Use of dexmedetomidine versus general anesthesia for endovascular repair of abdominal aortic aneurysms

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While abdominal aortic aneurysms have traditionally been treated with a major open surgical procedure, minimally invasive endovascular techniques are much less traumatic, with significantly less strain on the heart and vital organs. A sedation technique using dexmedetomidine, an alpha 2-adrenoreceptor agonist, was developed for this procedure. We retrospectively reviewed records of 231 patients who underwent endovascular repair of abdominal aortic aneurysms at the Baylor Jack and Jane Hamilton Heart and Vascular Hospital from January 1, 2001, until September 30, 2005. Intraoperative and early postoperative data of 14 patients who had endovascular repairs using the dexmedetomidine sedation technique were compared with those of 22 patients who received general endotracheal tube anesthesia for the procedure during the time period of January 1, 2003, through September 1, 2005. The surgery and anesthesia times were shorter in the dexmedetomidine group, and less opioid medication was required. In addition, the postoperative pain scores were lower, and the need for postoperative pain medication was less in the dexmedetomidine group. This retrospective analysis demonstrates that a dexmedetomidine sedation technique offers a successful alternative to routine general anesthesia for endovascular repair of abdominal aortic aneurysms.

The surgical treatment of abdominal aortic aneurysms has traditionally involved a major open procedure, which is associated with significant mortality and morbidity (1). The indications for surgery on abdominal aortic aneurysm have been predicated on these risks; surgery is recommended only when the aneurysm has reached a certain size, is rapidly expanding, or is symptomatic (2). With the successful development of the minimally invasive endovascular technique to treat abdominal aortic aneurysms, the procedure is much less traumatic, with significantly less strain on the heart and vital organs (3). The recovery from the endovascular surgery is much easier and shorter (3), which may result in the broadening of indications for surgical intervention.

In keeping with the less traumatic surgery, the anesthetic technique may be redesigned to be less invasive and have a reduced impact on the patient. The usual anesthetic technique for abdominal aortic aneurysm resection involves general anesthesia with invasive monitoring that includes the placement of right heart catheters and in some cases transesophageal echocardiography probes so that the heart function can be carefully monitored and protected during aortic cross-clamping and episodes of significant blood and fluid loss. Ensuring pulmonary function and oxygenation of vital organs has required intubation of the trachea and mechanical ventilation both intraoperatively and often for a period of time postoperatively in the intensive care unit (3).

Dexmedetomidine is a unique sedative anesthetic agent that allows accurate control of the depth of sedation and provides analgesia, cardioprotection, renal protection, and neuroprotection without causing respiratory depression. It is an alpha 2-adrenoreceptor agonist that modulates the release of catecholamines from the central and autonomic nervous systems. When patients sedated by dexmedetomidine are allowed to become responsive, they are calm and cooperative (4). No other sedative agent has this feature, and sedated patients frequently awaken in a confused state. The endovascular technique requires that the patient hold respiration at frequent intervals and remain still while contrast media is injected and the stents are deployed. The patient under dexmedetomidine sedation can hold his or her breath on command when the depth of anesthesia is appropriately adjusted.

Therefore, an anesthetic technique was developed that employs dexmedetomidine together with local anesthesia in the groins. This report compares, retrospectively, the outcomes of this technique with the use of routine general anesthesia for the endovascular repair of abdominal aortic aneurysms.

METHODS

After obtaining approval for this study from the institutional review board, we reviewed the records of 231 patients who underwent endovascular repair of abdominal aortic aneurysms at the Baylor Jack and Jane Hamilton Heart and Vascular Hospital from January 1, 2001, until September 30, 2005. A subset of 22 contemporaneous patients who underwent general anesthesia

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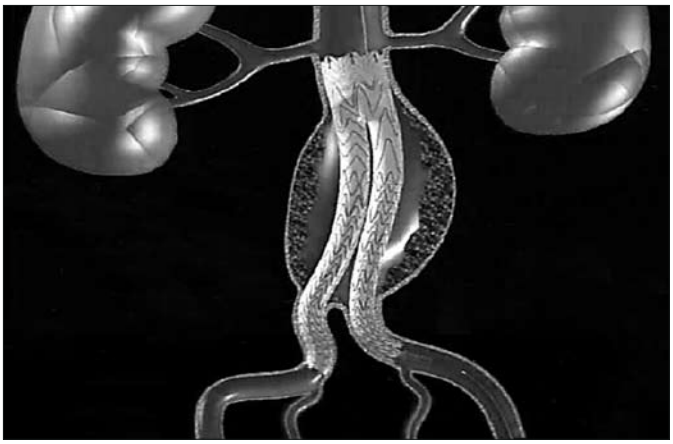

Figure. Illustration of a deployed bifurcated endograft (GORE EXCLUDER AAA Endoprosthesis) across an infrarenal abdominal aortic aneurysm. Courtesy of Gore.

was compared with the 14 patients who underwent the new dexmedetomidine sedation technique. Intraoperative and early postoperative data were analyzed to determine the feasibility and appropriateness of the dexmedetomidine technique.

Data analyzed included patient demographics, hemodynamics, the administration of vasopressors, complications, and outcomes. Hemodynamics measured included blood pressure and heart rate. Hemodynamic stability was assessed by calculating heart rate and systolic blood pressure variance along with blood pressure range and the use of vasopressors. Variance is a parameter that measures the dispersion of a random variable's probability. A higher systolic blood pressure variance denotes greater changes in blood pressure throughout the procedure. Records were screened for age, sex, and American Society of Anesthesiologists (ASA) score. Only patients with an ASA score ≤3 were included; two patients who had an ASA score of 4 and received general anesthetics were excluded from the review. Charts were also reviewed for any complications during the intra- and postoperative period, including airway interventions, hypotension, and death.

All patients were administered preoperative medications, including midazolam and/or metoclopramide at the discretion of the anesthesiologist. The patients undergoing general anesthesia underwent endotracheal intubation and mechanical ventilation. They were administered muscle relaxants and inhalational anesthetic agents together with intravenous opioids. The dexmedetomidine patients were administered supplemental oxygen via nasal cannulas, and the drug was administered in a tightly controlled manner via an infusion pump. A loading dose was delivered at 1 mcg/kg followed by a maintenance infusion of 0.3 to 0.7 mcg/kg/h adjusted to the patients' comfort requirements and the need for cooperation during the surgical procedure. The groin incisions were infiltrated with 0.5% bupivacaine in this group of patients.

In the endovascular technique, two 4-inch incisions were made in the groins, and the femoral arteries were dissected out and carefully controlled. Under fluoroscopic control, guide wires were inserted and directed into the infrarenal abdominal aorta. The endovascular graft tightly wrapped around a metal

Table. Demographic, intraoperative, and PACU data for 14 patients sedated with dexmedetomidine and 22 patients given general endotracheal tube anesthesia for endovascular repair of abdominal aortic aneurysm

Parameter	Dexmedetomidine	General endotracheal tube anesthesia
Age (years)	74.1 ± 8.8	73.3 ± 7.2
ASA risk score	3	3
Surgery time (min)	125 ± 41.7	154 ± 63.0
Anesthesia time (min)	176.5 ± 42.4	211.7 ± 55.5
Baseline blood pressure	135/74 ± 22.4/9.3	139/73 ± 21.5/9.2
Blood pressure range	100/53–140/72	99/51–142/71
Systolic blood pressure variance	196.46	225.21
Baseline pulse	70.7 ± 12.9	71.4 ± 12.2
Pulse range	60.6–69.7	56.3–73.0
Pulse variance	18.46	46.46
Dexmedetomidine dose (mcg/kg/h)	0.52 ± 0.16	NA
Sevoflurane (end-tidal)	NA	1.81 ± 0.46
Midazolam (mg)	3.5 ± 1.3	1.7 ± 1.5
Fentanyl (mcg)	208.9 ± 254.4	244.3 ± 117.5
Phenylephrine (mcg)	109.2 ± 152.3	106.8 ± 282.9
PACU fentanyl (mcg)	7.1 ± 26.7	11.9 ± 23.9
PACU morphine (mg)	0.14 ± 0.53	3.36 ± 10.5
PACU pain score (0–10: 0 = no pain; 10 = most pain)	1.78 ± 1.67	3.86 ± 2.12
PACU time (min)	214.1	155.4

Values are means (± standard deviation, where applicable).

ASA indicates American Society of Anesthesiologists; PACU, postanesthesia care unit; NA, not applicable.

stent was then carefully advanced up the guide wire and positioned inside the aneurysm until the proximal margin was above the aneurysm at the level of the renal arteries *(Figure)*. Multiple injections of contrast media were required to provide angiographic confirmation of correct positioning.

When the contrast material was injected, the patient was made apneic by stopping mechanical ventilation in the general anesthesia group or by awakening the patient in the dexmedetomidine group and asking the patient to hold his or her breath. This usually took 1 to 2 minutes, and the patient had to be completely still. The main body of the graft was then deployed immediately below the renal arteries. Again, the patient had to be extremely still and apneic during this deployment. This provided one limb of the graft that extended to the iliac arteries on the side used for the main body access. A short limb was then deployed on the other side of the patient to complete construction of a bifurcated graft from the infrarenal aorta to both iliac arteries. Once the grafts were successfully deployed, the guide wires were removed and the femoral arteriotomies

repaired. The femoral incisions were then closed and the patient was taken to the recovery room.

In the general anesthesia group of patients, the neuromuscular blockade was reversed with neostigmine and, when appropriate, the endotracheal tube was removed. The dexmedetomidine patients were taken to a lighter level of sedation and the drug was discontinued before they exited the operating room.

RESULTS

A detailed comparison of 22 consecutive patients who underwent general anesthesia in the same time period as the 14 dexmedetomidine patients was made. Both the dexmedetomidine and general anesthesia patients had their procedures between January 1, 2003, and September 1, 2005. The 22 general anesthesia patients represent all of the cases done solely under endotracheal tube anesthesia during that period. The demographic data were similar between groups.

In the dexmedetomidine group, the surgery time and anesthesia time were shorter, less opioid medication was required, and postoperative pain scores were lower, with less use of postoperative pain medication *(Table)*. The surgery was successfully completed without complication in both groups of patients. All patients were discharged from the hospital without significant complications. The small number of patients in the dexmedetomidine group precluded any statistical analysis of the study results.

DISCUSSION

The data from this retrospective study demonstrate that the dexmedetomidine sedation technique is a good alternative to general anesthesia for the endovascular repair of abdominal aortic aneurysm. The mean anesthesia time and mean surgery time were shorter in the dexmedetomidine group. Anesthesia time may have been reduced because of avoidance of general anesthesia emergence and extubation, while the reduction in surgery time may be related to avoidance of laparotomy and vessel anastomosis. The dexmedetomidine group also had lower pain scores and less use of intraoperative and postoperative pain medication. This result can be attributed to both the use of local anesthetic and the opioid-sparing properties of dexmedetomidine.

Dexmedetomidine provides myocardial protection similar to that provided by beta-blocking drugs and provides hemodynamic stability equivalent to that of general anesthesia for the patient at high risk of cardiac death (5). Hemodynamic outcomes were similar in the dexmedetomidine and general anesthesia groups, as reflected in the systolic blood pressure and heart rate variances. Both groups used phenylephrine equally, but the lower variance in the dexmedetomidine group reflects smaller changes in blood pressure and heart rate during the procedures.

Although no pulmonary complications occurred in either group, the avoidance of endotracheal intubation with dexmedetomidine sedation is another potential advantage, as patients with abdominal aortic aneurysms frequently have significant pulmonary compromise and may experience delays in being weaned from mechanical ventilation. Although no patients in our study experienced delirium, dexmedetomidine has been shown to have neuroprotective properties and may also prevent the delirium that can develop from the administration of benzodiazepine drugs and general anesthetic agents (6). This patient group also frequently has associated cerebrovascular disease, so a dexmedetomidine technique may provide significant advantages.

While this study demonstrates a difference in anesthesia time, surgery time, pain score, pain medication use, and hemodynamic variance, a larger study is necessary to investigate whether this difference is statistically significant.

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