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Research Article

Anesthetic Management and Perioperative Complications in Endovascular Interventions: The Turkish Experience

Abstract

Background and Aim: Thoracic, abdominal and thoraco-abdominal aortic pathologies have highest mortality and morbidity causing pathologies in cardiovascular surgery. Co-existing diseases and age significantly increase risk of anesthesia and mortality rate in treatment of these patients. Endovascular techniques are used increasingly due to minimally invasive approach, decreased anesthesia risk during implementation, reduced length of hospital stay, and low mortality and mobidity rates. The aim of this investigation was to report our anesthetic experiences in endovascular techniques performed at our center.

Materials and Methods: We evaluated 120 (19 females, 101 males; mean age: 67±12 years) consecutive symptomatic patients with thoracic and abdominal aortic pathologies who underwent endovascular stent graft surgery with either general or regional anesthesia or sedoanalgesia between 2009 and 2014, at our center.

Results: The number of patients having abdominal endovascular stent graft surgery was 81. Among the rest; 87% underwent thoracic endovascular aneurysm repair, while 13% had both of the interventions. The duration of anesthesia and surgery was not different among the intervention groups. 86.8% of patients had general anesthesia, while 12.3% and 0.9% had regional anesthesia and sedoanalgesia; respectively. Postoperatively, the rate of being intubated and the length of stay in intensive care unit were found significantly lower in endovascular aortic repair (EVAR) group.

Conclusion: EVAR should be considered as a beneficial alternative treatment option for high-risk and inoperable, elderly patients. Anesthesiological approach to be selected in these patients may be affected not only by general condition and cooperation of the patient, but also by the location of the pathology and duration of the process. Thus, the anesthesiologists should be prepared to face issues related to the patient's safety both during the administration of anesthesia and in the postoperative period.

Introduction

Abdominal and thoracic aortic aneurysms (AAA and TAA) are major common health problems in men over the age of 65 in developed countries [1]. The age-related increase in the incidence of AAA and TAAA makesmore difficult the intervention due to high rate ofcomorbidities [2-4]. Open repair is associated with high operative morbidity. On the other hand, some authors reported a mortality rate less than 5%and prolonged hospital stay in well organized centers, even in ruptured aneurysms the results did not differ significantly [5-8]. EVAR is a minimally invasive and an alternative treatment technique compared with traditional open surgery. By this way, hemodynamic fluctuations and endocrine stress response are lessened and cardiac and pulmonary complications are rare [9-12]. These advantages accelerate the weaning period [13]. An anesthesiologist plays an essential role for these patients. 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.

This paper evaluates the perioperative anesthetic experiences for a consecutive series of patients who underwent endovascular abdominal and thoracalaneurysm repair in our institution within a 5-year period.

Materials and Methods

Between 2009 and 2014, EVAR and TEVAR procedures were performed in one hundred and twenty symptomatic but unrupturedpatientsat Ankara Atatürk Education and Research Hospital. We analysed the data of these patients with regard to anesthetic issues. The Institutional ethics committee approved the study and informed consent was obtained from all patients.Patients were evaluated preoperatively. Routine anesthetic preprocedural evaluation focused on cardiovascular parameters, airway control, and other systemic dysfunctions. No premedication was given. Clinical data of patients, parameters for process, duration of intensive care unit and hospital stay up to discharge time were recorded. All procedures were performed in the interventional radiology unit in our hospital due to lack of hybrid operating room. After inserting an intravenous(IV) catheter into a large arm vein, standard monitoring was applied. In addition to standard monitoring, invasive arterial

blood pressure monitoring, urinary catheterization were performed in every patient. Decision of central venous catheterization was left to the anesthesiologist.Depending on the procedure some patients had cerebrospinal fluid (CSF) drainage. At the beginning of the procedure, we administered heparin 5000 U IV to achieve an activated coagulation time (ACT) measurement in the level twice as high of normal. Local anesthetic infiltration, consisting of 10-20 ml of 1% lidocaine was applied to the groin. General anesthesia (GA), or regional anesthesia(RA), or sedoanalgesia was preferred according to the anesthesiologist's decision. Different agents were used to provide anesthesia. The patients who underwent GA were orally intubated. Either sevoflurane (0.8%-1.1% minimum alveolar concentration) in an oxygen air mixture at FiO_2 of 50% combined with remifentanilinfusio(0.02-2 µg.kg^{-1}.min^{-1}) or propofol/remifentanil infusion (3-5mg.kg^{-1}.h^{-1}/0.02-2µg.kg^{-1}.min^{-1}) (total intravenous anesthesia technique) were used for maintenance of anesthesia. We aimed to keep the mean arterial pressure above 90 mmHg and systolic blood pressure less than 140 mmHg to prevent complications due to rupture and ischemia during the procedurein accordance with the literature [14]. To achieve this goal, hypovolemia, if present, was corrected by rapid volume expansioninitially. Hemodynamic data and target arterial pressure values determined the use of vasoactive and / or inotropic agents. The aim was to provide adequate coronary perfusion for normal systemic blood pressure avoiding tachycardia. When preload and contractility were evaluated as optimal, bolus ephedrine (5mg), or continuous epinephrine, and/or norepinephrine (0.03-0.06 µg.kg^{-1}.min^{-1}) infusions were used to correct arterial hypotension. Thus dopamine infusion was started as required.

Standard surgical techniques were applied to all patients. Either suprarenal or infrarenal fixation was used. For TEVAR patients, chimneystents were placed. In only 3 patients a two-by-two chimney-and-periscope technique was performed. The femoral access was obtained with micropuncture, and access angiogram was obtained via microcatheter before dilating the tract. After the procedure, completion angiography was performed in allcases to confirm satisfactory aneurysm exclusion. At the end of the procedure, catheters were removed and femoral access sites were sealed by tightening the preplaced closing sutures.

Infusion of intravenous nitroglycerin was performed when hypertension (rising more than 25% control value of intraoperative systolic blood pressure or rising above 140 mmHg) occured during operation. All vasoactive drugs were made available in perfusors during operation. Clinical neurological assessment of the patients were made by checking consciousness, speech, muscle strength and motor movements in patients who did not have GA. Patients receiving GA were preferred to be extubated in Cardiovascular Surgery Intensive Care unit; because of the long distance between the two units.

Statistical Analysis

Data analysis was performed in SPSS for Windows 15.0 packet programed. It was investigated by Smirnow Test whether the distribution of numerical variables were conformed with normal distribution. Descriptive statistics were shown as mean ± standart deviation or median (minimum-maximum) for numeric variables

and as the number of cases and (%) for categorical variables. One-Way ANOVA test was used in determination of numeric data conforming normal distribution in independent groups. In case of differences occurbetween groups, Tukey test was used as Post-Hoc test in order to determine from which group differences occured. Kruskal-Wallis test was used for not normally distrubeted data. Bonferroni correction and Mann-Whitney U test in groups were performedin case differences occur between groups. Categorical variables were assessed by Chi-Square. Results were considered statistically significant for p<0,05.

Results

A total of 120 endovascular stent graft patients were evaluated in this study(19 females, 101 males). Patient's demographic data are shown in Table 1. The mean age of the patients was 70 ± 11 in EVAR group, and it was 63 ± 11 in TEVAR group, while it was 60 ± 16in the group having both EVAR-TEVAR in one stage. The percentage of male sex was significantly higher(p=0,007). The distribution of ASA class among EVAR, TEVAR and EVAR-TEVAR patients did not differ (Table 1). The 18.5% of patients in EVAR and 23.5% of patients in TEVAR group were emergency cases but not ruptured. Invasive arterial monitoring was applied to all patients. Central venous catheterization was not performed in 35patients in EVAR group and8 patients in TEVAR group. Anesthesia and surgery duration, the need for blood transfusion and inotropic and vasodilator agents in EVAR and TEVAR groups were similar (Table 2).

In EVAR cases, 79% of patients had general anesthesia (GA). This incidence was 93.9% in TEVAR patients. Only 1 patient in EVAR group and 1 patient in EVAR-TEVAR group was able to cooperate with the anesthesiologist to have sedoanalgesia. The two patients having insufficient spinal anesthesia had GA afterwards. Unfortunately, one of these patients died because of hemodynamic instability due to bleeding, during open surgery. CSF drainage catheterization and intracranial pressure monitoring were performed in 18% of patients of TEVAR patients before the procedure.

Length of stay in ICU was 1 day in EVAR patients and 2 days in TEVAR ones.

After the procedure, 5 patients in EVAR group, 1 patient in TEVAR group, and 1 patient in EVAR-TEVAR group died in the first 5 days due to complications related to respiratory and renal insufficiencies. 30 day mortality could not be followed because of lack of communication between patients and clinicians.

Discussion

Nowadays, less invasive interventions may be more advantageous in patient populations of older age with higher mortality rates than open surgery due to cardiovascular comorbidities associated. Endovascular interventions for AAA provide protection from damage caused by surgical stress of a major surgery. Thus, perioperative complications, morbidity and mortality are decreased [15,16].

Anesthetic technique in high risk patients undergoing endovascular interventions is very important. Taking into account that these patients will have more advantages from less invasive approach, it is also stated that they will benefit from less invasive

Table 1: Demographic characteristics of patients.

		EVAR (n=81)	TEVAR (n=34)	EVAR+TEVAR (n=5)	p
Age (year)		69.94 ± 10.94	63.24 ± 11.20	60.20 ± 15.87	**0.006***
Gender	Male	74(91.4%)	24(70.6%)	3(60.0%)	**0.007***
	Woman	7(8.6%)	10(29.4%)	2(40.0%)	
Height (cm)		170(146-195)	169.5(150-180)	166(160-175)	0.682
Weight (kg)		76.81 ± 15.96	80.09 ± 12.81	81.60 ± 5.64	0.481
BMI (kg/m^2)		27.22 ± 4.96	29.09 ± 5.41	29.58 ± 2.17	
ASA	ASA II	24(29.6%)	13(38.2%)	1(20.0%)	0.795
	ASA III	41(50.6%)	14(41.2%)	3(60.0%)	
	ASA IV	14(17.3%)	7(20.6%)	1(20.0%)	
	ASA V	2(2.5%)	0(0.0%)	0(0.0%)	
EF (%)		60(20-65)	65(50-65)	65(45-65)	0.310
CAD	No	47(58.0%)	27(79.4%)	3(60.0%)	0.091
	Yes	34(42.0%)	7(20.6%)	2(40.0%)	
HT	No	24(29.6%)	5(14.7%)	0(0.0%)	0.053
	Yes	57(70.4%)	29(85.3%)	5(100.0%)	
DM	No	72(88.9%)	29(85.3%)	4(80.0%)	0.759
	Yes	9(11.1%)	5(14.7%)	1(20.0%)	
COPD	No	53(65.4%)	26(76.5%)	3(60.0%)	0.469
	Yes	28(34.6%)	8(23.5%)	2(40.0%)	
RF	No	72(88.9%)	32(94.1%)	5(100.0%)	0.519
	Yes	9(11.1%)	2(5.9%)	0(0.0%)	
CVE	No	78(96.3%)	30(88.2%)	4(80.0%)	0.175
	Yes	3(3.7%)	4(11.8%)	1(20.0%)	

BMI: Body mass index. EF: ejection fraction. CAD: Coronary Artery Disease. COPD: Chronic obstructive pulmonary disease. RF: Renal Failure. CVE: Cerebrovascular event.
Categorical values are shown as n (%).
Values with measurable normal distribution are shown as 'Mean ± Std Deviation'.
Values not showing normal distribution are shown as 'Median (Minimum-Maximum)'.

anesthesia techniques. Anesthetic techniquevary depending on the experience of the surgicalteam, the preferred approach for the intervention, the patient's medical history and accompanying hemodynamic problems [17-19].

Many studies have indicated that, the type of anesthesia was not a determinant [20-22] factor for cardiovascular complications inpatients. Thus; both GA and RA as well as local anesthesia and sedation (LAS) can be applied in endovascular procedures. Some studies do not take into account anesthesia as a factor in determining the result of surgical intervention [9,15]. However, anesthesiologists and intensive care specialists are responsible for the successful outcome of these patients. GA is still a popular anesthetic approach [23]. It is preferred in cases expected to have longer durations. While placing the graft, sometimes sessation of breathing is required [19]. At the same time comfort provided by GA is important for a non-experienced team.

The first series applying local anesthesia by midazolam and propofol infusions in EVAR is a study of 47 patients. In this study 30% of patients were ASA IV. The duration of procedure was 170 minutes, estimated blood loss was 620 ml. In only one patient, general anesthesia was required because of the injury in iliac artery. All patients were mobilized after 24 hours. The length of hospital stay was 2.1 days.

In the first 30 days, noncardiopulmonary complications developed in only 3 patients [24]. Cao et al., performed epidural anesthesia for 54% of 61 patients undergoing elective EVAR. The decision for anesthetic technique was left to the anesthesiologist in this patient population with an ASA score of III in 75%. They used midazolam for sedation in regional anesthesia group; so as to keep Ramsey sedation scale as 2. There was no significant difference between GA and RA, in terms of length of stay in ICU; however; the ones in RA group required less ICU referral [25]. Bettex et al., evaluated 91 patients, retrospectively. In contrast to Cao et al., the requirement for ICU stay in GA group was less than RA and LAS groups. However, the length of stay in hospital was significantly shorter in LAS group. The use of inotropes and crystalloids and duration of the procedure were also significantly less [26]. This contradictory results are interesting; but could be attributed to the experiences of the team, and characteristics of patient population. Similarly, in another study, significantly shorter duration of ICU stay (1.9 days) was observed in GA group, together with shorter duration of anesthesia, procedure and less IV fluid infusions. Thus, the authors stated that; patient's co-morbidities were more important than anesthesia technique in determination of the progress in these patients [21].

Verhoeven et al., recognized that respiratory complications were much more and duration of the procedure was longer in EVAR patients

Table 2: Comparison of groups in terms of perioperative characteristics.

		EVAR (n=81)	TEVAR (n=34)	EVAR+TEVAR (n=5)	p
Emergency/Elective	Emergency	15(18.5%)	8(23.5%)	0(0.0%)	-
	Elective	66(81.5%)	26(76.5%)	5(100.0%)	
Type of anesthesia	General	64(79.0%)	31(93.9%)	4(80.0%)	-
	Spinal	13(16.0%)	1(3.0%)	0(0.0%)	
	Sedation	1(1.2%)	0(0.0%)	1(20.0%)	
	Spinal+General	2(2.5%)	0(0.0%)	0(0.0%)	
	Epidural+general	1(1.2%)	1(3.0%)	0(0.0%)	
Central catheter location	No	35(43.2%)	8(23.5%)	1(20.0%)	-
	Right Jugular	44(54.3%)	25(73.5%)	4(80.0%)	
	Left Jugular	2(2.5%)	0(0.0%)	0(0.0%)	
	Left Femoral	0(0.0%)	1(2.9%)	0(0.0%)	
Artery cannulation	Right Radial	71(87.7%)	29(85.3%)	3(60.0%)	-
	Left Radial	2(2.5%)	0(0.0%)	0(0.0%)	
	Right brachial	7(8.6%)	5(14.7%)	1(20.0%)	
	Left brachial	1(1.2%)	0(0.0%)	0(0.0%)	
	Left femoral	0(0.0%)	0(0.0%)	1(20.0%)	
Anesthesia time (Min)		165(75-750)	165(75-460)	210(110-675)	0.744
Surgical time (Min)		135(45-720)	135(60-420)	190(95-630)	0.625
Transfusion	Yes	63(77.8%)	27(79.4%)	2(40.0%)	0.195
	No	18(22.2%)	7(20.6%)	3(60.0%)	
Erythrocyte transfusion (u)		1(1-8)	1.5(1-4)	2(1-3)	0.788
Inotropic Agent	No	66(81.5%)	29(85.3%)	5(100.0%)	0.524
	Yes	15(18.5%)	5(14.7%)	0(0.0%)	
Using of vasadilator agent	No	64(79.0%)	24(70.6%)	4(80.0%)	0.621
	Yes	17(21.0%)	10(29.4%)	1(20.0%)	

Categorical values are shown as n (%).
Values not showing normal distribution are shown as 'Median (Minimum-Maximum)'

undergoing GA [27]. Wax et al., had a high percentage of patients undergoing EVAR with regional anesthesia. The different anesthesia groups differed from each other in only length of stay at hospital [18]. In a series of 5557 EVAR cases, the increase in duration of procedure, ICU admission and systemic complications were associated with GA [23]. Thus, GA was found to be an independent risk factor for mortality following endovascular procedures [28]. Bakker et al., stated that postprocedural mortality and renal complications in the following 30 days after EVAR were increased in the patienst having GA. This was thus, correlated with longer durations of hospital stay [13]. In two other larger series of endovascular interventions, similar results were reported [23,29]. At our institution, we preferred general anesthesia with tracheal intubation, especially at the beginning of the procedures. We switched to the use of regional anesthesia or local anesthesia and sedation following an assumed learning curve and experiences of the team. For induction of anesthesia, we used thiopental sodium, 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. The long distance between radiology unit and ICU made us concerned about the safety of airway and hemodynamic parameters during the transport of the patients. 29% of patients required inotropic support. However, duration of anesthesia, procedure, blood transfusion requirement, and inotropic agent usage were similar between EVAR and TEVAR patients. The type of anesthesia did not make a difference in the length of stay in ICU. Five patients having GA for EVAR had early mortality in ICU.

One of the most important complication of TEVAR is SCI (Spinal cord ischemia).This is a multifactorial pathology and not clearly understood [30-32]. There is not a consensus about the application of CSF among the authors, however, it is mostly advised in chosen patients for this procedure [14]. We also had CSF drainage in some of TEVAR patients. This decision was made according to the opinions of surgeons and anesthesiologists. The seven patients having CSF drainage did not have any neurological problems after the procedure. In a series of 139 TEVAR patients, 30 day mortality rate was 1.5%

and the incidence of SCIwas 3% [33]. In another study of 13 patients, no complication like stroke was reported [34]. One of the suggested opinions in the prevention of complications, are avoidance of hypotension and keeping mean arterial pressure ≥ 90 mmHg. Besides, volume status of the patient is important [14].

In our study, anesthesia method was not randomized. As in other studies, according to the decision of anesthesiologist, the type of anesthesia and the pharmacological agents used are different. Similar to the other authors; we believe that anesthesia techniques and agents are not associated with major postprocedural complications. Regarding our results, we observed the importance of experience for improved clinical results. 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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