TÜBİTAK

Turkish Journal of Medical Sciences

http://journals.tubitak.gov.tr/medical/

Research Article

Turk J Med Sci
(2014) 44: 703-708
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doi:10.3906/sag-1305-49

Anesthetic management and perioperative complications in transcatheter aortic valve implantation: the Turkish experience

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Received: 09.05.2013 • **Accepted:** 18.09.2013 • **Published Online:** 27.05.2014 • **Printed:** 26.06.2014

Background/aim: To describe the anesthetic management and early results of transcatheter aortic valve implantation (TAVI) in a single center in Turkey.

Materials and methods: We evaluated 79 (54 females, 25 males; mean age: 76 ± 9 years) consecutive symptomatic patients with severe aortic stenosis who underwent TAVI under general anesthesia between July 2011 and September 2012. We preferred a transfemoral approach as the first option.

Results: The duration of anesthesia was 149 ± 49 min. Thirty-eight percent of the patients were extubated in the cardiac catheterization laboratory. Three patients required a permanent pacemaker, while 8 patients required inotropic support in the postoperative period. Mortality rate was 9% within 30 days. Fifteen patients had vascular complications, of which 53% were treated surgically.

Conclusion: Today, as a result of developments in technology, TAVI can be considered as a beneficial alternative treatment option for inoperable aortic stenosis patients. Thus, anesthesiologists will be confronted with a number of TAVI cases, and so they should be prepared to face issues related to the patient's safety both during the administration of anesthesia and in the postoperative period in the near future.

Key words: Transcatheter aortic valve implantation, anesthetic management, aortic stenosis

1. Introduction

Transcatheter aortic valve implantation (TAVI) has emerged as an alternative curative therapy in patients with severe calcific aortic stenosis, which, in aging populations, has a high operative rate (1). Continuing advances in percutaneous valve technology, prolonged life expectancy in this population, major progress in preprocedural routines, multidisciplinary assessment of patients in terms of full anesthetic evaluation, patient comorbidities, and increased experiences with randomized trials have introduced TAVI into clinical practice for primary valve implantation (2,3). An anesthesiologist plays an essential role in the TAVI team (4). For successful anesthetic management in these patients, it is important to select the best approach with an understanding of the patient's health status and choices (5). This paper evaluates the perioperative anesthetic experience with examination of early outcomes for a consecutive series of patients who underwent TAVI in our institution within a 1-year period.

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2. Materials and methods

Between July 2011 and September 2012, 79 TAVI procedures were performed via a transaxillary (n = 3) or transfemoral approach (n = 76) at Ankara Atatürk Education and Research Hospital. We investigated the data of these patients with regard to anesthetic issues. The institutional ethics committee approved the study and all patients gave signed written informed consent. Following evaluation of the individual patient on the basis of international recommendations by a cardiologist, cardiac surgeon, and anesthesiologist, a decision of suitability for not only the high risk of conventional surgery but also for TAVI was made (6–11). Preoperatively, in addition to clinical evaluation, all patients were screened by transthoracic echocardiography, coronary angiography, iliofemoral contrast angiography, and computed tomography.

The anesthesiologist determined the anesthetic management to be offered. The patients were followed as to clinical data, transthoracic echocardiographic results, parameters related to the procedure, and intensive care

unit and hospital stay lengths until hospital discharge. Afterwards, information on survival in the following 30 days was obtained after calling the patient by phone. We performed the procedure in the cardiac catheterization laboratory (CCL), which has similar sterility precautions as an operating room with mobile C-arm fluoroscopy. A retrograde transfemoral arterial valve implantation was initially planned for the patients. For those patients for whom the transfemoral approach was unsuitable, subclavian access was performed. The CoreValve (Medtronic CV, Luxembourg) or the Edwards Sapien (Edwards Lifesciences, Irvine, CA, USA) bioprostheses were implanted. Standard technical applications of the TAVI procedure were applied as have been previously described (12). Routine anesthetic preprocedural evaluation focused on cardiovascular parameters, airway control, and other systemic dysfunctions. Before the procedure, oral acetylsalicylic acid (100 mg), clopidogrel (300 mg), and intravenous (IV) antibiotics were administered to all patients. No premedication was given. All patients underwent general anesthesia under fluoroscopic and transesophageal echocardiography (TEE) guidance.

In the operating room, a heating blanket was placed beneath the patient to prevent hypothermia and nasopharyngeal temperature was measured during the procedure. After inserting an IV catheter into a large arm vein, standard monitoring was applied. We applied a 5-lead electrocardiogram, invasive arterial blood pressure measurement, pulse oximetry, and central venous pressure monitor. Pulmonary artery catheterization was not performed in any of the patients. At the beginning of the procedure, we administered heparin 5000 IV to achieve an activated clotting time of more than 250 s. Local anesthetic infiltration, consisting of 10–20 mL of 1% lidocaine, was performed in the groin. All procedures were performed under general anesthesia. Different agents were used to provide the general anesthesia (GA). Sodium thiopental (3–5 mg kg^{-1}), etomidate (3 mg kg^{-1}), or propofol (1–2 mg kg^{-1}) was used for anesthesia induction. Rocuronium (0.6 mg kg^{-1}) was used for muscular relaxation. All patients were orally intubated and mechanically ventilated with a tidal volume of 6–8 mL kg^{-1} and a respiratory rate of 12–16 breaths min^{-1}. End-tidal CO_2 concentrations of 30–35 mmHg were considered as adequate. The TEE probe was then inserted. According to the records, either sevoflurane (0.8%–1.1% minimum alveolar concentration) in an oxygen air mixture at 50% FiO_2 combined with a remifentanil infusion (0.02–2 μg kg^{-1} min^{-1}) or propofol/remifentanil infusion (3–5 mg kg^{-1} h^{-1}/0.02–2 μg kg^{-1} min^{-1}) (total intravenous anesthesia technique) was used for maintenance of anesthesia. However, hemodynamic stabilization was not easy to achieve in these elderly patients with reduced cardiac output by the total intravenous anesthesia technique. That is why we applied this technique in only 5 appropriate patients (6.3%). In the rest of the patients, we chose to use inhalational anesthesia in combination with remifentanil infusion. The remifentanil infusion also provided earlier recovery with a short-lasting muscle relaxant (rocuronium). We aimed to keep the mean arterial pressure above 65 mmHg during the procedure. To achieve this goal, hypovolemia was corrected by rapid volume expansion initially. When preload and contractility were evaluated by TEE as optimal, bolus or continuous ephedrine (5 mg), epinephrine (5 μg), and/or norepinephrine (0.03–0.06 μg kg^{-1} min^{-1}) infusions were used to correct arterial hypotension (systolic arterial pressure of <80 mmHg). After 4 bolus injections, we applied vasoactive drugs. Nevertheless, the mean arterial pressure was increased above 75 mmHg to prevent deterioration in hemodynamic parameters. Two external defibrillator pads were attached. Under fluoroscopic guidance, ventricular pacing was performed at a rate of 180 beats min^{-1} with a decrease in systolic arterial pressure to less than 50 mmHg. The ventricular outflow was minimized and balloon dilatation of the stenotic valve was performed. Fluoroscopy, aortography, and TEE were used to confirm proper positioning of the prosthesis and to assess perivalvular or transvalvular aortic regurgitation at the end of the procedure. The femoral artery was closed percutaneously, except in cases of difficulties, when the closure was performed surgically. Extubation immediately after the procedure in the CCL is routinely done in our clinic. However, the long distance between the intensive care unit (ICU) and the CCL meant that some of the anesthesiologists preferred extubation in the ICU. Patients with hemodynamic instability, acute complications related to femoral/subclavian vessel manipulations, and/or rhythm disturbances at the end of the procedure were not extubated and were transferred to the ICU. Postoperative analgesia was provided by 1.0 mg kg^{-1} of IV tramadol every 6 h.

2.1. Statistical analysis

SPSS 11.5 for Windows (SPSS Inc., Chicago, IL, USA) was used for data analysis. Whether the distributions of continuous variables were normal or not was determined by the Shapiro–Wilk test. Data were shown as mean ± standard deviation or median (min–max), where applicable. The median differences between pre- and postprocedure measurements regarding left ventricular ejection fraction, aortic velocity, and aortic valve gradient were analyzed by Wilcoxon signed-rank test. The McNemar test was applied for evaluation of the significance of differences in incidence of left ventricular hypertrophy. $P < 0.05$ was considered as statistically significant.

3. Results

All TAVI patients in this report received GA, because it was in the early phase of the physician's learning curve and TEE during the procedure was considered necessary and important. After this phase, we preferred local anesthesia plus sedation, but the case series was small (n = 6).

A total of 79 TAVI patients were evaluated in this study (25 men and 54 women). The mean age of the patients was 76 ± 9 years. Comorbidities and baseline characteristics of the TAVI population are listed in Table 1.

All the patients presented high surgical risk (Society of Thoracic Surgeons risk score: 17; logistic EuroSCORE: 17.3). Severe pulmonary hypertension was detected in 46 patients (pulmonary artery systolic pressure of >60 mmHg). In 6 of the patients with the transfemoral approach, the procedure required an open cut down to the vessels. The Edwards Sapien valve was implanted in the majority of patients (n = 53), while the Medtronic CoreValve Revalving System was chosen in only 26 patients. A retrograde transfemoral approach was suitable in 76 cases in the series, but in 3 cases, TAVI was performed by subclavian artery approach. Procedural and anesthesia-related outcomes are reported in Tables 2 and 3, respectively. No complications such as device migration, prosthesis malpositioning, or obstruction of coronary ostia occurred in the patients. The procedure lasted 109 ± 47 min.

Hemodynamic instability and target arterial pressure values determined the use of vasoactive and inotropic agents. Persistent atrioventricular block, resulting after the procedure in 3 patients, was treated with permanent pacemaker implantation. Sixty-two percent of the patients were extubated in the ICU. Only 6% had mechanical ventilation periods longer than 48 h. The mean length of stay in the ICU and in the hospital was 3 and 13 days, respectively.

Table 1. Demographic data and comorbidities of the TAVI patients.Loading, please wait...

Baseline clinical characteristics		
Sex, men	25 (32) *	
Age, years		76 ± 9 β
Height, cm		158 ± 11 β
Weight, kg		69 ± 14 β
BMI		27 ± 5 β
Atrial fibrillation	21 (27) *	
Hyperlipidemia	13 (17) *	
Renal failure (creatinine of >2 mg/dL or creatinine clearance of <30 mL/min)	4 (5) *	
Diabetes mellitus (insulin therapy)	22 (28) *	
Peripheral vascular disease	8 (10) *	
Coronary artery disease	46 (58) *	
Prior acute myocardial infarction	5 (6) *	
Prior coronary angioplasty	42 (53) *	
Prior CABG surgery	8 (10) *	
Prior valve surgery	4 (5) *	
COPD	15 (19) *	
Cerebrovascular disease	3 (4) *	
Pulmonary hypertension	46 (58) *	
Echocardiographic data		
Left ventricular ejection fraction		60 (15–70) γ
Mean gradient, mmHg		50 (24–101) γ
Peak gradient, mmHg		75 (37–125) γ

*: Data are expressed as number (%), β: data are expressed as mean ± standard deviation, γ: data are expressed as median (interquartile).

Table 2. Procedural parameters of the TAVI patients.

Total procedure time, min	109 ± 47 β
Valve type	
Medtronic CoreValve	26 (33) *
Edwards Sapien	53 (67) *
Postprocedural inotropic requirement	8 (10) *
Major vascular complication	8 (10) *
Pacemaker implantation	3 (38) *
30-day mortality	7 (9) *
Ventricular rupture	2 (3) *
Ventricular fibrillation following anesthesia induction	1 (1) *
Deaths in postoperative days	4 (5) *
Vascular complications	15 (19) *
Emergent vascular surgery	8 (10) *

β: Data are expressed as mean ± standard deviation, *: data are expressed as number (%).

Table 3. Anesthesia-related parameters of the TAVI patients.

Total anesthesia time (min)	149 ± 49 β
Norepinephrine	31 (39) *
Ephedrine	10 (13) *
Inotropic agent requirement	12 (15) *
Tracheal extubation in the CCL	30 (38) *
Length of stay in the ICU, days	3 (1–29) γ
Length of hospital stay, days	13 (3–30) γ
Mechanical ventilation of >48 h in ICU	5 (6) *

β: Data are expressed as mean ± standard deviation, *data are expressed as number (%), γ: data are expressed as median (interquartile).

Fifteen patients had vascular complications and 8 of these patients had vascular repair during the procedure due to a laceration in the femoral access site. Ninety-one percent of the patients survived 30 days after TAVI. Ventricular fibrillation following induction of anesthesia, intraprocedural left ventricular perforation, and early cardiac complications were the main causes of death.

4. Discussion

The early results of our study show that TAVI is emerging as a safe and successful therapy for high-risk patients with severe aortic stenosis in cases with no surgical options. This is an expected result in comparison to conventional aortic valve replacement (AVR), because almost one-third of patients who could benefit from AVR did not actually receive such treatment because of advanced age or significant comorbidities (13). It is pointed out that anesthesiologists and intensive care specialists come across new challenges during TAVI and other transcatheter-related procedures (14,15). However, anesthesia-related issues should be clarified by more comparative and randomized studies with longer follow-up periods (7,14,16). Many studies indicate that fast-track GA management is the most appropriate and safest anesthesia technique for any of the transfemoral, transapical, and transaxillary approaches (15,17–19). There are only a few studies comparing the anesthetic techniques used in patients undergoing TAVI (16,20,21). In the first report, decreased ICU stay and faster hospital discharge were reported in patients undergoing sedation (22). In another study, Dehédin et al. found not only a significantly lower requirement for vasoactive or inotropic drug use, but also a significantly shorter length of hospital stay in the monitored anesthesia care (MAC) group compared to the GA group (20). These data were comparable to Motloch et al.'s findings, but were in contrast to previous work by Bergmann et al., which did not show any superiority of MAC over GA management (16,21). At our institution, we preferred general anesthesia with tracheal intubation and continuous TEE monitoring at the beginning of the procedures. For induction of anesthesia, we used either sodium thiopental, etomidate, or propofol. A balanced technique, composed of sevoflurane combined with remifentanil or propofol/remifentanil infusion, was used during maintenance. This anesthetic practice allowed rapid recovery in the elderly patients. According to our protocol, all patients were transferred to the ICU at the end of the procedure and 38% of the patients had been already extubated in the CCL. The patients extubated in the ICU (62%) were the first patients to have this experience. The long distance between the CCL and ICU at our institution made us concerned about the safety of airway and hemodynamic parameters during the transport of the patients. We think that the number of patients extubated early during the study was low, but was closely associated with better management of anesthesia. Among those extubated in the ICU, only 5 patients had mechanical ventilation longer than 48 h due to hemodynamic instability, rhythm disturbances, and vascular access problems. However, like Covello et al. (15), we switched to the use of local anesthesia plus sedation

following an assumed learning curve, but our case series with this management was too small to compare it with published data. Both the lengths of ICU and hospital stay of the patients in the follow-up period were comparable with those of other authors (16,20). Our results in regards to 30-day mortality also compare well with those reported in other recently published studies (23–26).

Nevertheless, the 1-year mortality in our series cannot be reported because we could not complete the follow-up period in all patients due to a lack of communication. Tamburino et al. found a low rate of 30-day mortality that compared favorably with the 7% to 14% reported in earlier experiences with the third-generation CoreValve device (27). In our series, 53 patients received balloon-expanding Edwards Sapien bioprostheses; therefore, it is difficult to compare the results with those of Tamburino et al., who had mainly chosen a CoreValve device. As far as the hemodynamic goals are concerned, we carefully titrated intravenous fluid, as applied typically in aortic stenosis patients. We also used vasopressors prior to or immediately after rapid ventricular pacing to provide coronary perfusion as soon as possible. After the procedure, patients should be followed critically (7). However, most authors agree that anesthesia techniques and drugs are not associated with major postprocedural complications (7,20). On the other hand, the incidence of postprocedural complications in TAVI is low when compared to conventional AVR surgery (26,28,29). Interestingly, in our study, we had a high incidence of vascular complications. Surgery was required in 8 patients. Other authors encountered an incidence of 10%–15% of vascular complications using the retrograde transfemoral approach (8,30). In another study, femoral pseudoaneurysm appeared as a complication in diagnostic angiograms and interventional procedures at rates of 0.1%–0.2% and 0.8%–2.2%, respectively (31). Regarding our results, we believe in the importance of experience for improved clinical results. In conclusion, our results show that TAVI is becoming a beneficial alternative for inoperable aortic stenosis among elderly patients. Future studies in regard to anesthesia are required in this field, and, as anesthesiologists, we must be aware of the entire procedure and several other factors for the patient's safety.

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