Applied Cardiopulmonary Pathophysiology 16: 292-294, 2012

Cerebral embolism in transcatheter aortic valve implantation (TAVI): Mechanisms and strategies for prevention

Gabor Erdoes, Balthasar Eberle

Department of Anesthesiology and Pain Therapy, University Hospital Bern, Switzerland

Transcatheter aortic valve implantation (TAVI) has now widely been accepted as a treatment option for high-risk patients with severe symptomatic aortic stenosis. Recent clinical trials and current registries indicate, at follow-up of 24 - 30 months, excellent outcome and low mortality rates, which are similar to surgical aortic valve replacement in comparable patient cohorts. (1,2) Nevertheless, TAVI may be associated with severe adverse cerebrovascular events which may massively impair patients` post-procedural quality of life.

In a recent prospective registry series of 400 patients undergoing transapical or transfemoral TAVI, periprocedural stroke occurred in 2.8%. (3) Periprocedural stroke may be due to prevalent cerebro-vascular occlusive disease, intraprocedural embolic or hemodynamic ischemia, or to peri- and postprocedural cardioembolic events due to atrial fibrillation. (4) In a recent risk analysis of the Bern TAVI registry, abnormally low body mass index, prior stroke, and presence of atrial fibrillation at baseline contribute to the risk of postprocedural stroke. (5) Hence, TAVI patients are exposed to an increased risk of all-cause and cardiovascular mortality. (6) Apart from stroke, new but clinically silent ischemic lesions have been reported in up to 84% of TAVI recipients in postinterventional diffusion-weighted magnetic resonance imaging (DW-MRI) studies. (7) When investigating TAVI procedural phases separately by using transcranial Doppler (TCD) ultrasonography, the incidence of solid or gaseous embolic events was higher with the transfemoral access route and the deployment of self-expandable prostheses. (8,9) In this regard, manipulations on the calcified aortic valve (e.g. dense catheter traffic, prosthesis deployment, postimplantation balloon dilatation) and prolonged friction between the rigid hardware and the calcified aortic root due to gradual prosthesis release without rapid pacing, i.e., with ejection maintained, appear to be associated with more high-intensity transient signals (HITS), reflecting embolic load to the brain.(8-12)

The clinical significance of HITS has not yet been unequivocally resolved. Obviously, the majority of HITS has no clinically apparent sequelae, but neither do so many lesions on DW-MRI. This appears to be more a sensitivity problem of neurological and neurocognitive testing than of clinical relevance. Nevertheless, in view of current indications for TAVI and the respective patient population, it is highly questionable whether a completely HITS-free TAVI procedure can ever be designed. However, there is increasing evidence for postprocedural cognitive decline with higher HITS frequency (13,14) and associated with it, substantial costs in health care. Therefore all efforts should be made to reduce HITS during TAVI.

Currently, several embolic protection devices are in clinical evaluation. Future prevention strategies also include less traumatic delivery systems, as well as new prostheses

with better sealing and less need for redilatation and repositioning. (10) Likewise a heart-team based careful patient and device selection, and close intraprocedural collaboration within the treatment team appear to be an effective approach to optimize outcome. (15)

References

1. Wenaweser P, Pilgrim T, Kadner A, Huber C, Stortecky S, Buellesfeld L, Khattab AA, Meuli F, Roth N, Eberle B, Erdös G, Brinks H, Kalesan B, Meier B, Jüni P, Carrel T, Windecker S. Clinical outcomes of patients with severe aortic stenosis at increased surgical risk according to treatment modality. J Am Coll Cardiol 2011; 58: 2151-2162
2. Smith CR, Leon MB, Mack MJ, Miller DC, Moses JW, Svensson LG, Tuzcu EM, Webb JG, Fontana GP, Makkar RR, Williams M, Dewey T, Kapadia S, Babaliaros V, Thourani VH, Corso P, Pichard AD, Bavaria JE, Herrmann HC, Akin JJ, Anderson WN, Wang D, Pocock SJ; PARTNER Trial Investigators. Transcatheter versus surgical aortic-valve replacement in high-risk patients. N Engl J Med 2011; 364: 2187-98
3. Gloeckler S, Windecker S, Stortecky S, Kadner A, Pilgrim A, Huber C, Buellesfeld L, Khattab AA, Eberle B, Nietlispach F, Carrel T, Meier B, Wenaweser P. Transcatheter Aortic Valve Implantation from 2007 to 2011: A 400 Case Single Center Experience. Abstract for Euro PCR 2012
4. Holmes DR Jr, Mack MJ, Kaul S, Agnihotri A, Alexander KP, Bailey SR, Calhoon JH, Carabello BA, Desai MY, Edwards FH, Francis GS, Gardner TJ, Kappetein AP, Linderbaum JA, Mukherjee C, Mukherjee D, Otto CM, Ruiz CE, Sacco RL, Smith D, Thomas JD, Harrington RA, Bhatt DL, Ferrari VA, Fisher JD, Garcia MJ, Gardner TJ, Gentile F, Gilson MF, Hernandez AF, Jacobs AK, Kaul S, Linderbaum JA, Moliterno DJ, Weitz HH; American Heart Association; American Society of Echocardiography; European Association for Cardio-Thoracic Surgery; Heart Failure Society of America; Mended Hearts; Society of Cardiovascular Anesthesiologists; Society of Cardiovascular Computed Tomography; Society for Cardiovascular Magnetic Resonance. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement: developed in collaboration with the American Heart Association, American Society of Echocardiography, European Association for Cardio-Thoracic Surgery, Heart Failure Society of America, Mended Hearts, Society of Cardiovascular Anesthesiologists, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. J Thorac Cardiovasc Surg 2012; 144: e29-84
5. Pilgrim T, Kalesan B, Wenaweser P, Huber C, Stortecky S, Buellesfeld L, Khattab AA, Eberle B, Gloekler S, Gsponer T, Meier B, Jüni P, Carrel T, Windecker S. Predictors of Clinical Outcomes in Patients with Severe Aortic Stenosis Undergoing TAVI: A Multistate Analysis. Submitted to Circ Cardiovasc Int 2012
6. Stortecky S, Windecker S, Pilgrim T, Heg D, Buellesfeld L, Khattab AA, Huber C, Gloekler S, Nietlispach F, Mattle H, Jüni P, Wenaweser P. Cerebrovascular accidents complicating transcatheter aortic valve implantation: frequency, timing and impact on outcomes. EuroIntervention 2012; 8: 62-70.
7. Kahlert P, Knipp SC, Schlamann M, Thielmann M, Al-Rashid F, Weber M, Johansson U, Wendt D, Jakob HG, Forsting M, Sack S, Erbel R, Eggebrecht H. Silent and apparent cerebral ischemia after percutaneous transfemoral aortic valve implantation: a diffusion-weighted magnetic resonance imaging study. Circulation 2010; 121: 870-8
8. Erdoes G, Basciani R, Huber C, Stortecky S, Wenaweser P, Windecker S, Carrel T, Eberle B. Transcranial Doppler-detected cerebral embolic load during transcatheter aortic valve implantation. Eur J Cardiothorac Surg 2012; 41: 778-83

9. Kahlert P, Al-Rashid F, Döttger P, Mori K, Plicht B, Wendt D, Bergmann L, Kottenberg E, Schlamann M, Mummel P, Holle D, Thielmann M, Jakob HG, Konorza T, Heusch G, Erbel R, Eggebrecht H. Cerebral embolization during transcatheter aortic valve implantation: a transcranial Doppler study. Circulation 2012; 126: 1245-55
10. Webb JG, Barbanti M. Cerebral Embolization During Transcatheter Aortic Valve Implantation. Circulation 2012; 126: 1567-1569
11. Reinsfelt B, Westerlind A, Ioanes D, Zetterberg H, Fredén-Lindqvist J, Ricksten SE. Transcranial Doppler microembolic signals and serum marker evidence of brain injury during transcatheter aortic valve implantation. Acta Anaesthesiol Scand 2012; 56: 240-7
12. Drews T, Pasic M, Buz S, Unbehaun A, Dreysse S, Kukucka M, Mladenow A, Hetzer R. Transcranial Doppler sound detection of cerebral microembolism during transapical aortic valve implantation. Thorac Cardiovasc Surg 2011 Jun; 59(4): 237-42
13. Liu YH, Wang DX, Li LH, Wu XM, Shan GJ, Su Y, Li J, Yu QJ, Shi CX, Huang YN, Sun W. The effects of cardiopulmonary bypass on the number of cerebral microemboli and the incidence of cognitive dysfunction after coronary artery bypass graft surgery. Anesth Analg 2009; 109: 1013-22
14. Gerriets T, Schwarz N, Sammer G, Baehr J, Stolz E, Kaps M, Kloevekorn WP, Bachmann G, Schönburg M. Protecting the brain from gaseous and solid micro-emboli during coronary artery bypass grafting: a randomized controlled trial. Eur Heart J 2010; 31: 360-8
15. Wenaweser P, Pilgrim T, Roth N, Kadner A, Stortecky S, Kalesan B, Meuli F, Büllesfeld L, Khattab AA, Huber C, Eberle B, Erdös G, Meier B, Jüni P, Carrel T, Windecker S. Clinical outcome and predictors for adverse events after transcatheter aortic valve implantation with the use of different devices and access routes. Am Heart J. 2011; 161: 1114-24

Correspondence address:
OA Dr. med. Erdoes Gabor, DEAA
Universitätsklinik für Anästhesiologie und Schmerztherapie
Inselspital - Universitätsspital Bern
CH-3010 Bern, Switzerland
Gabor.Erdoes@insel.ch