

- self-expandable bare metallic stents. *Diagn Interv Radiol* 2010;16:308-11.
7. Lieber BB, Stancampiano AP, Wakhloo AK. Alteration of hemodynamics in aneurysm models by stenting: influence of stent porosity. *Ann Biomed Eng* 1997;25:460-9.
 8. Henry M, Polydorou A, Frid N, Gruffaz P, Cavet A, Henry I, et al. Treatment of renal artery aneurysm with the multilayer stent. *J Endovasc Ther* 2008;15:231-6.
 9. Ruffino M, Rabbia C. Endovascular treatment of visceral artery aneurysms with Cardiatiss multilayer flow modulator: preliminary results at six-month follow-up. *J Cardiovasc Surg (Torino)* 2011;52:311-21.
 10. Meyer C, Verrel F, Weyer G, Wilhelm K. Endovascular management of complex renal artery aneurysms using the multilayer stent. *Cardiovasc Intervent Radiol* 2011;34:637-41.
 11. Carrafiello G, Rivolta N, Annoni M, Fontana F, Piffaretti G. Endovascular repair of a celiac trunk aneurysm with a new multilayer stent. *J Vasc Surg* 2011;54:1148-50.
 12. Balderi A, Antonietti A, Ferro L, Peano E, Pedrazzini F, Fonio P, et al. Endovascular treatment of visceral artery aneurysms and pseudoaneurysms: our experience. *Radiol Med* 2012;117:815-30.
 13. Pulli R, Dorigo W, Fargion A, Pratesi G, Innocenti AA, Angiletta D, et al. Comparison of early and midterm results of open and endovascular treatment of popliteal artery aneurysms. *Ann Vasc Surg* 2012;26:809-18.
 14. Ruffino MA, Rabbia C. Endovascular repair of peripheral and visceral aneurysms with the cardiatiss multilayer flow modulator: one-year results from the Italian Multicenter Registry. *J Endovasc Ther* 2012;19:599-610.
 15. Euringer W, Südkamp M, Rylski B, Blanke P. Endovascular treatment of multiple HIV-related aneurysms using multilayer stents. *Cardiovasc Intervent Radiol* 2012;35:945-9.
 16. Natrella M, Castagnola M, Navarretta F, Cristoferi M, Fanelli G, Meloni T, et al. Treatment of juxtarenal aortic aneurysm with the Multilayer stent. *J Endovasc Ther* 2012;19:121-4.
 17. Benjelloun A, Henry M, Ghannam A, Vaislic C, Azzouzi A, Maazouzi W, et al. Endovascular treatment of a tuberculous thoracoabdominal aneurysm with the Multilayer stent. *J Endovasc Ther* 2012;19:115-20.
 18. Chocron S, Vaislic C, Kaili D, Bonneville JF. Multilayer stents in the treatment of thoraco-abdominal residual type B dissection. *Interact Cardiovasc Thorac Surg* 2011;12:1057-9.
 19. Chaikof EL, Blankensteijn JD, Harris PL, White GH, Zarins CK, Bernhard VM, et al. Reporting standards for endovascular aortic aneurysm repair. *J Vasc Surg* 2002;35:1048-60.
 20. Bakoyiannis CN, Economopoulos KP, Georgopoulos S, Klonaris C, Shialarou M, Kafza M, et al. Fenestrated and branched endografts for the treatment of thoracoabdominal aortic aneurysms: a systematic review. *J Endovasc Ther* 2010;17:201-9.
 21. Kallmes DF, Ding YH, Dai D, Kadirvel R, Lewis DA, Cloft HJ. A new endoluminal, flow-disrupting device for treatment of saccular aneurysms. *Stroke* 2007;38:2346-52.
 22. Leonardi M, Dall'olio M, Princiotta C, Simonetti L. Treatment of carotid siphon aneurysms with a microcell stent. A case report. *Interv Neuroradiol* 2008;14:429-34.
 23. Sfyroeras GS, Dalainas I, Giannakopoulos TG, Antonopoulos K, Kakisis JD, Liapis CD. Flow-diverting stents for the treatment of arterial aneurysms. *J Vasc Surg* 2012;56:839-46.
 24. Ebaugh JL, Morasch MD, Matsumura JS, Eskandari MK, Meadows WS, Pearce WH. Fate of excluded popliteal artery aneurysms. *J Vasc Surg* 2003;37:954-9.
 25. Singh KP, Patel MR, Kandzari DE, Zidar JP. Peripheral arterial disease: an overview of endovascular therapies and contemporary treatment strategies. *Rev Cardiovasc Med* 2006;7:55-68.
 26. Mardikar HM, Mukherjee D. Current endovascular treatment of peripheral arterial disease. *Prog Cardiovasc Nurs* 2007;22:31-7.
 27. White CJ, Gray WA. Endovascular therapies for peripheral arterial disease: an evidence-based review. *Circulation* 2007;116:2203-15.
 28. Lazaris AM, Maheras AN, Vasdekis SN. A multilayer stent in the aorta may not seal the aneurysm, thereby leading to rupture. *J Vasc Surg* 2012;56:829-31.

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INVITED COMMENTARY

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Nothing is as captivating as innovative thinking and new tools. In this issue of the *Journal of Vascular Surgery*, Zhang and colleagues from Shanghai, China provide the next first step in developing the story of flow-diversion as a tactic to treat aortic aneurysmal disease. This retrospective description of 34 patients undergoing repair of a spectrum of complex aortic diseases using multiple overlapping uncovered stents, as opposed to a singular multilayer stent system (MLS), fires a shot across the bow of aortic intervention, indicating it is time to take a closer look at this technology and what it may have to offer us in the realm of treating aneurysms and dissections in the thoracic and renovisceral segment, where side-branch maintenance is paramount.

True, we now sit on the precipice of the era of widespread commercial availability of fenestrated and branched endograft technology. This moment has been pursued with a cavalcade of custom-modified, chimney, snorkel, and periscope ingenuity. Yet technical challenges, skill development, cost, and time required for custom manufacturing remain concerns. The need and desire for off-the-shelf complex aneurysm endografting is evident; however, this may not be realistic in all care arenas. A more direct and easier way to address urgent and emergent scenarios is wanted. This report tries to convey flow-diversion technology as one possible option. Recent communication of available reports of arterial, including aortic, use of MLS was encouraging.¹ Shorter

operating room time, simplicity in concept, and less radiation are possible benefits. But delivery platforms are not significantly smaller than available endografts, and precision of deployment is demanding.

This report must be taken with both interest and suspicion. Only eight (23%) of 34 treated aortas were degenerative aneurysms. Most were pseudoaneurysms and dissections, a hemodynamic potpourri. Inclusion criteria described would have been within commercially available indications for use. The average lesion size was only 5.6 cm, and there was less than 12-month mean follow-up. Over 30% had residual flow at 6 months. Pressure drop in the pseudoaneurysm tested was only 15 mm Hg; certainly challenging to treatment convention and less than clinical surety.

Also, are we supposed to take it on face value that the purported hemodynamic effects with MLS are true? The case reports touting these beneficial effects cite flow dynamic data from the corporate website where commercially available MLSs are of aortic sizes. Early case descriptions and successes were lauded, but newer information both in the *Journal of Vascular Surgery*² and described at the recent Veith Symposium 2012 report rupture and complications. If this flow-diversion theory is true, why are we still challenged with endoleak after endografting? Why did aneurysm wiring historically fail miserably? An apropos letter to the editor of the *Journal of Vascular Surgery* regarding

the report of rupture provided insight into the need for behavioral and molecular investigation of the MLS, thrombus, and aortic wall interface.³ Herein, sac entrance length is defined and described as important. What will be the required aortic length of treatment? Would it require involvement of significant normal aorta? There must be a plea for basic work and in-depth in vivo animal testing to further define and describe hemodynamic effects on various morphologies. And what about the fate of target branch vessels? While promising patency is suggested early, what will be later effects, and will they now be relegated to open reconstruction when disease processes involve them? A prospective registry for MLS use in the aorta is ongoing in France, thus more rigorous information is hopefully forthcoming.

This novel approach is finding a voice, but remains currently sophomoric. Reports of use continue to mount.⁴ Just as our profession continues to challenge and scrupulously investigate endograft exclusionary therapy, we must demand the same of flow-diversion technologies with careful, tempered, and rational use. Zhang and

colleagues have provided another rung on the ladder. Let us see if it climbs to anywhere.

REFERENCES

1. Sfyroeras GS, Dalainas I, Giannakopoulos TG, Antonopoulos K, Kakisis JD, Liapis CD. Flow-diverting stents for the treatment of arterial aneurysms. *J Vasc Surg* 2012;56:839-46.
2. Lazaris AM, Maheras AN, Vasdekis SN. A multilayer stent in the aorta may not seal the aneurysm, thereby leading to rupture. *J Vasc Surg* 2012;56:829-31.
3. Michel JB, Rouer M, Alsac JM. Regarding "A multilayer stent in the aorta may not seal the aneurysm, thereby leading to rupture". *J Vasc Surg* 2013;57:605.
4. Natrella M, Castagnola M, Navarretta F, Cristoferi M, Fanelli G, Meloni T, et al. Treatment of juxtarenal aortic aneurysm with the multilayer stent. *J Endovasc Ther* 2012;19:121-4.