Surgical Complications in Kidney Transplantation: No Evidence for a Learning Curve

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OBJECTIVE: To evaluate whether surgical complications after kidney transplantation correlate with surgeon's experience and whether individual surgeons' complication rates improve during their learning process.

STUDY DESIGN: *Retrospective analysis*: A generalized linear mixed-effects model was used to identify risk factors for surgical complications. Plots of cumulative sums of complications were used to evaluate the individual surgeons' performance.

SETTING: Single-center experience of a teaching hospital in Switzerland.

PARTICIPANTS: Consecutive kidney transplant recipients operated from 1962 until 2003.

RESULTS: A total of 1496 kidney transplants were analyzed; 73% were from deceased donors and 27% from living donors. At least 1 surgical complication occurred in 352 patients (24%). Male gender (odds ratio [OR] = 1.35, 95% CI: 1.04–1.74), donor's age (OR = 1.14, 95% CI: 1.06–1.24 per decade increment), and third or fourth vs. first or second transplant in a recipient (OR = 2.90, 95% CI: 1.02–8.24) were significantly associated with surgical complications. The surgeon's transplant experience was not found to be associated with surgical complications. Even surgeons with an experience of less than 10 kidney transplants did not have higher complication rates, 30-day mortality, or 1-year graft survival. Individual surgeons' complication rates analyzed by cumulative sum plots did not improve with increasing experience.

CONCLUSIONS: We present the largest single-center study on surgical complications after kidney transplantation, with unique data on the surgeon's experience for every single procedure. We found no evidence for a learning curve during training for kidney transplantation. We conclude that carefully selected experienced general and vascular surgeons can achieve good results in kidney transplantation after a relatively short training period. (J Surg 71:748-755. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: kidney transplantation, surgical complications, learning curve, surgical training

COMPETENCIES: Medical Knowledge, Professionalism, Practice-Based Learning and Improvement

INTRODUCTION

There is a common sense notion that when a surgeon is introduced to a new procedure, the increase in experience during the learning process should be associated with a decrease in the rate of surgical complications and a better outcome. Although there is a wealth of data proving a correlation between outcome and the number of procedures performed by a surgeon per year (surgeon volume)[1] or the number of procedures performed at an institution per year (hospital volume),[2] there are surprisingly little reliable data as to whether outcome is correlated with the overall number of procedures that an individual surgeon has already performed (learning curve).[3,4] The data available are almost exclusively concerned with the introduction of novel procedures, such as laparoscopic colon surgery,[5,6] laparoscopic radical prostatectomy,[7,8] laparoscopic fundoplication,[9] or laparoscopic donor nephrectomy.[10] There are almost no data on the learning

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curves of conventional surgical procedures. In particular, there are no data assessing the correlation between a surgeon's experience in kidney transplantation and outcome.

Kidney transplantation is a very standardized procedure that has undergone only minor modifications since its introduction in 1962 so that surgical complication rates observed over a long period of time can be meaningfully compared. The aim of the present study was to analyze the effect of the surgeon's kidney transplant experience on surgical complications of all 1496 kidney transplants performed at the Basel University Hospital since 1967. The data presented are unique, because not only is the surgeon's kidney transplant experience precisely known for every single procedure, but also virtually all the surgeons involved, acquired their entire experience in kidney transplantation at our institution, enabling us to document their entire learning process in kidney transplantation from the first transplant they performed. This makes it possible to accurately assess the correlation of surgeon and surgical team experience with the occurrence of postoperative surgical complications and investigate the learning curves of individual surgeons.

MATERIAL AND METHODS

Patients

This is a retrospective analysis of all 1496 kidney transplants performed at the Basel University Hospital from the first procedure performed in July 1967 until December 2003.

Surgical Procedure

The graft was placed in the iliac fossa, and the vascular anastomoses were performed end to side to the external or common iliac vessels in all cases except 2 patients, in whom the vascular anastomoses were performed to the aorta and caval vein. The transplant ureter was anastomosed to the roof of the bladder with an antireflux plasty. All ureteric anastomoses were stented. Until 1988, an external stent was used, after that date an internal double-J stent was used.

Surgeon's Experience

The surgeon's level of experience for a given transplant was defined as the number of transplants he/she had previously performed as a surgeon. The combined surgeon and assistant experience was defined with the intention of taking into consideration the experience of the assistant surgeon as well. This was of particular significance for the procedures performed under supervision by an experienced instructor (teaching procedures). The combined surgeon and assistant experience was defined as the number of transplants the surgeon had previously performed plus the number of transplants the assistant had previously performed.

Teaching Procedures

If the assistant surgeon had previously performed more kidney transplants than the operating surgeon had, the procedure was counted as a teaching procedure. This coincided in every single instance with the relationship of seniority between both the surgeons at the time of surgery.

Postoperative Follow-up

All the operation notes and the patient charts during the first year after the transplantation were analyzed, i.e., the follow-up period was exactly 1 year for every patient. Only events occurring during the first year after transplantation were included. Surgical complications were classified into 6 different classes and defined as follows:

(1) *Hematoma/bleeding*: Any event that required reoperation.
(2) *Lymphocele*: Any collection of serous fluid around the graft requiring reoperation or percutaneous drainage.
(3) *Infection*: Any surgical site infection, independent of whether reoperation, antibiotic treatment, or no treatment was required, defined according to the CDC.[11]
(4) *Urological complications*: Stenosis of the ureter or ureteric anastomosis, ureteric necrosis, or urinary leak.
(5) *Vascular complication*: Stenosis, kinking, or thrombosis of the transplant artery, stenosis or thrombosis of the transplant vein.
(6) *Injury to neighboring organs*: Injury to the bladder, colon, small intestine, or spermatic duct.

Statistical Analysis

We fitted generalized linear mixed-effects models to investigate the influence of surgeon experience and recipient and donor characteristics on the incidence of any surgical complications (yes/no) within a year after the kidney transplantation. This model (with 2 partially crossed random effects) was chosen to take into account that these are not independent observations, because each surgeon operated several patients and some patients had multiple transplants but were not necessarily operated by the same surgeon each time. Only cases with complete data were taken into consideration (37 transplants where the age of the donor was missing were not considered for the linear mixed-effects analysis, the data of these transplants were, however, considered for the remainder of the results and analysis). Clearly, a third or fourth transplant in a patient is technically more difficult than a first or second transplant. Therefore, we assessed the effect of the third or fourth vs. first and second transplantation in a model with an additional binary covariate