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Choice of treatment for the patient with urgent AAA: practical tips

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Since the first successful attempts of emergency endovascular aneurysm repair (eEVAR) for patients with ruptured AAAs in the mid 1990s, surgeons have had to decide whether to treat patients by conventional open surgery or by minimally invasive but technically more demanding eEVAR. To date, selection of patients for eEVAR is still heavily debated and factors like hemodynamic instability, fear of treatment delay for patient transfer or imaging procedures and logistic issues often lead to the exclusion of anatomically suitable patients from eEVAR. However, these adverse factors may be overcome by adherence to an appropriate (intention-to-treat) protocol employing the use of a hypotensive hemostatic approach, transfemoral aortic balloon occlusion technique (when needed), different types of devices and an appropriate plan to resolve logistic issues, leaving anatomic suitability as the single most important determinant of suitability for EVAR

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In the past, there was no other choice than conventional open surgery (COS) for the treatment of ruptured abdominal aortic aneurysm (RAAA). Things started to change in the mid 90ies, when Yusuf, Hopkinson *et al.*[1] and Marin, Veith *et al.*[2] reported their first successful attempts of emergency endovascular aneurysm repair (eEVAR) for patients with RAAA. Surgeons then had to decide whether to treat patients by COS or by minimally invasive but technically demanding eEVAR. More than a decade after the introduction of eEVAR, the question remains: what is the better choice and which patient to treat by either method?

It is an accepted fact that despite advances in operative technique and perioperative care over the past 50 years, the results of COS for RAAA remain poor, with mortality rates in the 40-50% range.[3, 4] Recent meta-analysis comparing eEVAR with COS have shown a trend to lower mortality rates for eEVAR.[5-7] Furthermore, recently, two large single center series were published with very low mortality for eEVAR,[8, 9] further raising new hope for these patients.

However, analysis of the currently published literature shows wide variability in the inclusion rate of RAAA patients for eEVAR. Whereas the median inclusion rate for single center studies is around 40%, only about 10% or less of RAAA patients are reported to have had eEVAR in several large United States databases.[10-16]

Although still debated,[17] more and more evidence is accumulating to indicate that with an "EVAR first" approach mortality rates may be lowered for the whole RAAA patient cohort undergoing treatment (i.e. for patients treated by COS and eEVAR).[9, 11, 18-22] So what are the factors that determine whether a RAAA patient will be treated by eEVAR or not?

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The single most important factor seems to be arterial anatomy. RAAAs that extend above the renal arteries do not currently qualify for endovascular treatment – although they may in the future. For elective abdominal aortic aneurysm repair (EVAR), there is a general agreement that the neck (proximal landing zone) should not exceed 30 to 32 mm in diameter and should be at least 10 to 15 mm in length. Furthermore, it is generally agreed that severely angulated necks (>60°) should not be treated by EVAR although there may be some exceptions.[23] Since the availability of aorto-uni-iliac devices, the distal landing zone has become less of a concern, and more extended aorto-iliac aneurysms may be treated safely by these devices. When adhering to these criteria, the suitability of eEVAR for RAAA has been reported to be as low as 20%.[24] Reichart *et al.*, by loosening these criteria to a neck length of ≥10 mm and an angulation of ≤90°, report a feasibility of 40% in their series.[25] In our recently published series of 102 RAAAs treated by eEVAR, we were able to treat up to 88% of RAAAs by eEVAR by further extending these criteria (especially an acceptable neck length of ≥5 mm).[9]

Another major factor leading to the exclusion of patients for eEVAR is hemodynamic instability. In contemporary comparative series, the reported proportion of unstable patients included in the eEVAR group varies considerably, ranging from 14% to73%.[26, 27] In several of these studies, unstable patients were excluded from eEVAR.[25, 28-31] The definition of unstable patients also varies widely and generally takes into account only the systolic blood pressure although this may vary greatly with time and in the duration of hypotension. In various studies, patients qualify for being unstable when the lowest systolic blood pressure is less than 50 mmHg up to less than 100 mmHg. Additional variables include such statements as "despite resuscitation/not responding to a fluid bolus" or "no verbal reply/unconscious" or "severe arrhythmia/cardiac arrest" which are mentioned in certain publications.[28, 29, 31-37] However, since the introduction of the concept of hypotensive hemostasis [38] and the liberal use of transfemoral (supraceliac) balloon occlusion technique [39] by Veith and Ohki, unstable RAAA patients often may be restored to an improved hemodynamic status and therefore be rendered suitable candidates for eEVAR. In our series of 102 RAAA patients treated by eEVAR, nineteen patients were sufficiently unstable (less than 50 mmHg despite adequate resuscitation) to need transfemoral supraceliac aortic balloon occlusion, thus increasing feasibility by 19%.[9]

Even today, there is concern that time lost by transfer to another institution (offering eEVAR) or for imaging procedures needed to evaluate the suitability for eEVAR may negatively influence outcome. These are the reasons why many patients anatomically suitable for eEVAR are excluded from the procedure and treated by COS. However, strict adherence to the concept of hypotensive hemostasis and liberal use of aortic balloon occlusion allows most patients to be imaged appropriately and, if necessary, transferred to another institution, at least in Europe where distances are short. In fact, several reports confirm that although the transfer of patients with RAAA results in a treatment delay, it does not adversely affect the mortality rates associated with this condition.[40, 41] When first contacted by external institutions or emergency room staffs (first phone call), every member of our team stresses the importance of limiting all fluids or transfusions and suggests aiming for a target systolic blood pressure below 90 mmHg. Furthermore, by avoiding complex anesthetic procedures such as positioning of central venous catheters and by adhering to a "scoop and run" approach (well known in trauma surgery),[42] time loss can be minimized.

For decades, the need to rush to the operating room or theatre with RAAA patients was a generally accepted concept, leaving no time for further imaging procedures. However, this might often be the wrong paradigm as it has been shown by Lloyd *et al.* in a time to death study that the majority (88%) of RAAA patients remain hemodynamically stable within the first 2 hours of their admission to the treating institution.[43] In fact, the median time between rupture and death in a group of 56 patients offered only palliation was nearly 11 hours. We strongly suggest carrying out an urgent thoracoabdominal contrast CT scan in all RAAA patients, if it is available without delay (after a quick check only by the anesthetist) unless one has been obtained by the referring institution. This allows rapid online discussion about the best treatment modality (at our institution strictly on anatomical criteria only) between the vascular surgeon and radiologist while the anesthesiologists are simultaneously caring out the final patient preparation (i.e. placement of arterial lines and central venous catheters).[9]

Finally, logistics also seem to be an important basis for patient exclusion from eEVAR. In several contemporary comparative publications, logistic problems

are mentioned as often leading to the exclusion of anatomically suitable patients from eEVAR.[25, 26, 31, 32, 36, 44, 45] Suitable patients were excluded from eEVAR treatment because of: 1) lack of availability of staff (surgeons trained in EVAR, radiologists, specialized scrub nurses; specialized radiological technicians) during the week or on weekends; and 2) unavailability of endograft components. Articles dealing with the importance of having a protocol for eEVAR in RAAA patients emphasize the importance of having trained staff 24 hours a day, 7 days a week and an adequate equipment stock.[19, 20, 46] At our institution, a round-the-clock service is provided for vascular emergency procedures including eEVAR for RAAA.[9] At all times, one senior interventional radiologist, cardiovascular anesthetist and vascular surgeon are available. As an institution with a vast activity in elective EVAR procedures (approximately 800 abdominal and 250 thoracic EVAR procedures to date), a broad stock of bifurcated and aorto-uni-iliac endografts is available. eEVAR procedures may be carried out in a fully equipped emergency operating room or in an angiography suite. CT scans are available within 5-15 minutes as the scanner is part of the shock room. An eEVAR education program is provided to all potential staff members. All these requirements represent the ideal which may not be possible in every community or every institution. Even then, some groups have shown excellent results in much less ideal settings with a reasonable but limited emergency stock of endografts or without an interventional radiologist available.[28, 33, 34]

Last but not least, patients unfit for general anesthesia, might profit from the fact that eEVAR may often be carried out under local anesthesia (LA). The benefits of LA supplemented by analgosedation with remifentanyl in eEVAR for RAAA were first reported by Lachat *et al.* in 2002.[47] At our institution, 88% of RAAAs treated by eEVAR were excluded from the circulation under LA (and analgosedation by remifentanyl). This experience has been confirmed by several other groups.[33, 48, 49]

Conclusions

In summary, if it is believed that "EVAR first" is the better treatment choice for RAAA, anatomy is the single most important factor in determining suitability for this form of treatment. Other compromising factors such as hemodynamic instability, the fear of time loss etc. may be overcome by adherence to an appropriate (intention-to-treat) protocol employing the use of a hypotensive hemostatic approach, transfemoral aortic balloon occlusion technique (when needed), different types of devices and an appropriate protocol to resolve logistic issues.

References

1. Yusuf SW, Whitaker SC, Chuter TA, Wenham PW, Hopkinson BR. Emergency endovascular repair of leaking aortic aneurysm. Lancet 1994;344:1645.
2. Marin ML, Veith FJ, Cynamon J, Sanchez LA, Lyon RT, Levine BA *et al.* Initial experience with transluminally placed endovascular grafts for the treatment of complex vascular lesions. Ann Surg 1995;222:449-65; discussion 65-9.
3. Bown MJ, Sutton AJ, Bell PR, Sayers RD. A meta-analysis of 50 years of ruptured abdominal aortic aneurysm repair. Br J Surg 2002;89:714-30.
4. Morasch MD. EVAR for the treatment of ruptured AAA. Perspect Vasc Surg Endovasc Ther 2009;21:9-11.
5. Mastracci TM, Garrido-Olivares L, Cina CS, Clase CM. Endovascular repair of ruptured abdominal aortic aneurysms: a systematic review and meta-analysis. J Vasc Surg 2008;47:214-21.
6. Rayt HS, Sutton AJ, London NJ, Sayers RD, Bown MJ. A systematic review and meta-analysis of endovascular repair (EVAR) for ruptured abdominal aortic aneurysm. Eur J Vasc Endovasc Surg 2008;36:536-44.
7. Sadat U, Boyle JR, Walsh SR, Tang T, Varty K, Hayes PD. Endovascular vs open repair of acute abdominal aortic aneurysms--a systematic review and meta-analysis. J Vasc Surg 2008;48:227-36.
8. Holst J, Resch T, Ivancev K, Bjorses K, Dias N, Lindblad B *et al.* Early and intermediate outcome of emergency endovascular aneurysm repair of ruptured infrarenal aortic aneurysm: a single-centre experience of 90 consecutive patients. Eur J Vasc Endovasc Surg 2009;37:413-9.
9. Mayer D, Pfammatter T, Rancic Z, Hechelhammer L, Wilhelm M, Veith FJ *et al.* 10 years of emergency endovascular aneurysm repair for ruptured abdominal aortoiliac aneurysms: lessons learned. Ann Surg 2009;249:510-5.
10. Dillavou ED, Muluk SC, Makaroun MS. Improving aneurysm-related outcomes: nationwide benefits of endovascular repair. J Vasc Surg 2006;43:446-51; discussion 51-2.
11. Giles KA, Pomposelli F, Hamdan A, Wyers M, Jhaveri A, Schermerhorn ML. Decrease in total aneurysm-related deaths in the era of endovascular aneurysm repair. J Vasc Surg 2009;49:543-50; discussion 50-1.
12. Greco G, Egorova N, Anderson PL, Gelijns A, Moskowitz A, Nowygrod R *et al.* Outcomes of endovascular treatment of ruptured abdominal aortic aneurysms. J Vasc Surg 2006;43:453-9.
13. Leon LR, Jr., Labropoulos N, Laredo J, Rodriguez HE, Kalman PG. To what extent has endovascular aneurysm repair influenced abdominal aortic aneurysm management in the state of Illinois? J Vasc Surg 2005;41:568-74.
14. Lesperance K, Andersen C, Singh N, Starnes B, Martin MJ. Expanding use of emergency endovascular repair for ruptured abdominal aortic aneurysms: disparities in outcomes from a nationwide perspective. J Vasc Surg 2008;47:1165-70; discussion 70-1.
15. McPhee J, Eslami MH, Arous EJ, Messina LM, Schanzer A. Endovascular treatment of ruptured abdominal aortic aneurysms in the United States (2001-2006): a significant survival benefit over

open repair is independently associated with increased institutional volume. J Vasc Surg 2009;49:817-26.
16. Vogel TR, Dombrovskiy VY, Haser PB, Graham AM. Has the Implementation of EVAR for Ruptured AAA Improved Outcomes? Vasc Endovascular Surg 2009;43:252-7.
17. Hinchliffe RJ, Powell JT, Cheshire NJ, Thompson MM. Endovascular repair of ruptured abdominal aortic aneurysm: A strategy in need of definitive evidence. J Vasc Surg 2009;49:1077-80.
18. Anain PM, Anain JM, Sr., Tiso M, Nader ND, Dosluoglu HH. Early and mid-term results of ruptured abdominal aortic aneurysms in the endovascular era in a community hospital. J Vasc Surg 2007;46:898-905.
19. Mehta M, Taggert J, Darling RC, 3rd, Chang BB, Kreienberg PB, Paty PS *et al.* Establishing a protocol for endovascular treatment of ruptured abdominal aortic aneurysms: outcomes of a prospective analysis. J Vasc Surg 2006;44:1-8.
20. Moore R, Nutley M, Cina CS, Motarnedi M, Faris P, Abuznadah W. Improved survival after introduction of an emergency endovascular therapy protocol for ruptured abdominal aortic aneurysms. J Vasc Surg 2007;45:443-50.
21. Scharrer-Pamler R, Kotsis T, Kapfer X, Gorich J, Sunder-Plassmann L. Endovascular stent-graft repair of ruptured aortic aneurysms. J Endovasc Ther 2003;10:447-52.
22. Veith FJ, Lachat M, Mayer D, Malina M, Holst J, Mehta M *et al.* Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. Ann Surg 2009. In press.
23. Chisci E, Kristmundsson T, de Donato G, Resch T, Setacci F, Sonesson B *et al.* The AAA with a challenging neck: outcome of open versus endovascular repair with standard and fenestrated stent-grafts. J Endovasc Ther 2009;16:137-46.
24. Rose DF, Davidson IR, Hinchliffe RJ, Whitaker SC, Gregson RH, MacSweeney ST, *et al.* Anatomical suitability of ruptured abdominal aortic aneurysms for endovascular repair. J Endovasc Ther 2003;10:453-7.
25. Reichart M, Geelkerken RH, Huisman AB, van Det RJ, de Smit P, Volker EP. Ruptured abdominal aortic aneurysm: endovascular repair is feasible in 40% of patients. Eur J Vasc Endovasc Surg 2003;26:479-86.
26. Franks S, Lloyd G, Fishwick G, Bown M, Sayers R. Endovascular treatment of ruptured and symptomatic abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 2006;31:345-50.
27. Larzon T, Lindgren R, Norgren L. Endovascular treatment of ruptured abdominal aortic aneurysms: a shift of the paradigm? J Endovasc Ther 2005;12:548-55.
28. Alsac JM, Desgranges P, Kobeiter H, Becquemin JP. Emergency endovascular repair for ruptured abdominal aortic aneurysms: feasibility and comparison of early results with conventional open repair. Eur J Vasc Endovasc Surg 2005;30:632-9.
29. Arya N, Makar RR, Lau LL, Loan W, Lee B, Hannon RJ *et al.* An intention-to-treat by endovascular repair policy may reduce overall mortality in ruptured abdominal aortic aneurysm. J Vasc Surg 2006;44:467-71.
30. Vaddineni SK, Russo GC, Patterson MA, Taylor SM, Jordan WD, Jr. Ruptured abdominal aortic aneurysm: a retrospective assessment of open versus endovascular repair. Ann Vasc Surg 2005;19:782-6.
31. Visser JJ, Bosch JL, Hunink MG, van Dijk LC, Hendriks JM, Poldermans D *et al.* Endovascular repair versus open surgery in patients with ruptured abdominal aortic aneurysms: clinical outcomes with 1-year follow-up. J Vasc Surg 2006;44:1148-55.
32. Acosta S, Lindblad B, Zdanowski Z. Predictors for outcome after open and endovascular repair of ruptured abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 2007;33:277-84.
33. Coppi G, Silingardi R, Gennai S, Saitta G, Ciardullo AV. A single-center experience in open and endovascular treatment of hemodynamically unstable and stable patients with ruptured abdominal aortic aneurysms. J Vasc Surg 2006;44:1140-7.
34. Lee WA, Hirneise CM, Tayyarah M, Huber TS, Seeger JM. Impact of endovascular repair on early outcomes of ruptured abdominal aortic aneurysms. J Vasc Surg 2004;40:211-5.
35. Ockert S, Schumacher H, Bockler D, Megges I, Allenberg JR. Early and midterm results after open and endovascular repair of ruptured abdominal aortic aneurysms in a comparative analysis. J Endovasc Ther 2007;14:324-32.
36. Peppelenbosch N, Geelkerken RH, Soong C, Cao P, Steinmetz OK, Teijink JA, *et al.* Endograft treatment of ruptured abdominal aortic aneurysms using the Talent aortouniiliac system: an international multicenter study. J Vasc Surg 2006;43:1111-23; discussion 23.
37. Resch T, Malina M, Lindblad B, Dias NV, Sonesson B, Ivancev K. Endovascular repair of ruptured abdominal aortic aneurysms: logistics and short-term results. J Endovasc Ther 2003;10:440-6.
38. Veith FJ, Ohki T. Endovascular approaches to ruptured infrarenal aorto-iliac aneurysms. J Cardiovasc Surg (Torino) 2002;43:369-78.
39. Ohki T, Veith FJ, Sanchez LA, Cynamon J, Lipsitz EC, Wain RA *et al.* Endovascular graft repair of ruptured aortoiliac aneurysms. J Am Coll Surg 1999;189:102-12; discussion 12-3.
40. Azizzadeh A, Miller Iii CC, Villa MA, Estrera AL, Coogan SM, Meiner ST, *et al.* Effect of patient transfer on outcomes after open repair of ruptured abdominal aortic aneurysms. Vascular 2009;17:9-14.
41. Hames H, Forbes TL, Harris JR, Lawlor DK, DeRose G, Harris KA. The effect of patient transfer on outcomes after rupture of an abdominal aortic aneurysm. Can J Surg 2007;50:43-7.
42. Seamon MJ, Fisher CA, Gaughan J, Lloyd M, Bradley KM, Santora TA, *et al.* Prehospital procedures before emergency department thoracotomy: "scoop and run" saves lives. J Trauma 2007;63:113-20.
43. Lloyd GM, Bown MJ, Norwood MG, Deb R, Fishwick G, Bell PR *et al.* Feasibility of preoperative computer tomography in patients with ruptured abdominal aortic aneurysm: a time-to-death study in patients without operation. J Vasc Surg 2004;39:788-91.
44. Kapma MR, Verhoeven EL, Tielliu IF, Zeebregts CJ, Prins TR, Van der Heij B *et al.* Endovascular treatment of acute abdominal aortic aneurysm with a bifurcated stentgraft. Eur J Vasc Endovasc Surg 2005;29:510-5.
45. Yilmaz N, Peppelenbosch N, Cuypers PW, Tielbeek AV, Duijm LE, Buth J. Emergency treatment of symptomatic or ruptured abdominal aortic aneurysms: the role of endovascular repair. J Endovasc Ther 2002;9:449-57.
46. Veith FJ, Gargiulo NJ, 3rd. Explanation for variable results of EVAR for ruptured abdominal aortic aneurysm. In: Greenhalgh RM, editor. More Vascular and Endovascular Challenges: BIBA Publishing; 2007. p. 68-73.
47. Lachat ML, Pfammatter T, Witzke HJ, Bettex D, Kunzli A, Wolfensberger U *et al.* Endovascular repair with bifurcated stent-grafts under local anaesthesia to improve outcome of ruptured aortoiliac aneurysms. Eur J Vasc Endovasc Surg 2002;23:528-36.
48. Dalainas I, Nano G, Bianchi P, Stegher S, Casana R, Malacrida G *et al.* Endovascular techniques for the treatment of ruptured abdominal aortic aneurysms: 7-year intention-to-treat results. World J Surg 2006;30:1809-14; discussion 15-6.
49. Verhoeven EL, Kapma MR, Groen H, Tielliu IF, Zeebregts CJ, Bekkema F *et al.* Mortality of ruptured abdominal aortic aneurysm treated with open or endovascular repair. J Vasc Surg 2008;48:1396-400.