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The effects of anesthesia types on early postoperative results in elective endovascular repair of aortic aneurysms

Tuğba Avcı[1], Göktan Aşkın[1], Bekir Boğaçhan Akkaya[1], Ayla Ece Çelikten[1], Nevriye Salman[2], Ertekin Utku Ünal[1], Hakkı Zafer İşcan[1], Şeref Alp Küçüker[1]

[1]*Department of Cardiovascular Surgery, Ankara City Hospital, Ankara, Turkey*
[2]*Department of Anesthesia and Reanimation, Ankara City Hospital, Ankara, Turkey*

ABSTRACT

Objectives: This study aims to investigate the effects of anesthesia types on early postoperative outcomes in patients treated with endovascular aneurysm repair (EVAR).

Patients and methods: Between January 2012 and January 2018, a total of 134 patients (124 males, 10 females; mean age 69.1±7.9 years; range, 52 to 85 years) who were operated under local-locoregional or general anesthesia for abdominal aortic aneurysms were retrospectively analyzed. Type of anesthesia was chosen individually, according to the patient suitability, aneurysm anatomy, and technical difficulty. Early mortality was defined as mortality observed within 30 days after the operation.

Results: Of the patients, 42 were operated under local-locoregional anesthesia and 92 were operated under general anesthesia. There was no conversion to general anesthesia. The mean procedural time was 133.2±30.4 min in the local-locoregional group and 156.4±53.4 min in the general anesthesia group (p=0.012). In the early postoperative period, there was one (1.1%) early mortality. Four patients (4.3%) developed renal impairment. One patient (1.1%) in the general anesthesia group had myocardial infarction after the procedure. In the local-locoregional group, the mean length of intensive care unit (ICU) stay was 8.5±6.4 h and the mean length of hospital stay (LOS) was 2.9±1.5 days. In the general anesthesia group, the mean length of ICU stay was 9.6±0.4 h and the mean LOS was 3.1±2.9 days, indicating a statistically significant difference between the groups in terms of the ICU stay (p=0.013). The mean amount of radio-opaque solution was also statistically significant between the groups (p=0.01).

Conclusion: Endograft types, the American Society of Anesthesiologists (ASA) classification, patient's emotional health, aneurysm anatomy, and having a high risk for conversion to open surgery are the key factors for choosing the most appropriate anesthesia type. Based on our study results, type of anesthesia does not affect the early results, although local anesthesia is more suitable and most commonly used in unibody grafts and high-risk patients.

Keywords: Anesthesia type, endograft type, endovascular aneurysm repair.

Endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAAs) was first defined in the 1990s as a more practical and less destructive alternative to open surgery.[1] With the spread of this technique, the EVAR-1 trial confirmed that 30-day mortality, intensive care unit (ICU) and hospital stay, and blood loss were lower than the open repair.[2] Despite similar long-term results for cardiac events,[3] EVAR has become the first-choice option for AAA repair, owing to its less invasive nature and remarkably better short-term survival rates.[1-2,4,5]

After the approval of endovascular repair as a predominant treatment in infrarenal AAAs, the types of anesthesia have recently started to be discussed worldwide.[6-9] In many centers, miscellaneous anesthetic techniques such as general anesthesia, regional anesthesia (including spinal, continuous

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Correspondence: Tuğba Avcı, MD. Ankara Şehir Hastanesi Kalp ve Damar Cerrahisi Kliniği, 06800 Çankaya, Ankara, Turkey.
e-mail: dr.tugbadonmez@gmail.com

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spinal and epidural anesthesia), and local anesthesia are successfully applied.[10-13]

In the present study, we aimed to investigate the effects of anesthesia types on postoperative outcomes in patients treated with elective EVAR.

PATIENTS AND METHODS

This single-center, retrospective study included a total of 134 patients (124 males, 10 females; mean age 69.1±7.9 years; range, 52 to 85 years) who were electively operated under local-locoregional or general anesthesia for AAAs with a modular or unibody endograft in the hybrid operating room by a single surgical team between January 2012 and January 2018. Medical data were retrieved from hospital medical database. All the patients eligible anatomically for elective EVAR treatment were included in the study. *Exclusion criteria were as follows:* having an urgent intervention, percutaneous simultaneous coronary intervention, or simultaneous coronary artery bypass grafting. A written informed consent was obtained from each patient. The study protocol was approved by the Turkiye Yüksek Ihtisas Training and Research Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All symptomatic patients were evaluated by electrocardiogram, echocardiography, and coronary angiography along with pulmonary functional test, chest X-ray, and computed tomography (CT) for anatomic aortic evaluation. Conventional CT and three-dimensional (3D) CT images in which CT data were reformatted in planes perpendicular to the vessel in 3D space were used to assist in proper endograft selection. During follow-up, conventional CT was performed at one and three months and at six and 12 months according to technical challenge of the procedure individually. We also performed abdominal aortic color Doppler ultrasonography. Early mortality was defined as mortality observed within 30 days after the operation.

Unibody and modular type endograft

The Endologix AFX device (Endologix Inc., Irvine, CA. USA) consists of a main bifurcated unibody and a proximal aortic extension. This endograft is the only graft with anatomical fixation at the aortic bifurcation. The graft has a 17 French (F) introducer system ipsilaterally and a 9F sheath contralaterally. The aortic extension is placed at the infrarenal position. One-side femoral incision and exposure are sufficient and the contralateral side cannulation can be performed percutaneously. Modular endografts consist of the main module with suprarenal fixation and an ipsilateral leg and contralateral leg graft module. The system has anchor hooks for suprarenal fixation. The main device is delivered with an 18-21F introducer system ipsilaterally and the contralaterally device is delivered with a 14-18F introducer system. After the main part is opened, contralateral leg cannulation and extension is attached. Of note, this step may be time-consuming, according to the aneurysm anatomy.

Anesthetic management

Anesthetic management was chosen as local, loco-regional or general anesthesia (Table 1).

General anesthesia was induced using 3 mg/kg propofol, 1 μg/kg fentanyl, and 0.6 mg/kg rocuronium bromide. Anesthesia was maintained using 1 minimum alveolar concentration (MAC) sevoflurane in a 50% oxygen/air mixture and all patients received a bolus of remifentanil 1 μg/kg followed by an infusion of 0.5 μg/kg/min.

Prilocaine was used for local anesthesia in the groin, regardless of an additional intravenous sedation or pain therapy. Once the patient felt pain, additional doses were applied.

Locoregional anesthesia was performed uneventfully with 20 mg 0.5% hyperbaric bupivacaine in the sitting position using 27 Gauge (G) Quincke-type spinal needle at the L3-L4 interspace. Motor block up to T12 level was observed 15 min thereafter. A total dose of 0.05 $mg.kg^{-1}$ midazolam was used for mild intravenous sedation, while the patient was oxygenated by 2 L/min nasal oxygen. Also, the following criteria were considered, while choosing the anesthesia type:[14]

1. For general anesthesia
    - If the case is technically difficult and has the possibility for conversion to open repair
    - If there will be intense femoral dissection for exposure
    - Cases having a possibility to last long
    - Not suitable for regional anesthesia due to coagulopathy
    - Intolerable for the patient

Table 1. Anesthesia types

	Total	Modular	Unibody
Local/locoregional	42	5	37
General	92	66	26

2. For local anesthesia
   - Shorter cases
   - High-risk patients
   - Not suitable for regional anesthesia due to coagulopathy
   - Tolerable for the patient
3. For locoregional anesthesia
   - The presence of relative comorbidity for general anesthesia (particularly respiratory diseases)
   - Patients with cardiovascular comorbidity and if local anesthesia is not tolerable for the patient.

Statistical analysis

Statistical analysis was performed using the SPSS for Windows version 15.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables with normal distribution were expressed in mean ± standard deviation (SD), while categorical variables were expressed in number and frequency. Demographic features and perioperative variables were compared using the Mann-Whitney U test and chi-square test. A p value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic and clinical characteristics of the patients are summarized in Table 2.

Of the patients, 42 were operated under local-locoregional anesthesia and 92 were operated under general anesthesia. None of the patients were needed to be converted to general anesthesia. The mean procedural time was 133.2±30.4 min in the local-locoregional group and 156.4±53.4 min in the general anesthesia group (p=0.01). The mean radioscopy time was 17.8±8.7 min in the local-locoregional group and 19.1±10.4 min in the general anesthesia group (p=0.619). The mean amount of radio-opaque solution was 62.9±12.5 mL in the local-locoregional group and 75.1±24.2 mL in the general anesthesia group, indicating a statistically significant difference between the groups (p=0.010).

Table 2. Patient characteristics

	Local-locoregional (n=42)			General (n=92)			
Anesthesia type	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			68.6±7.4			70.0±6.9	0.154
Gender							0.422
Male	40	95.2		84	91.3		
Female	2	4.8		8	8.7		
ASA classification							0.162
I-II	16	38.1		47	51.1		
III-IV	26	61.9		45	48.9		
Glasgow Aneurysm Score (mean)			76.1±11.1			75.2±10.9	0.394
Diabetes mellitus	10	23.8		17	18.5		0.476
Hypertension	28	66.7		49	53.3		0.145
Chronic obstructive pulmonary disease	15	35.7		25	27.2		0.316
Chronic renal failure	9	21.4		5	5.4		0.005
Peripheral vascular disease	1	2.4		12	13.0		0.053
Coronary artery disease	24	57.1		46	50.0		0.442
Coronary artery bypass grafting	12	28.6		24	26.1		0.763
Chronic heart failure	3	7.1		4	4.3		0.500
Ever smoker	19	45.2		32	34.7		0.248
Malignancy	8	19.0		4	4.3		0.006
Symptomatic	14	33.3		21	22.8		0.199
Previous abdominal surgery	5	11.9		12	13.0		0.854
Ejection fraction (mean)			52.1±10.6			50.7±8.6	0.143
Aneurysm diameter (mean)			61.9±9.8			62.4±13.7	0.482

SD: Standard deviation; ASA: American Society of Anesthesiologists classification.

However, there were no statistically significant differences between the two groups in terms of the iliac or aortic extension requirement (p=0.140 and p=1.000, respectively). In addition, balloon angioplasty (p=0.344), embolectomy (p=1.000), or graft interposition (p=1.000) requirement was not statistically significant, although the rate of endarterectomy necessity was higher in the local-locoregional group (p=0.004).

In the postoperative period, there was one (1.1%) early mortality in the general anesthesia group. Four patients (4.3%) developed renal impairment. Of these patients, one died, the other needed hemodialysis, and the remaining two returned to normal renal functions. All these patients were at high risk for renal impairment with a serum creatinine level of >1.8 mg/dL. One patient (1.1%) in the general anesthesia group had myocardial infarction after the procedure. In the local-locoregional group, the mean length of intensive care unit (ICU) stay was 8.5±6.4 h and the mean length of hospital stay (LOS) was 2.9±1.5 days. In the general anesthesia group, the mean length of ICU stay was 9.6±0.4 h and the mean LOS was 3.1±2.9 days, indicating a statistically significant difference between the groups in terms of the ICU stay (p=0.013).

DISCUSSION

After the first report with no death or significant morbidity associated with local anesthesia in 47 consecutive patients treated with EVAR,[11] the benefits of anesthesia types were investigated.[10,11] Although the Society of Vascular Surgery reported that using local anesthesia for EVAR had a low-level recommendation and low-level evidence, local-locoregional anesthesia seems to be the first choice among many surgeons for eligible patient.[7,8,15] In addition, its feasibility, safety, and efficacy on reducing pulmonary complications and LOS have been proven.[8,16]

According to the specifications, endograft types have distinct advantages and disadvantages. Unibody grafts may be placed with one-side femoral artery exposure and there is no contralateral leg cannulation. These features make unibody endografts more compatible with local anesthesia. Occasionally, modular grafts are also suitable for local-locoregional anesthesia; however, if the patient has challenging anatomy or does not have suitable emotional status, the femoral cannulation site is deep or difficult to obtain. In such cases, we used general anesthesia in our study.

In the present study, the mean procedural time was significantly shorter in the local-locoregional group. The possible reason for this can be attributed to the fact that, in the local-locoregional group, unibody grafts were mostly used which does not require to be cannulated contralaterally and only ipsilateral femoral exposure is enough for the procedure. The amount of opaque solution is also less in the local-locoregional group. This can be explained with the placement of the bifurcation module of unibody grafts only under scopy without using the opaque solution.

Furthermore, the mean ICU stay was significantly shorter in the local-locoregional group, possibly due to the fact anesthetic recovery is longer with general anesthesia.

The ASA classification was another factor which affected our decision. For ASA III-IV high-risk patients, we gave much more effort to perform EVAR under local-locoregional anesthesia, due to a high number of cardiopulmonary comorbidities. However, if these patients were at high risk for conversion to open surgery, general anesthesia was chosen. Local anesthesia with appropriate sedation would be capable for an immobile patient during the procedure. Otherwise, there may be some measurement defects or lack of luxury for the medical team. Dijkstra et al.[17] used general anesthesia for ASA III-IV high-risk patients; however, in our series, we used local anesthesia much more liberal. We preferred local anesthesia and sedation with the bispectral index at 60 to 85. For sedation, before local anesthesia, we administered fentanyl 1μg/kg, 1 mg midazolam and, then, 0.05 μg/kg/min remifentanil infusion. With these medications, we could configure effective and sufficient analgesia to block undesired patient motions, and patient discomfort due to pain. This also serves to hinder the undesirable side effects of general anesthesia over the cardiopulmonary system and the recovery period in ICU. Local anesthesia may give the surgical luxury of general anesthesia with the support of sedation. More liberal use of local anesthesia would highlight the non-invasive nature of endovascular procedures.

Local anesthesia first can be applied in 75% of patients undergoing EVAR procedure. Anesthetic conversion rates from local anesthesia to general anesthesia vary from 1 to 33% and seem to be lower in centers with more experience.[15,18] In our series, there was no conversion and we achieved 100% technical success. We believe that the accurate patient selection and patient characteristics, technical

accomplishment, and successful collaboration between surgeons and anesthesia team were the key factors for successful early results, consistent with the literature.[19,20]

One of the major limitations of our study was that; it was compromised of a relatively small number of patients from a single center. Furthermore, the long-term data was not available for the current day. The short-term follow up may not be available enough to make such a definitive cocnlusion. Another remarkable limitation was the lack of some information regarding to the respective nature of the study. Some parameters such as visual pain analogue scale may be used for further studies.

In conclusion, type of anesthesia does not affect early postoperative results. Nevertheless, local anesthesia reduces ICU stay and shorter ICU stay is also important to reduce health-related cost, to increase the patient turnover rate in high volume centers, and to improve patient comfort. In addition, general anesthesia-related pulmonary complications can be avoided using local-locoregional anesthesia in eligible patients. Local anesthesia is more suitable and most commonly used in unibody grafts and high-risk patients.

Declaration of conflicting interests

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