

Anesthetic management for percutaneous aortic valve implantation: an overview of worldwide experiences

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ABSTRACT

Transcatheter aortic valve implantation is an emergent technique for high risk patients with aortic stenosis. Transcatheter aortic valve implantation poses significant challenges about its management, due to the procedure itself (i.e. the passage of large stiff sheaths in diseased vessels, the valve dilatation and the prosthesis positioning during a partial cardiac standstill) and the population of elder and high-risk patients who undergo the implantation. Retrograde transfemoral approach is the most popular procedure and a great number of cases is reported. Nevertheless, there is not a consensus regarding the intraoperative anesthesiological strategies, which vary in the different Centers. Sedation plus local anesthesia or general anesthesia are both valid alternatives and can be applied according to patient's characteristics and procedural instances. Most groups started the implantation program with a general anesthesia; indeed, it offers many advantages, mainly regarding the possibility of an early diagnosis and treatment of potential complications, through the use of the transesophageal echocardiography. However, after the initial experiences, many groups began to employ routinely sedation plus local anesthesia for transcatheter aortic valve implantation and their procedural and periprocedural success demonstrates that it is feasible, with many possible advantages. Many aspects about perioperative anesthetic management for transcatheter aortic valve implantation are still to be defined. Aim of this work is to clarify the different management strategies through a review of the available literature published in pubmed till June 2011.

Keywords: TAVI, anesthesia, intensive care, aortic valve replacement, aortic stenosis.

INTRODUCTION

Aortic stenosis is the most frequent and dangerous among native valve diseases (1, 2), affecting 2-4% of patients over 65 years. Aortic valve replacement is the definitive therapy for severe aortic stenosis (3, 4); however, it exposes patients to the risks associated with sternotomy or thoracotomy, cardiopulmonary bypass, cardiac ar-

rest and general anaesthesia (GA), which are ominous especially in the growing extremely aged population and those with medical comorbidities. Thus, one third or more of patients with severe symptomatic aortic stenosis are managed without operative intervention because of the high risk in case of surgery. Nevertheless, patients treated with medical therapy have a poor prognosis. In addition, heavily calcified aortas, previous mediastinal radiation and redo valvular surgery are frequent causes to refer patients for non-surgical therapies (5-7). Medical therapy and balloon aortic valvuloplasty are not deemed valid thera-

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peutic options for severe aortic stenosis (4). Given these considerations, Transcatheter Aortic Valve Implantation (TAVI) is currently performed with high-risk patients and represents a therapeutic chance in case of inoperability (8). We reviewed all available literature published in pubmed till June 2011 that addressed the anesthesiological management for TAVI.

TAVI procedure

Two technologies, the balloon-expandable Edwards/Sapien Bioprosthesis (Edwards Life-sciences Inc., Orange, CA), and the self-expandable CoreValve ReValving System (CRS TM, CoreValve Inc., CA, USA) have been used in the largest clinical series. These technologies present differences in design and implantation technique. Several other technologies are being developed and have entered or are expected to enter an active phase of clinical testing in the next months.

There are several approaches for TAVI: retrograde (through femoral artery, retroperitoneal iliac artery and the ascending aorta (9), or subclavian artery (10-12)) or transapical (passage through the left ventricle apex after thoracotomy (13, 14)). The retrograde transfemoral approach is the most popular transcatheter procedure, nevertheless it requires specific characteristics of the arterial access, particularly as far as size, tortuosity, calcification are concerned. The common femoral artery can be either approached surgically or percutaneously. Under fluoroscopic guidance, the severe stenotic aortic valve is dilated by balloon aortic valvuloplasty and, after introduction of the sheath, prosthesis is positioned and released. Rapid ventricular pacing is maintained during balloon aortic valvuloplasty and valve implantation to minimise cardiac output and possible slippage of the device. Availability of proper imaging technique, provided by high resolu-

tion fluoroscopy, contrast angiography and transesophageal echocardiography (TEE), is a key component in the success of TAVI. In fact, incorrect placement can result in device embolization distally into the aorta or proximally into the left ventricle causing hemodynamic instability. Other complications include excessive perivalvular regurgitation, coronary ostial obstruction, interference of mitral valve function, vascular dissection and tamponade. After the final imaging and hemodynamic assessment of device position and functions, and in case further dilatation of the valve stent is deemed unnecessary, the delivery system is removed and the vascular access sites closed. The venous puncture sites can be closed by manual compression, whereas the arterial entry sites can be closed by closure devices or with a surgical approach. Iliac and femoral angiography is advocated to ensure the integrity of the vessel repair and the absence of vascular complications such as perforation, dissection and occlusion. Surgical repair of these complications may be required, as well as endovascular stenting in selected cases. Vascular closure is often the most time-consuming aspect of the transfemoral procedure (8, 15).

There are currently at least 17 TAVI programs in active research worldwide and the number of published transfemoral cases reaches half a thousand (15).

Review of literature on techniques of anesthesia

Despite the impressive number of treated patients, there is still a lack of consensus about the anesthetic management of TAVI (16). Most groups started the implantation program with a GA (17-23). This technique was justified initially by uncertainty linked to a new procedure and to operator's learning curve. Indeed, many aspects were unknown at that time, particularly those dealing with the possible complications and the

hemodynamic challenges, mainly arising from the necessity of a temporary cardiac immobility during valvuloplasty and valve implantation. Lastly, patients with cardiac hypertrophy, comorbidities and advanced age require intense care under anesthesia. However, after the initial experience, cardiac anesthesiologists chose their own way, with a consistent number of Centers preferring the sedation with local anesthesia approach (LA) (18, 21, 22).

Ree et al. reported their experience with 40 cases of transfemoral implantation of balloon-expandable valve (23). After an initial approach with sedation, this group manages now TAVI procedures with GA.

In fact, surgical vascular repair is routinely performed in their Institution and needs a complete immobility of the patient during the procedure. Moreover, GA allowed the use of TEE. Ree et al prefer a balanced anesthetic technique, supported by the better protection from ischemic insult by administration of inhalation agents (24). Doses are reduced and titrated according to patients' characteristics. After the operation, extubation in the theater is always considered as an option; however, many patients need a longer respiratory weaning in Intensive Care Unit. Despite the advantages of GA, in their opinion local anesthesia could be a future perspective accompanying the development of minimally invasive devices, alternative ways to induce the outflow reduction and the possible use of intracardiac echocardiography.

Another group from Columbia University, Billings et al., described 29 cases (17). Again, they consider GA mandatory, as a consequence of the procedural characteristics and the necessity of TEE. In their Institute TEE is performed as a baseline examination and during the procedure. However, in their experience, transesophageal probe can sometimes interfere with the fluoroscopic imaging and may have to

be withdrawn. GA permits interruption of mechanical ventilation and limit the respiratory translocation of heart during valvuloplasty and implantation. On the other hand, in their opinion, sedation could be advantageous considering the mortality and morbidity risks of GA induction in patient with a significant aortic stenosis.

On the contrary, Behan et al. published a report (12 patients) that sustains the superiority of remifentanil-based sedation in TAVI procedures (18). According the Authors, there is a trend towards shorter procedure time, time to ambulation, high-dependency unit stay and hospital stay in patients treated with sedation. Moreover, in their opinion, GA could be very risky in these old patients causing respiratory complications and hypotension with renal dysfunction. They report one case of conversion to GA because of restlessness of the patient. Their strategy included a laryngeal mask and a spontaneous breathing (sevoflurane in oxygen and air) during the rest of the operation in this patient. Fluoroscopic imaging and aortogram are considered as safe as TEE in providing anatomical details. Our group recently published the report of 69 cases of transfemoral and subclavian approach for aortic valve implantation (22). In our experience, GA has been the preferred technique at the beginning of the implantation program, as described in our initial works (16, 19). In our Institute, anesthesia induction is performed with propofol, fentanyl and rocuronium; anesthesia is then maintained with sevoflurane and remifentanil. With increasing operators' expertise (the technique became straightforward and the feasibility of LA became apparent), a shift was seen towards an almost exclusive use of LA (lidocaine subcutaneously at the arterial and venous access sites, and remifentanil infusion). The passage of relatively large and stiff deployment catheters through the arteries is well toler-

ated with LA. Intravenous sedation is used to maximize comfort rather than to provide analgesia. In patients with reduced metabolic capacity (at increased risk for neurologic and cardiac toxicity), a preoperative ilioinguinal/iliohypogastric block (transfemoral approach) or superficial cervical plexus (subclavian approach) is performed to reduce the total dose of local anesthetics. When LA is employed the anesthesiologist must be ready to institute full GA at any moment (we described two cases of conversion to GA as a consequence of restlessness and a case of refractory ventricular fibrillation). Patients with anticipated difficult airway are obviously unsuitable for this technique. In our Institution, GA is reserved to specific situations which, according to operator's and anesthesiologist's clinical evaluation, lead to high risk of procedural complications. During the procedure, imaging is provided by fluoroscopy and angiography; TEE is performed in high risk cases or in case of complications when patients are intubated.

Guiding principles for anesthesia techniques

TAVI is an emergent technique in the treatment of AS and perioperative strategies keep on evolving. It poses significant challenges about its management, due to the procedure itself and to the population of elder and high-risk patients who undergo the implantation.

General agreement was expressed upon the importance of the presence of a cardiovascular anesthesiologist during the procedure, since he is familiar with advanced cardiac life support, TEE and anaesthesia care for mechanical circulatory support, during cardiopulmonary bypass and emergency valve or aortic surgical replacement (16-23). Operator-delivered sedation is unlikely to be successful for those patients whose hemodynamics are brittle and tolerance of

invasive procedures may be limited. As a consequence, the cath-lab has to be stocked with additional equipment and drugs that anesthesia providers typically require as monitoring and to manage difficult airways and hemodynamically unstable patients.

Procedural echocardiographic imaging evidently plays a key role in valve implantation and early diagnosis of complications. Thus, the main argument presented in favour of GA during TAVI is the necessity of transesophageal echocardiographic imaging. In the majority of published experience a preoperative evaluation (angio computed tomography, angiography, TEE) is described; diagnostic confirmation and valve sizing performed in the cath lab just before the procedure could be unnecessary and time spending. However, intraprocedural echocardiography is matter of debate, even if published data are few and refer to the initial experience with TAVI, been probably greatly affected by the operator's learning curve. TEE aides the advancement of guidewires and delivery system and allows to evaluate the effects of balloon aortic valvuloplasty (leaflet mobility, aortic regurgitation), the position of the prosthesis at deployment, and the post-implant valve assessment (area and gradient, leaflet mobility, regurgitation grade and location). TEE is of particular value when valve calcification are mild and fluoroscopic imaging is difficult. Moreover, it provides information about preload and ventricular function, thoracic aorta anatomy and procedure-related complications, such as pericardial effusion and iatrogenic mitral regurgitation, thus guiding a prompt management of these events. Recently Bagur et al. demonstrated that TEE used as primary imaging is associated to the same clinical and hemodynamic results as angiographic guided procedures (25). However, it is sometimes limited in its ability to clearly distinguish the prosthesis while crimped on the delivery system and

it may interfere with fluoroscopic imaging, necessitating probe withdrawal at the time of implantation (26, 27).

Despite the important role of echocardiographic imaging in prosthesis positioning and implantation, a high procedural success is reported also by authors who do not use TEE routinely. Nevertheless, cardiologists rightly make rationale use of available imaging techniques, according to procedural instances and personal experience.

Also, complications and death do not seem to diminish substantially when TEE is routinely performed, according to the few experiences published, even if the significant reduction in the use of contrast media may have a potential benefit on post-procedural nephropathy (28). The general opinion is that TEE helps in correct and rapid management of complications; however, its use as a routine may not be justified. Actually, when LA is performed, a rapid induction of GA in case of necessity (stand-by GA) permits to exploit ecocardiographic imaging very rapidly. In our experience, trans-thoracic echocardiography is always performed at the end of the procedure while periprocedural TEE evaluation is usually reserved to selected high-risk cases (aortic disease, concomitant heart valve problems) and when complications are suspected. Interestingly, Guarracino et al. recently described three cases during which TEE was performed passing the probe through a hole in a non-invasive-ventilation face mask during deep sedation (29).

Initial reports recently appeared in literature, where minimally invasive cardiac output monitoring during the procedure is reported in these patients or in hemodynamically unstable patients (30, 31).

Moreover, newer modalities including intra-cardiac and three dimensional echocardiography, and computed tomography angiography may further assist these procedures. These techniques could be a possible

future chance for TAVI, but their feasibility has to be proven.

Another important issue reported by the literature is the incidence of vascular complications which could be lowered if the patient is completely immobile under GA. Data reported do not confirm this concern: incidence of vascular complications is unrelated to the anesthetic technique, even if GA could be advantageous when a surgical repair is necessary and takes a long time (16-23). Tranfusions, in the same way, present a similar percentage when GA or LA is used (16-23).

Risks associated with GA induction are not common, according to presented data. Necessity of inotropic support seems to be higher in centres performing GA. Since pre-operative characteristics are similar in the different centers, vasodilation and cardiac effects produced by anesthetic drugs could be considered as a hypotension trigger.

Among authors performing LA, there is an agreement about the fact that when LA is employed the anaesthesiologist must be ready to institute full GA at any moment (18, 24).

Procedural timing appears to be higher when GA is preferred and particularly when preprocedural TEE is performed. ICU stay also seems to be longer in this groups however, given the variability of periprocedural approaches used in these institutions, any conclusion about timing and cost seems inappropriate (16-23).

Postprocedural management should be investigated in anesthesiological literature about TAVI because many aspects are not sufficiently cleared. First of all, which is the best postprocedural hemodynamical monitoring? Then, major attention should be drawn to complications like postprocedural bleeding and surgical intervention, antiplatelet therapy, development of renal injury and its prevention and treatment, incidence and prophylaxis of infections.

CONCLUSIONS

Seven years after the first successful implantation, many aspects about perioperative anesthesiologic management for TAVI are still to be defined. Surely, the presence of a cardiovascular anesthesiologist is mandatory, given procedural technical aspects and patient features.

Anesthetic strategies vary in the different Centers. Authors performing GA conclude in their works that LA would probably be a valid alternative in the future. Many groups already employ routinely LA for TAVI and their procedural and periprocedural success demonstrate that it is feasible, with many possible advantages. In our experience, LA or GA are both valid alternatives, to be titrated according to patient's characteristics and procedural instances. There is need for a randomized controlled trial of LA versus GA to determine the best anesthesiologic strategy for this kind of procedure.

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