

MAJOR SURGERY IN PATIENTS UNDERGOING HEMODIALYSIS

HIROSHI TAKAGI*, KAZUHARU UCHIDA**,
NOBUO YAMADA**, TAKESHI MORIMOTO*,
MITSUNORI YASUE*, YOSHIHIRO TOMINAGA**,
MACHIO KAWAI**, TADAYUKI KANO**,
and KATSUHIKO KAWAHARA**

Department of Surgery, Aichi Cancer Center Hospital,
Organ Transplant Center, Nagoya Second Red Cross Hospital**,
Nagoya, Japan*

*Supported by a grant for "Organ Transplantation"
from Aichi Cancer Center Hospital*

ABSTRACT

This report describes our experience with major surgery in hemodialysis patients and discusses special considerations in their surgical management. A total of 359 operations under general anesthesia excluding blood access operations were performed in hemodialysis patients (kidney transplantation, 168; bilateral nephrectomy with or without splenectomy, 38; graftectomy, 40; parathyroidectomy, 43; mastectomy, 2; gastrectomy, 24; biliary tract surgery, 9; surgery of intestinal obstruction, 2; appendectomy, 8; surgery of colon & rectum, 10; haemorrhoidectomy, 5; etc.). There were six postoperative deaths within 30 days (cadaveric kidney transplant, 1; graftectomy, 3; pancreaticoduodenectomy, 1; subtotal gastrectomy, 1). Recently, cadaveric kidney transplants are increasing and HLA-DR matching in cadaveric transplant has gained acceptance. The introduction of Cyclosporin A has remarkably improved the graft survival rate so far. Splenectomy has resulted in a significant improvement in the hematologic status of all patients. Bilaterally excised kidneys for a pretransplant procedure or because of severe hypertension decrease in weight progressively after the start of hemodialysis. Since the pathogenesis of renal osteodystrophy is highly complex, image diagnosis of parathyroid glands is valuable for (1) definite diagnosis of secondary hyperparathyroidism, (2) localization, and (3) diagnosis for effectiveness of conservative treatment. Fourteen of 18 patients with cancer (thyroid, 1; breast, 2; stomach, 4; bile duct, 1; head of pancreas, 1; colon & rectum, 8; kidney, 1) underwent curative surgery. Although hemodialysis patients remain chronically ill despite optimal hemodialysis, they tolerate major emergency or elective surgery rather well if the necessary precautions are taken.

Key words: Chronic renal failure, Hemodialysis,
Kidney transplantation, Cancer,
Secondary hyperparathyroidism

INTRODUCTION

The number of patients on long-term hemodialysis treatment due to chronic renal failure is steadily increasing along with the growing number of dialysis facilities in Japan. Each year the likelihood increases that a surgeon, unassociated with a dialysis or transplant center and/or unfamiliar with the specific needs of such patients, will have to perform emergency or elective surgery on a hemodialysis patient.

This report describes the authors' experience with major surgery in patients undergoing long-term hemodialysis and discusses problems peculiar to the proper surgical management of patients on hemodialysis.

PATIENTS AND VARIOUS TYPES OF SURGERY

In the eleven years from June 1972 to November 1983, a total of 359 operations under general anesthesia excluding blood access operations were performed in patients undergoing long-term hemodialysis in our joint program at Aichi Cancer Center Hospital and Nagoya Second Red Cross Hospital, which is responsible for about three thousand hemodialysis patients in its part of metropolitan Nagoya (Table 1).

There were six postoperative deaths within 30 days (cadaveric kidney transplant, 1; transplant graftectomy, 3; pancreaticoduodenectomy, 1; subtotal gastrectomy, 1).

1) *Kidney transplantations*

A total of 168 kidney transplantations (134 living related cases and 34 cadaveric cases) were performed according to a standard technique.^{1,2)} Bilateral nephrectomy with splenectomy in four cases and bilateral nephrectomy without splenectomy in four cases were simultaneously carried out through an upper midline incision of the abdomen in the living related cases. Preoperatively, the patient should be well dialysed but not too dry and as close as possible to the ideal body weight. Recently, cadaveric transplants have been increasing and the role of HLA-DR matching in cadaveric transplants has gained acceptance.³⁾ Since the introduction of Cyclosporin A as an immunosuppressive drug⁴⁾ at the end of November 1982, a total of 31 kidney transplants (18 living related cases and 13 cadaveric cases) have been performed, and all cases except one living related case who rejected the graft in an accelerated fashion have functioning grafts at this writing.

Table 1. Surgery in hemodialysis patients

Type of surgery	number
Kidney transplantation	168
(+Bil. nephrectomy & splenectomy)	4)
(+Bil. nephrectomy)	4)
Bil. nephrectomy & splenectomy	24
Bil. nephrectomy	14
Nephrectomy	5
Graftectomy	40
Parathyroidectomy	43
Simple mastectomy	2
Gastrectomy	24
Biliary tract surgery	9
Surgery of intestinal obstruction	2
Appendectomy	8
Surgery of colon & rectum	10
Haemorrhoidectomy	5
Other	5
Total	359

2) *Bilateral nephrectomy with or without splenectomy*

As a pretransplant procedure⁵⁾ or because of severe hypertension,⁶⁾ bilateral nephrectomy with splenectomy was performed in twenty-four cases through an upper midline incision of the abdomen; bilateral nephrectomy without splenectomy was carried out in fourteen cases through a posterior approach. The posterior approach in bilateral nephrectomy seems adequate especially for these small kidneys. Recently, bilateral nephrectomy is less frequently used for management of severe hypertension because of the new and improved antihypertensive drugs.

The weights of excised spleens ranged from 80 to 330g, with a mean of 143g. They were slightly heavier than that of normal Japanese. Hypersplenism with leukopenia, lymphocytopenia, thrombocytopenia and anemia in the hemodialysed patient has been noticed with excessive transfusion requirements.⁸⁾ Splenectomy, which decreases peripheral blood cell destruction, resulted in a significant improvement in the hematologic status of all cases. However, the beneficial effect of splenectomy on anemia was compromised in the long run by simultaneously performed bilateral nephrectomy.

3) *Unilateral nephrectomy*

Because of abdominal discomfort, a larger side polycystic kidney was removed in two cases, weighing 4700g and 4100g, respectively. Ruptured kidney due to acquired cystic disease was removed in another two cases. One of them, weighing 210g, turned out to have adenocarcinoma by histological examination. The contralateral side kidney, which was removed one month later, weighed 230g but failed to show any malignant changes. The patient himself had been on hemodialysis for ten years previously.

The development of acquired cystic disease and adenocarcinoma of the kidney in long-term hemodialysis patients was recently reported.⁹⁾ Thus, it is now our routine procedure to include CT study of kidneys in pretransplant examinations; if any cystic changes are noticed bilateral nephrectomy is performed before or at the same time as kidney transplantation.

Figure 1 shows the relationship between the weight of the excised kidney and the period of hemodialysis treatment. The weight of an excised kidney decreases progressively up to six years after the start of hemodialysis. Two patients who had been on hemodialysis more than 10 years showed increased weight because of acquired cystic disease with or without adenocarcinoma.

4) *Transplant graftectomy*

There were forty cases of transplant graftectomy (living related cases, 31; cadaveric cases, 9). Seven of 9 cadaveric graftectomies were performed within the first three months following the transplant mostly due to poor grafts which were harvested after cardiac death. The old transplant grafts which functioned more than 3 years and were rejected chronically were usually removed in subcapsular fashion. Some graftectomies were carried out under critical conditions (i.e., complication by disseminated intravascular coagulation, septicemia, etc.). There were three postoperative deaths.

5) *Parathyroidectomy*

Forty-three patients with chronic renal failure and secondary hyperparathyroidism underwent parathyroidectomy. The first 20 out of 43 patients were submitted to subtotal parathyroidectomy (Group A) and the last 23 patients underwent total parathyroidectomy and parathyroid autograft in the forearm (Group B).¹⁰⁾

Postoperatively, serum calcium levels were monitored 3 times a day during the first 2 to 4 days and then daily until stable. As soon as the serum calcium concentration dropped close to 7 mg/100 ml, constant infusion of calcium gluconate was administered intravenously to maintain serum calcium at more than 8 mg/100 ml. Intravenous calcium was gradually

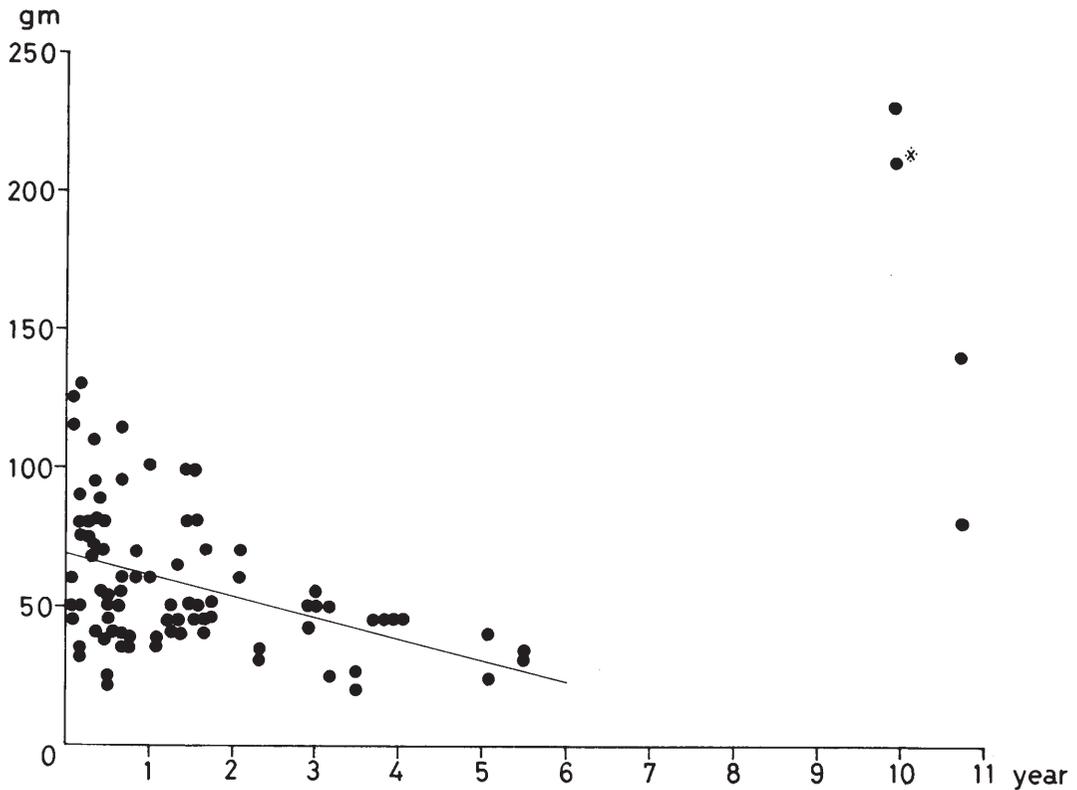


Fig. 1 The relationship between the weight of the excised kidney and the period of hemodialysis treatment. The weight of an excised kidney decreases progressively up to six years after the start of hemodialysis. ($Y = -0.65 \times 68.63$)

* : Adenocarcinoma

reduced with the addition of oral calcium lactate combined with $1\alpha, \text{OH}$ cholecalciferol until serum calcium was maintained between 8 and 10 mg/100 ml.

Clinical improvement after parathyroidectomy was equally remarkable in both groups. Bone pain was usually relieved within 24 to 48 hours after operation. Pruritus was also relieved within a few days after operation. Disappearance of soft tissue calcification or improvement of bone X-ray findings was noticed within the first six months after parathyroidectomy.

In the immediate postoperative period 8 patients in group A who had severe bony changes and 21 patients in group B needed supplemental calcium administration. The grafted tissues in all cases functioned well; reimplantation of the cryopreserved parathyroid tissues was unnecessary.

One case in each group showed a recurrence. One patient in group A was submitted to re-exploration of the neck with a lateral approach. The other patient in group B underwent excisions of the transplanted parathyroid tissues on three separate occasions under local anesthesia. The second operation was definitely easier and safer to manage after a total parathyroidectomy with autotransplantation to the forearm.¹⁰⁾

The pathogenesis of renal osteodystrophy is complicated by a number of factors, including: (1) phosphate retention, secondary to a decrease in the number of nephrons; (2)

failure of the diseased kidneys to hydroxylate 25-hydroxyvitamin D to the biologically active metabolite, 1,25-dihydroxyvitamin D, with subsequent defective internal absorption of calcium; (3) resistance of the bone to the action of parathyroid hormone (PTH); and (4) aluminium absorption from dialysate. Therefore, accurate diagnosis of secondary hyperparathyroidism is not always easy. The authors generally examine these patients by measuring the serum calcium, phosphorus, alkaline phosphatase, and PTH levels, and by X-ray films of the bone. Recent additions are CT, scintigraphy with $^{201}\text{TlCl}$ and $^{99}\text{TcO}_4$, and ultrasonography, all of which are valuable for (1) definite diagnosis of secondary hyperparathyroidism, (2) localization, and (3) diagnosis for effectiveness of conservative treatment.^{11,12)}

Enlargement of the parathyroid glands is supposed to be secondary from the standpoint of end-stage renal failure. However, the four glands excised from a given patient do not necessarily show similarities either in weight or in histopathologic pattern of hyperplasia. A review of patients undergoing parathyroidectomy at our hospital revealed polymorphism of the parathyroid glands in patients with chronic renal failure and secondary hyperparathyroidism.¹³⁾

In the 43 patients in this study four thyroid lesions (one follicular adenocarcinoma, two adenomas, and one cyst) were found by preoperative image diagnosis and removed by thyroid lobectomy at the same time as parathyroidectomy.

6) *Gastrectomy*

Twenty patients with gastro-duodenal ulcer associated with or without active bleeding underwent distal gastrectomy with vagotomy. One patient with massive upper gastrointestinal bleeding which was complicated following traumatic peritoneal puncture for an emergency dialysis was treated conservatively for a week without success and then submitted to a subtotal gastrectomy with vagotomy. The patient expired on the 7th postoperative day without any cessation of gastrointestinal bleeding. The autopsy study revealed active multiple ulcers throughout the gastrointestinal tract. The histological examination showed an inclusion body in the cells under the ulcers, and a high serum titer of cytomegalovirus infection was reported.

The high incidence of gastro-duodenal ulcers in hemodialysis patients is explained by the fact that patients with impaired gastric secretion in chronic renal failure show normal or increased gastric secretion following institution of regular hemodialysis due to removal of injurious factors accompanying azotaemia.¹⁴⁾ Since the recent introduction of Cimetidine¹⁵⁾ and intravenous hyperalimentation with special amino acid solutions, the conservative treatment of active bleeding ulcer of the gastroduodenum has been the first choice and gastrectomy on an emergency basis has been less frequent.

Four more patients who had adenocarcinoma of the stomach were submitted to radical gastrectomy without complication.

7) *Biliary tract surgery*

Five patients with cholecystolithiasis underwent cholecystectomy. One patient who had an advanced carcinoma of the common bile duct was submitted to transhepatic cholangiostomy. Another patient, a 65-year-old man with carcinoma of the pancreas head, first underwent a cholecystostomy for decompression of the biliary tract obstruction and then had a pancreaticoduodenectomy¹⁶⁾ twelve days later. The patient's condition was complicated by bile leakage from the choleduochojunostomic site due to a rubber drain compression which was repaired surgically. However, the man developed gastrointestinal bleeding and expired 17 days postoperatively.

8) *Surgery for intestinal obstruction*

Two patients with small intestinal obstruction who had a previous history of peritoneal dialysis underwent laparotomy. One of them was relieved by a division of peritoneal adhesions and another underwent an intestinal side-to-side anastomosis for the creation of an intestinal bypass.

9) Appendectomy

Six patients who had acute purulent appendicitis underwent appendectomy. Two more patients developed peritonitis due to perforated appendicitis. One showed a severe wound infection.

Symptoms and signs of appendicitis in hemodialysis patients seem atypical, and accurate diagnosis of appendicitis is sometimes difficult. Appendix removal is sometimes delayed.

10) Surgery of colon and rectum

Three out of five patients with rectal cancer underwent curative surgery (two abdomino-perineal resections and one anterior resection). Two of them were submitted to sigmoid colostomy as a palliative procedure. One patient with sigmoid cancer underwent radical sigmoidectomy. One of two patients with carcinoma of the ascending colon underwent right hemicolectomy and the other was submitted to ileo-transverse anastomosis as a palliative bypass surgery.

Interestingly, two patients who had chronic constipation developed fecal peritonitis from perforation of the sigmoid colon. After the abdominal cavity was irrigated and the perforated portion of the sigmoid colon was withdrawn for double lumen colostomy, three or four tubes were inserted for drainage. For five days postoperatively the patients received daily peritoneal dialysis through these drainage tubes with antibiotics (5g of Cephalexin and 2g of Kanamycin). The patients were treated successfully with reduction of the colostomy a few weeks later.

11) Other

Two patients underwent craniotomy for removal of epidural hematoma following trauma. Three patients underwent surgical repair for fracture of bone. These operations were performed either in the department of neurosurgery or orthopedic surgery. The patients were hospitalized in our hemodialysis unit.

12) Cancer in hemodialysis patients

Recent reports suggested there is an increased incidence of malignancies in hemodialysis patients.¹⁷⁾ Table 2 shows our experience of surgery for cancer in hemodialysis patients.

Table 2. Cancer in hemodialysis patients
The numbers in parentheses indicate the number of palliative operations.

Type of cancer	number
Thyroid	1
Breast	2
Stomach	4
Bile duct	1 (1)
Head of pancreas	1
Ascending colon	2 (1)
Sigmoid colon	1
Rectum	5 (2)
Kidney	1
Total	18 (4)

Fourteen of 18 patients underwent curative surgery and four patients had palliative operations. Unlike the preponderance of superficial carcinomas and lymphoproliferative tumors encountered in transplant patients,¹⁸⁾ no tumor types in hemodialysis patients showed a markedly increased incidence and the tumors represented a broad spectrum.

COMMENTS

A patient with end-stage renal disease remains chronically ill despite optimal hemodialysis. He is usually anemic, moderately hypertensive and has more generalized atherosclerosis than would be expected at his age.¹⁹⁾ Although the hematocrit is usually between 15 and 20 per cent, the tendency to overhydration causes expansion of total blood volume to levels slightly greater than normal. The volume of liquid allowed in the diet each day is usually 1000 ml, plus an amount equivalent to patient's urine output. Consequently, 2 to 4 liters of excess water must be removed by each dialysis treatment. Volume dependent hypertension and congestive heart failure are common problems. Generally, however, the hemodialysis patient can well tolerate major, emergency or elective surgery, if the necessary precautions are taken.

If, preoperatively, time and the patient's general condition permit, dialysis should be part of the preoperative preparation. Blood transfusion is usually given during this dialysis in order to bring up the hematocrit at least to 25 per cent.

For anticoagulation in the pre-and post-operative dialysis, regional heparinization with protamin block was used. Recently, Gebexate Mesilate with a small amount of Heparin has been preferred without protamin block.²⁰⁾ We make it a rule to check and to correct coagulation time of the patient just before the operation.

As for skeletal muscle relaxants to avoid any prolonged postoperative effect, the authors prefer to use succinylcholine, which is metabolized in the liver. However, the serum potassium level must be monitored in long-time surgery, because succinylcholine tends to induce hyperkalemia.²¹⁾

During the operation the tissues should be handled very gently and hemostasis should be achieved meticulously because the tissues are generally weaker and more fragile in hemodialysis patients. Hemostasis is somewhat more difficult to achieve in uremic patients because of a defect that makes blood platelets less "sticky". Troublesome oozing from tiny blood vessels can be minimized by extensive use of electrocautery for both cutting and coagulation. If preoperative dialysis has to be omitted or if the operation time is prolonged, the acidotic condition of the patient should be corrected with frequent checks of blood gas analysis.

Hyperkalemia is the most common serious postoperative problem. Tissue damage and operative stress, acidemia, and blood transfusion all contribute to increased serum potassium concentration which cannot be dealt with effectively by the uremic patient. Hyperkalemic cardiac toxicity with widened QRS complexes is a medical emergency that should be treated immediately by intravenous infusion of 10 per cent calcium gluconate. Meanwhile, the serum potassium concentration must be reduced by intravenous infusion of sodium bicarbonate, glucose, and insulin, and retention enema of ion exchange resins in sorbitol. The treatments outlined are usually adequate to reduce the serum potassium concentrations to less than 5 mEq per L. Emergency peritoneal or hemodialysis is rarely needed to control hyperkalemia.

Postoperatively, peristaltic movement of the bowels tends to resume sooner than usual, possibly due to the hyperkalemic and hyperosmotic condition.

Naturally, hemodialysis patients require major adjustment in the dosage of common therapeutic agents in order to avoid toxic side effects. Guides to drug therapy in renal failure

appear in the literature periodically and should always be consulted.²²⁾

Hypertension during the postoperative period which used to be controlled by intramuscular injections of hydralazine is now easily controlled by new antihypertensive drugs like Nifedipine (a calcium antagonist).⁷⁾

REFERENCES

- 1) Starzl, T.E.: Experience in Renal Transplantation. Philadelphia, W.B. Saunders Co., 1964.
- 2) Takagi, H., Uchida, K., Tominaga, Y., *et al.*, Chronic hypophosphatemia in the renal homograft recipient. *Nagoya J. Med. Sci.*, **44**, 83—87, 1982.
- 3) Takagi, H., Uchida, K., Oshima, S., *et al.*, Prospective HLA-DR matching in cadaveric renal transplantation. *Transplant. Proc.*, **15**, 2139—2141, 1983.
- 4) Starzl, T.E., Hakala, T.R., Rosenthal, J.T., *et al.*, Variable convalescence and therapy after cadaveric renal transplantation under Cyclosporin A and steroids. *Surg. Gynecol. Obstet.*, **154**, 819—825, 1982.
- 5) Freed, S.Z., Bilateral nephrectomy in transplant recipients. *Urology Suppl.*, **10**, 16—21, 1977.
- 6) Lee, C., Neff, M.S., Slifkin, R.F., *et al.*, Bilateral nephrectomy for hypertension in patients with chronic renal failure on a dialysis program. *J. Urol.*, **119**, 20—22, 1978.
- 7) The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure: The 1980 report of the joint national committee on detection, evaluation, and treatment of high blood pressure. *Arch. Intern. Med.*, **140**, 1280—1285, 1980.
- 8) Bengmark, S., Henrikson, H., Lindholm, T., *et al.*, Effect of splenectomy on anemia in patients on regular dialysis treatment. *Scand J. Urol. Nephrol.*, **10**, 63—69, 1976.
- 9) Ishikawa, I., Saito, Y., Onouchi, Z., *et al.*, Development of acquired cystic disease and adenocarcinoma of the kidney in glomerulonephritic chronic hemodialysis patients. *Clin. Nephrol.*, **14**, 1—6, 1980.
- 10) Takagi, H., Tominaga, Y., Uchida, K., *et al.*, Subtotal versus total parathyroidectomy with forearm autograft for secondary hyperparathyroidism in chronic renal failure. *Ann. Surg.*, accepted.
- 11) Takagi, H., Tominaga, Y., Uchida, K., *et al.*, Preoperative diagnosis of secondary hyperparathyroidism using computed tomography. *J. Comput. Assit. Tomogr.*, **6**, 527—528, 1983.
- 12) Takagi, H., Tominaga, Y., Uchida, K., *et al.*, Image diagnosis of parathyroid glands in chronic renal failure. *Ann. Surg.*, **198**, 74—79, 1983.
- 13) Takagi, H., Tominaga, Y., Uchida, K., *et al.*, Polymorphism of parathyroid glands in patients with chronic renal failure and secondary hyperparathyroidism. *Endocrinol. Japon.*, **30**, 463—468, 1983.
- 14) McConnell, J.B., Stewart, W.K., Thjodleifsson, B., *et al.*, Gastric function in chronic renal failure. Effects of maintenance hemodialysis. *Lancet*, **2**, 1121—1123, 1975.
- 15) Doherty, C.C., O'connor, F.A., Buchanan, K.D., *et al.*, Cimetidine for duodenal ulceration in patients undergoing haemodialysis. *Br. Med. J.*, **2**, 1506—1508, 1977.
- 16) Imanaga, H., A new method of pancreaticoduodenectomy designed to preserve liver and pancreatic function. *Surgery*, **47**, 577—586, 1960.
- 17) Kjellstrand, C.M., Are malignancies increased in uremia? *Nephron*, **23**, 159—161, 1979.
- 18) Penn, I., Malignant lymphomas in organ transplant recipients. *Transplant. Proc.*, **13**, 736—738, 1981.
- 19) Stuart, F.P., Simonian, S.J., Hill, J.L., Special considerations in surgical management of patients on hemodialysis and after successful kidney transplantation. *Surg. Clin. North Am.*, **56**, 15—19, 1976.
- 20) Taenaka, N., Shimada, Y., Hirata, T., *et al.*, New approach to regional anticoagulation in hemodialysis using gabexate mesilate (FOY). *Crit. Care. Med.*, **10**, 773—775, 1982.
- 21) Stevenson, P.H., Birch, A.A., Succinylcholine-induced hyperkalemia in a patient with a closed head injury. *Anesthesiology*, **51**, 89—90, 1979.
- 22) Howard, P.H., Raebel, M., Hurley, D.L., The use of antimicrobial agents in patients with hepatic and renal dysfunction. *Surg. Clin. North Am.*, **62**, 333—340, 1982.