



## ORIGINAL INVESTIGATION

## Comparison of anesthesia management in transcatheter aortic valve implantation: a retrospective cohort study

Gönül Erkan<sup>a</sup>, Buket Ozyaprak<sup>b</sup>, Ferdane Aydoğdu Kaya<sup>a</sup>, İhsan Dursun<sup>c,\*</sup>, Levent Korkmaz<sup>c</sup>

<sup>a</sup> Health Sciences University, Ahi Evren Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Anesthesiology and Reanimation, Trabzon, Turkey

<sup>b</sup> Health Sciences University, Bursa Yüksek İhtisas Training and Research Hospital, Department of Anesthesiology and Reanimation, Bursa, Turkey

<sup>c</sup> Health Sciences University, Ahi Evren Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Cardiology, Trabzon, Turkey

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### KEYWORDS

Heart valve prosthesis;  
Aortic stenosis;  
Local anesthesia;  
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### Abstract

**Background and objectives:** We aimed to investigate the effects of two different anesthetic techniques in our patients who underwent transcatheter aortic valve implantation (TAVI).

**Methods:** In this study, 303 patients who underwent TAVI procedure with a diagnosis of severe aortic stenosis between January 1, 2012 and December 31, 2018 were retrospectively evaluated. The patients were divided according to the type of anesthesia given during each procedure as; general anesthesia (GA), local anesthesia (LA).

**Results:** LA was preferred in 245 (80.8%) of 303 patients who underwent TAVI, while GA was preferred in 58 patients (19.1%). Median ages of our patients who received LA and GA were 83 and 84, respectively. The procedure and anesthesia durations of the patients in the GA group were longer than the LA group ( $p < 0.00001$ ,  $p < 0.00001$ , respectively). Demographic and pre-operative clinical data were similar in comparison between two groups ( $p > 0.05$ ) except for peripheral artery disease. Hypertension was the most common comorbidity in both groups. While the number of inotrope use was significantly higher in patients who received GA ( $p < 0.00001$ ), no significant differences were found between LA and GA patients in terms of major complications and mortality ( $p > 0.05$ ). Intensive care and hospital stays were significantly shorter in the LA group ( $p = 0.001$ ,  $p = 0.023$ , respectively).

\* Corresponding author.

E-mail: [ihsandursun76@gmail.com](mailto:ihsandursun76@gmail.com) (İ. Dursun).

*Conclusion:* The anesthetic technique of TAVI procedure did not have a significant effect on outcomes including; complications, mortality and success of the procedure. LA provides shorter duration of procedure and hospital stay.

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## Introduction

Severe aortic stenosis is an increasingly important health problem in elderly people.<sup>1,2</sup> If symptomatic aortic stenosis is not treated, it has a poor prognosis and results in mortality shortly.<sup>3-5</sup> Surgical aortic valve replacement (AVR) and transcatheter aortic valve implantation (TAVI) are the methods used in the treatment of aortic stenosis.<sup>6,7</sup> TAVI is an up-to-date treatment approach that is frequently preferred because it is less invasive than AVR, which is a superior surgical method compared to medical treatment.<sup>7</sup>

The fact that patients undergoing TAVI are high-risk and elderly patients may cause many difficulties in anesthesia management. General anesthesia (GA) and local anesthesia (LA) are the preferred anesthesia methods during TAVI procedure in our clinic and in many hospitals around the world.<sup>7,8</sup> Although GA was used more commonly in the beginning of our clinical studies, LA became more widespread with the increasing experience of those performing the procedure.<sup>9</sup> Comorbidities observed in each patient provides information regarding which anesthetic technique may provide advantage and be more suitable during the TAVI procedure.<sup>10,11</sup> In this study, we aimed to investigate the effects of two different anesthetic techniques on outcomes including complications, mortality, and success of the procedure in our patients who underwent TAVI procedure.

## Methods

Within the scope of the retrospective cohort study, 337 patients who underwent TAVI with a diagnosis of severe aortic stenosis between January 1, 2012 and December 31, 2018 in Trabzon Ahi Evren Training and Research Hospital were evaluated. The study was initiated after obtaining the local ethics committee approval (2019/07), in accordance with the principles of Helsinki declaration. The consents of the patient and/or patients' relatives were obtained through informed patient consent forms for TAVI procedure and for anesthetic management. The inclusion criteria was defined as patients over 18 years of age who underwent TAVI under GA, LA or conversion from LA to GA. Exclusion criteria was defined as patients under 18 years of age, with prior cardiac arrest before the procedure, open heart surgery during or after the procedure, and patients with missing data. The data were collected retrospectively from the patient files, hospital automation system, and anesthesia follow-up charts. The collected data includes: demographic data of the patients, comorbidity illnesses, American Society of Anesthesiologists (ASA) physical status, EuroSCORE (European System for Cardiac Operative Risk Evaluation) or STS (Society of Thoracic Surgeons) scores, ejection fraction (EF),

anesthetic technique, anesthesia and procedure times, use of anesthetic drugs, type of valve used, hemodynamic data, patients who needed inotropes, blood and blood products, duration of intensive care and hospital stay, incidence of complications, and mortality. Thirty-day mortality data were obtained according to hospital records and by phone calls. The patients were divided according to the type of anesthesia given during each procedure as general anesthesia (GA), and local anesthesia (LA).

## Pre-TAVI procedure

The TAVI procedure was decided on by the council consisting of a cardiac surgeon, a cardiologist, and an anesthesiologist. The severity of aortic stenosis was assessed by transthoracic echocardiography. Severe aortic stenosis was defined as aortic valve area of  $<1 \text{ cm}^2$ , peak aortic-jet velocity of  $\geq 4 \text{ m.s}^{-1}$  and mean aortic-valve gradient  $\geq 40 \text{ mmHg}$ . In the pre-anesthesia examination, detailed patients' history, comorbidity, physical examination, laboratory examination, consultation results, ASA, EURO, and STS score results were evaluated. The criteria for high risk for conventional surgical aortic valve replacement was included; logistic EuroScore  $\geq 20\%$  and/or STS predicted risk of mortality  $\geq 8\%$ , porcelain aorta, prior cardiac surgery, prior chest radiation, severe obstructive pulmonary disease, and frailty. Blood and blood products were prepared.

## Routine anesthesia procedure during TAVI

The procedures were performed in the angiography unit of our hospital under sterile conditions and fluoroscopy. Apart from the anesthetic technique planned, the equipment and drugs required for GA were available in the operation room. Arterial blood pressure was measured and recorded by invasive radial artery catheterization from the nondominant arm, and all patients were monitored with routine electrocardiography (ECG), Bispectral index (BIS), and peripheral oxygen saturation ( $\text{SpO}_2$ ). After intravenous peripheral venous cannulation was performed with 16G and 18G needles, two venous access routes were established and appropriate crystalloid solution infusions were started. Central venous catheterization was not used routinely. Central venous catheterization was performed only in some of the patients, and the reasons include the severity of the illness that required central venous pressure measurement and/or inotrope therapy or as there was no possibility to perform peripheral vascular access.

Anesthesia type was decided after evaluating the patient's general condition along with the details of the procedure, and either GA or LA was administered. Sedation and

analgesia were also administered to LA group. After radial artery cannulation, blood samples were obtained from all patients for ACT (activated clotting time) and blood gas measurement. In patients that received GA, intravenous midazolam at a dose of 1 or 2 mg.kg<sup>-1</sup> (Zolamid, And Pharmaceutical Industry, Turkey) was administered. Anesthesia was induced with intravenous fentanyl at a dose of 1–2 µg.kg<sup>-1</sup> (Talinat, And Pharmaceutical Industry, Turkey), propofol at a dose of 2 mg.kg<sup>-1</sup> (Propofol, Fresenius vial, Germany), and rocuronium at a dose of 0.6 mg.kg<sup>-1</sup> (Myokron, et Pharmaceutical Co., Turkey). The patients were intubated endotracheally and ventilation was provided with an anesthesia device (Drager Primus, Germany). Normoxic and normocapnic conditions were targeted in the ventilation parameters. Sevoflurane (Sevorane, Abbott, USA) was used as inhalation to maintain anesthesia. In LA group, 2 L.min<sup>-1</sup> of O<sub>2</sub> was administered via nasal cannula. The targeted sedation and analgesia level was determined as a report of Ramsey sedation score of 3 or 4. Intravenous doses of fentanyl (1 µg.kg<sup>-1</sup>) and midazolam (0.05 mg.kg<sup>-1</sup>) were administered. If adequate patient comfort could not be provided, intravenous doses of midazolam (1–3 mg), propofol infusion (Fresenius vial, Germany) (2–5 mg.kg<sup>-1</sup>.h<sup>-1</sup>), and remifentanyl infusion (Ultiva 2 mg/vial, Glaxo Smith Kline, United Kingdom) (0.025–0.2 µg.kg<sup>-1</sup>.min<sup>-1</sup>) were used as necessary by the anesthesiologist.

During LA technique, patients who needed deep anesthesia developed complications due to open surgery or who developed respiratory depression were intubated and GA was applied. The combination of LA and sedation has advantages such as early detection of neurological complications, shorter duration of the procedure, rapid recovery from anesthesia, and decreasing the need for postoperative care. In addition, in cases where the transapical, subclavian or aortic approach is used, GA provides advantages such as managing a difficult airway, planning transesophageal echocardiography, increased patient compliance, and transition to emergency surgery if necessary. If LA is preferred, the patients avoid the occurrence of adverse events related to GA.

A decrease in intraoperative systolic blood pressure more than 25% of the control values or a decrease below 90 mmHg was accepted as hypotension. After fluid bolus and infusion of normal saline for low blood pressure, if a response was not observed in 5 minutes, 5–10 mg IV (intravenous) ephedrine was administered. Later, if there is no response, noradrenaline infusion at a dose of 0.03–0.05 µg.kg<sup>-1</sup>.min<sup>-1</sup> was planned. Also, it was planned to add dobutamine infusion at a dose of 2–20 µg.kg<sup>-1</sup>.min<sup>-1</sup> dobutamine to patients whose hypotension did not improve despite these treatments and who had severe hemodynamic instability.<sup>12,13</sup>

### Routine cardiology procedure during the TAVI procedure

The transfemoral approach is used in most of the patients. For patients who are not eligible for the transfemoral approach, alternatives are the subclavian/axillary, transaortic, and transapical approach. One of the femoral arteries was cannulated for contrast agent injection and one of the femoral veins for the pacemaker. All TAVI patients require a

temporary pacemaker, which is usually performed by insertion of a temporary pace electrode through the femoral vein. A pigtail catheter was placed in the aortic root, and a pacemaker lead was placed in the right ventricle. Then the contralateral femoral artery was cannulated surgically or percutaneously. The calcified valve was passed through with the stiff guidewire advanced through the AL2 diagnostic catheter. Anticoagulation was provided with 70–100 IU.kg<sup>-1</sup> unfractionated heparin to maintain ACT > 250 seconds. The stiff wire in the left ventricular cavity was replaced with a stiff wire with a flexible tip to minimize the risk of rupture with the aid of a pigtail catheter. Before valve implantation, the stenotic valve was dilated by balloon valvuloplasty. The Edwards-Sapien valve was brought to the aortic root with the help of the delivery system and inflated with the help of a balloon, which was then placed. The Medtronic-CoreValve was released slowly under fluoroscopy at the aortic root with the help of a conveyor system and automatically expanded and placed in place. During the balloon valvuloplasty procedure and valve implantation, short-term ventricular pacing was performed at a rate of 180–200/min to minimize heart movement and prevent the prosthetic valves from slipping.

After the procedure, paravalvular leakage was evaluated by aortography. If paravalvular leaks and/or pericardial effusion is suspected with fluoroscopy, transthoracic echocardiography was performed to evaluate quantify paravalvular leaks or effusion was significant. The femoral artery entry site was closed surgically or by using a percutaneous vascular closure device (Prostar XL, Abbott Vascular, Redwood City, CA, USA). Peripheral angiography was performed to evaluate vascular leak. The pacemaker is usually removed at the end of the TAVI procedure, but if a complete atrioventricular block occurs during the procedure and when using the CoreValve valve, which is more associated with conduction complications, the temporary pacemaker is removed 24 hours later.

### Routine procedure after TAVI

Among those who received GA, patients with stable hemodynamics and sufficient respiratory effort were extubated in the procedure room. Patients who could not be extubated because they did not meet these criteria were transferred to the coronary intensive care unit intubated. All patients, including those who underwent LA, sedation, and analgesia after the procedure were transferred to the coronary intensive care unit.

### Statistical analysis

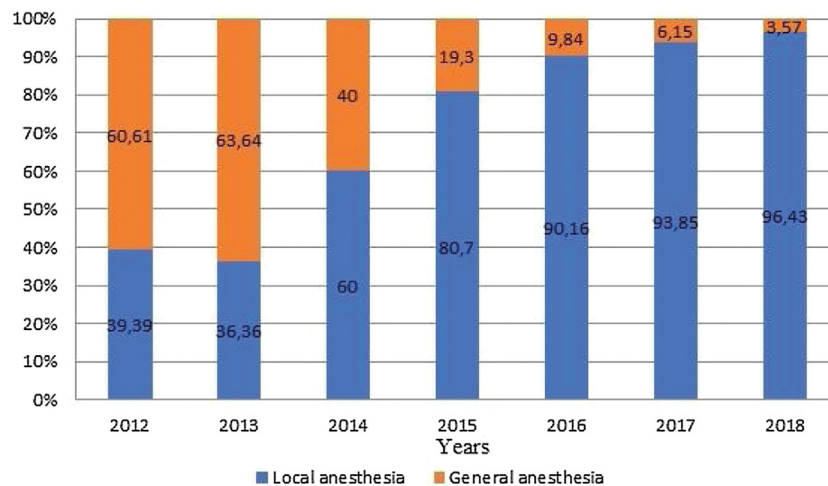
The normally distributed data are presented as mean ± standard deviation, and non-normally distributed data as median (interquartile range). Categorical variables are expressed in numbers and percentages. SPSS 24 (Statistical Package for Social Sciences software, SPSS Inc. Chicago, Illinois, USA) program was used in the analysis of the study. In group comparisons, chi-square test was used for frequency comparisons in categorical variables. Independent sample *t*-test was utilized for comparison of mean values among continuous variables, whereas Mann-Whitney non-parametric test

**Table 1** Comparison of patients' demographic and pre-procedural data.

	Local anesthesia (n = 245)	General Anesthesia (n = 58 )	p value
Age (years)	83 (78.5–86)	84 (77.7–86.2)	0.543
Male gender (%)	104 (42.4)	26 (44.8)	0.748
ASA 3 (%)	197 (80.4)	40 (68.9)	0.368
ASA 4 (%)	48 (19.5)	18 (31)	0.123
EF (%)	60 (50–60)	55 (40–60)	0.201
Logistic EuroSCORE	21 (18–25)	22 (17.5–25)	0.661
STS risk score	12 (8.6–20)	13.5 (10–17.2)	0.418
HT (%)	167 (68.1)	43 (74.1)	0.615
DM (%)	85 (34.6)	21 (36.2)	0.906
COPD (%)	68 (27.7)	13 (22.4)	0.396
CVD (%)	25 (10.2)	6 (10.3)	0.944
CRF (%)	19 ( 7.7)	5 (8.6)	0.810
CAD (%)	154 (62.8)	36 (62)	0.929
PAD (%)	1 (0.4)	5 (8.6)	<b>0.011</b>

Values are median (interquartile range).

ASA, American Society of Anesthesiologists; EF, Ejection Fraction; DM, Diabetes Mellitus; COPD, Chronic Obstructive Pulmonary Disease; CVD, Cerebrovascular Disease; CRF, Chronic Renal Failure; CAD, Coronary Artery Disease; PAD, Peripheral Artery Disease.

**Figure 1** Distribution of the anesthesia technique throughout the years.

was used for comparison of median values. A  $p$ -value  $< 0.05$  was considered statistically significant.

## Results

A total of 337 patients who underwent TAVI between January 1, 2012 and December 31, 2018 were screened and 303 patients were included in the study. The median age of our patients was 83 (78–86) years. Clinical and demographic characteristics of the patients before the procedure are shown in Table 1. When the demographic and pre-procedural data were examined between the two groups, no significant difference was found ( $p > 0.05$ ) except for peripheral artery disease ( $p = 0.011$ ) (Table 1). Hypertension was the most common comorbidity in both groups.

The rate of patients who underwent LA increased and that of patients who underwent GA gradually decreased from 2012 to 2018 (Fig. 1). In Table 2, intraoperative data of patients who underwent LA and GA are com-

pared. Considering the findings obtained, it is seen that the duration of anesthesia, the duration of the procedure and the amount of fluid administered during the procedure were significantly higher in patients who underwent GA ( $p < 0.00001$ ,  $p < 0.00001$  respectively). In addition, no significant difference was found between the use of blood and blood products, ephedrine use, valve types, and transfemoral approach rates in patients undergoing GA and LA ( $p > 0.05$ ). It was found that peripheral artery disease was comorbid in 5 patients who underwent the transapical approach. Although hemodynamic instability was higher in the GA group, the difference was not statistically significant ( $p = 0.052$ ) (Table 2). On the other hand, the rate of inotrope use was significantly higher in patients who had GA in comparison to patients who underwent LA ( $p < 0.00001$ ).

The postoperative data and major complications of the patients who underwent LA and GA are compared in Table 3. According to the results, it is seen that the duration of stay

**Table 2** Comparison of patients' data during the procedure.

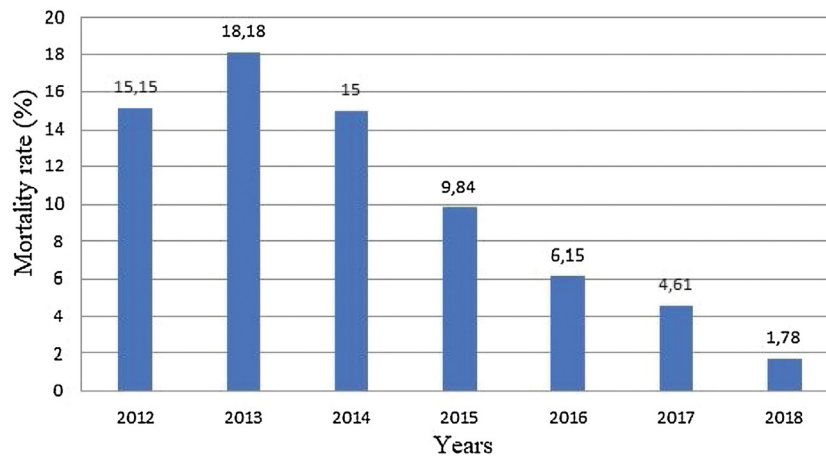
	Local anesthesia (n = 245)	General anesthesia (n = 58)	p value
Duration of anesthesia (min)	95 (75–120)	160 (135–191.25)	< 0.00001
Duration of the procedure (min)	80 (60–110)	147.5 (120–181.25)	< 0.00001
Fluid administered during the procedure (ml)	760 (650–900)	1215 (977.5–1705)	< 0.00001
Use of blood products (%)	76 (31,20)	20 (34.8)	0.622
Hemodynamic instability (%)	32 (13.06)	15 (25.4)	0.052
Ephedrine use (%)	29 (11.8)	13 (22.4)	0.086
Inotrope use (%)	5 (2.0)	12 (20.6)	< 0.00001
Edwards-Sapien valve (%)	198 (97.1)	57 (98.2)	0.943
Medtronic-Core valve (%)	7 (2.8)	1 (1.7)	0.655
Transfemoral approach (%)	245 (100)	53 (93.3)	0.614
Transapical approach (%)	–	5 (8.6)	–

Values are median (interquartile range).

**Table 3** Comparison of postoperative data and major complications.

	Local anesthesia (n = 245)	General anesthesia (n = 58)	p-value
Duration of stay in the intensive care unit (days)	2 (1–3)	3.5 (2–6)	0.001
Length of hospital stay (days)	6 (5–7.75)	7 (5–10)	0.023
Pacemaker requirement (%)	28 (11.4)	6 (10.3)	0.827
Arrhythmia (%)	32 (13)	7 (12)	0.841
Vascular complications (%)	18 (7.3)	5 (8.6)	0.617
Infection (%)	8 (3.2)	2 (3.4)	0.806
Neurological dysfunction (%)	5 (2)	3 (5.1)	0.257
Paravalvular leak (%)	7 (2.8)	1 (1.7)	0.101
Myocardial infarction (%)	3 (1.2)	2 (3.4)	0.180
Renal dysfunction (%)	14 (5.7)	4 (6.8)	0.782
30-day mortality	19 (7.7)	5 (8.6)	0.808

Values are median (interquartile range).

**Figure 2** Distribution of mortality rate throughout the years.

in the intensive care unit of the patients who received GA was significantly longer in comparison to patients with LA ( $p = 0.001$ ). In addition, the length of hospital stay was significantly shorter in the LA group ( $p = 0.023$ ). No significant difference was found between patients who underwent LA and GA in terms of major complications and mortality (Table 3). The rate of mortality was observed to decrease from 2012 to 2018 (Fig. 2).

## Discussion

In our study, where we retrospectively investigated the data of patients who underwent TAVI due to severe aortic valve stenosis with regard to the anesthesia method, the duration of intensive care and hospital stay were significantly shorter in the patient group who underwent TAVI procedure along with LA. On the other hand, no significant differences were

found between the two anesthetic techniques in terms of outcomes, including complications and thirty-day mortality, and success of the procedure.

TAVI is a noninvasive treatment option that is frequently preferred in high-risk AD cases, such as those with advanced age and comorbidity related factors. In the PARTNER study, one of the important researches on TAVI, it has been shown that the procedure is a safe and effective treatment.<sup>10</sup> Anesthesia applications are an integral part of this noninvasive approach, which requires multidisciplinary work. It includes applications ranging from GA to LA or regional anesthesia.<sup>8</sup> In our study, LA was preferred in 245 (80.86%) of the 303 patients, while GA was preferred in 58 (19.14%) (Table 1). Regional anesthesia was not preferred. The main reason for this is the necessity to perform an antiplatelet treatment procedure performed prior to, during, and after the intervention. Spinal hematoma risk limits the application of regional anesthesia. In addition, patients should be investigated in terms of bleeding diathesis in the preoperative period against possible bleeding from the vascular intervention site.<sup>11,14</sup> Blood and blood products should be prepared.

In the studies by Gürcü et al. and Azizoglu et al.,<sup>7,9</sup> the mean ages of patients who underwent TAVI were  $78.30 \pm 6.44$  and  $77.78 \pm 6.60$ , respectively. These results are also dependent on the application of TAVI treatment to patients with advanced valves. The results of our study are consistent with these studies, as the median age in ours was 83 (78–86) years. There was no significant difference in the distribution by gender. Comorbidities of the patients are one of the factors in determining the type of anesthesia and surgical risk score calculation. In our study, hypertension was the most common comorbid factor, which also included diabetes mellitus, coronary artery disease, chronic obstructive pulmonary disease, cerebrovascular disease, chronic renal failure, and peripheral artery disease. Both the most common and other commodities found in our study were consistent with the studies in the literature.<sup>7,9</sup> Peripheral artery disease was statistically significantly higher in the GA group compared to LA group (Table 1). This was due to the preference of the transapical approach and GA in these patients.

Preoperative surgical risk assessment is important for the TAVI procedure. According to the logistic EuroSCORE and STS surgical risk scoring, high-risk and inoperable patients constitute the potential patient group for TAVI. The patient group with high surgical risk is constituted by those with Logistics EuroSCORE > 20% and STS scores above 10%.<sup>15</sup> In our patients, the logistic EuroSCORE value was  $22.80 \pm 8.36$  in GA patients, and  $21.73 \pm 6.76$  in patients with LA. The STS score was  $14.81 \pm 7.49$  in GA patients and  $14.07 \pm 7.39$  in patients who underwent LA (Table 1). In the literature, it is known that LA should be preferred instead of GA due to the risk of increased mortality for patients with high EuroSCORE values.<sup>16</sup> However, especially in the first years where TAVI procedure became more widely performed throughout the world, there was an opposing view in the literature that GA was more appropriate and safer. Factors such as the size and diameter of the catheters, delivery systems, and team experience were important in the choice of GA.<sup>17</sup> It was also stated that general anesthesia is a more appropriate anesthesia method, both to facilitate the management of possible

hemodynamic instability and enable the operating team to work more comfortably.<sup>18</sup> In addition, in cases where the transapical, subclavian, or aortic approach is used, general anesthesia provides advantages such as managing a difficult airway, planning transesophageal echocardiography, increased patient compliance, and transition to emergency surgery if necessary.<sup>19</sup>

On the other hand, the increase in the experience of the operators and the advances in technology have raised the application of local anesthesia.<sup>17</sup> The increase in the frequency of transfemoral approach is also a factor in this preference.<sup>17</sup> According to the results of our study, the application of LA technique increased in the following years compared to GA technique (Fig. 1). Transfemoral approach was also significantly preferred.

In a study comparing LA and GA during TAVI procedures, more stable hemodynamics, shorter procedure time, and earlier mobilization were reported with LA.<sup>20</sup> It has been demonstrated that the combination of local anesthesia and sedation has advantages such as early detection of neurological complications, shorter duration of the procedure, rapid recovery from anesthesia, and decreasing the need for postoperative care. Another published research stated that patients having GA showed longer procedure times than those of the LA group.<sup>21</sup> Therefore, LA is preferred more frequently in high-volume centers.<sup>10,11,14,20–22</sup> Among our patients, in GA group the procedure and anesthesia durations were significantly longer than patients in LA group.

The prominent effect of GA during the TAVI procedure is hemodynamic. It is also stated in some publications that the use of vasopressors and inotropic agents is more common during general anesthesia.<sup>23,24</sup> In the literature, it has also been reported that GA increases the need for inotropic support compared to LA applications, and at least two vasoactive drug infusions are required due to severe hemodynamic stability.<sup>12,13</sup> These patients may be hypovolemic due to the diuretic treatment that may be administered before the procedure, and the vasodilator and cardiac depressant effects of general anesthetic agents may lead to hemodynamic instability.<sup>24</sup> Adequacy of left ventricular preload must be ensured to avoid hypovolemia. According to the results of our study, intraoperative fluid use was the highest in the general anesthesia group due to the length of the procedure (Table 2).

The use of blood and blood products for our patients is based on the anemia criteria of the World Health Organization (WHO). The WHO defined anemia as hemoglobin values below  $13 \text{ g.dL}^{-1}$ , in males, and below  $12 \text{ g.dL}^{-1}$ , in females.<sup>25</sup> In TAVI patients, in the presence of additional symptoms and signs such as angina, dyspnea, edema, heart failure, and in patients with severe ischemic heart disease, the planned procedure is a major surgical procedure. In our institution, in conjunction with cardiology and cardiac surgery clinic protocols, for patients undergoing TAVI procedure, the hemoglobin value is kept at a level of 10 to  $12 \text{ g.dL}^{-1}$ . Based on this criterion, in our clinic, blood and blood products were used in 76 patients (31.2%) in LA group, whereas 20 patients (34.8%) in GA group, and the comparison between groups were similar ( $p > 0.05$ ).

Hemodynamic instability and the use of inotropic agents were significantly higher in our study in the GA group and this result is consistent with the literature.<sup>23,24</sup> We

think this may be due to the general anesthetic agents. Azizoğlu et al. stated the anesthetic agents they used in their study were propofol, thiopental, midazolam, and fentanyl, in order of frequency.<sup>9</sup> In our patients, midazolam, fentanyl, and propofol were the most commonly used anesthetic agents in both groups. In the GA group, the agent used for neuromuscular blockade was rocuronium. In our anesthesia applications, in addition to dose titration, vasopressor and inotropic agents were also administered according to the protocol of our study. Melidi et al. also stated that dose titration is more important than the agent in keeping hemodynamics stable and that a medium-effective agent such as rocuronium can be used as a muscle relaxant for intubation.<sup>22</sup>

With the advancing technology, different valve models were developed for use in TAVI. The expansion of the EdwardsSapien (Edwards Lifesciences) model valve occurred through a balloon in the early years. The CoreValve (Medtronic Inc, MN), which was developed later, is a self-expandable model.<sup>26</sup> There was no difference between the groups according to the types of valves used in our study. There are cardiac and non-cardiac complications in the TAVI procedure. In a meta-analysis, TAVI patients undergoing general and local anesthesia were compared, and it was reported that there was no difference in terms of stroke, myocardial infarction, arrhythmia, annular rupture, cardiovascular mortality, permanent pacing, vascular complications, major bleeding, and renal failure.<sup>27</sup> When the patients in our study were compared in terms of complications related to the procedure, no statistically significant difference was found between the two groups. It was also stated in another study that the complication rates do not depend on the type of anesthesia.<sup>17</sup>

In the studies conducted, the length of stay in the intensive care unit and in the hospital were investigated according to the type of anesthesia applied in the TAVI procedure. It has been reported that local anesthesia significantly shortened these periods.<sup>28–30</sup> In our study, consistent with the literature, the length of hospital stay and the duration of intensive care unit stay were significantly shorter in the local anesthesia group. Although there was no investigation about cost effectiveness in our study, we think that shortening the length of stay in the hospital and the intensive care unit will decrease the cost. The cost-effectiveness could have been studied, and this is a limitation of our study.

Ehret et al. reported that thirty-day mortality rates were similar in their systematic review and meta-analysis, in which they compared GA and LA.<sup>29</sup> Again, in different studies, they found that thirty-day mortality did not differ according to the types of anesthesia.<sup>12,28</sup> In our results, no statistically significant difference was found in terms of thirty-day mortality when the groups undergoing GA and LA were compared. Factors such as the procedure itself and the patients' comorbidities are more determinant on the prognosis. In addition, according to our data, the mortality rate showed a diminishing rate throughout the years (Fig. 2). We think that the increase of experience over the years is also effective in this decrease in mortality.

The first of the limitations of our study is that it, could not be conducted in a prospective, randomized study design. The reason is that we had little experience at the beginning of these procedures and later we read the advances in the

literature. The other limitation is that the group of patients in LA is much larger than the group in GA. The choice of anesthesia was made according to the severity of the illness and comorbidities that required the use of LA technique instead of GA, due to possible adverse events related to GA and difficult airway. Another limitation is that cost effectiveness was not included in the study. However, we believe that sharing experiences covering 303 cases is also important in terms of contributing to the literature.

## Conclusion

Multidisciplinary team management is essential for the success of the procedure, regardless the anesthesia technique during TAVI procedures. The role of the anesthesiologist is important in all stages of the procedure, and these include evaluation preoperatively, during the, operation where titration of anesthetic agents and other essential drugs are administered as well as in the immediate intervention of potential life-threatening complications. Early diagnosis of adverse events related to both surgical and anesthetic techniques requires adequate knowledge and experience for both surgical and anesthetic teams. Therefore, the task of selecting the most appropriate anesthesia technique in line with patient and surgical procedure requirements is important. In our study, we have retrospectively evaluated our experience on outcomes including: complications, mortality and success of the procedure that was done under GA or LA, and no differences were found in comparison between two different anesthesia techniques. However, LA shortens the duration of intensive care and hospital stays.

## Conflict of interests

The authors declare no conflicts of interest.

## Ethical approval

The study was initiated after obtaining the local ethics committee approval (2019/07), in accordance with the principles of Helsinki declaration.

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