time 3D visualization  
24 of the true and false lumens during the procedure (Fig. 2C). Fusion imaging also proved very  
25 helpful in the catheterization of target vessels (Fig. 2D), so much so that contrast injection

1 was not required before target vessel catheterisation, only being necessary to check patency  
2 after placement of the covered stents. An early type III endoleak was identified arising  
3 between the two aortic components. This was resolved by the adjunct of an aortic extension  
4 cuff. There was no type I or III endoleak on final completion angiography . The duration of  
5 the operation was 245 minutes, contrast volume 145 mL and fluoroscopy time 60 minutes.  
6 The early postoperative follow-up was uneventful, no spinal cord ischemia symptoms were  
7 depicted. The 1 month postoperative CTA (Fig. 3) revealed a type II endoleak and four patent  
8 target vessels.

## 9 **Discussion**

10 Total endovascular repair of chronic dissecting aneurysms including the visceral arteries with  
11 fenestrated endografts is a challenging procedure. In the few cases that have been reported<sup>4</sup>,  
12 authors have highlighted challenges surrounding the navigation of the true and false lumens  
13 and in catheterizing visceral vessels. Aneurysm exclusion demands that the proximal and  
14 distal sealing zones of the endograft are located in the true lumen. This is often very narrow,  
15 and this may hinder both the ability to manipulate the main device and catheterize the target  
16 vessels. We anticipated technical difficulty with catheterization of the target vessels,  
17 particularly the left renal artery because of the communication between the true and the false  
18 lumen at that site. With this in mind, we designed an endograft with wires preloaded into the  
19 renal fenestrations<sup>2</sup>. Sheathes for the renal arteries were advanced directly through the renal  
20 fenestrations without the usual need to catheterize these small fenestrations. Catheterization  
21 of the renal arteries was then performed with a catheter advanced through the sheath parallel  
22 to the preloaded wires. This system provides stability and support for the catheter and wire  
23 being used to access the renal artery. We contend that the operative and fluoroscopy times are  
24 shortened with this system.

25 Neuroradiologists were the first these advanced 3D road-map software during challenging

1 brain aneurysm repairs<sup>5</sup>. Geenberg et al<sup>6</sup> described the first use of fusion images in  
2 endovascular aneurysm repairs. With CTA fusion, 3D roadmapping is available without the  
3 need for operative contrast injection and, contrast-free thoracic endovascular repair has now  
4 been reported with this imaging technique<sup>7</sup>. Even if contrast is required, the location of target  
5 vessel origins and their catheterisation are easier and fluoroscopy times are reduced.

6 It is important to acknowledge that the deformations imposed by stiff guidewires and sheaths  
7 can lead to a mismatch between the overlaid 3D preoperative CT and the real location of the  
8 arterial structures (Fig 2D). Further technologies might anticipate such deformations and  
9 propose a deformed aortoiliac overlay.

10 This experience describes one application of fusion imaging but the ultimate aim of computer  
11 aided imaging and surgery is to simplify complex surgery by making all pre-operative data  
12 available and usable in the operating room.

13

#### 14 **Conclusion**

15 In this article, we report the case of an endovascular repair of a complex thoracic dissection  
16 facilitated by “fusion imaging”. While fusion imaging is a new technology in the vascular  
17 field, we anticipate that with further developments it will be a useful tool for endovascular  
18 procedures to reduce contrast and radiation dose.

19

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22 804 for its support in the processing of imaging data.

23

#### 24 **Conflict of interest**

25 SH is a consultant for Cook medical

## 1 **References**

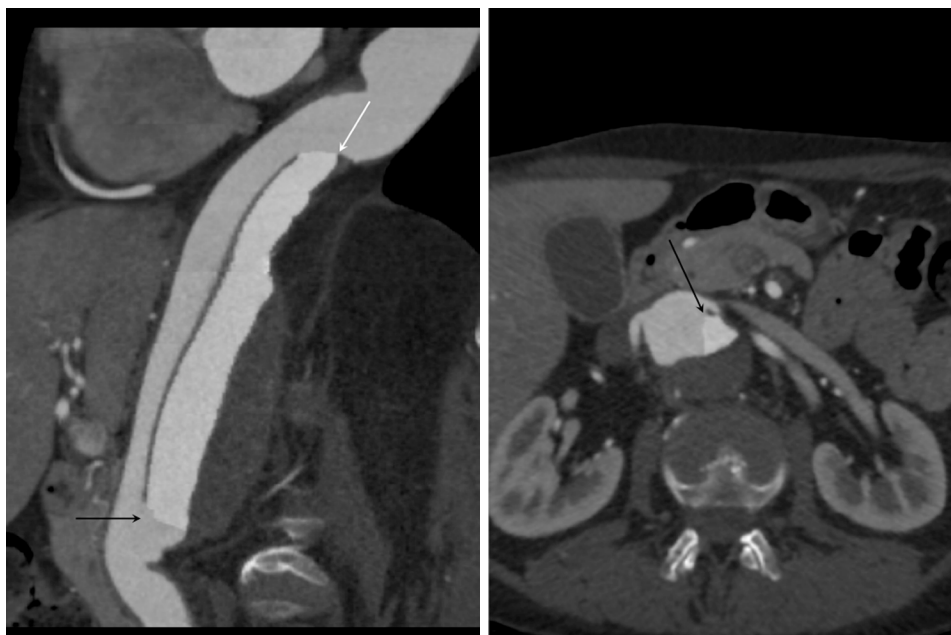
- 2 1. Kaladji A, Lucas A, Cardon A, Haigron P. Computer-Aided Surgery: Concepts and  
3 Applications in Vascular Surgery. *Perspect Vasc Surg Endovasc Ther.* 2012.
- 4 2. Resch TA, Dias NV, Sobocinski J, Sonesson B, Roeder B, Haulon S. Development of  
5 Off-the-shelf Stent Grafts for Juxtarenal Abdominal Aortic Aneurysms. *Eur J Vasc Endovasc*  
6 *Surg.* 2012.
- 7 3. Kaladji A, Lucas A, Kervio G, Haigron P, Cardon A. Sizing for endovascular  
8 aneurysm repair: clinical evaluation of a new automated three-dimensional software. *Ann*  
9 *Vasc Surg.* 2010 Oct;24(7):912-20.
- 10 4. Trimarchi S, Righini P, Grassi V, Lomazzi C, Segreti S, Rampoldi V, et al. Do  
11 branched and fenestrated devices have a role in chronic type B aortic dissection? *J*  
12 *Cardiovasc Surg (Torino).* 2011;52(4):529-38.
- 13 5. Lin CJ, Blanc R, Clarencon F, Piotin M, Spelle L, Guillermic J, et al. Overlying  
14 fluoroscopy and preacquired CT angiography for road-mapping in cerebral angiography.  
15 *AJNR Am J Neuroradiol.* 2010;31(3):494-5.
- 16 6. Dijkstra ML, Eagleton MJ, Greenberg RK, Mastracci T, Hernandez A. Intraoperative  
17 C-arm cone-beam computed tomography in fenestrated/branched aortic endografting. *J Vasc*  
18 *Surg.* 2011;53(3):583-90.
- 19 7. Kobeiter H, Nahum J, Becquemin JP. Zero-contrast thoracic endovascular aortic repair  
20 using image fusion. *Circulation.* 2011;124(11):280-2.

21



1 **Figures**

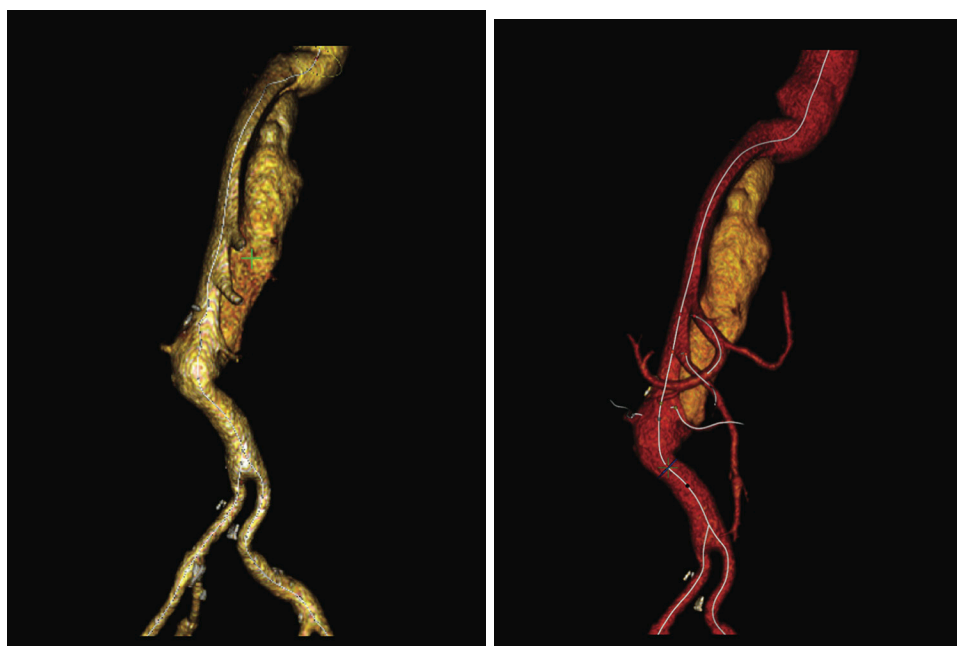
2 Figure 1 Pre operative sagittal (figure 1A) and axial (figure 1B) CT Multiplanar  
3 reconstructions. The white arrow shows the proximal entry tear located at the  
4 thoracoabdominal junction and the black arrow the exit tear near the origin of the left renal  
5 artery.



6  
7 A

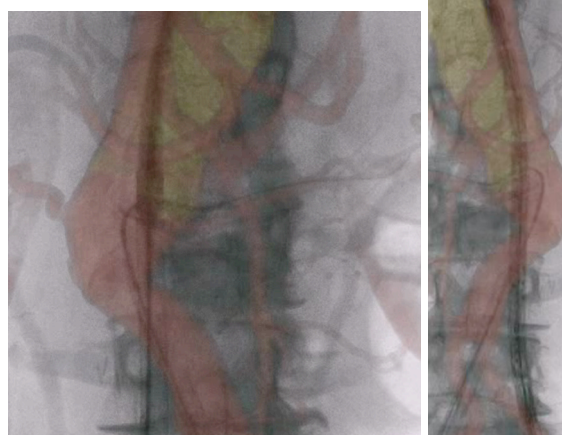
8  
9 B

1 Figure 2 Preoperative 3D Volume rendering of the aorta before (figure 2A) and after (figure  
2 2B) postprocessing of the true lumen in red and the false lumen in yellow. The postprocessing  
3 volume is then superimposed onto the 2D intraoperative fluoroscopy image (Figure 2C): the  
4 left renal artery was cannulated with a guidewire to check the accurate location of the target  
5 vessels with the fusion. The position of the endograft delivery system within the true lumen  
6 (red area) was confirmed (Figure 2D).



A

B



C

D

- 1 Figure 3 Postoperative CT control confirmed patency of all target vessels, and no residual
- 2 flow in the false lumen.



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