Classification of gutter type in parallel stenting during endovascular aortic aneurysm repair

Simon P. Overeem, MSc,[a,b] Johannes T. Boersen, MSc,[a,b,c] Richte C. L. Schuurmann, MSc,[a,b] Erik Groot Jebbink, MSc,[a,c] Cornelis H. Slump, PhD,[a] Michel M. P. J. Reijnen, MD, PhD,[c] *and* Jean-Paul P. M. de Vries, MD, PhD,[b] *Enschede, Nieuwegein, and Arnhem, The Netherlands*

ABSTRACT

Objective: Gutters can be described as the loss of continuous apposition between the main body of the endograft, the chimney stent graft, and the aortic wall. Gutters have been associated with increased risk of type IA endoleaks and are considered to be the Achilles' heel of chimney endovascular aneurysm repair (ch-EVAR). However, there is no classification yet to classify and quantify gutter types after ch-EVAR.

Methods: Different gutter types can be distinguished by their morphologic appearance in two- and three-dimensional views and reconstructed slices perpendicular to the center lumen line.

Results: Three main categories are defined by (1) the most proximal beginning of the gutter, (2) the length of gutter alongside the endograft, and (3) its distal end. Type A gutters originate at the proximal fabric of an endograft, type B gutters originate as loss of apposition of the chimney stent graft in the branch vessel, and type C gutters start below the fabric of the endograft. To determine eventual changes of gutter size during follow-up computed tomography angiograms (CTAs), measurements may be performed with dedicated software on the follow-up CTA scan to assess the extent of gutters over the aortic circumference, ranging from 0° to 360° of freedom, together with the maximum gap between the endograft material and the aortic wall as it appears on reconstructed axial CTA scan slices.

Conclusions: The proposed gutter classification enables a uniform nomenclature in the current ch-EVAR literature and a more accurate risk assessment of gutter-associated endoleaks. Moreover, it allows monitoring of eventual progression of gutter size during follow-up. (J Vasc Surg 2016;■:1-6.)

Clinical Relevance: Gutters have been associated with an increased risk of type Ia endoleaks and are considered to be the Achilles' heel of chimney endovascular aneurysm repair (ch-EVAR). However, there is no classification yet to classify and quantify gutter types after ch-EVAR. The proposed gutter classification enables a uniform nomenclature in the current ch-EVAR literature, a more accurate risk assessment of gutter-associated endoleaks, and allows monitoring of eventual progression of gutter size during follow-up.

Most reinterventions after endovascular aneurysm repair (EVAR) are needed to repair complications at the proximal part of the endograft caused by sealing failures and endograft migration.[1,2] Positioning of the endograft close to the lowest renal artery to optimize the sealing area can be challenging in hostile proximal necks (necks <15 mm, severe angulation >60°, diameter >28 mm, and thrombus).[3-5]

Juxtarenal abdominal aortic aneurysms (JAAAs) are defined as aneurysms that involve the lower margins of at least one of the renal artery origins and account for 15% of all AAAs.[6-9] Standard EVAR is not a valid option in JAAAs because of the absence of a sufficient landing zone in the aortic neck. JAAAs are treated by open surgical repair, fenestrated EVAR (f-EVAR), or chimney EVAR (ch-EVAR).

Fenestrated aortic endografts have been developed for and applied in patients with a JAAA and have a proven clinical efficacy, with a lower 30-day mortality rate compared with open surgery (2.4% vs 3.4%) and an early type Ia endoleak rate of 4.3%.[10] One of the disadvantages of custom-made fenestrated endografts is the interval between the computed tomography (CT) scan and implantation (manufacturing time of 4 to 8 weeks), making the procedure unsuitable for urgent AAA repairs. Moreover, implantation of fenestrated endografts is substantially more time consuming and expensive compared with standard EVAR procedures.[11]

The chimney technique, or parallel grafting, involves the deployment of side branches alongside the main endograft.[12] The procedure was originally described by Greenberg et al[13] in 2003 as a bailout procedure for the treatment of patients with a short proximal aortic neck. The chimney technique can be used as an alternative

From the MIRA Institute for Biomedical Technology and Technical Medicine, University of Twente, Enschede[a]; the Department of Vascular Surgery, St. Antonius Hospital, Nieuwegein[b]; and the Department of Vascular Surgery, Rijnstate Hospital, Arnhem.[c]

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Correspondence: Simon P. Overeem, MSc, Department of Vascular Surgery, St. Antonius Hospital, Koekoekslaan 1, Nieuwegein 3435 CM, the Netherlands (e-mail: s.overeem@antoniusziekenhuis.nl).

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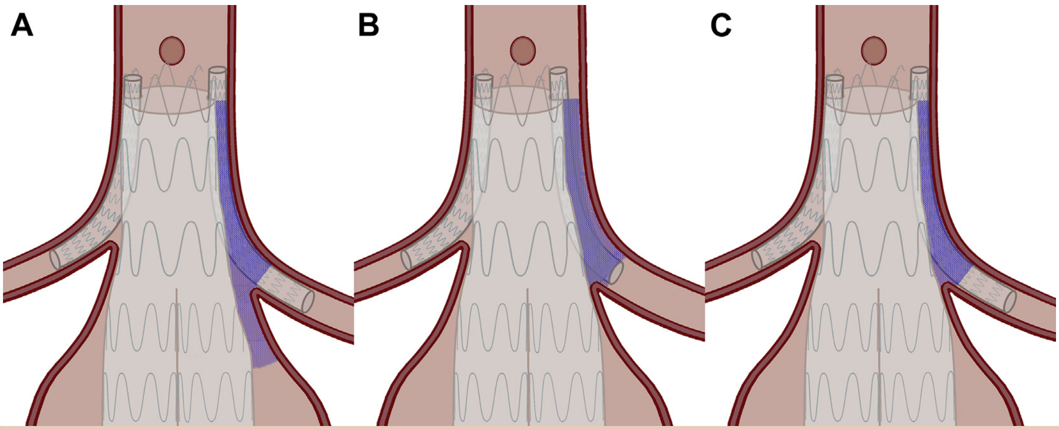

Fig 1. A, Type A1 gutter originates at the proximal start of the fabric of the endograft with continuation in the aneurysm sac. **B,** Type A2 gutter originates at the proximal start of the fabric of the endograft and extends into the side branch vessel because of lack of sealing of the chimney graft in the branch vessel. **C,** Type A3 gutter begins at the proximal start of the endograft fabric and terminates proximal to the aneurysm sac or chimney stent graft.

for f-EVAR in an emergency setting when there is no time for custom-made endografts or when the patient's anatomy precludes the use of other endografts.[10,11,14] The safety and midterm durability of ch-EVAR is proven and has been associated with a lower mortality rate compared with open or hybrid reconstructions.[15-18] Drawbacks of the chimney technique include the necessity of an upper extremity arterial access, which can lead to ischemic stroke in 3.2% of procedures, chimney stent graft compression, and gutter formation.[10] Gutter formation is considered to be the Achilles' heel of ch-EVAR and has been associated with a higher incidence of type Ia endoleaks compared with f-EVAR.[18,19]

Gutters can be defined as loss of continuous apposition between the main body of the endograft, the chimney stent graft, and the aortic wall. The conformability of the endograft around the chimney stent grafts is likely to differ between stent graft types because of particular stent graft architecture and the materials used in the graft.[20] The larger the volume of the gutter and the longer its length, the more likely it is that endoleaks type IA will develop.[21] However, not all gutters will lead to type IA endoleaks. Gutters can differ regarding the location alongside the endograft circumference as well as their proximal and distal end. Besides location, evaluating gutter size and volume over time is important. So far, a classification system for the different gutter types after ch-EVAR is lacking, which is the subject of this report.

METHODS

A definition of gutter, as proposed: *Gutter is characterized as the space formed by the loss of continuous aortic wall apposition between the endograft or chimney grafts, or both, and the aortic wall, with or without the persistence of blood flow in the aortic aneurysm.*

Alongside the length of the endograft and chimney grafts, three main gutter types can be defined:

Gutter type A (Fig 1): A gutter that originates at the proximal start of the endograft fabric. This gutter can be subdivided into types A1, A2, and A3. Type A1 is a gutter originating at the proximal start of the fabric of the endograft and continuing into the aneurysm sac, with a high risk of type Ia endoleak and pressurization of the aneurysm. Type A2 is defined as a gutter originating at the proximal start of the fabric of the endograft and extending into the side branch vessel because of lack of sealing of the chimney graft in the branch vessel. Type A3 is a gutter that begins at the proximal start of the endograft fabric and terminates proximal to the aneurysm sac or chimney stent graft.

Gutter type B (Fig 2): Defined as loss of apposition between the distal end of the chimney stent graft and the visceral artery. A type B1 gutter is defined when the gutter connects the visceral artery with the aneurysm sac, potentially leading to a type IB endoleak. A type B2 gutter is defined when there is no connection with the aneurysm sac.

Gutter type C (Fig 3): A gutter originating below the fabric of the endograft, without any connection to the proximal and distal chimney end or continuation into the aneurysm sac. Type C gutter describes an enclosed volume; typically, type C gutter is not related to endoleak.

Differences in gutter size may be assesed during follow-up by determination of the part of the aortic wall circumference where full apposition is lost betweeen the graft material and the aortic wall. This parameter is clockwise oriented, ranging from 0° to 360° of freedom, similar to the orientation of fenestrations in f-EVAR (Fig 4).[22] Axial slices of a center lumen line CT reconstruction can be used. The maximum gap between the graft material and the aortic wall can also be measured and eventual changes evaluated during follow-up (Fig 4).