Anesthetic Management for Patients with Transplanted Organs

An Essay Submitted for fulfillment of the requirements of M.Sc degree in Anesthesiology

By

Ahmed Farag Mohamed Shedid

M.B. B.Ch.
Cairo University

Under Supervision of

Professor Dr. Afaf Ahmed Abdalla

Professor of Anesthesiology,
Faculty of Medicine, Cairo University

Professor Dr. Amina Hassan Omran

Professor of Anesthesiology,
Faculty of Medicine, Cairo University

Dr. Ossama Hamed Aboushanab

Lecturer of Anesthesiology,
Faculty of Medicine, Cairo University

Faculty of Medicine
Cairo University
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بسم الله الرحمن الرحيم

Dedication

I dedicate this work to my family, my wife and my daughter, whom without their sincere emotional support and pushing me forward, this work would not have ever been completed.

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Abstract

The transplant recipients have considerable medical, physiological, and pharmacological problems; therefore, a clear understanding of the physiology of the transplanted organ, the pharmacology of the immunosuppressive drugs, and the underlying surgical conditions is essential for these patients to safely undergo anesthesia and surgery.

Local, regional, or general anesthesia can be safely delivered to transplant recipients, and a successful anesthetic and perioperative management can be provided.

Keywords: transplant recipients, immunosuppressive drugs, Local, regional, or general anesthesia, anesthetic and perioperative management, end-stage organ disease, lung, liver, heart, kidney, intestine, pancreas.

List of Abbreviations

ACE : Angotensin converting enzyme

ATG : Antithymocyte globuline

BSLT : Bilateral sequential lung transplantation

CAD : Coronary artery disease

CAV : Coronary artery vasculopathy

CF : Cystic fibrosis

CO2 : Carbon dioxide

COPD : Chronic obstructive pulmonary disease

DM : Diabetes mellitus

ECG : Electrocardiogram

ESRD : End-stage renal disease

FEV : Forced expiratory volume

FEV1 : Forced expiratory volume in 1st second

FIO2 : Inspired fraction of oxygen

FRC : Functional residual capacity

FVC : Forced vital capacity

GFR : Glomerular filtration rate

HIV : Human immunodeficiency virus

HLT : Heart-lung transplantation

ICP : Intracranial pressure

IPF : Idiopathic pulmonary fibrosis

LV : Left ventricle

M3G : Morphine-3-glucuronide

M6G : Morphine-6-glucuronide

NYHA : New York Heart Association

PaCO2 : Arterial partial pressure of carbon dioxide

PAK : Pancreas transplant after successful kidney Transplantation

PAO2 : Alveolar partial pressure of oxygen

PAP : Pulmonary artery pressure

PCWP : Pulmonary capillary wedge pressure

PH2O : Alveolar partial pressure of water vapor

PPH : Primary pulmonary hypertension

PTA : Pancreas transplant alone

PVR : Pulmonary vascular resistance

R : Respiratory quotient

RV : Residual volume

RV : Right ventricle

SLT : Single-lung transplantation

SPK : Simultaneous pancreas-kidney transplantation

TEE : Transesophageal echocardiography

TLC : Total lung capacity

VC : Vital capacity

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Introduction and Aim of Work

Organ Transplantation

The improvement in the success of solid organ transplantation over the past decades is remarkable and well documented. It is now a well-accepted treatment modality for patients with end-stage organ disease. Refinement of perioperative care and improved post-transplant patient management over recent years have resulted in a dramatic improvement in both 1- and 5-year graft survival. These changes have led to a significant increase in the number of medical centers performing solid organ transplantation and, hence, increased public awareness. In addition, the indications for solid organ transplantation have been broadened. Some known contraindications such as concomitant human immunodeficiency virus (HIV) infection and excessive age are being obsolete in selected cases.[1]

In the United States, the number of patients wait-listed for solid organ transplantation increased by 8.7% between 2000 and 2001, yet the number of organs transplanted in the same period increased by only 4.7%. [2]

The organs most frequently transplanted are the kidney and liver, which accounted for 59% and 21% of all transplanted organs, respectively, in 2001. On the other hand, only 54% of all donated cadaveric organs were actually recovered in 2001. This fact, in conjunction with public perception about organ donation and brain death and limited awareness of health care professionals, has contributed to a severe shortage of cadaveric donor organs. Different strategies have been adopted to increase the donor pool, including extension of donor criteria and the use of living donors,

particularly for kidney and liver transplantation. However, it is unlikely that these attempts alone will improve the shortage in the long run. [3]

The success of organ transplantation is based on a highly specialized team approach, including the cooperation of planning organizations, transplant coordinators, nurses, and physicians from many specialties. With the exception of kidney transplantation, most solid organ transplantations are performed at tertiary medical centers, which can provide all the needed medical, logistic, and technical expertise necessary to support a successful transplant program. Increasingly, medical subspecialties are providing physicians dedicated to the field of transplantation. In addition to transplant surgeons, most major centers rely on dedicated transplant hepatologists, nephrologists, pulmonologists, and cardiologists. [3]

With regard to anesthesia providers, transplant specialization is not generally the rule. Anesthesia for kidney and pancreas transplantation is performed by most anesthesiologists. A cardiac anesthesia team generally performs heart and lung transplantation. Most major centers have a dedicated liver transplant anesthesia team. However, smaller centers may not have enough transplant volume or personnel to staff a separate liver transplant anesthesia team. As a result, anesthesiologists who have experience in major hepatic surgery or cardiothoracic surgery are frequently called on to provide anesthesia for these complex and challenging cases. [3]

KIDNEY TRANSPLANTATION

The first description of anesthesia for kidney transplantation appeared in the early 1960s. It detailed the pioneering efforts in Boston with living donor kidney transplantation between identical twins. [4] The only monitors

used then were a blood pressure cuff and electrocardiogram (ECG), and all recipients received spinal anesthesia. Much has changed in the anesthetic management of these cases. What was once seen as heroic and exceptional is now commonplace. These patients are challenging to anesthetize because end-stage renal disease (ESRD) often causes dysfunction of other organ systems, which in turn may produce less predictable responses to anesthetic drugs and techniques. In addition, these patients are at high risk for cardiac and other perioperative complications because of their underlying disease. [5]

In the year 2000, almost 15,000 kidney transplants were performed in each of three major regions of the world, the United States, Europe, and Asia. [6]

This number represents a steady increase throughout the 1990s. Considerable variation in the proportion of organs that come from cadaveric versus living donors occurs worldwide, with some countries relying almost entirely on cadaveric donors (China) and some relying largely on living donors (Japan, Taiwan). [9]

In the United States, the number of cadaveric kidneys for transplantation has reached a plateau at around 8000 per year, whereas the number of living donors continues to increase. Between 2000 and 2001, the number of living donors increased 13.7%. Currently, approximately 50,000 patients are awaiting kidney transplantation in the United States, with an average waiting time of longer than 3 years. [2]

Kidney transplantation is one of the most important, cost-effective methods of treating ESRD; it causes a 40% to 60% decrease in the death rate when compared with those remaining on dialysis. [7]

The overall graft survival rate among cadaveric kidney transplant recipients at 3 years is greater than 70%, and it is approximately 80% in recipients who receive a kidney from a living donor. [8]

PANCREAS AND KIDNEY-PANCREAS TRANSPLANTATION

Pancreas transplantation provides a primary cure for diabetes mellitus (DM) by providing nearly physiologic insulin replacement. Nephropathy develops in about 50% to 60% of insulin-dependent diabetic patients, so it is common to also transplant a kidney at the time of pancreas transplantation. The appearance of new immunosuppressants such as tacrolimus and mycophenolate mofetil has dramatically increased pancreas graft survival. [9]

The best results in terms of graft survival are obtained with simultaneous pancreas-kidney transplantation (SPK), but good results are also achieved with a pancreas transplant alone (PTA) or a pancreas transplant after successful kidney Transplantation (PAK). [10]

Diabetic patients who undergo simultaneous pancreas-kidney transplantation (SPK) have greater long-term survival than do diabetics who receive a cadaver kidney alone. [10]

In 2002, 550 pancreas transplants and 905 SPKs were performed in the United States. More than 16,000 pancreas transplants have been performed worldwide according to the International Pancreas Transplant Registry. The 3-year graft survival rate ranges from 60% to 80%. Almost 4000 patients are on wait lists for either PTA or SPK, with the average waiting time currently being 1 to 2 years. [10]

LIVER TRANSPLANTATION

In 2002, 5329 liver transplantations were performed in the United States, including an increasing number of living liver donors. In the same period, 1132 cadaveric liver transplantations were documented by Eurotransplant, which covers six central European states. As of spring 2003, 17,221 patients were on the waiting list for liver transplantation in the United States; approximately 1640 patients died in 2002 while awaiting liver transplantation. Nationwide, the 3-year survival rate after transplantation is over 75%. [11]

This rate underscores the fact that liver transplantation should not be considered experimental and is indeed the treatment of choice for eligible patients with end-stage liver disease. The growing discrepancy between organ supply and recipients on the waiting list has made finding alternatives to cadaveric liver transplantation of great importance. This discrepancy may become greater in view of the fact that cirrhosis will develop in 25% to 30% of the more than 4 million Americans with hepatitis C. [12] Recurrent disease, especially with hepatitis C, will necessitate retransplantation in the years to come and further aggravate the acute organ shortage problem. [13]

The challenge of meeting organ shortages may be overcome if donor liver allocation is optimized and the donor pool can be increased with new approaches such as the use of living liver donors or suboptimal donors. [14]

Combined liver-kidney transplantation is performed infrequently, with only 69 performed in the United States in 1999. Renal disease in the setting of cirrhosis can be due to primary renal disease, hepatorenal syndrome, and acute tubular necrosis. [15]