Published in final edited form as:

Anesth Analg. 1971 ; 50(2): 169–174.

Anesthesia Experience With Living Renal Transplant Donors

J. ANTONIO ALDRETE, M.D.[†], JACK T. SWANSON, M.D., ISRAEL PENN, M.D., and THOMAS E. STARZL, M.D., Ph.D.

Departments of Anesthesiology and Surgery, University of Colorado Medical Center, and the Veterans Administration Hospital, Denver, Colorado 80220

Renal transplantation has become a form of treatment for end-stage kidney disease in the last several years. Procurement of organs from volunteer living donors for transplantation has been conducted in our institution since 1962. Several authors¹⁻⁶ have reported on the anesthetic management of recipients of renal transplants, mentioning briefly the technics used and morbidity encountered in the donor patients. We have reviewed the anesthetic agents and technics, as well as the complications observed in administering anesthesia to a group of healthy renal donors, in the belief that these results may help to make future transplantation operations as safe and comfortable for the donor patients as possible.

MATERIALS AND METHODS

Anesthetic records of 238 patients who underwent nephrectomy for renal transplant donation at the University of Colorado Medical Center and the Veterans Administration Hospital in Denver, Colorado, from March 1962 to June 1969, were studied. In all cases, the anesthetic agents were administered by anesthesiology residents, supervised by staff anesthesiologists. The preanesthetic evaluation of the patient, anesthetic technics and agents, blood loss and fluid replacement, complications during anesthesia, and probable related morbidity following anesthesia were reviewed.

For the surgical procedure, the patient was positioned in the left or right lateral decubitus, and was sometimes anesthetized in this position. When anesthesia had been induced, the operating table was placed in the nephrectomy position and the kidney rest was raised. Exposure was obtained through a thoracoabdominal incision. In the early cases, the approach was through the 11th rib bed and the pleura was not opened. In the later cases, the approach was through the 10th rib bed, purposely entering the pleural cavity, but avoiding the peritoneum. An electric cautery was used during the operation.

[†]Dr. Aldrete's present address: University of Miami School of Medicine, Miami, Florida 33152.

Generic and Trade Names of Drugs

Meperidine HCl—Demerol HCl

Morphine sulfate

Sodium secobarbital—Seconal Sodium

Sodium pentobarbital—Nembutal Sodium

Hydroxazine HCl—Vistaril Atropine

Scopolamine hydrobromide

Sodium thiopental—Pentothal® Sodium

Succinylcholine—Anectine, Quelicin, Sucostrin

Halothane—Fluothane

Fluroxene—Fluoromar

Methoxyflurane—Penthane

Gallamine triethiodide—Flaxedil

Good muscular relaxation was necessary to enable the surgeon to remove the kidney with an adequate length of renal artery, vein, and ureter. As soon as the surgeon began to handle the kidney, 12.5 gm. of mannitol were given intravenously by the anesthesiologist. A catheter was placed in the pleural cavity as the diaphragm and chest wall were closed. All air and fluid within the pleura were then evacuated by suction and the lungs were hyperinflated as the catheter was removed. Because of the meticulous dissection necessary to free the kidney, its vessels, and the ureter, the operating time, from 3 to 5 hours, is longer than the standard nephrectomy performed for other reasons.

RESULTS

The 238 patients included 138 males and 100 females. The average age was 36, ranging from 18 to 57 years. Preanesthetic evaluation classified 168 (75 percent) as A.S.A. class I, and 70 (25 percent) as A.S.A. class II. Patients in class II included those with such conditions as minor electrocardiographic abnormalities, hematocrits from 35 to 40 percent, history of asthma or chronic bronchitis, obesity, chronic sinusitis, past history of hepatitis, and pneumonia completely resolved. There were no class III, IV, or V patients.

In all cases, premedication included various combinations of analgesics (meperidine or morphine) with sedatives (secobarbital, pentobarbital, or hydroxyzine) and anticholinergic drugs (atropine or scopolamine). General inhalation anesthesia was administered in every case with endotracheal intubation. Hypothermia was employed only in the first 24 cases of this series.

After an adequate period of preoxygenation, anesthesia was induced with various combinations of intravenous barbiturates and relaxants (table 1). In 4 cases, inhalation agents were used exclusively.

Table 2 shows the anesthetic agents used in maintenance of anesthesia and table 3 lists the muscle relaxant drugs administered.

The average estimated blood loss was 41.2 ml., ranging from 80 to 1450 ml. The amount of intravenous fluids administered averaged 1933 ml. (5 percent dextrose in lactated Ringer's solution), ranging from 700 to 3900 ml. Ten patients (4.1 percent) required, in addition, either blood or plasma expander; 4 (1.6 percent) required 1 unit of whole blood, 3 (1.2 percent) required 2 units of whole blood, and 3 (1.2 percent) required 500 ml. of albumin.

Hypotension (tables 4 and 5) was considered a complication if the blood pressure fell more than 20 percent of the values recorded at the preanesthetic visit (rather than in the operating room prior to induction). In no case did the blood pressure drop more than 40 percent of the original values. This does not represent the actual incidence of hypotension, since more than one episode occurred during the same anesthetic procedure in some cases.

Other complications during the operative period are listed in table 6. The postoperative morbidity probably related to the anesthetic management is shown in table 7. There were no deaths or life-threatening complications.

DISCUSSION

The volunteer renal donors in this study were carefully selected for the operation, as described elsewhere.⁷ All were considered to be in good health, and appeared to have no condition contraindicating any technic of anesthesia. Primarily because of the length of the surgical procedure and the uncomfortable position, all operations were done under inhalation anesthesia with endotracheal intubation. The various agents used for

premedication, induction, maintenance, and muscle relaxation were entirely the choice of the individual anesthesiologists in charge of each case, and, in general, reflected no special change from the anesthetic management of patients undergoing surgery of this magnitude (except for the 24 cases involving hypothermia).

Although only 7 patients in the entire series required blood transfusion of 1 or 2 units, whole blood should be available for these operative procedures, since there is manipulation of major vessels including the renal artery and vein, and in some cases, the inferior vena cava, which, if accidentally injured, can cause severe hemorrhage.

Because all the patients were in good preoperative health, the complications and morbidity observed can be attributed either to the anesthetic technic or the surgical procedure. By far the most common complication during anesthesia was a fall in arterial blood pressure at some time during the procedure. In 100 cases (42 percent), a drop in systolic pressure of greater than 20 percent of the preanesthetic level occurred. Of these, in 59 patients (25 percent) hypotension appeared in the early phase of anesthesia, during induction and positioning. Therefore, the following specific points have received considerable attention:

1. Adequate hydration of the patient before the surgical operation. For this, each patient is given an intravenous infusion of 1000 ml. of fluid during the 10 hours before the operation.
2. Slow induction of anesthesia.
3. Gradual positioning of the operating table according to the patient's tolerance, as indicated by the change in blood pressure.
4. Elevation of the kidney rest only when the blood pressure appeared stable.
5. When susceptibility of certain patients to this complication is foreseen, tracheal intubation might be done in the lateral decubitus position, if no difficulties with airway management are anticipated.

Treatment of hypotension can include one or several of the following measures:

1. Rapid administration of intravenous fluids.
2. Decrease of the concentration of the anesthetic agent.
3. Partial or total reversal of the nephrectomy position.
4. Atropine sulfate, 1 mg. administered intravenously.

Vasopressor drugs are not recommended, as their use may cause decreased blood flow to the kidneys, with the danger of lengthening ischemia in the kidney to be removed. Correlation of hypotension with the anesthetic agents used showed that, proportionally, fluroxene was significantly less often involved than halothane and methoxyflurane.

None of the other complications during anesthesia (table 6) can be attributed directly to a specific aspect of the nephrectomy operation, but rather are those that can occur with any general anesthetic procedure. Of these, only respiratory depression is important.

The incidence of respiratory complications compared favorably with the study by Forthman and Shepard,⁷ probably because of the better physical condition in our selected group of donors.

Of the cases involving postoperative morbidity, those with pneumothorax, the pressure points under the "kidney rest" area, the head and neck of the fibula and the lateral malleolar area of the dependent leg, eyelid swelling, and peripheral nerve palsies can be directly

ascribed to the operation or the particular position required. The other morbidity (table 7) can be seen following any general anesthesia for a major surgical procedure.

From this experience, to avoid areas of pressure and nerve damage, extreme care is now taken when positioning these patients. A pneumatic bag is placed under the dependent axilla to protect the brachial plexus, and extra padding is used to protect the head and neck of the fibula and thus avoid peroneal nerve palsy. Padding is also used to protect the dependent lateral malleolar area from undue pressure.

Further investigation into the postoperative complications in these patients revealed that all residual pneumothoraces were on the side of kidney removal. Either inadvertent entrance to the pleural space or insufficient removal of the residual air was responsible for this problem. Of the 32 patients in whom pneumonitis or atelectasis developed in the postoperative period, 22 (70 percent) of such complications were in the contralateral side from the nephrectomy, suggesting that postural accumulation of secretions and/or ventilation:perfusion ratio alterations during the operation might have been at least partially implicated in this complication.

Not surprisingly, all the pleural effusions occurred in the side where the pleural cavity was entered. The cases of brachial plexus and peroneal nerve palsy were on the dependent side.

As mentioned in the report by Penn,⁸ of the 4 patients who developed hepatic dysfunction postoperatively, all received halothane as main anesthetic, 1 had a doubtful relation to the organ donation procedure, and in only 1 was there evidence to suggest a hepatocellular lesion, which appeared on the 4th postoperative day and subsided spontaneously 3 days later. All recovered satisfactorily. Two women were later found to have been in early gestational periods of pregnancy at the time of nephrectomy. Both gave birth to healthy infants.

The experience herein reported demonstrates that general anesthesia contributed only slightly to morbidity in healthy donors. This fact supports the position that the use of living relatives for this purpose is justified, since 12-month survival of recipients from this group has been over 90 percent since the introduction of antilymphocyte globulin. The survival for recipients of cadaveric kidneys is somewhat lower.⁹

SUMMARY

In a review of the anesthetic records of 238 kidney donors from 1962 to 1969, the commonly used anesthetic agents were found generally employed. Blood loss was not excessive, but blood for transfusions should always be available, as hemorrhage is always possible. The most frequent complication during anesthesia was arterial hypotension, associated with positioning of the patient; to prevent this condition, certain measures are recommended. Other complications were those common to any general anesthetic procedure. The only significant postoperative morbidity attributable to the specific operation was considered position-related.

The absence of serious complications or of deaths in this series demonstrates that the administration of anesthesia to such healthy individuals is safe and justified, considering the greater possibilities of success when the transplanted kidney is provided by a compatible donor who is a relative of the recipient.

Acknowledgments

Drs. Robert W. Virtue, David S. LeVine, and Ted F. Gingrich, among many other members of the Anesthesiology Division of the University of Colorado Medical Center, actively participated in the administration of anesthesia to this group of patients.

This work was supported in part by USPHS Grant AI-08898.

Biography

J. Antonio Aldrete, M.D., is a 1960 graduate of the National University of Mexico, College of Medicine, in his native Mexico City. A Residency in Anesthesiology at the University Hospitals, Cleveland, Ohio, and at the University of Colorado Medical Center, Denver, Colorado, followed an internship and two years of surgical training in the United States.

Prior to his current position as Associate Professor, University of Miami School of Medicine, Department of Anesthesiology and a member of the Staff of the Jackson Memorial Hospital, Miami, Florida, he was Associate Professor of Anesthesiology at the University of Colorado Medical Center and Chief Anesthesiologist, Veterans Administration Hospital in Denver, Colorado.

REFERENCES

1. Katz J, Kountz SL, Cohn R. Anesthetic considerations for renal transplant. *Anesth & Analg*. 1967; 46:609–613.
2. Le Vine DS, Virtue RW. Anaesthetic agents and techniques for renal homotransplants. *Canad Anaesth Soc J*. 1964; 11:425–438. [PubMed: 14184039]
3. Vandam LD, Harrison JH, Mullray JE, et al. Anesthetic aspects of renal homotransplantation in man. *Anesthesiology*. 1962; 23:783–792. [PubMed: 13996166]
4. Virtue, RW. Anesthesia for patients involved in renal homotransplantation. In: Starzl, TE., editor. *Experience in Renal Transplantation*. WB Saunders Company; Philadelphia: 1964. p. 63-67.

5. Wyant GM. The anaesthetist looks at tissue transplantation: three years experience with kidney transplants. *Canad Anaesth Soc J*. 1967; 14:255–275. [PubMed: 5340458]
6. Kucher VR, Steinbereithner K. Anästhesie and Intensivpflege. *Wien Med Wschr*. 1968; 118:191–193. [PubMed: 4881864]
7. Forthman HJ, Shepard A. Postoperative pulmonary complications. *Southern Med J*. 1969; 62:1198–1200. [PubMed: 4899147]
8. Penn I. The use of living donors in kidney transplantation in man. *Arch Surg*. 1970; 101:226–231. [PubMed: 4916014]
9. Starzl TE, Groth CG, Brettschneider L, et al. Perspectives in organ transplantation. *Antibiot Chemother*. 1969; 15:349–383. [PubMed: 4180987]

TABLE 1

Induction Agents

Agents	Number of cases
Thiopental-succinylcholine	226
Thiopental alone	4
Thiopental-d-tubocurarine	2
Methohexital-d-tubocurarine	2
Cyclopropane	2
Ether	1
Halothane	1
Total	238

TABLE 2**Anesthetic Agents Used for Maintenance**

Agents	Number of cases
Halothane-nitrous oxide	108
Fluroxene-nitrous oxide	104
Methoxyflurane-nitrous oxide	19
Meperidine HCl (I.V.)-nitrous oxide	6
Cyclopropane-nitrous oxide	1
Total	238

TABLE 3**Muscle Relaxants (Other Than for Intubation)**

Drugs	Number of cases
d-Tubocurarine	128
Gallamine	92
d-Tubocurarine-gallamine	3
None	15
Total	238

TABLE 4

Frequency and Possible Causes of Arterial Hypotension During Anesthesia

	Number of hypotensive episodes	Percent
During positioning of patient and raising of kidney rest	59	24
Due to anesthetic agent (overdose)	27	11
Probably due to hypovolemia	32	13
During hypothermia	5	2
Clamping of renal vessels	5	2
Opening of pleura	2	0.7
Closing of pleura	3	1.1
Due to pressure on vena cava	1	0.4
During emergence from anesthesia	1	0.4

TABLE 5

Agents Responsible for Hypotension

	Number for cases used	Number of complicated cases	Percent significance
1. Hypotension after induction with thiopental and succinylcholine (19 cases):			
Halothane	108	11	10
Fluroxene	106	5	4.2 p<.05
Methoxyflurane	19	3	15.6 p<.05
2. Hypotension during maintenance of anesthesia (33 cases):			
Halothane	108	23	21.3
Fluroxene	106	6	5.5 p<.01
Methoxyflurane	19	4	21.0 p<.01

TABLE 6**Other Transanesthetic Complications**

	Number
Difficult intubation	18
Hiccups	13
Immediate vomiting	7
Bucking	4
Coughing	3
Cyanosis during opening of pleura	3
Endotracheal tube cuff leak	2
Prolonged respiratory insufficiency needing respiratory assistancepostoperatively	1
Dislodged two front teeth on intubation	1

TABLE 7

Postoperative Morbidity

	Cases
Pneumonitis and/or atelectasis	32
Residual pneumothorax (minimum)	25
Small pleural effusion	12
Late nausea and/or vomiting	7
Hepatic dysfunction	4
Pulmonary embolus	3
Transient peroneal nerve palsy (temporary)	3
Pressure point, under kidney rest area	2
Edema of eyelids and conjunctiva	2
Brachial plexus palsy (temporary)	1
Small corneal abrasion	1