**University of
Zurich**^{UZH}

**Zurich Open Repository and
Archive**

University of Zurich
University Library
Strickhofstrasse 39
CH-8057 Zurich
www.zora.uzh.ch

Year: 2021

Sleeve Gastrectomy Enables Simultaneous Pancreas and Kidney Transplantation in Severely Obese Recipients

Rössler, Fabian ; Hübel, Kerstin ; Di Natale, Samuela ; Oberkofler, Christian ; Gerber, Philipp ; Bueter, Marco ; de Rougemont, Olivier

Abstract: Background Obesity adversely affects wait-listing and precludes patients with concomitant end-stage renal disease and type 1 diabetes mellitus from getting a simultaneous pancreas and kidney transplantation (SPK). Objective To analyze safety and efficacy of laparoscopic sleeve gastrectomy (LSG) before SPK in severely obese type I diabetics. Methods We assessed weight curve, complications, and graft function of three patients who underwent LSG before SPK. Results LSG was uneventful in all patients. Body mass index dropped from 38.4 (range 35.7 - 39.9) before LSG to 28.5 (26.8 - 30.9) until SPK, with a mean loss of 25.8% (22.4 - 32.3). Interval between LSG and SPK was 364.3 (173 - 587) days. Pancreas and kidney graft function was excellent, with 100% insulin-free and dialysis-free survival over a mean follow-up of 3.6 (2.9 - 4.5) years. A1C dropped from 7% (6.3 - 8.2) before LSG to 4.9% (4.7 - 5.3) and 4.8% (4.5 - 5.1) 1 and 2 years after SPK, respectively. Conclusion LSG before SPK is safe and effective to enable severely obese type I diabetics to receive a lifesaving transplant. This is the first study analyzing the role of bariatric surgery before simultaneous pancreas and kidney transplantation.

DOI: <https://doi.org/10.1111/ctr.14197>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-196162>

Journal Article

Accepted Version

Originally published at:

Rössler, Fabian; Hübel, Kerstin; Di Natale, Samuela; Oberkofler, Christian; Gerber, Philipp; Bueter, Marco; de Rougemont, Olivier (2021). Sleeve Gastrectomy Enables Simultaneous Pancreas and Kidney Transplantation in Severely Obese Recipients. *Clinical Transplantation*, 35(3):e14197.

DOI: <https://doi.org/10.1111/ctr.14197>

Sleeve gastrectomy enables simultaneous pancreas and kidney transplantation in severely obese recipients

Fabian Rössler¹, Kerstin Hübel², Samuela Di Natale¹, Christian Oberkofler¹,

Philipp Gerber³, Marco Bueter¹, Olivier de Rougemont¹

¹ Department of Surgery and Transplantation, University Hospital Zurich, Switzerland

² Department of Nephrology, University Hospital Zürich, Switzerland

³ Department of Endocrinology, University Hospital Zurich, Switzerland

fabian.roessler@usz.ch, kerstin.huebel@usz.ch, samuela.dinatale@usz.ch,
christian.oberkofler@usz.ch, philipp.gerber@usz.ch, marco.bueter@usz.ch,
olivier.derougemont@usz.ch

Corresponding author:

Olivier de Rougemont, MD

University Hospital Zurich

Department of Surgery and Transplantation

Raemistrasse 100

8091 Zurich

Switzerland

Email: olivier.derougemont@usz.ch

Tel.: +41 44 255 9285

Fax: +41 44 255 8941

Short title: Bariatric surgery prior to transplantation

Data Availability Statement: Research data are not shared.

Key words:

Bariatric surgery, Laparoscopic sleeve gastrectomy, Simultaneous pancreas and kidney transplantation

Conflicts of interest and source of funding:

All authors of this manuscript declare no conflicts of interest. No funding or financial support was provided for the study.

Abstract:

Background: Obesity adversely affects waitlisting and precludes patients with concomitant end-stage renal disease and type 1 diabetes mellitus from getting a simultaneous pancreas and kidney transplantation (SPK).

Objective: To analyze safety and efficacy of laparoscopic sleeve gastrectomy (LSG) before SPK in severely obese type I diabetics.

Methods: We assessed weight curve, complications and graft function of three patients who underwent LSG before SPK.

Results: LSG was uneventful in all patients. Body mass index dropped from 38.4 [range 35.7 - 39.9] before LSG to 28.5 [26.8 - 30.9] until SPK, with a mean loss of 25.8% [22.4 - 32.3]. Interval between LSG and SPK was 364.3 [173 - 587] days. Pancreas and kidney graft function were excellent, with 100% insulin-free and dialysis-free survival over a mean follow-up of 3.6 [2.9 - 4.5] years. A1C dropped from 7% [6.3 - 8.2] before LSG to 4.9% [4.7 - 5.3] and 4.8% [4.5 - 5.1] 1 and 2 years after SPK, respectively.

Conclusion: LSG before SPK is safe and effective to enable severely obese type I diabetics to receive a lifesaving transplant. This is the first study analyzing the role of bariatric surgery before simultaneous pancreas and kidney transplantation.

Abbreviations:

BS: Bariatric surgery

LRYGB: Laparoscopic Roux-en-Y gastric bypass

LSG: Laparoscopic sleeve gastrectomy

GB: Gastric banding

BMI: Body Mass Index

SPK: Simultaneous pancreas and kidney transplantation

PTA: Pancreas transplantation alone

T1DM: Type 1 diabetes mellitus

T2DM: Type 2 diabetes mellitus

ESRD: End-stage renal disease

A1C: Hemoglobin A1C

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration

GFR: Glomerular filtration rate

CCI: Comprehensive Complication Index

DBD: Donors after brain dead

HLA: Human leukocyte antigen

%EBMIL: Percentage of excess body mass index loss

%TWL: Percentage of total weight loss

OPTN: Organ Procurement and Transplantation Network

UNOS: United Network for Organ Sharing

SRTR: Scientific Registry of Transplant Recipients

CVA: Cerebrovascular accident

HT: Head trauma

Introduction:

The growing number of patients with morbid obesity is a matter of concern in the transplant population. Due to their increased morbidity and possible inferior graft outcome, obese patients are often excluded from transplant programs, such as simultaneous pancreas and kidney transplantation (SPK).[1-4] However, SPK has been shown to be a lifesaving procedure, with life-years saved per patient comparable to heart transplantations.[5, 6] Furthermore, SPK was shown to result in long-term improved glycemic control and thus, protection of the transplanted kidney.[7] This emphasizes the importance of access to transplantation for all type 1 diabetic patients, including morbidly obese patients.

Bariatric surgery (BS) is to date the most successful measure to achieve a long lasting weight loss in patients with morbid obesity.[8, 9] BS has been shown to be safe in patients with end-stage renal disease (ESRD) prior to and after kidney transplantation, improving patient and graft survival as well as graft function.[10-13] Furthermore, successful series of simultaneous liver transplantation and sleeve gastrectomy have been reported.[14-16]

However, no data is available for BS done as a path to eligibility for SPK. Safety and efficacy of BS prior to pancreas transplantation alone (PTA) has been described for gastric banding (GB) and Roux-en-Y gastric bypass (RYGB) once.[17] As RYGB radically changes the gut anatomy, there is reluctance to offer this procedure in transplant candidates due to potentially negative pharmacokinetic effects on the absorption of immunosuppressive drugs. No significant differences in excess Body Mass Index (BMI) loss between laparoscopic sleeve gastrectomy (LSG) and RYGB have been described.[18-20] Therefore, LSG may be the surgery of choice in this population.[21-23]

We report our initial experience in patients with morbid obesity that underwent LSG prior to SPK for type 1 diabetes mellitus (T1DM) and ESRD.

Methods:

We retrospectively reviewed the medical records within our prospective database including all patients that underwent a pancreas transplantation at our institution between 1.1.2001 and 31.2.2019. Within this period, we performed 134 SPKs in 126 patients, all for T1DM and ESRD. Out of these, three patients underwent LSG for morbid obesity prior to transplantation.

We assessed weight loss, changes in A1C, graft function and postoperative complications. Functioning of the pancreas graft was defined as no need for insulin treatment after transplantation and normal A1C values. C-peptide levels were monitored before waitlisting, however not after BS and SPK, and hence not included. Kidney function was assessed by calculation of glomerular filtration rate (GFR) using the creatinine clearance, according to the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation.[24, 25] Percentage of excess BMI loss after bariatric surgery (%EBMIL) was calculated for all patients, based on BMI 25 kg/m² as a constant end-point for all patients.[26] In addition percentage of total weight loss (%TWL) was calculated.[27] All patients underwent multidisciplinary evaluation, endoscopy and esophageal manometry before LSG. LSG was performed with standardized technique, i.e. 36-French bougie along the lesser curvature for calibration and oversuturing of the staple line after resection. After LSG, patients were put on hold for 6 months on the national waiting list. All SPK were performed identically with the portal vein to the inferior vena cava and the duodenal segment to the second jejunal loop. The kidney was grafted to the left external iliac vessels.

Immunosuppression induction included steroids and anti-thymocyte globulin.

Maintenance immunosuppression consisted of tacrolimus in combination with mycophenolic acid and rapid 5-day steroid taper.

Complications were assessed according to the validated and severity-oriented Clavien-Dindo classification.[28, 29] Minor complications were defined as $\leq$ grade II and major complications as $\geq$ grade IIIa. We used the Comprehensive Complication Index (CCI) to assess the cumulative postoperative morbidity, a continuous metric model to measure the postoperative complications morbidity on a scale from 0.0 (uneventful) to 100.0 (death).[30-32]

The local ethic committee reviewed and approved the study protocol (2016-01710).

For descriptive statistical analysis mean values, standard deviations, absolute and relative frequencies were calculated. Statistical analysis was performed with STATA (version 14, Stata Corp., College Station, Texas) and GraphPad Prism 6.

Results:

Patient characteristics and course:

Three patients with morbid obesity, one male and two female, underwent LSG before wait-listing for SPK (Table 1). All patients suffered from T1DM with associated ESRD, two were on dialysis at time of listing. All patients failed multiple attempts of conventional weight loss.

Patient 1: 48-year old male patient with a 30-year history of T1DM, with intermittent episodes of life-threatening hypoglycemia. Kidney function was slowly deteriorating, not yet requiring dialysis. BMI before bariatric surgery was 35.7 kg/m², with a glycated hemoglobin (A1C) of 6.5% under conventional diet and insulin therapy. He

underwent LSG 11 months before SPK without complications. Until SPK, BMI had dropped to 27.7 kg/m². The immediate postoperative course was uneventful, with excellent pancreas and kidney graft function. A peri-pancreatic abscess was successfully treated with percutaneous drainage and antibiotics in the later course. An intermittent BK-Virus replication was treated with reduction of immunosuppression and privigen®. 2.5-year follow-up shows full insulin-free pancreas graft function with, good kidney function (GFR 74 ml/min) and stable weight (BMI of 28.1 kg/m²).

Patient 2: The 35-year old woman was diagnosed with T1DM at the age of twelve. She suffered from hypoglycemic unawareness, resulting in multiple emergency admissions. She was morbidly obese with a BMI of 39.9 kg/m², with obstructive sleep apnea syndrome requiring continuous positive airway pressure therapy. She was on hemodialysis three years before SPK. She underwent LSG 1.5 years before SPK, without complications. BMI decreased to 30.9 kg/m² until SPK. Dissection and thrombosis of the iliac artery occurred during kidney implantation. The iliac artery was replaced with an arterial graft from the same donor and the kidney implanted successfully. The postoperative course was uneventful. The pancreas graft showed immediate full function, with no more need for insulin. The kidney developed a short period of delayed graft function due to the prolonged warm ischemia time. However, after one dialysis kidney graft function improved. Further follow-up was uneventful, with stable kidney function and persisting insulin-freedom.

Patient 3: This 28-year old female patient had a 17-year history of T1DM. She developed preeclampsia during pregnancy, with proteinuria and rapidly deteriorating kidney failure. She was on peritoneal dialysis for two years prior to SPK and treated with an insulin pump. BMI at first presentation was 39.6 kg/m² with A1C of 8.2%. She underwent uneventful LSG six months before SPK. At time of SPK, BMI and A1C had

been greatly reduced to 26.8 kg/m² and 6.4%, respectively. Intra- and postoperative course was uneventful, with immediate full function of pancreas and kidney grafts. Graft functions remained excellent within the next 4 years.

Outcome:

Patient characteristics, donor and surgical details are listed in Table 1 and 2. Course of BMI and weight loss is shown in Table 3 and Figure 1. Mean BMI dropped from 38.4 [35.7 - 39.9] kg/m² before LSG to 28.5 [26.8 - 30.9] kg/m² at time of SPK, with a mean %EBMIL of 74.3 [60.4 - 87.7] and mean %TWL of 27.9 [22.1 - 38] until SPK. Transplant kidney function and changes in A1C after LSG and SPK are listed in Table 1 and 2. Mean follow-up after SPK was 3.6 [2.9 - 4.5] years, without loss to follow-up.

LSG was uneventful in all three patients, represented by a CCI of 0 at discharge and after 90 days. After SPK, two patients developed complications until discharge. A peripancreatic fluid collection was drained percutaneously (Clavien-Dindo Grade IIIa) and intravenous antibiotics were admitted (Clavien-Dindo Grade II) in one patient. In addition, a wound infection required bedside wound opening, resulting in a CCI of 34.6 at discharge. Due to readmission for a recurrent peri-pancreatic abscess with need for a second percutaneous drainage and antibiotic treatment, 90-day CCI increased to 48.2 in the same patient. The second patient developed a transient delayed graft function (DGF), (Clavien-Dindo Grade I), with only one dialysis after transplant. One patient was readmitted six weeks after SPK due to elevated creatinine levels. Kidney biopsy ruled out acute rejection and kidney function improved spontaneously.

Mean CCI at discharge and 90 days after SPK was 11.5 [0 - 34.6] and 18.9 [0 - 48.2], respectively. Mean length of hospitalization after SPK was 19.3 [10 - 26] days.

Discussion:

Morbid obesity has become a major challenge in surgery. The number of individuals with overweight and obesity in the population is steadily rising and inevitably leads to an increase in potential transplant recipients with obesity. Our case series demonstrates safety and efficacy of LSG before SPK. The three patients had uneventful postoperative courses after LSG and all reduced their body weight sufficiently to be considered safe for transplantation. Furthermore all three patients maintained their weight loss over the follow-up period, although regain of weight is frequently observed in patients qualifying for SPK without BS. Perioperative morbidity after SPK was low, with excellent graft function for both pancreas and kidney. To the best of our knowledge this is the first series to investigate the role of BS before SPK.

Data regarding effects of obesity in pancreas transplantation is conflicting. On one hand registry data from the Organ Procurement and Transplantation Network (OPTN) and the United Network for Organ Sharing (UNOS) as well as from the Scientific Registry of Transplant Recipients (SRTR) indicate that obesity is an independent predictor of short and long-term graft loss.[33, 34] On the other hand, two single-institution retrospective studies identified obesity to be a predictor for overall postoperative complications, but not for graft and patient survival.[35, 36] Possible explanations for this discrepancy may be related to differences in timing and study design, but also to the fact that the degree of obesity varied substantially between the study populations. Laurence et al. showed indeed higher occurrence of wound infections and acute rejection, but no difference in graft and patient survival.[36] The obese group of 60 patients, however, had a mean BMI of 32.1 kg/m² indicating that the included patients suffered only from low-grade obesity. In contrast, data from Bedat et al. show a significant inferior 90 days graft survival in

patients with severe obesity, defined by BMI higher than 35 kg/m². [33] However, BS in our series was predominantly performed to avoid transplantation in recipients with severe obesity and the three patients clearly decreased their BMI from the level of high-grade obesity to the level of overweight after LSG.

BS in non-transplant populations has been shown to be beneficial in multiple ways including superior diabetic control compared to intensive medical treatment, reduction of hypertension and cardiovascular risk, improvement in joint pain and physical function. [37-40] Whether such results can be translated to patients with ESRD is still unclear, although recent data from a randomized trial comparing the effect of BS versus best medical treatment on early-stage CKD in patients with type 2 diabetes mellitus (T2DM) and obesity suggest that this is the case. Cohen et al found that LRYGB was more effective than best medical treatment for remission of albuminuria and rate of CKD. [41] However, caution is advised, as other reports have shown higher morbidity and postoperative mortality after BS in patients with ESRD. For example, in a nationwide analysis from the United States, patients with ESRD had higher morbidity and mortality risk after BS compared to patients without renal disease. It needs to be noted, however, that the absolute morbidity risk was nevertheless fairly low and that mortality was comparable to the expected mortality risk without surgery for patients with ESRD. [42] Taken together it is highly inconceivable from an obese patient's perspective not to assess him or her for BS prior to transplantation for ESRD and T1DM.

A different approach to transplantation in recipients with obesity is to change the surgical technique for SPK. Traditionally, SPK is performed through a midline laparotomy with grafting of the pancreas on the right and the kidney on the left iliac axis. A novel approach is robotic-assisted pancreas transplantation. Feasibility was

shown in 2012 in normal BMI patients.[43] In 2019, results of robotic pancreas transplantation in ten consecutive patients with obesity were compared to the results after pancreas transplantation via an open approach.[44] While graft and patient survival were similar, there were less wound infections after robotic pancreas transplantation. This technical advancement could be the gateway to transplantation for many obese patients. Nevertheless, it needs to be adopted cautiously. First, the mean BMI in this study was 33.7 kg/m² and it is questionable whether results can be translated into patients with high-grade obesity, too. Second, the technique was altered to the point that 30% of the patients had a bladder drainage of their pancreas instead of an enteric one, which nowadays is considered in many places the gold standard due to fewer urological comorbidities[45]. As in many reports for novel surgical techniques, the patients were not included in prospective studies approved by an ethical committee. However, adoption of novel surgeries does not address overweight-related metabolic disorders.

This study has limitations due to its retrospective nature and the small number of patients. The amount of morbidly obese patients referred for SPK however is very low. Over a timespan of almost two decades, only three patients were included. The number of potential candidates barred from transplantation remains thus unclear.

Conclusion:

This is the first report of BS prior to SPK for type I diabetic patients. Results are encouraging in that surgical complications and graft survival were similar to non-obese patients without BS. We recommend BS before SPK in all type I diabetic patients with BMI ≥ 35 kg/m² and evaluation for BS in candidates with BMI ≥ 30 kg/m²

before wait-listing. Larger cohorts should be analyzed to corroborate this recommendation.

References:

1. Curran SP, Famure O, Li Y, Kim SJ. Increased recipient body mass index is associated with acute rejection and other adverse outcomes after kidney transplantation. *Transplantation*. 2014; **97**: 64-70.
2. Cannon RM, Jones CM, Hughes MG, Eng M, Marvin MR. The impact of recipient obesity on outcomes after renal transplantation. *Annals of surgery*. 2013; **257**: 978-84.
3. Lynch RJ, Ranney DN, Shijie C, Lee DS, Samala N, Englesbe MJ. Obesity, surgical site infection, and outcome following renal transplantation. *Annals of surgery*. 2009; **250**: 1014-20.
4. Spengler EK, O'Leary JG, Te HS, et al. Liver Transplantation in the Obese Cirrhotic Patient. *Transplantation*. 2017; **101**: 2288-96.
5. Rana A, Gruessner A, Agopian VG, et al. Survival benefit of solid-organ transplant in the United States. *JAMA Surg*. 2015; **150**: 252-9.
6. White SA, Shaw JA, Sutherland DE. Pancreas transplantation. *Lancet*. 2009; **373**: 1808-17.
7. Lehmann R, Graziano J, Brockmann J, et al. Glycemic Control in Simultaneous Islet-Kidney Versus Pancreas-Kidney Transplantation in Type 1 Diabetes: A Prospective 13-Year Follow-up. *Diabetes care*. 2015; **38**: 752-9.
8. Patterson EJ, Urbach DR, Swanson LL. A comparison of diet and exercise therapy versus laparoscopic Roux-en-Y gastric bypass surgery for morbid obesity: a decision analysis model. *Journal of the American College of Surgeons*. 2003; **196**: 379-84.
9. Adams TD, Davidson LE, Litwin SE, et al. Weight and Metabolic Outcomes 12 Years after Gastric Bypass. *The New England journal of medicine*. 2017; **377**: 1143-55.
10. Cohen JB, Lim MA, Tewksbury CM, et al. Bariatric surgery before and after kidney transplantation: long-term weight loss and allograft outcomes. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2019; **15**: 935-41.
11. Kienzl-Wagner K, Weissenbacher A, Gehwolf P, Wykpiel H, Ofner D, Schneeberger S. Laparoscopic sleeve gastrectomy: gateway to kidney transplantation. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2017; **13**: 909-15.
12. Kim Y, Jung AD, Dhar VK, et al. Laparoscopic sleeve gastrectomy improves renal transplant candidacy and posttransplant outcomes in morbidly obese patients. *American journal of transplantation : official journal of the American Society of Transplantation and the American Society of Transplant Surgeons*. 2018; **18**: 410-6.
13. Takata MC, Campos GM, Ciofica R, et al. Laparoscopic bariatric surgery improves candidacy in morbidly obese patients awaiting transplantation. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2008; **4**: 159-64; discussion 64-5.
14. Neshar E, Mor E, Shlomei A, et al. Simultaneous Liver Transplantation and Sleeve Gastrectomy: Prohibitive Combination or a Necessity? *Obesity surgery*. 2017; **27**: 1387-90.
15. Zamora-Valdes D, Watt KD, Kellogg TA, et al. Long-term outcomes of patients undergoing simultaneous liver transplantation and sleeve gastrectomy. *Hepatology (Baltimore, Md)*. 2018; **68**: 485-95.
16. Heimbach JK, Watt KD, Poterucha JJ, et al. Combined liver transplantation and gastric sleeve resection for patients with medically complicated obesity and end-stage liver disease. *American journal of transplantation : official journal of the American Society of Transplantation and the American Society of Transplant Surgeons*. 2013; **13**: 363-8.
17. Porubsky M, Powelson JA, Selzer DJ, et al. Pancreas transplantation after bariatric surgery. *Clinical transplantation*. 2012; **26**: E1-6.
18. Salminen P, Helmio M, Ovaska J, et al. Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss at 5 Years Among Patients With Morbid Obesity: The SLEEVEPASS Randomized Clinical Trial. *Jama*. 2018; **319**: 241-54.
19. Peterli R, Wolnerhanssen BK, Peters T, et al. Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss in Patients With Morbid Obesity: The SM-BOSS Randomized Clinical Trial. *Jama*. 2018; **319**: 255-65.
20. Peterli R, Wolnerhanssen BK, Vetter D, et al. Laparoscopic Sleeve Gastrectomy Versus Roux-Y-Gastric Bypass for Morbid Obesity-3-Year Outcomes of the Prospective Randomized Swiss Multicenter Bypass Or Sleeve Study (SM-BOSS). *Annals of surgery*. 2017; **265**: 466-73.
21. Greenblatt HK, Greenblatt DJ. Altered drug disposition following bariatric surgery: a research challenge. *Clinical pharmacokinetics*. 2015; **54**: 573-9.
22. Padwal R, Brocks D, Sharma AM. A systematic review of drug absorption following bariatric surgery and its theoretical implications. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 2010; **11**: 41-50.
23. Rogers CC, Alloway RR, Alexander JW, Cardi M, Trofe J, Vinks AA. Pharmacokinetics of mycophenolic acid, tacrolimus and sirolimus after gastric bypass surgery in end-stage renal disease and transplant patients: a pilot study. *Clinical transplantation*. 2008; **22**: 281-91.
24. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. *Annals of internal medicine*. 2009; **150**: 604-12.
25. Levey AS, Coresh J, Greene T, et al. Using standardized serum creatinine values in the modification of diet in renal disease study equation for estimating glomerular filtration rate. *Annals of internal medicine*. 2006; **145**: 247-54.
26. Deitel M, Gawdat K, Melissas J. Reporting weight loss 2007. *Obesity surgery*. 2007; **17**: 565-8.

27. Brethauer SA, Kim J, el Chaar M, et al. Standardized outcomes reporting in metabolic and bariatric surgery. *Surgery for obesity and related diseases : official journal of the American Society for Bariatric Surgery*. 2015; **11**: 489-506.
28. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Annals of surgery*. 2004; **240**: 205-13.
29. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Annals of surgery*. 2009; **250**: 187-96.
30. Slankamenac K, Graf R, Barkun J, Puhan MA, Clavien PA. The comprehensive complication index: a novel continuous scale to measure surgical morbidity. *Annals of surgery*. 2013; **258**: 1-7.
31. Slankamenac K, Nederlof N, Pessaux P, et al. The comprehensive complication index: a novel and more sensitive endpoint for assessing outcome and reducing sample size in randomized controlled trials. *Annals of surgery*. 2014; **260**: 757-62; discussion 62-3.
32. Clavien PA, Vetter D, Staiger RD, et al. The Comprehensive Complication Index (CCI(R)): Added Value and Clinical Perspectives 3 Years "Down the Line". *Annals of surgery*. 2017; **265**: 1045-50.
33. Bédat B, Niclauss N, Jannot AS, et al. Impact of recipient body mass index on short-term and long-term survival of pancreatic grafts. *Transplantation*. 2015; **99**: 94-9.
34. Sampaio MS, Reddy PN, Kuo HT, et al. Obesity was associated with inferior outcomes in simultaneous pancreas kidney transplant. *Transplantation*. 2010; **89**: 1117-25.
35. Hanish SI, Petersen RP, Collins BH, et al. Obesity predicts increased overall complications following pancreas transplantation. *Transplantation proceedings*. 2005; **37**: 3564-6.
36. Laurence JM, Marquez MA, Bazerbachi F, et al. Optimizing pancreas transplantation outcomes in obese recipients. *Transplantation*. 2015; **99**: 1282-7.
37. Aminian A, Zajichek A, Arterburn DE, et al. Association of Metabolic Surgery With Major Adverse Cardiovascular Outcomes in Patients With Type 2 Diabetes and Obesity. *JAMA*. 2019.
38. Bueter M, Ahmed A, Ashrafian H, le Roux CW. Bariatric surgery and hypertension. *Surg Obes Relat Dis*. 2009; **5**: 615-20.
39. King WC, Chen JY, Belle SH, et al. Change in Pain and Physical Function Following Bariatric Surgery for Severe Obesity. *JAMA*. 2016; **315**: 1362-71.
40. Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric Surgery versus Intensive Medical Therapy for Diabetes - 5-Year Outcomes. *N Engl J Med*. 2017; **376**: 641-51.
41. Cohen RV, Pereira TV, Aboud CM, et al. Effect of Gastric Bypass vs Best Medical Treatment on Early-Stage Chronic Kidney Disease in Patients With Type 2 Diabetes and Obesity: A Randomized Clinical Trial. *JAMA surgery*. 2020: e200420.
42. Cohen JB, Tewksbury CM, Torres Landa S, Williams NN, Dumon KR. National Postoperative Bariatric Surgery Outcomes in Patients with Chronic Kidney Disease and End-Stage Kidney Disease. *Obes Surg*. 2019; **29**: 975-82.
43. Boggi U, Signori S, Vistoli F, et al. Laparoscopic robot-assisted pancreas transplantation: first world experience. *Transplantation*. 2012; **93**: 201-6.
44. Spaggiari M, Tulla KA, Okoye O, et al. The utility of robotic assisted pancreas transplants - a single center retrospective study. *Transplant international : official journal of the European Society for Organ Transplantation*. 2019; **32**: 1173-81.
45. Monroy-Cuadros M, Salazar A, Yilmaz S, McLaughlin K. Bladder vs enteric drainage in simultaneous pancreas-kidney transplantation. *Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association*. 2006; **21**: 483-7.

Table 1. Patient characteristics and surgical details

<u>Patient characteristics:</u>	
<ul style="list-style-type: none"> • Age at LSG (years) • Interval LSG to SPK (days) • Time on transplant waiting list (days) • BMI (kg/cm²) <ul style="list-style-type: none"> ○ prior LSG ○ prior SPK ○ %EBMIL until SPK ○ %TWL until SPK • A1C (%) <ul style="list-style-type: none"> ○ prior LSG ○ prior SPK ○ 1-year after SPK ○ 2-years after SPK • GFR (ml/min) <ul style="list-style-type: none"> ○ 1-year after SPK ○ 2-years after SPK 	37 [28 - 48] 364.3 [173 - 587] 505 [368 - 644] 38.4 [35.7 - 39.9] 28.5 [26.8 - 30.9] 74.3 [60.4 - 87.7] 27.9 [22.1 - 38] 7 [6.3 - 8.2] 6.7 [6.4 - 7.2] 4.9 [4.7 - 5.3] 4.8 [4.5 - 5.1] 61.6 [55 - 74] 68.3 [50 - 81]
<u>Surgical details:</u>	
<ul style="list-style-type: none"> • Donor age (years) • Donor BMI (kg/cm²) • Donor cause of brain death (n) <ul style="list-style-type: none"> ○ CVA ○ HT ○ other • Duration of SPK (minutes) • Cold ischemia time (hours) <ul style="list-style-type: none"> ○ Pancreas ○ Kidney 	16 [13 - 19] 21 [20.1 - 21.6] 1 1 1 275 [240 - 595] 7.1 [4.6 - 9] 10.7 [9.2 - 11.8]

Values are presented in means with range [min - max], except for time of surgery in median with range [min - max]. BMI, body mass index (kg/m²). %EBMIL, percentage of excess body mass index loss. %TWL, percentage of total weight loss. LSG, laparoscopic sleeve gastrectomy. SPK, simultaneous pancreas and kidney transplantation. A1C (%), Hemoglobin A1C. GFR, glomerular filtration rate. CVA, cerebrovascular accident. HT, head trauma

Table 2. Patient characteristics in detail

	# 1	# 2	# 3
Age at LSG (years)	48	35	28
Interval LSG to SPK (days)	333	587	173
Time on waiting list (days)	368	503	644
Donor age (years)	13	17	19
Donor BMI (kg/cm ²)	20.1	21.6	21.2
Duration of SPK (minutes)	275	595	240
Cold ischemia time <ul style="list-style-type: none"> pancreas (hours) kidney (hours) 	9.0 10.9	4.6 11.8	7.6 9.2
A1C (%) <ul style="list-style-type: none"> prior LSG prior SPK 1-year after SPK 2-years after SPK 	6.5 6.7 4.7 4.8	6.3 7.2 5.3 5.1	8.2 6.4 4.8 4.5
GFR (ml/min) <ul style="list-style-type: none"> prior SPK 1-year after SPK 1-year after SPK 	27 74 74	Dialysis 55 50	Dialysis 56 81

#, patient number. BMI, body mass index (kg/m²). %EBMIL, percentage of excess body mass index loss. LSG, laparoscopic sleeve gastrectomy. SPK, simultaneous pancreas and kidney transplantation. GFR, glomerular filtration rate. A1C (%), Hemoglobin A1C.

Table 3. Weight loss in detail

	# 1	# 2	# 3
BMI <ul style="list-style-type: none"> • prior LSG • prior SPK • 1 year post SPK • 2 years post SPK 	35.7 27.7 27.7 28.1	39.9 30.9 31.6 32.2	39.6 26.8 23.2 24.3
%EBMIL <ul style="list-style-type: none"> • until SPK • 1 year post SPK • 2 years post SPK 	74.8 74.8 71	60.4 55.7 51.7	87.7 112.3 104.8
%TWL <ul style="list-style-type: none"> • until SPK • 1 year post SPK • 2 years post SPK 	23.5 24.2 21	22.1 20.5 16.7	38 43.5 40.7

#, patient number. BMI, body mass index (kg/m²). %EBMIL, percentage of excess body mass index loss. %TWL, percentage of total weight loss. LSG, laparoscopic sleeve gastrectomy. SPK, simultaneous pancreas and kidney transplantation.

Figure 1. Body Mass Index following Laparoscopic Sleeve Gastrectomy

BMI, body mass index (kg/m^2); LSG, laparoscopic sleeve gastrectomy; SPK, simultaneous pancreas and kidney transplantation.