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Impact of panniculectomy on transplant candidacy of obese patients with chronic kidney disease declined for kidney transplantation because of a high-risk abdominal panniculus: A pilot study

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Background. *Obese patients can develop a large lower abdominal panniculus (worsened by significant weight loss). Patients with advanced chronic kidney disease (CKD) affected by this obesity-related sequela are not infrequently declined for kidney transplantation because of the high risk for serious wound-healing complications. We hypothesized that pretransplant panniculectomy in these patients would (1) render them transplant candidates, and (2) result in low posttransplant wound-complication rates.*
Methods. *In a pilot study, adult patients with CKD who had a high-risk panniculus as the only* absolute *contraindication to kidney transplantation subsequently were referred to a plastic surgeon to undergo a panniculectomy in order to become transplant candidates. We analyzed the effect of panniculectomy on (1) transplant candidacy and (2) wait list and transplant outcomes (04/2008–06/2014).*
Results. *Overall, 36 patients had panniculectomy (median prior weight loss, 38 kg); all were wait-listed with these outcomes: (1) 22 (62%) patients were transplanted; (2) 7 (19%) remain listed; and (3) 7 (19%) were removed from the wait list. Survival after panniculectomy was greater for those transplanted versus not transplanted (at 5 years, 95% vs 35%, respectively;* P = *.002). For the 22 kidney recipients, posttransplant wound-complication rate was 5% (1 minor subcutaneous hematoma).*
Conclusion. *For obese CKD patients with a high-risk abdominal panniculus, panniculectomy was highly effective in obtaining access to the transplant wait list and successful kidney transplantation. This approach is particularly pertinent for CKD patients because they are disproportionally affected by the obesity epidemic and because obese CKD patients already face multiple other barriers to transplantation. (Surgery 2015;■:■-■.)*

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Obese patients can develop a large lower abdominal panniculus with and without preceding weight loss.[1,2] In addition, increasing laxity of abdominal connective tissues attributable to aging, physical deconditioning, frailty, and previous pregnancies can all affect adversely panniculus size and morphology.[1,2] In patients with advanced chronic kidney disease (CKD), a large lower abdominal panniculus often encompasses the site of a potential future kidney transplant incision. A panniculus may therefore adversely impact posttransplant wound healing for several reasons. First, the large overhanging skin fold can create an ideally moist environment for chronically festering fungal and bacterial skin infections, setting the stage for postoperative surgical-site infections.[1] Second, the large amount of subcutaneous adipose tissue of the panniculus that must be transected during a kidney transplant operation is at high risk for fat necrosis, infection, and poor wound healing.[1] Third, a panniculus can cause substantial shear stress by gravity on the incision when patients are standing up posttransplantation, causing

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separation of wound edges. Fourth, the large, loose subcutaneous wound space that results from a transpannicular approach to the iliac fossa during the transplant operation increases the risk of hematoma. Fifth, weight loss has been shown to be a risk factor for posttransplant wound complications.[3] A panniculus that results from a weight loss is therefore at even greater risk for posttransplantation surgical-site infections. As the result of all of these issues, CKD patients with a high-risk lower abdominal panniculus are often declined for transplantation.

To restore access to a mortality-lowering CKD treatment modality for these high-risk patients, we modified our approach.[4] We hypothesized that removal of the abdominal panniculus before transplantation in a separate operative procedure would (1) enable these patients to become transplant candidates, and (2) allow for the kidney transplant operation to proceed with a very low risk for wound complications. To study this hypothesis, we initiated a novel clinical pathway for our pilot study. We systematically referred patients to a plastic surgeon for panniculectomy if (1) their high-risk panniculus was deemed an absolute contraindication to renal transplantation based on the evaluation by a transplant surgeon and (2) there were no other contraindications to proceed with transplantation. The referral was made with the intent to transplant these patients after recovery from their panniculectomy. Previous preliminary reports have focused—in a limited group of initial patients—on the panniculectomy procedure itself, its feasibility in patients with end-stage renal disease, and on immediate postoperative panniculectomy outcome.[5,6] In contrast, the present work involves a much larger number of patients that underwent panniculectomy—both at our and at outside institutions—and focuses specifically on the impact of that intervention on transplant candidacy, transplant waitlist outcomes, access to transplantation, and operative and nonoperative posttransplant outcomes.

METHODS

Study population. The study population consisted of all adult patients (≥18 years of age) who had been evaluated at our center for a kidney transplant and had subsequently undergone panniculectomy in preparation for transplantation between 04/2008 and 06/2014 (with the first transplant in this cohort then being performed in 01/2009). This retrospective study was authorized by the University of California, Davis, Institutional Review Board.

Control cohort. We studied wound-complication rates in a group of similarly obese recipients without a high-risk panniculus that had received similar immunosuppression, but had been evaluated and transplanted at our center before the implementation of our coordinated approach to patients with a high-risk abdominal wall. Inclusion criteria for control group recipients were age ≥18 years, kidney-only transplant, body mass index (BMI) 30–35 kg/m^2, and transplant date between 08/2004 and 12/2008.

Evaluation for kidney transplantation. All patients with CKD referred to our transplant center initially were evaluated by a transplant nephrologist. According to our Transplant Center's recipient selection criteria, a BMI >40 kg/m^2 constituted an absolute contraindication to transplantation and to proceeding with further evaluation. If a patient was considered to be a transplant candidate after completing the medical, psychosocial, and financial evaluation and was identified as potentially having a high-risk lower abdominal panniculus, he was referred for evaluation by a transplant surgeon. If the transplant surgeon deemed the panniculus to constitute an absolute contraindication to transplantation, we subsequently referred the patient—as authorized by the insurance carrier—to a plastic surgeon. Factors taken into consideration during the panniculus evaluation included its size, shape, location, and extent as well as the history and presence of infrapannicular skin irritation, maceration, and frank fungal and bacterial infection.[1] Generally, panniculi that covered the upper thigh (Grade 3), or larger, were referred routinely for panniculectomy[1] (Fig 1, *A* and *B*). Panniculi that covered the genitals (Grade 2), as well as Grade 2 to Grade 3 panniculi were referred selectively, depending on the clinical history, location and morphology of the panniculus.[1]

Only nonsmokers were accepted for the operative management of a high-risk panniculus and subsequent transplantation. Also, although none of the obese recipients with a high-risk abdominal panniculus presented with a peritoneal dialysis catheter, the latter constituted during this early part of our experience a contraindication to proceeding with panniculectomy according to our protocol. The approach to these patients would have therefore entailed transition to hemodialysis before the removal of the peritoneal dialysis catheter (and panniculectomy).

Panniculectomy. Technique and extent of the panniculectomy, as well as the location of the panniculectomy incision, were left to the discretion of the operating plastic surgeon (Fig 2).

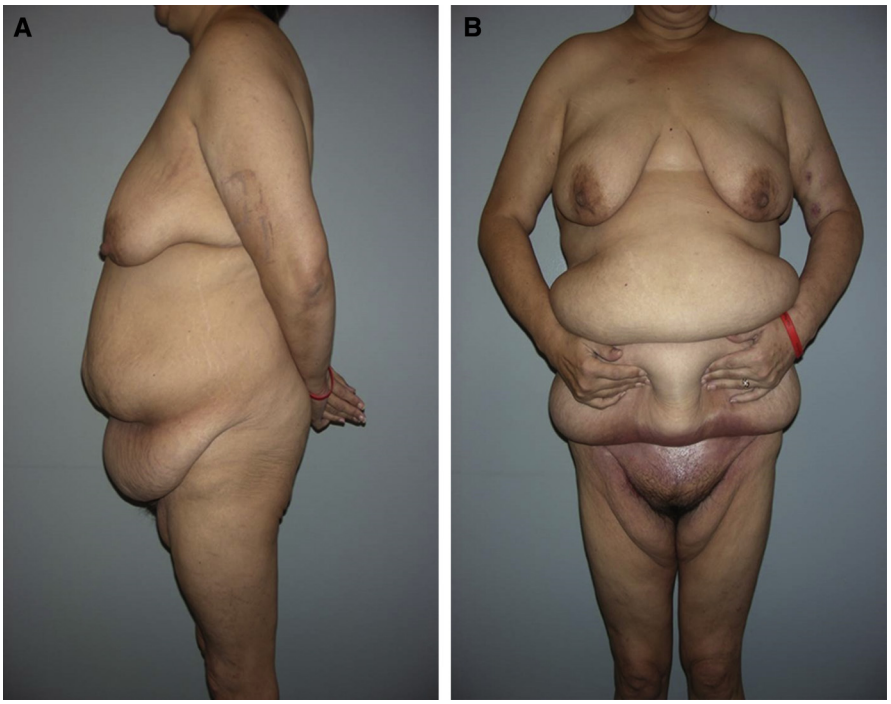

Fig 1. Grade 3 panniculus in a 51-year-old woman (weight, 99 kg; BMI, 32.2) referred for kidney transplantation. (*A*) *Left lateral view.* Note the panniculus that covers the mons pubis, thigh crease, and proximal upper thigh. (*B*) Anterior view with panniculus lifted by the patient. Note the chronic skin changes, induration, and erythema that have resulted from the recurrent soft-tissue infections underneath the panniculus.

The technique used for the panniculectomies performed at our institution has been described in detail elsewhere.[5,6] Standard perioperative antibiotic prophylaxis consisted of 1,000 to 2,000 mg of cefazolin given intravenously on induction of anesthesia, with continuation of this drug for the first 24 hours. Postoperatively, after hospital discharge, UC Davis patients were prospectively closely followed in the Plastic Surgery Clinic until wound healing was completed. All wound-healing complications were systematically documented. Patients were given at least 3 months to complete panniculectomy wound healing, allowing for complete resolution of wound inflammation and edema before clearing the patients for kidney transplantation (Fig 2).

Patients who required pretransplant panniculectomy but whose medical insurance carrier did not cover the procedure at our medical center were referred as appropriate to an institution where the panniculectomy procedure was covered by the patient's insurer. For the minority of patients that had their panniculectomy performed at an outside institution, consistently available panniculectomy-related information was limited to the date on which the procedure took place. After completion of panniculectomy wound healing, the patients were scheduled for a live donor kidney transplant or were registered on the deceased donor transplant wait list, as applicable.

Kidney transplant operation. All transplants were done through a standard right or left lower quadrant kidney transplant incision (eg, hockey stick incision and Gibson incision). Transplant incision location and type were chosen by the operating surgeon on the basis of the patient's abdominal and pelvic morphology; no particular effort was made to incorporate or avoid a previous panniculectomy incision. Standard perioperative antibiotic prophylaxis consisted of 1,000 mg of cefazolin given intravenously on induction of anesthesia, with continuation of this drug for the first 24 hours. Our transplant program's operative default approach does not entail placement of deep and superficial wound drains. Placement of such drains in patients with a previous panniculectomy occurred at the discretion of the transplant surgeon as well.

Our standard immunosuppressive protocol (which was identical for the control and the study cohort) included (1) for induction therapy: 3 doses of intravenous antithymocyte globulin (Thymoglobulin; Genzyme Corporation, Cambridge, MA; 4.5 mg/kg total dose) and methylprednisolone, as well as oral mycophenolate mofetil (MMF), and (2) for the (steroid-free) maintenance

Fig 2. Three months postpanniculectomy at the time of activation on the transplant wait list *(left lateral view)* (same patient as in Fig 1). The lateral aspect of the panniculectomy incision, as well as the proximal upper thigh, thigh crease, and mons pubis are now visible. Note also the significant central obesity which does not constitute a contraindication to transplantation.

Table I. Baseline demographics at panniculectomy (n = 36)

Male/female (%)	25/75
Median age (range), y	57 (28–73)
Race/ethnicity, n (%)	
White	19 (53)
African American	7 (19)
Latino	6 (17)
Asian	4 (11)
Median BMI (range), kg/m^2	31.1 (20.7–37.4)
Median reported maximal weight loss, (range), kg	38 (5–186)
Primary renal disease, n (%)	
Diabetic nephropathy	19 (53)
Hypertensive nephropathy	3 (8)
FSGS	3 (8)
Other	7 (20)
Unknown	4 (11)
Comorbidities, n (%)	
Hypertension	36 (100)
Diabetes	25 (70)
Coronary artery disease	9 (25)
Cerebrovascular disease	4 (11)
Dialysis status	
Predialysis, n (%)	4 (11)
Dialysis, n (%)	32 (89)
Hemodialysis, n	32
Peritoneal dialysis, n	—
Previous kidney transplant, n (%)	1 (3)

BMI, Body mass index; *FSGS*, focal-segmental glomerulosclerosis.

therapy: tacrolimus and MMF. For immunologically high-risk recipients, the immunosuppressive protocol included (1) for induction: 5 doses of intravenous antithymocyte globulin (7.5 mg/kg total dose) as well as intravenous steroids and oral MMF, and (2) for maintenance: triple therapy with prednisone, tacrolimus, and MMF.

Posttransplantation, we followed all patients prospectively in our Transplant Clinic. Wound checks were done weekly for the first month and then every 2 weeks for the following 8 weeks. All wound healing complications were documented systematically.

Data analysis. For all patients who had undergone panniculectomy, we reviewed and analyzed demographics and postpanniculectomy outcomes with respect to transplant candidacy as well as waitlist and transplant outcomes (as applicable). For the patients who had undergone panniculectomy at our institution, we also reviewed operative outcomes of the panniculectomy procedure. An operative wound complication was defined as any wound complication that involved the superficial operative site (skin, subcutaneous wound space). Graft loss was defined as return to permanent dialysis or death.

We compared categorical variables by use of the chi-square test and Fisher exact test and continuous variables by use of the Mann-Whitney U test. Graft and patient survival were calculated according to Kaplan-Meier. We compared patient survival between transplanted versus nontransplanted patient groups by using the log-rank test.

RESULTS

Panniculectomies done in preparation for renal transplantation. In all, 36 patients underwent panniculectomy. The majority of these patients was women, elderly, diabetic, and on dialysis (Table I). Of these 36 patients, 3 (8%) had a history of previous bariatric surgery. At panniculectomy, median reported weight loss was 38 kg.

Operative outcomes of the panniculectomy procedure. Of the 36 panniculectomies, 28 (78%) were done at our institution (M.W.).[5,6] For those

28 patients, median panniculectomy specimen weight was 3,025 g (range, 1,191–4,940 g). Median postoperative duration of stay was 1 day (range, 1–7 days). In all, 3 (11%) patients required operative reintervention for a panniculectomy complication (2 hematomas, 1 abscess). One of the patients who had developed a hematoma required administration of blood products (and eventually received a transplant). Overall, 12 (43%) patients experienced a minor wound complication that did not require operative reintervention (eg, minor wound skin separation, small infected and noninfected seroma, cellulitis). Perioperative mortality for all 36 panniculectomies was 0%.

Current patient status. All 36 patients who underwent panniculectomy became active transplant candidates. To date, 22 (61%) of those patients have received a kidney transplant (4 [18%] from a live donor, 18 [82%] from a deceased donor) and 14 (39%) have not been transplanted (Table II).

For the transplanted patients, the median wait time (time between dialysis start and kidney transplantation) was 47 months (range, 12–187 months). Their median BMI was 30.8 kg/m^2 (range, 24.5–36.5 kg/m^2) at panniculectomy versus 30.1 kg/m^2 (range, 24.6–34.6 kg/m^2) at transplant (Table III).

Of the 14 nontransplanted patients, 7 (50%) remain waitlisted at our Transplant Center (active status, 4; inactive status, 3), and 7 (50%) have been removed from the wait list (nonsuitable for transplant and alive, 1; deceased, 6) (Table II). The 6 deceased patients all died late after the panniculectomy (from causes not directly related to that procedure) at a median of 31 months (range, 15–60 months) after panniculectomy.

Transplanted versus nontransplanted panniculectomy patients. Demographic variables were not substantially different for panniculectomy patients who received a kidney transplant versus those that did not (Table III). For patients who had not been transplanted, median time to waitlist removal, death, or most recent follow-up was substantially longer than the median time between panniculectomy and transplant for transplant recipients (30 vs 22 months, respectively; P = .04) (Table III). The demographics and other characteristics of the patients that had died before being able to receive a transplant were not statistically significantly different as compared with the transplanted patients (Table III). Patient survival after panniculectomy was greater for those transplanted versus not transplanted (at 5 years, 95% vs 35%, respectively; P = .002) (Fig 3).

Table II. Current patient status after panniculectomy (n = 36)

Current status	
Transplanted, *n*	22
Alive, functioning graft, *n* (%)	20 (90)
Alive, lost graft, *n* (%)	1 (5)
Deceased, *n* (%)	1 (5)
Not transplanted, *n*	14
Registered on transplant wait list, *n* (%)	7 (50)
Active status, *n*	4
Inactive status, *n*	3
Removed from transplant wait list, *n* (%)	7 (50)
Alive, *n*	1
Deceased, *n*	6

Transplant outcomes. Of the 22 transplants, 21 were performed at our institution. In 8 (38%) of these 21 patients, a subcutaneous drain was placed during closure of the transplant incision. In these 21 recipients, we observed 1 posttransplant wound complication (5% wound complication rate). The complication consisted of a minor superficial wound hematoma that did not require reintervention. In the control cohort, we observed a 13% wound-complication rate even though that group's characteristics (lower median age, lower proportion of diabetics, and greater proportion of live donor transplants [49%]) trended more favorably with respect to risk factors for wound complications compared with the study population (Table IV). The difference in wound complication rates between study and control cohort was not statistically significant.

With a median posttransplant follow-up of 2.4 years for the 22 recipients, we noted 2 graft losses (1 death with function at 4 months attributable to systemic sepsis [secondary to pneumonia] unrelated to the noninfected, completely healed transplant incision; 1 graft loss at 6 months attributable to graft fibrosis). There were no other recipient deaths. Posttransplantation, 1-year graft survival was 90.2% and 1-year recipient survival was 95.2 % (Fig 4).

DISCUSSION

Patients with a substantial abdominal panniculus who present for a renal transplant evaluation may be declined as candidates because of the significantly increased risk for wound complications. A major risk factor for the development of an abdominal panniculus is weight loss.[1] Some of the patients considered initially too obese for transplantation may therefore paradoxically be

Table III. Panniculectomy in preparation for renal transplantation (n = 36): demographics and outcomes according to transplant status*,†

		Not transplanted (n = *14*)	
	Transplanted (n = *22*)	*All patients* (n = *14*)	*Deceased* (n = *6*)
Male/female, %	27/73	21/79	0/100
Median age* (range), y	60 (31–74)	61 (44–72)	67 (44–72)
Race/ethnicity, *n* (%)			
White	12 (54)	7 (50)	2 (33)
African American	3 (14)	4 (29)	3 (50)
Latino	3 (14)	3 (21)	1 (17)
Asian	4 (18)	—	—
Median BMI* (range), kg/m^2	30.1 (24.6–34.6)	31.7 (20.7–37.4)	30.2 (28–37.4)
Diabetic, *n* (%)	14 (64)	11 (79)	4 (66)
Primary renal disease, *n* (%)			
Diabetic nephropathy	9 (41)	10 (72)	3 (49)
Hypertensive nephropathy	2 (9)	1 (7)	1 (17)
FSGS	2 (9)	1 (7)	—
Other	6 (27)	1 (7)	1 (17)
Unknown	3 (14)	1 (7)	1 (17)
Dialysis status*			
Predialysis, *n*	—	—	—
Dialysis, *n*	22	14	6
Hemodialysis, *n* (%)	21 (95)	12 (86)	6 (100)
Peritoneal dialysis, *n* (%)	1 (5)	2 (14)	—
Blood type, *n* (%)			
O	8 (36)	7 (50)	3 (50)
A	12 (57)	2 (14)	1 (17)
B	2 (10)	4 (28)	2 (33)
AB	—	1 (8)	—
PRA*			
Median (range), %	24 (0–100)	31 (0–100)	5 (0–100)
PRA >85%, *n* (%)	5 (23)	4 (29)	1 (17)
Deceased, *n* (%)	1 (5)	6 (43)	6 (100)
Median time from panniculectomy to transplant (range), mo	22 (5–49)	na	na
Median time from panniculectomy to removal from wait list, death, or most recent follow-up (in absence of transplant)‡, (range), mo	na	30 (15–70)	29 (15–68)

*Demographic variables refer (1) for kidney transplant recipients to the time of transplant and (2) for nontransplanted patients to their status at the time of the most recent follow-up.
†P = not significant (>0.05) for all group comparisons.
‡The date of the event that occurred first was used for the calculation.
BMI, body mass index; *FSGS*, focal-segmental glomerulosclerosis; *na*, not applicable; *PRA*, panel-reactive antibodies.

denied access to transplantation again—despite achieving a significant weight loss. This issue is even more relevant for patients with CKD, because prevalence of obesity in that group is much greater than in the general population to begin with, and because obesity in general has been shown to impair access to kidney transplantation.[7-9]

At our transplant center, we attempted to provide patients with a high-risk panniculus with a realistic chance for a renal transplant and its cardiovascular morbidity- and mortality-lowering benefits. We developed a novel clinical pathway in collaboration with our plastic surgeons by devising a 2-stage approach that included panniculectomy followed by a transplant.

We identified 36 patients whose high-risk abdominal panniculus constituted an absolute contraindication to renal transplantation and who therefore underwent panniculectomy. As previously noted, panniculectomy in this high-risk population of patients with advanced stages of renal failure and a very high proportion of diabetics is associated with a distinct set of surgical postpanniculectomy complications.[5,6] Nonetheless, all panniculectomy patients

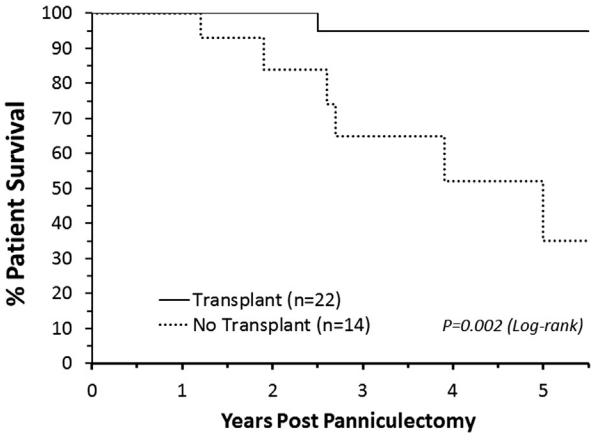

Fig 3. Patient survival after panniculectomy according to current transplant status.

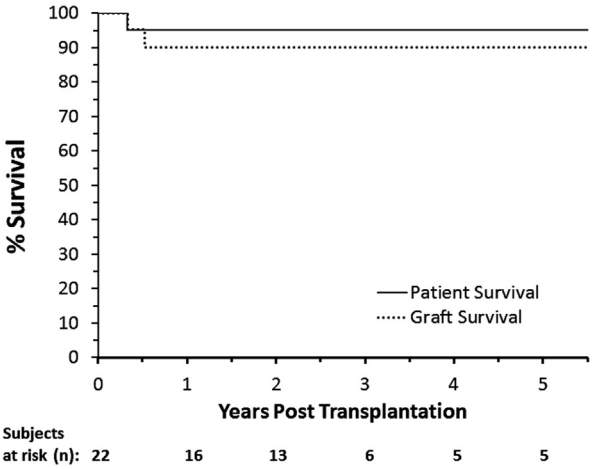

Fig 4. Posttransplant graft and patient survival.

Table IV. Control cohort (patients transplanted in the prepanniculectomy era): demographics at transplantation and posttransplant wound complications

	Kidney transplant recipients (n = *89*)
Male/female, %	67/33
Median age (range), y	54 (21–74)
Race/ethnicity, *n* (%)	
White	50 (56)
African American	10 (11)
Latino	21 (24)
Asian	8 (9)
Median BMI (range), kg/m^2	32.0 (30.0–35.0)
Diabetic, *n* (%)	29 (33)
Primary renal disease, *n* (%)	
Diabetic nephropathy	28 (31)
Hypertensive nephropathy	6 (7)
FSGS	7 (8)
Other	37 (42)
Unknown	11 (12)
Wound complications, *n* (%)	
Recipients with ≥1 wound complication	12 (13)
Superficial	10 (11)
Deep*	3 (3)

*One recipient had a superficial and deep wound complication.
BMI, Body mass index; *FSGS*, focal-segmental glomerulosclerosis.

ultimately qualified for placement on the transplant wait list, and the majority of these patients has to date been able to successfully gain access to a transplant. Our approach may especially benefit obese women with CKD in need of a transplant. A recent analysis of the US Renal Data System database that focused on obese patients with CKD showed that obese women have a lesser probability of receiving a kidney transplant than obese men.[9] This access disparity for obese women is further compounded by their greater likelihood of developing a high-risk panniculus, as also suggested by our study cohort's sex distribution.

The patients who underwent panniculectomy displayed—in addition to their underlying CKD—a challenging demographic profile with respect to risk factors for wound complications. After panniculectomy, we observed no mortality. Our panniculectomy wound-healing complication rate was somewhat greater than previously reported by some (but not all) studies on outcomes after panniculectomy in non-CKD settings. Analyses of the American College of Surgeons National Surgical Quality Improvement Program database have reported wound-complication rates for panniculectomy that ranged from 8 to 10%.[10-12] Complication rates reported in several single-center series were even greater and consistent with our own observations. In those studies, complication rates ranged from 33 to greater than 45%, and operative reintervention rates from 11 to 20%.[13-15] Importantly, the perioperative risk profile of our patient cohort—compared with all of the aforementioned studies' cohorts—appears to differ substantially: for instance, the proportion of diabetic patients in these studies was less than 20% (vs 70% in the present study), and the incidence of CKD V was not reported (and is therefore assumed to be very low or even close to 0% [vs 100% in our study]).[10-15] Hence, a direct comparison of our outcomes with these previous reports is difficult, because diabetes and CKD stage have a substantial adverse impact on wound and other complication rates after abdominal operative procedures.[16]

Our very favorable *posttransplant* operative wound-complication rate (only 1 minor nonoperatively treated wound hematoma) suggests that panniculectomy may be an effective approach to prevent posttransplant wound complications in operatively high-risk kidney recipients. Our low wound-complication rate contrasts favorably with the greater posttransplant wound-complication rates reported for contemporaneous kidney recipient populations (with surgical-site infection rates ranging from 7 to 19%).[3,17,18] Pretransplant panniculectomy may be effective in preventing surgical-site infections and wound complications, because it directly addresses each of the multiple mechanisms through which a high-risk panniculus may adversely impact posttransplant wound healing (*vide supra*). Importantly, for the placement of the kidney transplant incision, a preceding panniculectomy did not impact the transplant surgeon's preferences, as we purposely did not mandate inclusion or exclusion of the panniculectomy incision. This practice was validated by our favorable outcomes; a previous panniculectomy does thus not impede a kidney transplant from an operative perspective because it does not restrict the transplant surgeon's options with respect to the choice and location of the transplant incision.

Another unique aspect of our novel clinical pathway is the timing of the panniculectomy. There is a substantial body of published evidence on outcomes in patients undergoing gynecologic and general operative procedures *concomitant* with panniculectomy.[10-12,14,19] In contrast, we chose to pursue a staged approach because of the requirement for the high-dose immunosuppressive peritransplant induction and maintenance therapy and its inhibitory effects on wound healing. Our favorable outcomes suggest that there may be a substantial benefit in uncoupling the panniculectomy from the transplant operation, thus avoiding the need for a large panniculectomy incision in the face of high-dose peritransplant immunosuppression. Our staged approach is also supported by previous reports on complication rates that were twice as high for panniculectomy in combination with another abdominal procedure (eg, a ventral hernia repair) versus for panniculectomy alone.[10-12,14] Arguably, our approach has shifted some of the wound complications to the panniculectomy procedure. Such a shift would still be advantageous according to our experience because all these complications could resolve in the absence of immunosuppressive drugs and had in fact completely done so by postoperative month three.

The requirement for a panniculectomy does extend the time span from evaluation to becoming active on the wait list due to the time necessary for planning and performing the procedure and for wound healing after the panniculectomy. This potential drawback, however, did not pertain to our patients, as none of them would have been a transplant candidate in the absence of a panniculectomy to begin with. Also, despite the majority of our recipients receiving a graft from a deceased donor, median time between panniculectomy and transplantation was only 22 months. Furthermore, pending the completion of the evaluation and panniculectomy, we registered all medically suitable candidates on the deceased donor wait list in an inactive status. These patients were thus able to already accrue wait time from the moment their need for panniculectomy was recognized. Also, with the new kidney allocation system that has been implemented in the United States in December 2014, the start-of-dialysis date is now used to calculate waiting time.[20] In the future, panniculectomy in patients already on dialysis will therefore not impact waiting time accrual—even if registration on the wait list were to occur only after the panniculectomy procedure.

Our experience suggests also that some of the patients that undergo panniculectomy subsequently experience difficulties progressing to a transplant or are not transplanted at all. In our series, those that were not transplanted had a greater mortality than those that received a kidney. This finding is consistent with findings of previous studies on the survival benefit associated with transplantation (vs remaining on dialysis). In those analyses, the benefit was noted to be particularly significant for diabetic patients.[21] Given the very high proportion of diabetic patients in the panniculectomy cohort, our observed differences in outcome depending on the transplant status are therefore not surprising. Also, according to our analysis, there were no obvious traditional risk factors (including demographics and comorbidities) that would have allowed predicting whether a particular panniculectomy patient would eventually also become a transplant recipient. Interestingly, sensitization did also not appear to be an obvious risk factor in that regard, as several of our deceased donor graft recipients had a PRA >85%. Likely, there were other noncaptured risk factors for not progressing sooner or at all to a transplant. Such factors associated with a lower likelihood of receiving a transplant might include functional status, frailty, as well as psychosocial and financial support and insurance issues. Clearly, additional

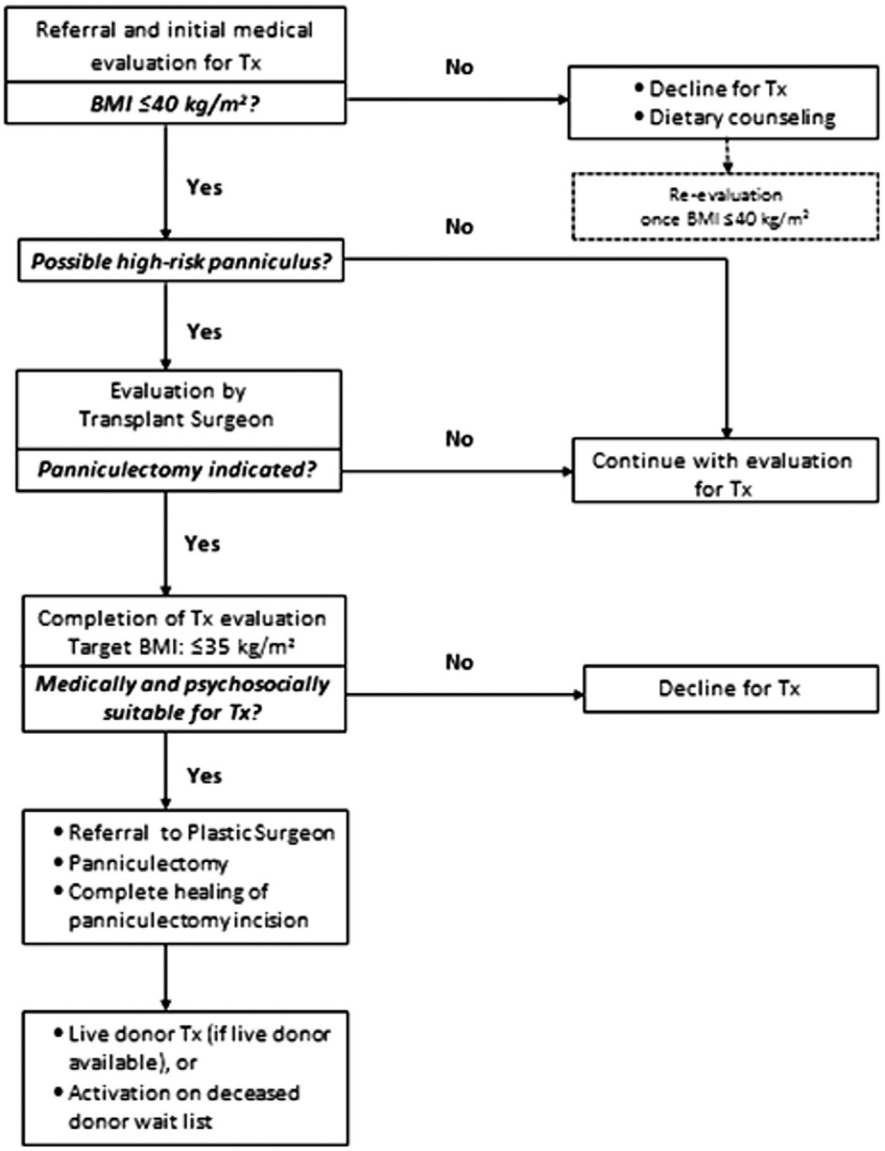

Fig 5. Algorithm for the management of CKD patients with a high-risk abdominal panniculus referred for transplant evaluation. *BMI*, Body mass index; *Tx*, kidney transplantation.

research with respect to optimizing patient selection for this procedure is necessary.

From a cost perspective, the addition of the panniculectomy to the treatment cost for a given patient's CKD may merely postpone the break-even point (ie, when the transplant becomes more cost effective than remaining on dialysis) by a relatively modest amount of time.[22] Panniculectomy is a limited surgical procedure with a very short length of stay in our experience. It does not require extensive preoperative testing or postoperative follow-up. Frequently, results of the medical pretransplant work-up (eg, from cardiac stress tests) can be used for preoperative panniculectomy risk stratification too. Panniculectomy would, for instance, not be anticipated to generate more cost than a live donor nephrectomy, which is universally covered by the recipient's insurance carriers. Overall, from a third-party payer perspective, panniculectomy in preparation for renal transplantation would appear to constitute a highly cost-effective approach, given the overwhelming financial benefit of treating CKD by way of transplantation versus remaining on dialysis.[22] Further study and financial outcome analysis is necessary to corroborate this assumption.

Our study has several limitations. It is nonrandomized and retrospective and—although our

cohort's challenging demographics might suggest otherwise—there may have been an unconscious selection bias in that only candidates who were thought to be able to withstand the panniculectomy and the transplant operation were selected. We were not able to include a stringent control group (ie, CKD patients with high-risk panniculus undergoing kidney transplantation without preceding panniculectomy) because the presence of a high-risk abdominal panniculus constituted an *absolute* contraindication to transplantation. Nonetheless, the posttransplant wound complication rate in our high-risk panniculectomy cohort trended lower than the baseline wound complication rate in a control cohort that consisted of kidney recipients at our center who had comparable body composition and demographic characteristics and who had been subjected to the same posttransplant immunosuppression.

Following these encouraging initial outcomes of the present pilot study, we are therefore currently considering future studies that include larger numbers of patients that have a high-risk abdominal panniculus that may only constitute a *relative* contraindication to transplantation and who could thus be randomized. In the meantime, using the proposed algorithm summarized in Fig 5, we will continue to systematically pursue panniculectomy for those patients with a high-risk panniculus who would otherwise not be able to become transplant candidates. On the basis of our outcomes, however, we will pay particular attention to the selection of patients for this clinical pathway to minimize drop-outs (as the result of intervening medical contraindications to transplantation or death) while awaiting transplantation. Selection criteria that might prove useful and that we are considering are based on frailty, body composition, functional status, and severity of cardiovascular disease and of other significant, potentially life-limiting medical comorbidities.

In summary, our initial results suggest that panniculectomy has the potential to become an important adjunct for lowering access barriers and maximizing transplant opportunities for obese and previously obese patients that have developed a high-risk abdominal panniculus. The greater survival rates after panniculectomy for those that were transplanted underscored the benefits of receiving a transplant (vs remaining on dialysis) also for this particular patient population. This novel approach is particularly relevant for CKD patients as they are disproportionately affected by the obesity epidemic and because CKD patients that are obese already face multiple other barriers to transplantation.[7-9]

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