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Original Research

Surgical outcomes of renal transplant recipients after abdominal surgery not connected with transplantation. A retrospective case-control study

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ABSTRACT

Background: Due to the increasing number of patients after kidney transplantation, elective and emergency surgery of transplanted patients is becoming a relevant challenge in clinical routine. The current data on complication rate of patients after kidney transplantation, which must undergo another elective or emergency abdominal surgery, is inhomogeneous. Therefore, the aim of our study was to evaluate the outcome of renal transplant patients undergoing abdominal and abdominal wall surgery.

Material and methods: We performed an observational study of patients after kidney transplantation undergoing graft-unrelated abdominal surgery between 2005 and 2015. We randomly created a non-transplanted control for a case-matched controlled analysis. Primary endpoint was the comparison of complication rate. Secondary, a risk analysis of all patients was performed and differences in mortality, length of hospital stay and reoperation rates were calculated.

Results: Overall 101 kidney transplanted patients were eligible for inclusion. 20 (19.8%) died after graft-unrelated surgery and 60 (59.4%) suffered from postoperative complications. Case-matched analysis could be performed for 84 out of these 101 patients. We found no significant difference in morbidity rate (58.3% vs. 45.2%, $p = 0.090$). Transplanted patients had, however, a significantly higher mortality (19% vs. 2.4%, $p = 0.001$), a longer hospital stay (28.2 vs. 16.9 days, $p = 0.020$) and a higher rate of re-operations (38.1% vs. 20.2%, $p = 0.017$). .

Conclusions: Patients after renal transplantation undergoing graft-unrelated abdominal surgery have a significantly increased mortality risk, are more frequently re-operated and have to stay significantly longer in hospital than non-transplanted patients.

1. Introduction

Renal transplantation is the treatment of choice for selected patients with end-stage renal disease, not only increasing the survival of the recipients but also improving their quality of life when compared with maintenance dialysis [1–3]. In 2016, 2.094 renal transplantations were performed in Germany [4], with an estimated half-life for deceased and living donor grafts of about 14 and 22 years [5], respectively. Therefore, nowadays surgeons are faced with an increasing number of renal transplant recipients with graft-unrelated surgical problems, requiring elective or emergency surgery. Renal transplant recipients undergoing graft-unrelated abdominal surgery constitute a unique population as they are chronically immunosuppressed, resulting in an increased risk for development of infectious complications. Recent literature shows inhomogenous data regarding postoperative mortality and morbidity of renal transplant recipients after elective or emergency graft-unrelated surgical procedures. Therefore, the aim of our study was to critically evaluate our own results of renal transplant patients in comparison with a not-transplanted control group.

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2. Methods

2.1. Study design

We performed a retrospective monocentric and controlled cohort study at the Department for General and Visceral Surgery of the University Medical Center. The study was approved by the ethical committee of the Medical Faculty of the University and performed according to the principles of the declaration of Helsinki and to the guidelines of the international Council for Harmonisation (ICH) for a good clinical practice (GCP). Study was registered in an approved primary register of the WHO. All data were handled strictly confidential and access was just granted to study personal. Study is reported in line with the STROCSS criteria [6].

2.2. Raw data

Data was obtained using the search function of the electronic patient management system "Prometheus" (Version 4.9.77.0). All patients treated in the Department of General and Visceral Surgery from 2005 to 2015, who had the international classification of diseases (ICD) code for renal transplantation (Z 94.0), were separated. Raw data was extracted manually and examined for potentially suitable patients on basis of inclusion and exclusion criteria. All patients eligible for inclusion were evaluated using the electronic patient curve in "Copra" (COPRA System GmbH, Version 6.73.4) or "Meona" (Meona GmbH, Version 70.542) and available documents in "Prometheus" (Version 4.9.77.0). Data were collected anonymously in a pre-formed table. Patients after transplantation of other organs, as well as combined transplantation and patients requiring renal replacement therapy were excluded. All kind of abdominal wall and abdominal surgery not related to transplanted kidney of adult patients (> 18 years) was eligible for inclusion. Data was evaluated by four authors.

2.3. Control group

Creation of control group was performed by two authors. We randomly selected non-transplant patient with normal renal function, who underwent abdominal surgery in the Division of General and Visceral Surgery of the University Hospital between 2005 and 2015 (see appendix for whole strategy of creation of control group). The type of operation had to correspond with operations in the transplanted group. The equality of encryption (OPS, modification of International Classification of Procedures in Medicine) of operation was defined as criterion for inclusion. Criteria for exclusion were renal dysfunction and organ transplantation in the past. Similarly to the method of data generation of kidney-transplanted patients, we searched for encryption via the electronic search function (see appendix for searched encryptions). Inclusion- and exclusion criteria of the corresponding patient were checked and eligible patients were included into the control group.

2.4. Definition of complications and extent of operations

As a complication were documented: Urinary tract infection, urinary retention, pneumonia, postoperative bleeding, hematoma, adrenocortical insufficiency, pulmonary embolism, extremity vascular occlusion, cardiac decompensation, myocardial infarction, abdominal stoma complications, lymphoid fistula, intestinal fistula, mechanical ileus, intestinal perforation, acute mesenteric ischemia, peritonitis, anastomotic leakage, wound infection, abdominal wound dehiscence and intraabdominal abscess. The total number of complications collected includes all the complications mentioned. The following complications have additionally been redefined as a surgical complication: Wound infection, pneumonia, intraabdominal abscess, peritonitis, anastomotic leakage, intestinal ischemia or perforation, ileus, postoperative bleeding, abdominal stoma complication, abdominal wound dehiscence, urinary tract infection.

Complications were stratified according to the modified Clavien classification [7] of postoperative complications and the diagnosis was made either clinically or by appropriate diagnostic measures (laboratory values, ultrasonography, computed tomography, magnetic resonance imaging). Radiologically confirmed were pneumonia and thromboembolism (peripheral vascular occlusion and pulmonary embolism). Also radiologically, intraabdominal complications such as abscesses, ischemia, fistula (lymph or intestine) and mechanical ileus were diagnosed. Bleeding was diagnosed as a result of blood examination and sonography. Hematoma and urinary retention were confirmed clinically and sonographically. Kidney or adrenal complications were diagnosed by laboratory tests. Urinary tract infections were confirmed by urinalysis. Anastomotic leakage was diagnosed endoscopically or during revision surgery. The diagnosis of a wound infection was made after emptying purulent secretions from the wound. Abdominal wound dehiscence was the present of a fascia dehiscence with prolapse of the intestine.

The following surgical techniques were defined as major surgery: Wedge resections and non-anatomic resections of the liver, anatomic resections of the liver, right or left hemihepatectomy, segmental resections of small bowel, all types of colectomy and rectal resection, gastrointestinal continuity restoration surgery, esophagectomy, gastrectomy, pseudocystojejunostomy, pancreatic necrosectomy, cystic kidney nephrectomy, splenectomy, pancreaticoduodenectomy.

As minor operations were defined: Adhesiolysis, creation of ascending stoma, appendectomy, cholecystectomy, diagnostic laparoscopy, exploratory laparotomy (without further resection), suture of duodenum, restoration of ileostomy, hernia (inguinal, navel, scar) repair with or without mesh, revision of stoma and removal of retroperitoneal hematoma.

As extraabdominal operation all hernia repairs as well as stoma revisions were defined.

2.5. Statistical analysis

IBM SPSS® (version 23.0) was used for analysis. Sample size was calculated on basis of an assumed large effect size of 0.6–74 patients per group. $P < 0.05$ was considered significant. Primary endpoint was the comparison of complication rate of kidney transplant recipients compared to non-transplanted controls. Results were checked for normal distribution. Evaluation was carried out by T-test as an analysis of two independent groups. Chi squared test was utilized to test for trends and significance and compare groups of categorical data. Correlation analysis was performed using Pearson's correlation analysis.

3. Results

From January 2005 to December 2015 a total of 1535 kidney transplant recipients were admitted to the Department of General and Visceral Surgery at the Medical Center of the University. In total, 101 cases were eligible for inclusion.

The mean age of included patients was 59.2 years [range 41–77 years]. The gender distribution of the patients was 38 females (37.6%) and 63 males (62.4%). The mean time since transplantation was 15.8 years [± 9.3 years]. Patients had to stay in hospital on average for 27.5 days [range 2–312 days]. More than half of the patients (n = 66, 65.3%) underwent elective surgery. Performed operations of case-matched analysis are shown in Table 3. Further operations, which were performed and are not mentioned in Table 3 due to exclusion from case-matched analysis, were: Cystic kidney nephrectomy, adhesiolysis, resection of gastrocolic ligament, removal of retroperitoneal hematoma and pancreatic necrosectomy.

Table 1
Risk analysis of 101 patients after renal transplantation.
* Chi squared test.

Indication	Emergency (n = 35)	Elective (n = 66)	p*
Mortality [%]	10 [28.6]	10 [15.2]	0.107
Postoperative complication [%]	24 [68.6]	36 [54.5]	0.172
Surgical complication [%]	17 [48.6]	32 [48.5]	0.993
Need for revision operation [%]	13 [37.1]	25 [37.9]	0.942
Extent of operation	Major (n = 49)	Minor (n = 52)	p*
Mortality [%]	15 [30.6]	5 [9.6]	**0.008**
Postoperative complications [%]	35 [71.4]	25 [48.1]	**0.017**
Surgical complication [%]	33 [67.3]	16 [30.8]	**< 0.001**
Need for revision operation [%]	25 [51]	13 [25]	**0.007**
Intra- vs. extra abdominal operation	Intra (n = 78)	Extra (n = 23)	p*
Mortality [%]	18 [23.1]	2 [8.7]	0.128
Postoperative complications [%]	50 [64.1]	10 [43.5]	0.077
Surgical complication [%]	42 [53.8]	7 [30.4]	**0.048**
Need for revision operation [%]	33 [42.3]	5 [21.7]	0.074
Age	< 60years (n = 54)	> 60years (n = 47)	p*
Mortality [%]	8 [14.8]	12 [25.5]	0.178
Postoperative complication [%]	32 [59.3]	28 [59.6]	0.974
Surgical complication [%]	25 [46.3]	24 [51.1]	0.633
Need for revision operation [%]	20 [37.0]	18 [38.3]	0.896
Gender	male (n = 63)	female (n = 38)	p*
Mortality [%]	9 [14.3]	11 [28.9]	0.073
Postoperative complication [%]	35 [55.6]	25 [65.8]	0.310
Surgical complication [%]	30 [47.6]	19 [50.0]	0.817
Need for revision operation [%]	24 [38.1]	14 [36.8]	0.900
Time since transplantation	< 10 years (n = 34)	> 10years (n = 67)	p*
Mortality [%]	5 [14.7]	15 [22.4]	0.360
Postoperative complication [%]	21 [61.8]	39 [58.2]	0.731
Surgical complication [%]	18 [52.9]	31 [46.3]	0.526
Need for revision operation [%]	15 [44.1]	23 [34.3]	0.337

3.1. Mortality

20 patients out of 101 (19.8%) died. The main cause of death was sepsis (13 patients with abdominal sepsis, one with pulmonary sepsis). Six patients were operated as emergency, eight were elective patients. Performed operations were hemicolectomy, gastrointestinal continuity restoration, Hartmann's procedure, resection or suture of small bowel (two times), retroperitoneal necrosectomy, gastrectomy, splenectomy, sigma resection (two times), pseudocystojejunostomy and adhesiolysis.

Three patients died due to postoperative hemorrhagic shock (one of those had a fulminant pulmonary embolism with necessity of anticoagulation, which leads to an uncontrollable bleeding), two from cardiovascular complications and one due to progress of neoplastic disease.

3.2. Morbidity

49 patients out of 101 (48.5%) suffered from surgical complications. In 16 patients (15.8%), postoperative bleeding occurred. Six patients (5.9%) had urinary tract infections and two (2%) had urinary retention. 11 patients (10.9%) developed pneumonia postoperatively. One patient each (1% each) had a lymph fistula, an intestinal fistula, a mechanical ileus or an intestinal ischemia. Eight patients (7.9%) presented clinically with peritonitis. Thirteen patients (12.9%) had a wound infection,

Table 2
Description of included patients (case-matched analysis, n = 168).
(SD = Standard deviation, *T-Test)
°Due to criteria of inclusion results must be the same as transplanted group.

	Transplanted (n = 84)	Control (n = 84)	Total (n = 168)	p*
Age [years ± SD]	59.0 ± 9.0	60.5 ± 15.5	59.8 ± 12.7	0.444
Gender [male/female %]	61.9/38.1	56.0/44.0	58.9/41.1	0.349
Mean length of hospital stay [days ± SD]	28.2 ± 39.2	16.9 ± 19.6	22.5 ± 31.4	**0.020**
Type of surgery				
Emergency operation [%]	22 [26.2]	22 [26.2]°	44 [26.2]	–
Major operation [%]	46 [54.8]	46 [54.8]°	93 [55.4]	–
Intra-abdominal surgery [%]	62 [73.8]	62 [73.8]°	125 [74.4]	–

Table 3
Type of surgery and percentage of transplanted patients and emergency surgery on mortality (case-matched analysis, n = 168).
*Pseudocystojejunostomy, suture of duodenum, diagnostic laparoscopy and exploratory laparotomy
°50% of each procedure are transplanted and 50% are non-transplanted patients.

Type of surgery	n°	Emergency	Mortality [%]	Percentage of … on mortality	
				Transplanted patients	Emergency surgery
Hartmann's procedure	14	100%	2 [14]	100%	100%
Left or right hemicolectomy	12	60%	2 [17]	100%	100%
Colectomy	2	0%	0	0%	0%
Sigma and rectal resection	16	12.5%	2 [13]	100%	0%
Creation or revision of ostomy	4	100%	1 [25]	100%	100%
Appendectomy	2	100%	0	0%	0%
Cholecystectomy	10	80%	1 [10]	0%	100%
Segmental resections of small bowel	10	40%	2 [20]	100%	100%
Gastrectomy	6	0%	1 [17]	100%	0%
Right or left hemihepatectomy	6	0%	0	0%	0%
Anatomic or non-anatomic resections of the liver	6	0%	1 [17]	100%	0%
Restoration of ileostomy	12	0%	0	0%	0%
Gastrointestinal continuity restoration	14	0%	1 [7]	100%	0%
Hernia repair (inguinal, navel, scar)	38	0%	1	100%	0%
Splenectomy	2	0%	1 [50]	100%	0%
Esophagectomy	2	0%	0	0%	0%
Pancreaticoduodenectomy	4	0%	1 [25]	100%	0%
Others*	8	50%	2 [25]	50%	50%

six patients (5.9%) developed an abdominal wound dehiscence and four patients (4%) had an intra-abdominal abscess. 38 out of 101 patients received an anastomosis. Of these, 11 patients (28.9%) suffered from anastomotic leakage.

Overall morbidity was 59.4% (n = 60). Two patients (2%) suffered from a vascular occlusion of the extremities and five patients (5%) from a cardiovascular complication (decompensation/infarction). One patient each had a pulmonary embolism, a renal allograft rejection or an adrenocortical insufficiency.

3.3. Risk analysis

The whole risk analysis of 101 patients after renal transplantation is shown in Table 1. The extent of the surgery (major vs. minor) showed an influence on mortality and morbidity of the patients. 30.6% of patients after major surgery and only 9.6% of patients after minor surgery died (p = 0.008). 71.4% of patients after major surgery suffered complications (compared to 48.1% for minor surgery, p = 0.017). The difference was even bigger for surgical complications (67.3% vs. 30.8%, p < 0.001). The need for re-operation was twice as high in the major group as in the minor group (51% vs. 25%, p = 0.007). We found no significant difference in mortality, complication rate or need for re-operation in relation to an emergency indication for surgery (calculation see Table 1). We also found no relation between time since transplantation or patients' age and development of complications, mortality or need for reoperation (calculation see Table 1).

Slightly more than half of the patients (n = 55, 55%) were treated with tacrolimus, which resulted in a significantly lower mortality (31% of patients without tacrolimus died, but only 11% of patients with tacrolimus, p = 0.012). We found no influence of tacrolimus on complication and reoperation rates. Nearly all of the patients (n = 90) had a steroid treatment, which had no statistical influence on mortality, complication and reoperation rates. Other immunosuppressants (cyclosporine (n = 32), mycophenolate mofetil (n = 67), sirolimus (n = 5) and azathioprine (n = 3)) did not affect mortality, complication and reoperation rates (data not shown). However, any form of drug modification (whether preoperative or postoperative) resulted in a significantly increased complication rate (p = 0.001) and an increased rate of reoperations (p = 0.037).

3.4. Comparison with control group

For 84 patients of the original 101 patients it was possible to randomly find a control patient who underwent the exact same operation in the years 2005–2015 at the University Medical Center: 5 patients undergoing exploratory laparotomy without resection, 7 patients with adhesiolysis without resection, one each with resection of the ligamentum gastrocolicum, a retroperitoneal necrosectomy or a retroperitoneal hematoma removal, and 2 patients with cystic kidney nephrectomy. In total, 168 patients (84 kidney transplant patients, 84 control patients without organ transplantation) were compared. Description of case-matched patients is shown in Table 2.

3.5. Primary target

49 complications (58.3%) occurred in 84 kidney transplants. 40 complications (47.6%) were defined as surgical complication. In the comparison group, 38 complications (45.2%) were documented, of which 30 were surgical complications (35.7%). The difference is statistically neither for all complications (p = 0.090) nor for the subgroup of surgical complications (p = 0.119) significant.

3.6. Secondary targets

On average, patients suffered from 1.25 complications [range 0–6], the case group was suffering on average from 1.68 complications [range 0–6] and the control group from 0.82 complications [range 0–4].

73 out of 168 patients received an anastomosis. Of these, a total of 16 patients (21.9%) suffered from anastomotic leakage. 11 patients (29.7%) belonged to the case group and 5 patients (13.9%) to the control group. The difference was not statistically significant (p = 0.105). Whole frequency of complications is shown in Table 4.

In total, 18 patients (10.7%) died, 16 belonged to the transplanted group. Kidney transplant patients died significantly more frequently (p < 0.001).

Looking at the entire collective of 168 patients, we made the following observation: Patients, who had a complication, died significantly more frequently (p = 0.001). Patients, who had undergone emergency surgery, suffered more frequently from complications (p = 0.004). The larger the extent of operation (major vs. minor) was, the more patients died (p = 0.043) or suffered from complications

Table 4
Frequency of complications (case-matched analysis, n = 168).
(SD = Standard deviation, *T-Test)
[+]73 patients out of 168 received an anastomosis, 36 of the control group and 37 of the case group.

	Transplanted (n = 84)	Control (n = 84)	Total (n = 168)	p*
Mean length of hospital stay [days ± SD]	28.2 ± 39.2	16.9 ± 19.6	22.5 ± 31.4	**0.020**
Mortality [%]	16 [19]	2 [2.4]	18 [10.7]	**< 0.001**
Postoperative complication [%]	49 [58.3]	38 [45.2]	87 [52.8]	0.090
Surgical complication [%]	40 [47.6]	30 [35.7]	70 [41.7]	0.119
Reoperation [%]	32 [38.1]	17 [20.2]	49 [29.2]	**0.017**
Wound infection [%]	13 [15.5]	20 [23.8]	33 [19.6]	0.176
Abdominal wound dehiscence [%]	6 [7.1]	4 [4.8]	10 [6.0]	0.517
Anastomotic leakage [%]	11 [29.7][+]	5 [13.9][+]	16 [21.9][+]	0.105
Peritonitis [%]	4 [4.8]	2 [2.4]	6 [3.6]	0.652
Intra-abdominal abscess [%]	3 [3.6]	1 [1.2]	4 [2.4]	0.317
Urinary tract infection [%]	3 [3.6]	3 [3.6]	6 [3.6]	1.000
Urinary retention [%]	1 [1.2]	2 [2.4]	3 [1.8]	0.563
Pneumonia [%]	9 [10.7]	3 [3.6]	12 [7.4]	0.073
Postoperative bleeding [%]	14 [16.7]	1 [1.2]	15 [9.0]	**0.001**
Adrenocortical insufficiency [%]	1 [1.2]	0	1 [0.6]	0.320
Pulmonary embolism [%]	1 [1.2]	0	1 [0.6]	0.319
Vascular occlusion of extremity [%]	2 [2.4]	0	2 [1.2]	0.157
Cardiovascular complication [%]	4 [4.8]	1 [1.2]	5 [3.0]	0.175
Abdominal stoma complication [%]	0	3 [3.6]	3 [1.8]	0.081
Lymphoid fistula [%]	1 [1.2]	1 [1.2]	2 [1.2]	1.000
Intestinal fistula [%]	1 [1.2]	1 [1.2]	2 [1.2]	1.000
Mechanical ileus [%]	1 [1.2]	3 [3.6]	4 [2.4]	0.315
Intestinal perforation [%]	5 [6.0]	0	5 [3.0]	**0.024**
Acute mesenteric ischemia [%]	1 [1.2]	0	1 [0.6]	0.320

($p = 0.002$). When complications occurred, patients stayed significantly longer in the hospital ($p = 0.001$).

4. Discussion

This retrospective single center study shows a significantly higher mortality rate, a prolonged length of hospital stay and a significantly higher rate of re-operation for renal transplant recipient after abdominal wall and abdominal surgery not connected with transplantation compared to non-transplanted patients.

Some previous studies reported similar results. The largest analysis so far of 2616 kidney transplanted patients after colorectal surgery showed that transplanted patients had higher mortality rates than non-transplanted patients (6.3% vs. 3.6%) [8]. Other small studies reported contradictory results. Krysa et al. supported the higher mortality rate (n = 21, mortality rate 5%) [9]. Reshef et al. reported that no patient (neither in the group of transplanted patients (n = 14) nor in the comparison group (n = 14)) died after elective colorectal surgery [10]. The rates for emergency operations are stated to be much higher. Krysa et al. indicated a mortality rate of 26% for colorectal emergency operations (n = 14) [9]. Reshef et al. concluded that kidney transplant patients have an increased mortality risk to die after emergency surgery, because they observed a higher mortality rate of kidney transplanted patients after urgent diverticulitis surgery (14% vs. 0%) [10]. Even though the mortality rate in the emergency group of our patients was twice as high, our calculation did not reach the level of statistical significance. We assume that this might be a bias caused by the assumption that a university medical center like us might have elective patients at a greater surgical risk.

Similar to the mortality rates, morbidity rates of transplanted patients reported in recent literature are quite inhomogeneous and pose a considerable bias risk due to the lack of control groups. Kałuża et al. found a wound infection rate in kidney transplant recipients (n = 54) undergoing general surgery of 12.7% [11]. Banli et al. evaluated 16 kidney transplant patients after laparoscopic cholecystectomy and reported a morbidity rate of 14.3% [12]. In a systematic review the overall morbidity of patients after solid organ transplantation, which had to undergo emergency surgery because of a gallbladder disease, was 13.6% [13]. Savar et al. showed an overall complication rate of 24% in 17 transplanted patients after appendectomy [14]. Yannam et al. compared results after laparoscopic hernia repair of pancreatic and renal transplant patients (n = 31) with non-transplant patients (n = 57), but they found no increased morbidity (45.2% vs. 40.4%). The previous mentioned largest analysis of transplanted patients after colorectal surgery found a wound complication rate of 7.4% (non-transplanted 4.2%, $p < 0.001$) and a rate of 8.7% after emergency colorectal surgery (non-transplanted 7.2%, $p = 0.04$) [8]. A systematic review investigating morbidity after emergency surgery for complicated sigmoid diverticulitis in transplanted patients showed an overall rate of 32.7% and a rate of 47.7% in kidney transplant recipients [15].

Different to what is commonly expected morbidity rate is not increased due to an increased rate of anastomotic leakage. Neither our results nor the results of other large studies showed a significantly increased rate of anastomotic leakage in transplant patients [8,15]. The leading cause of morbidity in our study was postoperative bleeding. Halabi et al. found also a significantly higher rate of postoperative bleeding in transplanted patients after elective colorectal surgery (4.4% vs. 2%, $p < 0.001$), but not after emergency surgery (1.73% vs. 3%) [8]. Reshef et al. also had a slightly higher rate (11% vs. 3%, not significant) of postoperative bleeding in transplanted patients after emergency surgery [10]. Even if an increased risk for infectious complications is due to immunosuppression conclusive, the assumption could not be confirmed with certainty by recent studies. Our results showed a slightly increased rate, but it did not reach the level of statistical significance. Halabi et al. reported a similar risk for transplanted and non-transplanted patients [8]. Two further studies indicated an increased risk [13,15]. The discussion of mortality and morbidity rates and comparison of complications is quite challenging. The documentation of complications is not always consistent. Documentation via classification of Clavien-Dindo [7], for example, will create higher complication rates as it defines any deviation from the normal postoperative course as a complication (as seen in our study as well as in the study of Yannam et al. [16]). Moreover, it is also a problem, that unusually high complications rates might be unpublished to protect reputation. The risk of complications also depends on the experience of the surgeon, but this is rarely considered in analyses of mortality and

morbidity rates. These assumptions explain quite simply why such a large variance of complication rates can be found in literature.

The influence of extent of the operation on the mortality and morbidity risk is indisputable as well as conclusive and has to be considered. Our results showed also a significant influence of extent of surgery on mortality and morbidity.

Another explanation for high mortality and morbidity in our study might also be that only patients in bad condition opt for surgery in a university hospital. Nevertheless, high morbidity and mortality rates of transplanted patients are conclusive. Patients after renal transplantation have a long medical history, more comorbidities [8] and their physical condition is pre-stressed by years of renal insufficiency. Chronic renal insufficiency leads to metabolic disorders, cardiovascular diseases and causes damage to other organs [17,18]. They are also not only physically burdened. The burden of a long-term illness might lead to a different perspective on one's own illness. We had a few patients in our cohort, who consciously chose not to treat their complications even though they had previously been thoroughly informed that they might die without treatment.

Transplanted patients spend a lot of time in contact with physicians and in the hospital anyway. Due to the possible increased risk for postoperative complications it can be assumed that transplanted patients will not only be hospitalized longer because of actual development of postoperative complications, but also for safety reasons. Therefore, it is not surprising, that our transplanted patients had to stay in hospital significantly longer than non-transplant patients, which is also supported by recent literature [8,14].

Retrospective evaluations always entail the risk of limitations due to documentation errors. To avoid mistakes during data collection, data collection was performed by one author under control of two others. Strength of our study is that we were able to enroll a larger number of transplanted patients than most previous studies and that a randomly selected control group for comparison was generated.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Data statement

Data is available to other scientist on reasonable request. If required, the corresponding author can be contacted.

Ethical approval

Study was approved by local ethical committee (EK: 203/17).

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None.

Author contribution

All authors have made substantial contributions to conception and design of the study, or acquisition of data, or analysis and interpretation of data, drafting the article or revising it. All contributors who do not meet the criteria for authorship were listed in the acknowledgements section.

CRediT author statement:

Ann-Kathrin Lederer: Conceptualization, Methodology, Formal Analysis, Investigation, Visualization, Writing – Original Draft.

Dominic Haffa: Methodology, Formal Analysis, Investigation, Visualization, Resources, Data curation, Writing – Review & Editing.

Verena Martini: Conceptualization, Methodology, Writing – Review & Editing.

Frank Makowiec: Software, Validation, Formal Analysis, Writing – Review & Editing.

Roman Huber: Conceptualization, Validation, Writing – Review & Editing, Supervision.

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Conflicts of interest

All authors disclose any financial and personal relationships with other people or organisations that could inappropriately influence their work. The authors have no conflict of interest or financial ties to disclose.

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Appendix ASupplementary data

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References

[1] A.O. Ojo, F.K. Port, R.A. Wolfe, E.A. Mauger, L. Williams, D.P. Berling, Comparative mortality risks of chronic dialysis and cadaveric transplantation in black end-stage renal disease patients, Am. J. Kidney Dis. 24 (1) (1994 Jul) 59–64.
[2] P. Schnuelle, D. Lorenz, M. Trede, F.J. Van Der Woude, Impact of renal cadaveric transplantation on survival in end-stage renal failure: evidence for reduced mortality risk compared with hemodialysis during long-term follow-up, J. Am. Soc. Nephrol. 9 (11) (1998) 2135–2141.
[3] F.K. Port, Comparison of Survival Probabilities for Dialysis Patients vs Cadaveric Renal Transplant Recipients, JAMA, J. Am. Med. Assoc. 270 (11) (1993 Sep 15) 1339.
[4] Deutsche Stiftung Organtransplantation. Jahresbericht-Organspende und Transplantation in Deutschland, [Internet] 2016; 1–112. Available from: https://www.organspende-info.de/sites/all/files/files/JB_2016_Web(1).pdf, (2016) , Accessed date: 11 October 2018.
[5] S. Hariharan, C. Johnson, B. Bresnahan, S. Taranto, Improved graft survival after renal transplantation in the United States, 1988 to 1996, N. Engl. J. Med. 342 (9) (2000) 605–612.
[6] R.A. Agha, M.R. Borrelli, M. Vella-Baldacchino, R. Thavayogan, D.P. Orgill, for the STROCSS Group, The STROCSS Statement: Strengthening the Reporting of Cohort Studies in Surgery, Int. J. Surg. 46 (2017) 198–202.
[7] D. Dindo, N. Demartines, P.-A. Clavien, Classification of Surgical Complications, Ann. Surg. 240 (2) (2004 Aug) 205–213.
[8] W.J. Halabi, M.D. Jafari, V.Q. Nguyen, J.C. Carmichael, S. Mills, A. Pigazzi, et al., Colorectal surgery in kidney transplant recipients: a decade of trends and outcomes in the United States, Am. Surg. 79 (10) (2013 Oct) 1026–1033.

[9] J. Krysa, V. Patel, J. Taylor, A.B. Williams, E. Carapeti, M.L. George, Outcome of patients on renal replacement therapy after colorectal surgery, Dis. Colon Rectum 51 (6) (2008 Jun) 961–965.
[10] A. Reshef, L. Stocchi, R.P. Kiran, S. Flechner, M. Budev, C. Quintini, et al., Case-matched comparison of perioperative outcomes after surgical treatment of sigmoid diverticulitis in solid organ transplant recipients versus immunocompetent patients, Colorectal Dis. 14 (12) (2012 Dec) 1546–1552.
[11] B. Kałuża, I. Ziobrowski, M. Durlik, Surgical Procedures Not Connected with Transplantation in Patients After Kidney or Kidney and Pancreas Transplant with Stable Function of Graft, Pol. J. Surg. 84 (4) (2012 Jan 1).
[12] O. Banli, N. Guvence, H. Altun, Laparoscopic cholecystectomy for renal transplants, Transplant. Proc. 37 (5) (2005 Jun) 2127–2128.
[13] N. de'Angelis, F. Esposito, R. Memeo, V. Lizzi, A. Martìnez-Pérez, F. Landi, et al., Emergency abdominal surgery after solid organ transplantation: a systematic review, World J. Emerg. Surg. 11 (1) (2016 Dec 30) 43.
[14] A. Savar, J.R. Hiatt, R.W. Busuttil, Acute appendicitis after solid organ transplantation, Clin. Transplant. 20 (1) (2006) 78–80.
[15] A. Merchea, Z.M. Abdelsattar, T. Taner, P.G. Dean, D.T. Colibaseanu, D.W. Larson, et al., Outcomes of Colorectal Cancer Arising in Solid Organ Transplant Recipients, J. Gastrointest. Surg. 18 (3) (2014 Mar 20) 599–604.
[16] G.R. Yannam, T.L. Gutti, R. High, R.B. Stevens, J.S. Thompson, M.C. Morris, Experience of laparoscopic incisional hernia repair in kidney and/or pancreas transplant recipients, Am. J. Transplant. 11 (2) (2011 Feb) 279–286.
[17] J.W. Groothoff, M. Offringa, M. Grootenhuis, K.J. Jager, Long-term consequences of renal insufficiency in children: lessons learned from the Dutch LERIC study, Nephrol. Dial. Transplant. (March) (2017 Jul 7) 1–9.
[18] J. Kooman, M. Dekker, L.A. Usvyat, P. Kotanko, F. Van der Sande, C.G. Schalkwijk, et al., Inflammation and premature aging in advanced chronic kidney disease, Am. J. Physiol. Renal. Physiol. 313 (4) (2017) F938–F950 ajprenal.00256.2017.