Eur J Vasc Endovasc Surg (2019) 57, 475–476

EDITORIAL

# Distal Landing in TEVAR: Challenges in Reaching "The Dead Centre"

"Accuracy landing" is one of the oldest skydiving disciplines in which jumpers must land as closely as possible to a defined target on the ground. This target is called "dead centre". The diameter of this dead centre used to be 10 cm, but it has been reduced to just 2 cm since 2007. As skydivers usually land on their feet, most try to hit the dead centre with the heel of one shoe. The world record in accuracy landing was broken in 2014 with 10 consecutive landings on the 2 cm target.

In thoracic endovascular aortic repair (TEVAR) treatment, success also depends on accurate landing in the seal zones. For most stent grafts, a minimum landing zone of 2 cm is required.[1] Whereas a skydiver only targets one landing zone, the surgeon must achieve accuracy with two landing zones in TEVAR. TEVAR technology has largely focused on precise deployment in the proximal landing zone. Among other features, the proximal to distal deployment course and the availability of proximal bare stents help to achieve precise proximal deployment. Similar mechanisms to help us land in the distal landing zone are somewhat lacking. Although dedicated distal components are available (Zenith Alpha, Cook Medical, Valiant Captivia, Medtronic), or more controlled deployment mechanisms (CTAG, W.L. Gore), and even a double sheath deployment (Relay; Terumo Aortic), the distal landing accuracy is far from equalling the dead centre achieved by skydivers.

Berezowski *et al*. analysed the accuracy of landing in the distal landing zone in patients with a short distal landing zone.[2] Of 59 patients, they managed to deploy the stent graft accurately in the distal landing zone in just 10 (16.9%) patients. Precise landing was defined as a distance to the target vessel $\leq$5 mm. Missing the target vessel and landing too far away were not the only problems in the distal landing. In three (5.1%) patients, the target vessel was at least partially covered. Among those who required later distal re-intervention, the accidental target vessel coverage rate was 27%. Furthermore, a 30% stent graft malposition in the distal landing zone was observed. Indeed, the edge of the stent graft did not intersect perpendicularly to the aortic centre line, resulting in "wedge apposition". This phenomenon significantly reduces the functional landing zone (i.e., the anatomical landing zone covered by the stent graft). Additionally, oblique stent graft apposition in the landing zone carries a serious risk of distal endoleak, as the oversizing is lower that measured in an optimal perpendicular direction. Inaccurate distal stent graft deployment in this series was associated with a high rate of distal type I endoleak and associated with need for re-intervention.

These clinical study results motivated the authors to return to the laboratory to better understand the landing mechanism in the distal landing zone in an *in vitro* setting.[3] Two three dimensional printed aortas were prepared based on computed tomography angiography examinations of patients with thoracic aortic aneurysms with a short distal landing zone. The difference between both models was the presence or lack of aortic tortuosity in the distal landing zone area. The E-vita THORACIC 3G (JOTEC GmbH, Hechingen, Germany), Relay Plus (Terumo Aortic, Sunrise, FL, USA), and Valiant Captivia (Medtronic Vascular, Santa Rosa, CA, USA) were implanted 10 times in three different clinical scenarios. In the first scenario, the stent graft was implanted in a regular proximal to distal direction landing proximally in the aortic aneurysm and distally in the distal landing zone. In the second, the stent graft was implanted in a regular proximal to distal direction but landing proximally in a previously implanted stentgraft and distally in the distal landing zone. In the third, the stent graft was implanted in the reverse direction (distal to proximal) landing first in the distal landing zone and second in the proximal one. The results of this experiment confirmed the hypothesis that a short distal landing zone is the genuine TEVAR dead centre. Accurate stent graft deployment within 5 mm was only possible in every other implantation. Despite aiming to land just above the distal target vessel, stent grafts usually landed more proximally ("stent graft jump phenomenon"). This invariably occurred at the very last moment when the stent graft exited the delivery device. This can be attributed to the natural law of conserving momentum, which results in the stent graft being pushed both towards the aortic wall and away from the deployment of the sheath. Interestingly, the stent graft tended to jump less frequently when a proximal stent graft was present. Most interestingly, reverse stent graft deployment (from distal to proximal) increased the accuracy of landing in the distal landing zone. In all reversal deployments, it was possible to land just above the target vessel's upper edge. Furthermore, reversal deployment reduced distal "wedge apposition".

Understanding the mechanism of stent graft deployment is essential to develop better sheaths and deployment mechanisms in TEVAR to achieve accurate distal landing. Perfect landing in the 2 cm dead centre from the sky in 10 subsequent jumps is the current world record. More work needs to be done to achieve similar results for the TEVAR distal dead centre.


https://doi.org/10.1016/j.ejvs.2018.10.025

## CONFLICT OF INTEREST

This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

## REFERENCES

1 Riambau V, Böckler D, Brunkwall J, Cao P, Chiesa R, Coppi G, et al. Management of descending thoracic aorta diseases: clinical practice guidelines of the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg* 2017;**53**:4–52.

2 Berezowski M, Morlock J, Beyersdorf F, Jasinski M, Plonek T, Siepe M, et al. Inaccurate aortic stent graft deployment in the distal landing zone: incidence, reasons and consequences. *Eur J Cardiothorac Surg* 2018;**53**:1158–64.

3 Berezowski M, Kondov S, Beyersdorf F, Jasinski M, Plonek T, Siepe M, et al. In vitro evaluation of aortic stent-graft deployment accuracy in the distal landing zone. *Eur J Vasc Endovasc Surg* 2018;**56**:808–16.

Bartosz Rylski*
*Department of Cardiovascular Surgery, Heart Centre Freiburg University, Freiburg, Germany*
*Faculty of Medicine, University of Freiburg, Freiburg, Germany*

*Heart Centre Freiburg University, Hugstetter Str. 55, 79106 Freiburg, Germany.
*Email-address:* bartosz.rylski@universitaets-herzzentrum.de