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Araştırma / *Research Article*

General Anesthesia Versus Local Anesthesia Plus Sedation in High Risk Patients Underwent Transcatheter Aortic Valve Implantation (TAVI): A Retrospective Cohort Study

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Transkateter Aort Kapak İmplantasyonu (TAVİ) Uygulanan Yüksek Riskli Hastalarda Genel Anestezi ile Lokal Anesteziye Eşlik Eden Sedasyon Uygulamasının Karşılaştırılması: Retrospektif Kohort Çalışma

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ABSTRACT

Objective: *Transcatheter Aortic Valve Implantation (TAVI) poses significant challenges concerning anesthesia management. There is no current consensus on the type of safer anesthesia for high-risk patients undergoing TAVI procedures. The aim of this retrospective cohort study was therefore to describe the pre- and perioperative issues related to anesthesia and to compare the outcomes of high-risk patients treated with general anesthesia (GA) versus local anesthesia plus sedation (LAPS) during TAVI procedures.*
Method: *We conducted a study with 49 patients who underwent TAVI under general anesthesia or local anesthesia plus sedation. Patients were retrospectively allocated to two cohort-study groups: GA (n=23) and LAPS (n=26). Demographic characteristics and procedural data were recorded at important time points.*
Results: *The two groups were similar with respect to demographic characteristics. Total colloid consumption was significantly higher in GA group (p<0.001). Heart rates after valve implantation in GA were significantly lower (p<0.05). Mean arterial pressures were similar. Peripheral oxygen saturations before and after valve implantation in GA were significantly higher. The durations of anesthesia and procedure in LAPS group were significantly shorter (p<0.001).*
Conclusion: *Careful preoperative assessments concerning anesthetic agent preferences, complications related to catheterization and hemodynamic stability, as well as a requirement for immobility and adequate analgesia, are very important for successful outcomes. Particularly for cases where there is no need for transesophageal echocardiography or for a cardiovascular surgeon to dissect and repair the artery, we have concluded that LAPS can be used safely during TAVI procedures.*

Keywords: *aortic stenosis, transcatheter aortic valve implantation, transfemoral, local anesthesia, general anesthesia*

ÖZ

Amaç: *Transkateter Aort Kapak İmplantasyonu (TAVİ), anestezi yönetimi konusunda önemli zorluklar doğurmaktadır. Yüksek riskli TAVI işlemi için hangi tip anestezinin daha güvenli olduğu konusunda güncel bir görüş birliği yoktur. Bu retrospektif kohort çalışmanın amacı, anestezi ile ilişkili pre- ve perioperatif sorunları tanımlamak ve TAVI işlemleri sırasında genel anestezi (GA) ve lokal anestezik ile sedasyon (LAPS) ile tedavi edilen yüksek riskli hastaların sonuçlarını karşılaştırmaktır.*
Yöntem: *Bu çalışma, genel anestezi veya lokal anestezi ile sedasyon altında TAVİ uygulanan 49 hasta üzerinde gerçekleştirildi. Hastalar retrospektif olarak iki kohort çalışma grubuna ayrıldı: Genel Anestezi (GA, n=23) ve Lokal Anestezi ile Sedasyon (LAPS, n=26). Demografik özellikler ve işlem verileri önemli zaman noktalarında kaydedildi.*
Bulgular: *İki grup demografik özellikler açısından birbirine benzerdi. Total kolloid tüketimi GA grubunda anlamlı derecede daha yüksekti (p<0.001). GA grubunda kapak implantasyonu sonrası kalp atım hızları anlamlı olarak düşüktü (p<0.05). Ortalama arter basınçları benzerdi. GA grubunda kapak implantasyonu öncesi ve sonrası periferik oksijen satürasyonu anlamlı olarak yüksekti. LAPS grubunda anestezi ve işlem süreleri anlamlı olarak kısaydı (p<0.001).*
Sonuç: *Dikkatli preoperatif değerlendirme, anestetik ajan tercihleri, hemodinamik stabilite ve kateterizasyon ile ilgili komplikasyonların yanı sıra immobilite gerekliliği ve yeterli analjezi başarılı sonuçlar için çok önemlidir. Özellikle transözofageal ekokardiyografiye ya da kardiyovasküler cerrahın arter diseksiyonu ve onarımına gereksinim duymadığı durumlarda, lokal anestezi ile sedasyon uygulamasının TAVI işlemlerinde güvenle kullanılabileceği sonucuna vardık.*

Anahtar kelimeler: *aort darlığı, transkateter aort kapak implantasyonu, transfemoral, lokal anestezi, genel anestezik*

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INTRODUCTION

Aortic stenosis (AS) is the most frequently acquired valvular heart disease and is associated with high mortality in elderly patients [1]. It has a mortality rate of 50% in the first two years after the onset of early symptoms such as angina, syncope or heart failure [2]. While aortic valve replacement (AVR) surgery has low perioperative morbidity and mortality, most patients with severe and symptomatic AS cannot undergo surgical interventions due to their age and comorbidities [3]. Transcatheter aortic valve implantation (TAVI) has thus become a less-invasive alternative to AVR surgery in high-risk and inoperable patients [4]. TAVI is mostly performed using a transfemoral approach, but it can also be performed using transapical and transaxillary approaches [5].

Nowadays, TAVI procedure can nonetheless carries life-threatening complications. Ideally, TAVI procedures should be performed by a multidisciplinary team, including anesthesiologists, in a cardiac catheterization laboratory [6]. Hemodynamic instability is the biggest risk during the procedure, especially prolonged hypotension and sudden hypertensive attacks, and transesophageal echocardiography (TEE) can be an important tool for guiding the procedure and detecting complications immediately.

In many places, TAVI procedures are performed under general anaesthesia (GA). However, since technological advancements have led to the use of less-invasive methods, such as the transfemoral and transaxillary approaches [7], TAVI procedures are now also performed using local anaesthesia plus sedation (LAPS) [8]. Regardless of whether GA or LAPS is used, anaesthesia management and an experienced medical team are very important due to patients' older ages and comorbidities. There is no current consensus on which type of anaesthesia is safer for high-risk patients undergoing TAVI procedures. The aim of this retrospective cohort study was therefore to describe the pre- and perioperative issues related to anaesthesia and to compare the outcomes of high-risk patients treated with GA versus LAPS during TAVI procedures in a university hospital. Based on our findings, we discuss the advantages and disadvantages of different anaesthesia management strategies for patients undergoing TAVI procedures.

MATERIALS AND METHODS

Study Protocol

Our study protocol was approved by the Local Ethics Committee. We conducted a retrospective cohort clinical study with 49 patients who underwent TAVI from May 2017 to June 2018 in a university hospital. This study was prepared in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines [9].

Study Participants

Our study included patients with American Society of Anesthesiology (ASA) scores of II–IV, who ranged from 45-90 years old and who were considered inoperable or at very high risk during AVR surgery. Patients were excluded if they had uncontrolled diabetes mellitus, pulmonary disease or cerebrovascular disease. Patients who refused written informed consent were also excluded.

Preoperative Procedures

Patients' anaesthesiologic preoperative evaluations planning to undergo TAVI were performed by a trained cardiac anesthesiologist who studied cardiovascular, pulmonary, renal and hepatic function as well as the best airway management for patient. After the fasting period of 8 hours, patients were admitted into the operating room after premedication with midazolam (0.01-0.02 mg/kg). Heart rate (HR), noninvasive blood pressure (NIBP), five-lead electrocardiogram (ECG), peripheral oxygen saturation (SpO_2), and body temperature (using esophageal or tympanic probes) were monitored. Two external defibrillator pads were positioned on patients' chest in the perspective of possible shockable rhythm. Preoperative blood samples were drawn before the procedure for each patient.

Study Design

Forty-nine patients were retrospectively allocated to two cohort study groups: TAVI under GA (Group GA, n=23) and TAVI under LAPS (Group LAPS, n=26). We performed the procedure under GA in patients in which a surgical approach was mandatory. All the other procedures were achieved in LAPS. All patients received standard intervention procedures determined by the same team of cardiologists and an anesthesiologist with experience in TAVI; the TAVI intervention management was not changed in any way between the two groups.

Anaesthesia

All patients received preoperative midazolam (0.01-0.02 mg/kg) before being taken to the catheter laboratory. For patients in Group GA, a standardized GA protocol was administered by an experienced anesthesiologist. After preoxygenation (100% 4 L/min O_2 for 3 min) patients were induced with propofol (1-2 mg/kg) or etomidate (0.15-0.2 mg/kg), rocuronium (0.4-0.6 mg/kg) and fentanyl (1 µg/kg) via intravenous (IV) route at doses calculated according to ideal body weight. Patients were intubated with a single lumen endotracheal tube and were ventilated mechanically with a tidal volume of 6–8 mL/kg based on ideal body weight and a frequency of 12–14 breaths/min using a Dräger Primus ventilator (Dräger AG, Lübeck, Germany). End-tidal carbon dioxide ($EtCO_2$) was continuously monitored after intubation. Ventilation rate were adjusted to maintain the $EtCO_2$ at 35-45 mmHg. Anaesthesia was maintained by desflurane inhalation of a 0.5 O_2 oxygen-air mixture. Rocuronium or atracurium were intermittently injected according to need. In patients who did not experience complications during the surgery, sugammadex (IV, 2-4 mg/kg, Bridion®, MSD, Greenville, USA) or atropine (IV, 0.02 mg/kg, Galen, Turkey) plus neostigmine (IV, 0.03 mg/kg, Adeka, Turkey) were then administrated to reverse residual muscle relaxation at the end of surgery. Patients were then extubated in the cardiac catheterization laboratory before being taken to the intensive care unit (ICU).

Patients in Group LAPS, after premedication with midazolam (0.01–0.03 mg/kg), received subcutaneous injections of 20 ml of 1% lidocaine in their vascular access sites. Repetitive IV boluses of midazolam (0.03-0.2 mg/kg) and fentanyl (0.01-0.05 mcg/kg) were administered. The anesthesiologist was responsible for patient comfort, hemodynamic stability, immobility, adequate analgesia and airway management. All patients were monitored using invasive femoral artery blood pressure.

TAVI

TAVI is approved for clinical use by the European Association of Cardiothoracic Surgery and the European Society of Cardiology in patients with severe symptomatic AS who are inoperable or are at high risk during AVR surgery [10]. All patients in our study were evaluated and operated on by the same experienced medical team, which consisted of cardiologists, cardiovascular surgeons and an anesthesiologist, each of them completed at least 50 procedures. All TAVI procedures were performed in the cardiac catheterization laboratory. In the GA group, TAVI procedures were performed using the transfemoral approach; each patient's femoral artery was prepared by a cardiovascular surgeon using a surgical approach. In the LAPS group, cardiologists used a percutaneous transfemoral approach. Cardiovascular surgeons were not involved in the TAVI procedures for LAPS group, although they stood ready inside the operating theater if required for any emergency. For all 49 patients, TAVI procedures were performed using the ProGlide self-expandable Medtronic CoreValve ReValving System (Medtronic Inc., Minneapolis, MN). After retrograde crossing and predilatation of the native valve, the Medtronic CoreValve was guided and positioned within the aortic annulus and then delivered by balloon inflation under rapid (160-200 beats/min) ventricular pacing. Cardiologists estimated the diameter of the aortic annulus using fluoroscopy and contrast angiography. TEE was not used in either group.

Procedure Characteristics

For each patient, AS or aortic insufficiency were assessed and defined by the same cardiologist, using the New York Heart Association (NYHA) classification and the European System for Cardiac Operative Risk Evaluation (EuroSCORE) [11]. The duration of anesthesia or sedation was defined as the time from premedication with midazolam until the transfer of the patient to the post-anesthesia care unit (PACU). The duration of the procedure was defined as the time from the first femoral access until the closure of vascular access. The duration of implantation was defined as the time from the first taking hold of the device until the final correction of the implanted image. The duration of ICU stay was defined as the time between admission in ICU until the discharge.

Outcome Measures

We evaluated the demographics, procedure data and hospital records of 49 patients who underwent transfemoral TAVI. EuroSCOREs were calculated for all patients, and their NYHA functional class, medication, concomitant diseases and laboratory parameters were obtained from the University Patient Database. ICU records were also analyzed.

Patient HR, mean arterial pressure (MAP), SpO_2, and $EtCO_2$ were retrospectively collected from database at clinically important time points: 5 min before GA or sedation induction (T0); 5 min after intubation or sedation induction (T1); 5 min before valve implantation (T2); 5 min after valve implantation (T3), and end of procedure (T4). The duration of anesthesia or sedation and procedure, as well as perioperative and postoperative complications, were recorded.

Postoperative Management

Patients were monitored in the PACU in early postoperative time; they were transferred to the coronary ICU once they achieved a score of 9 or higher on the Modified Aldrete scoring system (range 0-12; scores of 9 and above indicate that the patient can be discharged from the PACU) [12]. In all patients, postoperative analgesia was achieved using appropriate doses of tramadol (0.5-1 mg/kg, IV) and paracetamol (1 gr, IV) at the time of beginning skin sutures.

Statistical Analysis

All statistical analyses were performed using Statistical Package for the Social Sciences software (SPSS 22.0, Chicago, USA). Quantitative data are presented as mean±standard deviation and categorical data are shown as numbers or percentages. Differences between groups were evaluated using Chi-square tests for discrete variables and Student's t-test for continuous variables. $P < 0.05$ was considered statistically significant.

RESULTS

Mean participant age was 76.42±7.60. The two groups were similar with respect to age, gender, height, weight, body mass index and ASA physical status. Most patients in both groups needed the procedure due to AS (Group GA: 22 patients; Group LAPS: 21 patients). Patients in both groups had similar NYHA classifications and EuroSCOREs. All patients had invasive arterial monitorization. The duration of implantation in GA group (6.91±4.20 min) was shorter than in LAPS group (8.38±4.80 min), but the difference was not significant. The total crystalloid consumption of both groups was similar, but total colloid consumption was significantly higher in patients in GA group than for those in LAPS group ($p<0.001$). The need for a permanent pacemaker was also significantly higher in GA group ($p<0.05$). The duration of anesthesia or sedation and procedure in Group LAPS (59.03±15.81 min and 49.34±16.45 min, respectively) were significantly shorter than in Group GA (105.65±30.31 min and 89.56±27.58 min, respectively; $p<0.001$; Figure 1). There was no any catheter related complication, such as bleeding or hemato-

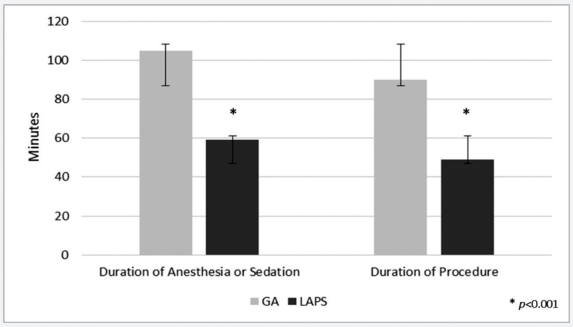

Figure 1. The duration of anesthesia or sedation was defined as the time from premedication with midazolam until the transfer of the patient to the post-anesthesia care unit. The duration of the procedure was defined as the time from the first femoral access until the closure of vascular access.

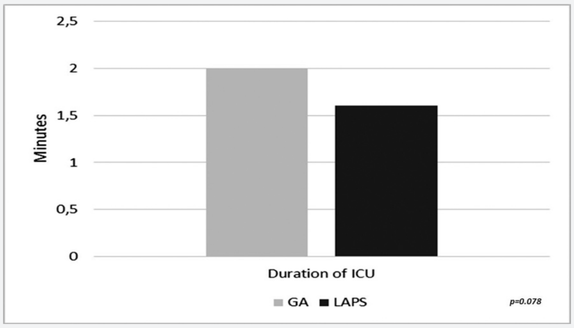

Figure 2. The duration of ICU stay was defined as the time between admission in ICU until the discharge.

mas. The length of stay in ICU was similar in both groups (Figure 2). Demographics and procedure data are presented in Table 1.

HRs at T0, T1, T2 and T4 were similar between both groups. However, HRs at T3 in GA group were significantly lower than in LAPS group (p<0.05). HRs are presented in Table 2. MAPs at all times were similar between both groups; they are presented in Table 3. SpO_2 levels at T2 and T3 were significantly higher in GA group than in LAPS group, but at the other timepoints there was no significant differ-

Table 1. Demographics and procedure data.

	Group GA (n=23)		Group LAPS (n=26)		
	Range	Mean±std	Range	Mean±std	p value
Age, years	48-89	77.73±8.25	60-87	75.26±6.93	0.261
Gender, male, n (%)	-	15 (57.7%)	-	11 (42.3%)	0.572
Height, cm	150-180	166.87±7.14	155-180	166.42±7.43	0.832
Weight, kg	50-110	74.26±12.87	50-100	73.23±11.95	0.773
BMI	21-35	27.08±3.90	19-39	26.65±4.66	0.728
ASA, II/III	-	0/23	-	4/22	0.112
Aortic stenosis/Aortic insufficiency	-	22/1	-	21/5	0.194
NYHA Classification, III/IV	-	23/0	-	24/2	0.491
EuroSCORE	21-32	27.08±2.82	20-34	26.19±3.91	0.370
Hemoglobin	9-15	12.13±1.51	9-16	12.23±1.94	0.843
Hematocrit	30-47	37.13±4.68	26-50	38.65±5.91	0.327
Invasive Arterial Monitorization, n	-	23	-	26	
Duration of implantation, min	2-14	6.91±4.20	2-20	8.38±4.80	0.263
Total crystalloid, ml	400-1000	726±222	300-1500	715±371	0.905
Total colloid, ml	0-1000	434±232	0	0	<0.001*
Cardioversion, n (%)	-	2 (7.6%)	-	2 (8.7%)	1.000
Pacemaker, n (%)	-	12 (52.2)	-	6 (23.1%)	0.043*
Hypotension during procedure, n (%)	-	6 (26.0%)	-	4 (15.3%)	0.685
Inotropic support, n (%)	-	6 (26.0%)	-	4 (15.3%)	0.685
Duration of anesthesia or sedation, min	50-160	105.65±30.31	105.65±30.31	59.03±15.81	<0.001*
Duration of procedure, min	40-140	89.56±27.58	20-90	49.34±16.45	<0.001*
Duration of ICU, day	1-6	2.00±0.95	1-2	1.61±0.49	0.078

*ASA; American Society of Anesthesiology, BMI; Body Mass Index, EuroSCORE: European System for Cardiac Operative Risk Evaluation, Group GA: TAVI under general anesthesia, Group LAPS: TAVI under Local Anesthesia plus Sedation, IBW; Ideal Body Weight, ICU: Intensive Care Unit, NYHA: New York Heart Association, std; Standard Deviation, TAVI: Transcatheter Aortic Valve İmplantation, * p<0.05 (statistically significant)*

Table 2. Heart rates.

Time	Heart rate (/min) (Mean±std)		p value
	Group GA (n=23)	Group LAPS (n=26)	
T_0	80.69±8.59	79.76±14.12	0.786
T_1	75.52±15.17	79.30±13.95	0.368
T_2	72.69±17.67	83.07±24.15	0.096
T_3	71.91±14.31	81.69±18.82	0.048*
T_4	76.87±9.88	81.92±11.67	0.111

*T_0: 5 min before GA or sedation induction, T_1: 5 min after intubation or sedation induction, T_2: 5 min before valve implantation, T_3: 5 min after valve implantation, T_4: End of procedure, * p<0.05 (statistically significant)*

Table 3. Mean arterial pressures.

Time	Mean arterial pressures (mmHg) (Mean±std)		p value
	Group GA (n=23)	Group LAPS (n=26)	
T_0	101.21±16.50	107.30±19.31	0.244
T_1	78.69±15.81	88.07±21.81	0.095
T_2	67.17±15.66	74.46±17.49	0.133
T_3	74.65±13.28	82.61±17.29	0.080
T_4	85.60±15.03	92.73±18.44	0.148

*T_0: 5 min before GA or sedation induction, T_1: 5 min after intubation or sedation induction, T_2: 5 min before valve implantation, T_3: 5 min after valve implantation, T_4: End of procedure, * p<0.05 (statistically significant)*

ence between the groups. SpO_2 levels are presented in Table 4.

DISCUSSION

TAVI has been shown to be a clinically effective alternative option for high-risk patients with severe and symptomatic AS [13]. The present retrospective cohort study examined the results from 49 patients who underwent either GA or LAPS during TAVI procedures. We found that total colloid consumption, the need for permanent pacemakers, the duration of anesthesia or sedation and procedure was significantly lower in LAPS group than in GA group. These

Table 4. Peripheral oxygen saturation values.

Time	Peripheral oxygen saturation (%) (Mean±std)		p value
	Group GA (n=23)	Group LAPS (n=26)	
T_0	94.65±2.90	95.34±2.78	0.398
T_1	96.91±2.06	95.50±3.26	0.081
T_2	97.43±1.70	95.69±3.73	**0.039***
T_3	97.65±1.55	95.88±3.07	**0.014***
T_4	94.60±3.66	96.34±2.74	0.065

*T_0: 5 min before GA or sedation induction, T_1: 5 min after intubation or sedation induction, T_2: 5 min before valve implantation, T_3: 5 min after valve implantation, T_4: End of procedure, * p<0.05 (statistically significant)*

results indicate that patients in both groups who underwent TAVI had anesthetic challenges related to the procedure.

Due to the complexity of the anaesthesia management, TAVI procedures should be performed by a trained cardiac anesthesiologist. Cardiovascular anesthesiologists are experienced at providing advanced cardiac life support and mechanical circulatory support in case there is an unexpected need for cardiopulmonary bypass (CPB) and emergency AVR surgery. The ideal setting for TAVI procedures is a hybrid operating theater that includes imaging equipment, especially if CPB or conventional open surgery are required. In many centers, most TAVI procedures are typically performed in a cardiac catheterization laboratory. In our center, TAVI procedures currently occur in a cardiac catheterization laboratory that is very close to the cardiac operating theater. Cardiovascular surgeons are ready in case they are required to perform any emergency surgery. Specifically, it had to be stocked with additional equipment and drugs that anesthesiologists may need in case of difficult airway management and hemodynamic instability. Prior to performing any TAVI procedure, anesthesiologists should verify that the catheterization laboratory has adequate facemasks, intubating stylets, tube-changer or gum elastic bougies, laryngeal mask airways, videolaryngoscopes, rigid laryngoscope blades of varying designs or sizes, fiberoptic-guided intubation and aspirators for unexpectedly difficult airway management, all monitoring devices, emergency drugs, and defibrillators [14].

Patients undergoing TAVI procedures require detailed monitoring for severe cardiovascular disease, comorbidities and, especially, hemodynamic instability. Five-lead ECG, pulse oximetry, invasive arterial blood pressure, central venous pressure, and urine output are all standard monitors [1,5]. Temperature monitoring is also essential to avoid hypothermia, and in our study we used an external warming system on every patient with continuous temperature monitoring. We also placed external chest pacing pads for early management of arrhythmias such as ventricular fibrillation. However, although transcranial Dopplers can be used to determine cerebral hypoperfusion and embolic events during TAVI procedures [15], and cerebral oximeters may provide beneficial information about cerebral oxygenation [16], we did not use either of these measures because our cardiac catheterization laboratory was not designed for the additional equipment. Pulmonary artery catheterization is not preferred in our center as many studies have found that it is useful only for specific situations such as left ventricular dysfunction and/or pulmonary hypertension [8]. Finally, although TEE monitoring can play a major role during TAVI procedures in conjunction with fluoroscopy and contrast angiography [17], the cardiologists in our study choose not to use TEE because they found that fluoroscopy and contrast angiography were sufficient to evaluate possible complications related to the procedures.

Nearly all previous studies have reported that GA was the preferred anesthetic strategy based on the use of TEE and surgical femoral incisions and the possibility of severe complications that might require rapid interventions [1,4,6,13,18]. Ree et al. [18] reported their experience with 40 cases of retrograde percutaneous AVR–managed TAVI procedures under GA because of the routine need for surgical vascular repair and the complete immobility of patients in their institution. The authors concluded that there were no contraindications for GA due to patients' general status or health problems; however, they also noted that the development of minimally invasive implantation devices might provide a better alternative to GA in order to avoid the cardiac depressant effects and longer respiratory weaning typical of GA drugs. In our study, we found that fluoroscopy and angiography imaging were sufficient in both the GA and LAPS groups without the use of TEE. However, for patients in our GA group, we choose to use GA because patients in this group needed a cardiovascular surgeon to dissect and repair the femoral artery surgically and this required a longer procedure. We found that it was hard to control hemodynamic stability during the procedure under GA because of the cardio depressant effects of the anesthetics. We observed SpO_2 values in GA group higher before and after valve implantation, while there was no any changes in oxygen percentage during the valve implantation period. The possible reasons for the increase in SpO_2 values in GA group; improvement of restricted lung functions by mechanical ventilation and aortic valve function due to increased stroke volume. While a few differences between the two groups reached statistical significance, such as HRs in LAPS group being higher after valve implantation and SpO_2 values in GA group being higher before and after valve implantation, all results were within normal ranges and none of the differences suggested any meaningful clinical differences. The present study therefore shows that the need for colloid consumption, the duration of anesthesia or sedation and procedure in were significantly lower LAPS group than in GA group and that there were no serious contraindications for the use of LAPS.

Anesthesiologists in many centers have begun to choose the LAPS approach for TAVI procedures based on their prior experiences with GA [7]. Behan et al. [19] reported that remifentanil-based sedation for TAVI procedures has many advantages, such as shorter durations of the procedure and hospital and ICU stays and decreased respiratory complications and hypotension. In our study, we observed that the duration of anesthesia or sedation and procedure in LAPS group were significantly shorter than in GA group ($p<0.001$ for both groups). Prior to inducing LAPS, we also had all the necessary ready to convert LAPS in GA.

The primary intraoperative risk during TAVI procedures is hemodynamic instability. It is therefore absolutely essential for anesthesiologists and cardiologists to diagnose the causes of hemodynamic instability that may require rapid intervention, using invasive arterial monitoring, TEE, Transthoracic Echocardiography (TTE), fluoroscopy and contrast angiography. It is especially important being careful about hypotension due to rapid ventricular pacing during balloon aortic valvuloplasty. In our study, we observed in both groups that there were no meaningful changes in HR, MAP and SpO_2; while a few differences between the two groups reached statistical significance, all results were within normal ranges. In other words, none of the patients had complications during or related to the procedure.

According to the protocols for all TAVI procedures, all patients should be transferred to the ICU at the end of the procedure. Regardless of whether GA or LAPS is used, all patients must be fully monitored after the procedure for respiratory function, hemodynamics, cardiac arrhythmias, vascular complications and neurologic deficits. Pettet et al. [20] reported that TAVI procedures that used a transfemoral approach had the lowest number of pulmonary complications and the shortest lengths of hospital and ICU stays. In our study, we used short-acting hypnotic drugs and opioids for early extubation for the patients who underwent GA, then transferred them to the ICU without any observed pulmonary or cardiovascular complications. For patients in the LAPS group, we used midazolam and fentanyl in minimal doses and also transferred them to the ICU without any observed complications. Hemodynamics were stable in almost all patients in both groups. There was no significant difference between both groups with respect to the duration of ICU stays and they were all within acceptable limits (2.00±0.95 days in GA group and 1.61±0.49 days in LAPS group).

LIMITATIONS

Our study had several limitations. First, this retrospective study was based on a data analysis of anaesthesia and hospital records. Some important values (e.g., pulmonary arterial pressure, post-aortic peak pressure, etc.) were unfortunately not included in these records. Second, all the patients were from a single center and the sample size was relatively small. Third, there is need for a prospective randomized controlled trial of GA versus LAPS to determine the best anesthetic strategy.

CONCLUSION

The present retrospective cohort study showed that total patient colloid consumption per patient, need for permanent pacemakers and duration of procedure were significantly lower for patients who received LAPS rather than GA. While a few clinical differences between the two groups reached statistical significance, all results were within normal ranges and none of the differences suggested any meaningful clinical differences. Particularly for cases where there is no need for TEE or for a cardiovascular surgeon to dissect and repair the artery, we therefore conclude that LAPS can be used safely during TAVI procedures. However, although anesthetic strategies vary in different centers, careful preoperative assessments of anesthetic agent preferences, of complications related to catheterization and of hemodynamic stability including arrhythmia and myocardial ischemia following rapid ventricular pacing, as well as a requirement of immobility and adequate analgesia, are very important to achieve successful outcomes.

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