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General versus locoregional anesthesia for endovascular aortic aneurysm repair: influences of the type of anesthesia on its outcome

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Abstract
Of 31 patients who underwent elective endovascular aortic aneurysm repair (EVAR) in our facility in 2007, 12 underwent EVAR under general anesthesia, and in 19 patients EVAR was done under locoregional anesthesia. In a retrospective analysis of the medical records from these two groups, we observed that locoregional anesthesia for the anesthetic management of EVAR was well tolerated, and it had advantages over general anesthesia with respect to a reduction in the incidence of postoperative intensive care unit (ICU) stay and the duration of the operation. Our single-institutional experience confirms that patients undergoing EVAR are likely to benefit from the use of locoregional anesthesia.

Key words Endovascular aortic aneurysm (EVAR) · General anesthesia · Locoregional anesthesia · Outcome

Although its long-term durability and outcome still remain to be elucidated [1,2], endovascular aortic aneurysm repair (EVAR), a new endovascular technique to treat patients with abdominal aortic aneurysm, appears to reduce the 30-day perioperative mortality as compared to that for the conventional open surgical repair largely owing to its less invasive nature [3,4]. Thus, EVAR is especially suitable for those who were considered unfit for conventional open surgical vascular reconstruction due to their pre-existing comorbidities [5].

In our facility, approximately 30 patients, especially those considered unfit for open surgical vascular reconstruction, undergo EVAR annually. Until the middle of 2007, when we introduced locoregional anesthesia (i.e., epidural anesthesia and/or ultrasound-guided peripheral nerve block) for EVAR, almost all the patients had undergone EVAR under general anesthesia, based on the standard recommendations [6]. As the feasibility of locoregional anesthesia for EVAR has become apparent, a shift has taken place toward the almost exclusive use of locoregional anesthesia, although the decision on the type of anesthesia used depended entirely on the participating physicians' and on the patients' preferences. Consequently, of 31 patients who underwent elective EVAR in our facility in 2007, 12 underwent EVAR under general anesthesia, and in 19 patients EVAR was done under locoregional anesthesia; this prompted us to retrospectively evaluate the effects of anesthesia type on the outcome of elective EVAR.

In the general anesthesia group, anesthesia was accomplished with propofol (target concentration, $3\ \mu g \cdot ml^{-1}$ by target-controlled infusion [TCI]) and fentanyl ($1–2\ \mu g \cdot kg^{-1}$), and the patients' tracheas were intubated, facilitated by the use of vecuronium bromide ($0.1\ mg \cdot kg^{-1}$) for neuromuscular blockade. Subsequent anesthesia was maintained with propofol (target concentration, $2\ \mu g \cdot ml^{-1}$) and intermittent bolus injection of fentanyl. For the locoregional anesthesia group, either epidural anesthesia and/or ultrasound-guided peripheral nerve block were used. For epidural anesthesia, the catheter was inserted a day prior to the surgery, followed by the injection of 5–10 ml of 1% lidocaine through the catheter on the day of surgery. For peripheral nerve blockade, ilio-inguinal and ilio-hypogastric nerve blocks were performed under ultrasound guidance. Briefly, the external oblique, the internal oblique, and the transverse abdominis muscles, and the associated fascial sheaths, were visualized under high-resolution ultrasound imaging (GE LOGIQ Book XP; GE, San Jose, CA, USA). With a blunt regional anesthesia needle (Stimuplex®; 21-G × 100 mm; B. Braun, Melsungen, Germany), a total amount of 10 ml of 1% ropivacaine combined with 10 ml of 1% lidocaine was injected ipsilaterally beneath the internal oblique muscle. When necessary, lidocaine infiltration was added to the groin. During the surgical procedure, one patient in the locoregional anesthesia group had to be

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Table 1. Patients' characteristics, and pre-existing comorbidities in patients who underwent elective EVAR

Measurements	General anesthesia ($n = 12$)	Locoregional anesthesia ($n = 19$)	Statistical significance
Patients' characteristics			
Age (years)	73.3 (58–83)	75.36 (60–86)	$P = 0.541$[a]
Sex (M/F)	9/3	17/2	$P = 0.292$[b]
BMI (kg/m^2)	23.67 (18.07–40.8)	22.19 (14.99–29.51)	$P = 0.612$[a]
Diameter (mm)	53.83 (32–78)	51.82 (41–65)	$P = 0.823$[a]
ASA (II/III)	3/9	4/15	$P = 0.798$[b]
SVS-ISCVS risk factors (n)			
Smoking	8	14	$P = 0.675$[b]
Hypertension	11	16	$P = 0.546$[b]
Hyperlipidemia	5	7	$P = 0.789$[b]
Cardiac disease	6	5	$P = 0.179$[b]
Carotid disease	4	9	$P = 0.441$[b]
Renal disease	7	5	$P = 0.075$[b]
COPD	4	10	$P = 0.0014$[b]
Devices (n)			
Zenith	11	16	$P = 0.172$[b]
Excluder	0	3	
In-house	1	0	

Data values are expressed as means (ranges)
[a] Kruskal-Wallis and Wilcoxon rank sum tests
[b] χ^2 Test and logistic regression analysis

converted to general anesthesia, in which the use of propofol was required for sedation owing to the long duration of surgery.

Differences in preoperative and operative details among the two groups were analyzed using the χ^2 test and logistic regression for discrete variables and the Kruskal-Wallis and Wilcoxon rank sum tests for continuous variables. The mean age, the male predominance, BMI (body mass index), aortic aneurysm diameter, and the distributions according to the American Society of Anesthesiologists (ASA) classification were similar in the general anesthesia group and the locoregional anesthesia group (Table 1). For Society for Vascular Surgery-International Society for Cardiovascular Surgery (SVS-ICVS) risk factors [7], there were no significant differences between the two groups in the prevalence of cigarette smoking, hypertension, hyperlipidemia, and cardiac disease (Table 1). For those who had chronic obstructive pulmonary disease (COPD), the locoregional anesthesia technique was used preferentially (Table 1), reflecting the participating physicians' intention to avoid the possible deteriorative effects of mechanical ventilation on COPD. No significant differences in the use of stent brands from different companies were evident with respect to the type of anesthetic technique (Table 1). The two brands listed in Table 1 are second-generation fully stented modular stent grafts that, because of their refinement from first-generation brands, do not require an induced hypotension technique during the deployment of the grafts.

The number of patients requiring postoperative ICU stay and the duration of operation were significantly lower in the locoregional anesthesia group (Table 2). In the general anesthesia group, 3 of the 12 patients were admitted to the ICU postoperatively, whereas no single patient was admitted in the locoregional anesthesia group. Two of these 3 patients, who had pre-existing coronary artery disease, developed ST-T changes in the electrocardiogram during the surgical procedure. By contrast, we did not observe any similar episodes in the locoregional anesthesia group, despite there being no statistically significant differences in the prevalence of coronary artery disease between the two groups (Table 1). This difference may have in part resulted from the attenuation of surgical stress response and sympathectomy obtained by locoregional anesthesia [8]. The third patient was admitted to the ICU because of the presence of co-existing thoracic aortic aneurysm and chronic kidney disease requiring hemodialysis after the surgery.

Because of the retrospective nature of our report, the precise reasons why the duration of the operation was significantly reduced in the locoregional anesthesia group remain unclear. Except for one patient, in conditions where the patients were kept fully awake, conscious, and cooperative throughout the surgery, we speculate that the physicians were tempted to complete the procedure as quickly, and as comfortably for the patients as possible. In addition, the patient could easily perform some special maneuvers as requested by the physician, such as holding his/her breath for angiography during the deployment of the stent or taking up certain postures for the insertion of the stents, which features may have also contributed to the reduction of

Table 2. Effects of anesthesia type on the early (30-day) outcome of elective EVAR

Measurements	General anesthesia (n = 12)	Locoregional anesthesia (n = 19)	Statistical significance
Duration of operation (min)	236.4 (160–355)	181.1 (140–235)	$P = 0.0037$[a]
Postoperative ICU stay (n)	3	0	$P = 0.022$[b]
Postoperative hospital stay (days)	9.45 (5–25)	7.21 (4–12)	$P = 0.292$[a]
Blood loss (g)	213.16 (50–658)	309.05 (5–905)	$P = 0.453$[a]
Endoleak (n)	5	10	$P = 0.171$[b]
Type I	1	0	
Type II	4	9	
Type III	0	1	
Postoperative 30-day mortality (n)	1	0	$P = 0.201$[b]
Cardiac complications (n)	0	0	NA
Respiratory complications (n)	0	0	NA
Renal complications (n)	0	0	NA

Data values are expressed as means (ranges)
NA, not applicable
[a] Kruskal-Wallis and Wilcoxon rank sum test
[b] χ^2 test and logistic regression analysis

the duration of operation. However, it is also possible that improvements in skills have shortened the duration of the operation as the number of cases has increased.

There were no cases of device-related or arterial complications on failure to complete the EVAR procedure in either group. The presence of an endoleak on computed tomography (CT) scan at discharge does not necessarily predict patient outcome following EVAR [9], although it suggests the presence of continued blood flow in the aneurysm sac. We observed that 15 out of the 31 patients had an endoleak, with a type II being most predominant (Table 2); these findings were comparable to those from other facilities [9]. The incidence of endoleak and the amount of blood loss during the surgery were not correlated with any particular type of anesthetic technique (Table 2), in contrast to previous observations showing that the use of locoregional anesthesia reduced the incidence of endoleak [7].

There was one patient with early mortality in the general anesthesia group; this death resulted from nonocclusive mesenteric ischemia (NOMI), as revealed by postmortem examination. Because this patient had been on regular hemodialysis for more than 20 years and her systemic vascular disease was prominent when she had undergone EVAR, it was unlikely that the complication was etiologically correlated to the type of anesthesia. Except for this patient, there was no mortality, and there were no postoperative cardiopulmonary or renal complications in either group.

Our single-institutional experience confirms that the use of a locoregional anesthesia technique for EVAR is well tolerated, and it has advantages over general anesthesia with respect to a reduction in the incidence of postoperative ICU stay and a reduction in the duration of the operation. As the number of patients who undergo EVAR increases year after year, the question as to which type of anesthesia is most suitable for the anesthetic management of EVAR is becoming a serious issue of debate [7,10,11], because the vast majority of these patients present with serious comorbidities [3–5]. De Virgilio et al. [10] reported that there were no obvious advantages in the use of locoregional anesthesia for EVAR over general anesthesia with respect to a reduction of perioperative cardiopulmonary mortality and complications. On the contrary, Ruppert et al. [7], as well as Verhoeven et al. [11] suggested that patients might benefit from the use of locoregional anesthesia for the anesthetic management of EVAR. Although EVAR is still mostly conducted under general anesthesia, with only approximately 30% of the procedures done under locoregional anesthesia [11], it seems that the patients would be likely to benefit from the use of locoregional anesthesia.

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