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EDITORIAL COMMENT

Three-dimensional transesophageal echocardiography in the prevention of transcatheter aortic valve implantation-related stroke: Another brick in the wall?

ETE-3D na prevenção do AVC peri-TAVI: uma nova arma?

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The introduction of transcatheter aortic valve implantation (TAVI) has changed the classical treatment of patients with severe aortic stenosis (AS). Nowadays, TAVI is recommended for patients with severe symptomatic AS who are considered unsuitable for conventional surgery, according to an evaluation performed by a heart team (in high-risk patients, but still candidates for surgical valve replacement, the decision remains individualized).

As a rapidly evolving technique, with significant technical improvements leading to higher success rates, long-term durability and fewer complications, patient selection criteria and clinical indications for TAVI are likely to expand in the future to non-high-risk surgical candidates (in intermediate-risk patients randomized trials with appropriate scoring systems to assess outcomes and durability are needed).

TAVI requires a multidisciplinary heart team approach, involving clinical and interventional cardiologists, cardiac surgeons, anesthesiologists, and cardiovascular imaging specialists. Imaging plays a central role during TAVI implementation, since it is essential at several stages of the procedure, including patient selection, choice of procedural access, prosthesis type and sizing, intraprocedural guidance, and detection of early and late complications.

Though intraprocedural guidance is usually performed with transesophageal echocardiography (TEE), it is still a matter of debate whether the added value of TEE imaging during TAVI is worth the price of general anesthesia, compared to conventional fluoroscopy (with the associated lack of spatial resolution and increased contrast load and ionizing radiation). Though alternative imaging modalities without general anesthesia, such as intracardiac echocardiography and transnasal TEE, are being explored, they appear to provide inferior quality imaging compared to TEE, and there are concerns with the safety of intracardiac echography.

Compared with the two-dimensional (2D) approach, three-dimensional (3D) TEE appears better for visualizing balloon-expandable valves (though 3D TEE expertise is needed), and also provides a better characterization of cardiac and noncardiac structures involved in the procedure. In the near future, fusion imaging with real-time synchronization of echocardiography and fluoroscopy images using 2D or 3D echocardiography will minimize radiation exposure and may improve outcomes.

During TAVI, periprocedural monitoring with TEE plays an important role. Its advantages include assessment of aortic root morphology and valve leaflet behavior both during balloon valvuloplasty (visualization of the balloon in the aortic annulus, assessment of the space within the sinuses to accommodate the calcified leaflets, imaging of coronary ostia to determine risk of obstruction, and detection of severe regurgitation post valvuloplasty) and during valve deployment (correction of valve positioning post deployment, avoiding complications arising from low and high positioning and allowing correction of position and post-dilatation.

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Additionally, TEE is essential in the early detection and treatment of major classical TAVI complications (aortic regurgitation, myocardial ischemia, mitral regurgitation, pericardial effusion, aortic dissection or root rupture, and stroke).

Although TAVI is considered an effective and safe therapeutic option for patients with AS and high surgical risk, the 30-day and in-hospital mortality of patients undergoing this procedure is still variable, between 5 and 10%.[1–3] This mortality is mainly associated with procedure-related complications such as vascular complications, device embolization and stroke.

Periprocedural stroke[1–4] is in fact a major issue in TAVI. Though its frequency is highly variable (rates ranging from 0 to 10%), it is associated with poor prognosis, 30-day mortality being about 40%, compared to around 5% in patients without stroke.[4]

The pathophysiology of peri-interventional ischemic stroke is multifactorial, and many possible sources are detectable by TEE: thromboembolism from catheters (atherosclerotic material displaced from the arterial tree during valve delivery or catheter advancement), post-valvuloplasty valve remains (embolization of aortic cusp fragments), erosion of ascending aorta and aortic arch plaques, aortic arch dissection extending into the supra-aortic vessels, thrombosis of the implanted valve, air embolism, spontaneous echo contrast in the left atrium, atrial fibrillation, and prolonged hypotension.

In this issue of the *Journal*, Arroyo-Úcar et al.[5] specifically investigate the incidence and clinical relevance of the presence of mobile echogenic images (MEI) as potential embolic sources, detected with 3D TEE during TAVI procedures. Though they identified MEI in 11% of TAVI procedures (in most cases thrombus attached to catheters or remains of former valve structures), they did not observe an increased incidence of periprocedural stroke in patients with MEI. Additionally, in 45% of cases, the MEI disappeared during the procedure without a higher incidence of periprocedural stroke.

From these results some important issues arise:

1. Thorough preprocedural screening by multiple invasive and noninvasive imaging techniques is imperative for TAVI candidates, in order to fully characterize the aortic annulus, the adjacent aorta and the vascular tree, and to define the optimal route for arterial access in order to minimize ischemic stroke.
2. The role of peri-interventional TEE in the identification of potential causes of stroke (particularly embolization of aortic cusp fragments and thromboembolism from catheters) is crucial. The identification and characterization of MEI can help operators to modify their strategy, avoiding and correcting specific precipitating factors (for instance heparin dosage and type of arterial access), minimizing the risk of embolism. This probably partially explains the disappearance of MEI without stroke in 45% of the patients, though small subclinical microembolic stroke and minor non-cerebral embolism should also have been systematically excluded.
3. The potential incremental role of 3D TEE (over the 2D approach) seems to be particularly useful in correct characterization of the embolic source, since the real-time 3D image provides high-quality information on its location, time of onset, mechanism and relation to cardiac structures and devices used during the procedure.

In conclusion, the paper by Arroyo-Úcar et al. raises a number of important issues, though many of them remain unanswered. Accordingly, the results of this study should be confirmed in further studies in multiple centers, with large number of patients and with different designs and aims. These should assess the clinical impact of MEI detection on operators' strategy in order to modify potential stroke-precipitating factors and their clinical consequences in patient outcomes. The presence of minor subclinical microembolism, cerebral and non-cerebral, should also be systematically excluded. Finally, generalization of the results to other available TAVI systems should also be addressed in future studies.

Conflicts of interest

The author has no conflicts of interest to declare.

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