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REVIEW ARTICLE

Abdominal wall complications after kidney transplantation: A clinical review

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Abstract

Introduction: Abdominal wall complications are common after kidney transplantation, and although they have a minor impact on patient and graft survival, they increase the patient's morbidity and may have an impact on quality of life. Abdominal wall complications have an overall incidence of 7.7–21%.

Methods: This review will explore the natural history of abdominal wall complications in the kidney transplant setting, with a special focus on wound dehiscence and incisional herni, with a particular emphasis on risk factors, clinical characteristics, and treatment.

Results: Many patient-related risk factors have been suggested, including older age, obesity, and smoking, but kidney transplant recipients have an additional risk related to the use of immunosuppression. Wound dehiscence usually does not require surgical intervention. However, for deep dehiscence involving the fascial layer with concomitant infection, surgical treatment and/or negative pressure wound therapy may be required.

Conclusions: Incisional hernia (IH) may affect 1.1–18% of kidney transplant recipients. Most patients require surgical treatment, either open or laparoscopic. Mesh repair is considered the gold standard for the treatment of IH, since it is associated with a low rate of postoperative complications and an acceptable rate of recurrence. Biologic mesh could be an attractive alternative in patients with graft exposition or infection.

KEYWORDS

biological mesh, component separation, dehiscence, immunosuppression, Incisional hernia, infection, kidney transplantation, laparoscopic, mesh, negative pressure wound therapy, open, pancreas, paratransplant hernia, primary suture, transplantation, wound

1 | INTRODUCTION

Kidney transplantation is considered the gold standard treatment for end-stage renal disease.[1] However, although numerous advances have been registered in surgical techniques and immunosuppressive therapy, further efforts are still required to minimize morbidity, hospitalization, readmission and reoperation rates.[2]

Incisional hernia (IH), wound dehiscence, and infections are the most common posttransplant surgical complications, leading to a potential increase in posttransplant morbidity.[3] Abdominal wall and wound complications are categorized according to their depth in relation to the fascia and to the presence of infection [3,4]: Wound dehiscence may be divided into superficial when there is a separation of only skin and subcutaneous tissues, and deep when muscular fascia is involved. Infection should be suspected when there are signs and symptoms of infection, such as pain, fever, tenderness, and/or purulent drainage from the superficial incision or from the fascial or muscular layers.[3] The perigraft collection is defined as a collection of fluid surrounding the graft detected at diagnostic imaging; in most cases, these collections are caused by postoperative bleeding or the formation of lymphocele, lymphatic collection with pseudomembranes, and incisional hernia.

The overall incidence of abdominal wound complications in transplant recipients is 7.7–21%,[3,5–13] most of which are superficial wound dehiscence.

Incisional hernia, defined as any abdominal wall gap with or without a bulge in the area of a postoperative scar perceptible or palpable by clinical examination or imaging,[14] is a frequent surgical problem resulting from the loss of the integrity of the abdominal wall at the site of a previous surgical incision due to a defect in the abdominal wall closure.[15] Indeed, it arises from weakness in the scar tissue or in the fascial muscular layer of the wall around the surgical site.[16]

In the general population, the incidence of IH following a midline incision is generally estimated to be 10–20%,[17,18] but it could be potentially higher depending upon a variety of factors, including patient population, time to follow-up, suture materials, and comorbid conditions.[17,19–23] The incidence of IH after transverse or oblique laparotomy, as performed in renal transplants, varies from 0% to 4%.[24,25] Incisional hernia is associated with a significant reduction in health-related quality of life through its impact on occupation, activities of daily living, mobility and psychological well-being.[23,26] The site of IH has a significant impact on the rate of recurrence: midline IH has postoperative 10-year recurrence rates of 32% in the case of prosthetic repair and 63% in the case of primary suture repair,[27] while the recurrence rate for lateral IH varies from 0% to 4.9%.[24,25]

Risk factors for IH are immunosuppressive therapy, diabetes, obesity, and postoperative wound infection, which are usually present in various combinations in kidney transplant recipients.[23,26] As a consequence, kidney transplant recipients are expected to have an increased risk of developing an IH due to immunosuppressive therapy and the increased risk of postoperative infections; however, surprisingly, the incidence of IH in renal transplant recipients is remarkably lower than that in the general population, ranging from 1.1% to 18%,[5–10,28] with an overall risk ranging between 3.2%[26] and 7%[29] at 4.5 years after transplantation, with a recurrence rate ranging from 0% to 20% in the case of mesh repair.[29-31] In their review, Smith et al.[8] found an incidence of IH of 2.5%, 4.9%, and 7.0% at 1, 5, and 10 years after transplantation, respectively. As observed in the general population, IH in kidney transplantation develops early after transplantation, usually within the first 3 months after transplantation,[8,14,30] and 97% of IHs occur within 5 years after RT.[7,32] Compared to other surgical complications, IH has a minor impact on patient and graft survival but increases patient morbidity and may have an impact on quality of life.[33]

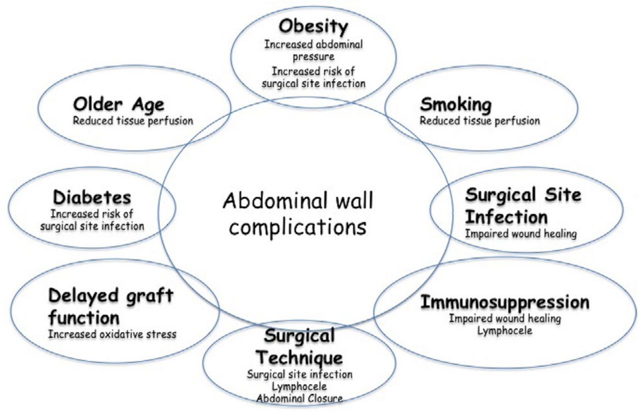

FIGURE 1 Risk factors for abdominal wall complications in kidney transplant population

In this review, we have evaluated the natural history of abdominal wall complications in a kidney transplant setting, with a special focus on wound dehiscence and incisional hernia, with a particular emphasis on risk factors, clinical characteristics, and treatment.

2 | RISK FACTORS FOR ABDOMINAL WALL COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Risk factors for abdominal wall complications could be classified as general risk factors and transplant-related risk factors.[3] General risk factors include obesity (body mass index [BMI] > 30 kg/m^2), age > 50 years, deceased donor graft, postoperative lymphocele, diabetes, reoperation through the same incision, smoking, and female sex, while transplant-related risk factors include immunosuppression and delayed graft function[27,34–42] (DGF, Figure 1).

Shahrestani et al.[10] performed a systematic review to examine factors contributing to incisional hernia formation in kidney and pancreas transplant recipients. In their analysis, the incidence of IH was 4.4%. Age above or below 50 years did not predict hernia formation, while BMI > 25 kg/m^2, the use of sirolimus and hockey-stick incisions were associated with an increased risk of IH; in contrast, the use of mycophenolate mofetil and paramedian and Rutherford-Morison incisions were associated with a lower rate of IH.[10]

In their large series of 1564 transplant recipients, Ooms et al.[7] found an incidence of IH of 3.2% over the median follow-up of 59 months. Risk factors for IH development were female sex, BMI > 30 kg/m^2, concurrent abdominal wall hernia, multiple explorations of the ipsilateral iliac fossa, history of smoking, and duration of the kidney transplantation procedure. In the multivariate analyses, female sex (hazard ratio [HR] 2.6), history of smoking (HR 2.2), obesity (BMI > 30; HR 2.9), and concurrent abdominal wall hernia (HR 2.3) were the most relevant independent risk factors.

The prevalence of cigarette smoking among kidney transplant recipients is 25% and 35–40% in American and European patients, respectively,[43,44] with 90% who continue to smoke after KT.[44]

Patients with a history of smoking have a four-fold increased risk compared with nonsmokers, probably as a consequence of the decreased blood supply to the parietal wall, which impairs wound recovery and can predispose them to incisional hernia development.[7,34,39]

Obesity is a growing problem among kidney transplant recipients, with more than a quarter of US waitlisted candidates with a BMI of 30 to < 35 kg/m^2 and 17.8% with a BMI of ≥ 35 kg/m^2, and this incidence has continued to grow during the last two decades.[45] A similar trend also was observed in Europe, where the incidence of patients with a BMI of ≥ 30 kg/m^2, while starting dialysis or having a pre-emptive kidney transplantation, increased from 11.4% in 2004 to 20.2% in 2015.[46]

Obesity is a well-known risk factor for IH in both general and transplant populations because it increases mechanical stress to the abdominal incision by increasing intra-abdominal pressure,[7,8,32,41,42] increases operative time and tissue ischemia,[3] and increases the risk of lymphocele development, which may cause further mechanical stress on the parietal incision, with delayed wound healing.[4,8,9,47,48] Moreover, obesity may also increase the risk of surgical site infection (SSI), which is a well-known cause of incisional hernia.[8] Wound complications are significantly associated with a BMI > 30 kg/m^2, and in most cases, obesity is considered the most significant risk factor for the development of wound complications,[10,39,41] although some authors did not find such an association.[49]

Immunosuppression represents the most important specific risk factor for the development of IH in the transplant population. Almost all immunosuppressants may cause various degrees of wound healing impairment, finally resulting in a potentially higher risk of wound dehiscence and IH, particularly when other patient-related risk factors are simultaneously present.

Corticosteroids may increase the incidence of IH by interfering with wound healing, especially when a higher dose is requested to contrast an acute rejection.[39,40] Additionally, the most commonly used immunosuppressants, mycophenolate mofetil, tacrolimus, and sirolimus, may increase the risk of developing an IH through a direct effect in impairing the wound healing process or in increasing the rate of posttransplant lymphocele due to their antiproliferative effect caused by the reduction of fibroblast and endothelial growth factors,[10,39,40,50–52] although some authors suggested that MMF could have a protective role.[8] Sirolimus-based immunosuppression increases the risk of any wound complications during the first 30 days posttransplant,[51,52] particularly superficial wound infections and incisional hernias,[52] and the rate of incisional hernia formation may increase from 3.7% for patients without sirolimus-based immunosuppression to 18.1% in patients treated with sirolimus.[10] This effect is particularly evident for obese patients receiving a higher dosage of sirolimus and when sirolimus is used in combination with corticosteroids.[2] Moreover, sirolimus may not allow correct mesh incorporation, and it should be discontinued before planning mesh repair for IH to allow adequate mesh incorporation.[53] A higher incidence of wound complications was observed even in patients receiving everolimus, where the incidence of wound healing adverse events may increase up to 35% of patients.[13]

According to the Ventral Hernia Working Group (VHWG) grading system, transplant patients are included in Grade 2 for the development of SSI due to the presence of immunosuppression.[54] SSI has a prominent role in IH development,[40,52,55] and it occurs in 3.8–18.5% of RT recipients, with a higher incidence in obese patients[56] and in those with peripheral vascular disease.[56] Many recent studies have suggested that SSI is a strong predictor of IH in kidney transplant recipients,[4,48,57] with an HR of 28.8,[8] probably due to the bacterial proliferation triggered by SSI, which causes an immune response that impairs collagen synthesis, finally delaying wound recovery.

A well-performed parietal closure is therefore a key element for reducing the risk of SSI and the risk of IH.[21–59] As a consequence of prolonged immunosuppressive therapy and the higher prevalence of comorbidities, renal recipients would be expected to be at higher risk of incisional hernia.[6,60] However, many studies found that incisional hernia is significantly less frequent in renal recipients, probably as a consequence of many specific factors, including the site and size of the abdominal incision, the method of wound closure, the Rutherford-Morison transplant incision, the neuromuscular trauma due to the operation, the strength and the local biomechanical forces around the closed incision, and, above all, the surgeon's experience.[7,40,61–66]

Delayed graft function is defined as the need for dialysis within seven days after kidney transplantation as a consequence of ischemia/reperfusion injury,[26,67] and it is associated with reduced graft survival and longer hospitalization with higher costs and increased complications.[16,26,30,68,69] Hemodialysis in patients with DGF is associated with increased oxidative stress and impairment of B and T cells, which may be responsible for delayed wound healing, so kidney transplant recipients with DGF may be exposed to an increased risk of IH,[26,62] although some authors did not confirm such an assumption.[8]

3 | KIDNEY TRANSPLANT SURGICAL TECHNIQUE

The kind of incision may play an important role in the prevention of abdominal wall complications, and an optimal surgical approach to kidney transplantation may minimize the risk of this complication.

Kidney transplantation can be performed through a variety of incisions, including paramedial incisions, oblique incisions, extended inguinal incisions, pararectal incisions, or hockey-stick incisions[1,70] (Figure 2).

In the nontransplant population, paramedian and transverse abdominal incisions present a lower risk of incisional hernia than midline incisions,[71] while the risk is similar among paramedian, hockey-stick, and pararectal incisions, as they all use the same anatomic structures (semilunar ligament, laterally to the rectus abdominis) and in cases of oblique and extended inguinal incisions.[72,73]

Few studies have investigated the different incidences of IH in RT on the basis of different incisions. In their study, Nanni et al.[61] found that the incidence of incisional hernia was four-fold lower after an oblique incision (Rutherford-Morison incision) compared to a hockey-stick incision, and this finding was confirmed by Filocamo et al.,[66]

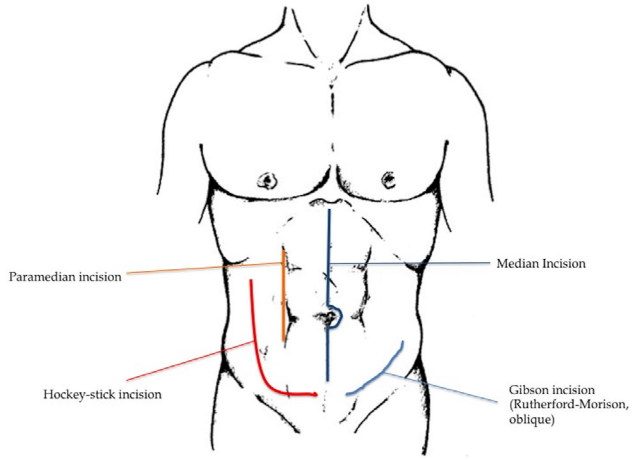

FIGURE 2 **Surgical incisions for kidney transplantation**. Single kidney transplant is placed in either right or left iliac fossa through a Gibson incision. In dual kidney transplantation can be used two Gibson incisions (one for each side, bilateral dual kidney transplantation) or a hockey stick incision (monolateral dual kidney transplantation). In re-transplantation can be used a Gibson incision in contralateral side (second transplant) or an abdominal median or paramedian incision or re-exploration of the same iliac fossa (third or more kidney transplant)

who found a five-fold increased risk of IH in patients undergoing a hockey-stick incision compared with a midline incision. More recently, Shahrestani et al.,[10] in their meta-analysis, found that the Rutherford-Morison and paramedian incisions were associated with lower rates of incisional hernia formation than the hockey-stick incision, although the difference was not statistically significant. To reduce the risk of IH after renal transplantation, some authors have suggested reducing the length of the incision, thus minimizing injury to abdominal neuromuscular structures.[10] Yildız et al.,[75] using a 10–15 cm oblique incision, found a very low rate of IH in the follow-up, suggesting that the small semilunar incision should be the preferred approach for kidney transplantation surgery.

Dual kidney transplantation is a valuable alternative to single kidney transplantation from expanded criteria donors.[76–80] Various techniques have been described, including bilateral placement, unilateral placement with separate anastomoses, and unilateral placement with patch anastomoses,[76–80] with comparable graft and patient survival and postoperative complications.[77] In the large series of 100 unilateral dual kidney transplantations, Ekser et al.[76] reported seven patients (7%) with wound dehiscence and only one (1%) with incisional hernia. Dual kidney transplantation has been associated with an increased incidence of wound complications compared with single transplantation (32% vs 10%, respectively, $P = .009$),[79] probably due to the prolonged operative time,[7] older recipient age, and the two incisions, although a recent study did not confirm such an association.[80]

More than 10% of kidney transplant recipients receive a retransplantation. The surgical technique is similar to first-kidney transplantation, and usually, the second graft is placed in the contralateral iliac fossa. Although most studies did not find a significant association between retransplantation and abdominal wall complications,[3,28,81] it could be potentially associated with an increased risk of IH and wound complications as a consequence of long-term exposure to immunosuppression and reoperation through the same incision.

In summary, the Rutherford-Morison and paramedian incisions are associated with lower rates of IH compared with the hockey-stick incision, and even though a standardized approach has not yet been established,[5,7,9,29,82] the increasing utilization of the inguinal oblique incision instead of the traditional hockey-stick incision has reduced the rate of IH.[61]

4 | ABDOMINAL WALL CLOSURE

The European Hernia Society guidelines on abdominal wall closure suggest that the small bite closure technique may reduce the risk of incisional hernia after midline incisions, but a similar positive effect has not been described in cases of oblique or paramedian incisions.[72,83]

Single- or multifascial closures do not seem to influence the incidence of incisional hernia,[10] although a study suggested that single-layered parietal closure leads to a 2.89-fold higher risk of IH than two-layer closure.[64]

Successful muscle closure following renal transplantation in adults, in some cases, may represent a challenging dilemma to transplant surgeons. A discrepancy between the retroperitoneal space and the graft size or a reduced volume of recipient pelvic cavity may lead to parenchymal compression[84] and narrowing of the renal vein,[85,86] causing renal transplant compartment syndrome (RTCS) with possible graft thrombosis.[84,86] In these situations, successful tension-free abdominal wall closure is essential to prevent complications and to prevent wound dehiscence and incisional hernia.[87] However, when tension-free closure cannot be achieved, many types of synthetic mesh closure techniques have been proposed. Nevertheless, most surgeons are reluctant to place a synthetic mesh near a kidney graft for fear of infections, wound dehiscence, and interference with posttransplant follow-up, including graft biopsy, postoperative sonography, or re-exploration of the iliac fossa. Prophylactic mesh placement may be useful to reduce the rate of IH in high-risk patients,[88–90 and a] recent multicenter randomized study reported a 2-year incidence of IH of 30% for primary closure, 13% for onlay mesh reinforcement, and 18% for sublay mesh reinforcement.[89]

The porcine dermis-derived mesh is an acellular sheet of porcine dermal collagen and elastin fibers maintained in their original three-dimensional forms. It takes advantage of not being cytotoxic, hemolytic, pyrogenic, or allergenic, thus minimizing the risk of infection,[84,91] so that it can be used in direct contact with kidney grafts or bowels.[91,92] Porcine mesh was mainly adopted for abdominal wall closure in pediatric renal transplantation, and it was associated with a very low rate of IH,[91,92] bowel fistulation,[92] or intraperitoneal adhesions.[91] Similar results were reported with the use of polytetrafluoroethylene (PTFE) dual mesh, although they need prolonged closed suction drainage to prevent seroma,[93,94] particularly in patients treated with sirolimus or everolimus, but they do not preclude ultrasound evaluation or biopsy of the graft.[93,94] In their study, Nguan et al.[94] evaluated 16 patients undergoing primary PTFE-assisted closure for excessive tension of fascial closure, causing a change in graft perfusion, or a secondary closure in patients with suspected RTCS. In these patients, a large ellipsoid piece of polypropylene mesh was draped loosely and without tension over the graft by attaching the mesh to the posterior fascial edges. No wound infections or incisional hernia developed as a result of mesh placement.[94]

However, even in high-risk patients, the use of prophylactic mesh for abdominal wall closure in renal transplantation is still controversial, since immunosuppression may increase the risk of mesh infection, and the presence of the mesh could make future explorations of the iliac fossa more difficult.[7,72,95–99] Recently, Michalski et al.[100] evaluated the impact of prophylactic absorbable polyglactin mesh reinforcement on the incidence of short-term post-RT wound complications in 23 patients; when compared with 46 RT patients without preventive onlay mesh reinforcement, RT patients undergoing mesh reinforcement had a lower, although not significant, rate of early postoperative wound complications and were not at higher risk of developing SSI.[100] In patients with suspected RTCS not suitable for mesh repair, subcutaneous,[95] or intraperitoneal[86,96] placement of the graft are alternative methods of abdominal closure since they are associated with a low rate of complications and RTCS.[100] Veroux et al.[86] described an interesting case of iliocaval thrombosis as a consequence of inferior vena cava compression by a large-for-size kidney transplant. After an urgent relaparotomy, the graft was finally placed in the peritoneal cavity, with progressive resolution of venous thrombosis.

5 | RENAL PARATRANSPLANT HERNIA

Renal paratransplant hernia (RPH) is an uncommon type of IH, caused by the entrapment of a bowel loop through a defect in the peritoneum covering the transplant kidney, and is a potentially life-threatening complication.[101,102] A total of 12 cases have been reported in the literature,[102,103] and it should be considered an iatrogenic surgical complication; in almost all cases, a defect of the peritoneum is found intraoperatively. It has been postulated that RPH could be a consequence of inappropriate maneuvers while sliding the peritoneum to prepare the iliac vessels for anastomosis and for creating space for the kidney graft. Moreover, the defect in the peritoneum could be related to a tear in the peritoneum caused by one or more stitches during abdominal wall closure.[104] Alternatively, RPH may be caused by a rupture of a posttransplant lymphocele in the abdominal cavity, thus leaving a defect of peritoneum that could lead to small bowel entrapment.[103,104] Risk factors for RPH are similar to those for IH and include obesity, a large-for-size graft and the formation of lymphocele.[101–104] Renal paratransplant hernia develops more frequently in men with a mean age of 41.2 years (range 22–64 years) and in most cases is an early postoperative complication, with a time from transplantation to presentation varying from three days to 18 months, with a median of 30 days.[102,103] Given its rarity, a timely diagnosis is mandatory to avoid potentially lethal complications, and RPH should be suspected in every transplant recipient displaying signs and symptoms of small bowel obstruction. In most cases, computed tomography scans are useful for confirming the clinical suspicion of RPH.[101,104] Once the diagnosis is established, early surgical intervention is warranted with immediate laparotomy. Surgical treatment of RPH may be challenging, because the peritoneal defect is usually small and strangulation is more likely, and because the reported mortality associated with bowel necrosis in transplant patients may be as high as 80%.[102] The surgical approach should take into account the possible injury to the graft during small bowel manipulation and the need for intestinal resection if bowel necrosis is evident. Among the 12 recipients with RPH, four (33.3%) required bowel resection for intestinal necrosis.[101–104] A side-to-side two-layer hand-sewn anastomosis may be preferable[102] due to a potentially higher risk of postoperative bleeding after stapler use.[102,105] Closure of the peritoneal defect could be performed with interrupted absorbable sutures or, in the event of a larger defect, with a mesh.[102] Conservative treatment is strongly discouraged due to the high risk of intestinal necrosis. Immediate surgical treatment results in an excellent outcome; only one patient died, in the setting of multiple organ failure after undergoing small bowel resection, but no recurrence of RPH has been reported thus far.[102]

6 | TREATMENT OF ABDOMINAL WALL COMPLICATIONS

In the kidney transplant setting, the combination of surgical factors and patient comorbidities plays an important role in the occurrence of wound complications. In such situations, a combination of both preventive and therapeutic modalities plays a pivotal role in the management of surgical wound complications, and a tailored approach to immunosuppression in high-risk patients may be useful for reducing the incidence of abdominal wall complications. Sirolimus therapy should be reduced or discontinued in obese patients and in patients developing a wound complication. At the same time, patients with a BMI > 30–35 kg/m^2 should be encouraged to have a controlled diet and a considerable weight reduction before listing for kidney transplantation.[2]

6.1 | Treatment of wound complications

Generally, superficial wound dehiscence and other superficial wound complications are treated either by packing with gauze, dressing and waiting for secondary healing, or by surgical drainage or debridement.[2] In the case of infected wounds or anergic wounds requiring secondary healing due to failed granulation tissue, the healing process may be stimulated with vacuum sealing methods,[2] which optimize wound drainage, stimulating granulation tissue formation (Figure 3).

Negative pressure wound therapy (NPWT) takes the theoretical risk of hemorrhage and urine leak from the transmission of suction pressure on the vascular and ureteric anastomoses.[106] Shrestha et al.,[106] in their review, reported 22 patients treated with NPWT, mostly due to wound dehiscence or urine leakage, and all patients had a resolution of wound infection after a treatment duration ranging from 5 to 180 days.

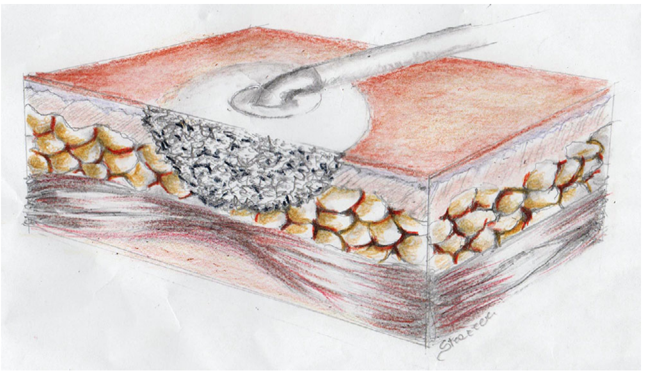

FIGURE 3 **Abdominal Vacuum-assisted closure in kidney transplantation**. The wound therapy acts through the foam, with the macro- and microdeformation, fluid removal, and mechanical alteration of the wound environment (2107)

Chen et al.[107] reported a series of 16 transplant patients treated with vacuum sealing drainage (VSD) with a negative pressure between 125 and 150 mmHg for resistant wound infections; the mean age was 41.7 years, most patients were male, and 35% of patients with wound infections had DGF. Ten patients developed a superficial wound infection, while six patients had deep infections with graft exposure; the duration of effective VSD therapy ranged from 6 to 111 days, and the combination of antibiotics and debridement with VSD therapy led to 100% wound healing. More recently, Lau et al.[11] reported a series of 64 kidney recipients with abdominal wall complications. The overall incidence of wound complications was 7.7%, and they were more frequent in males and in patients with a BMI > 30 kg/m^2. In 70% of patients, superficial wound dehiscence occurred, while nine patients (14%) had complete wound dehiscence involving the fascia, requiring surgical intervention. While there was a trend toward an increased incidence of complete fascial dehiscence in older patients with higher BMI, the only significant factors for complete fascial dehiscence were the presence of documented peripheral vascular disease and the presence of a superficial wound collection.[11] The majority of recipients (40/64, 63%) with abdominal wall complications did not require an operative intervention, while 17 patients were managed with surgical debridement and/or NPWT. Patients requiring NPWT were older and had a higher BMI, but only diabetes and superficial wound infection were considered the most significant factors for the requirement for NPWT. All recipients had complete wound healing after a median length of NPWT of 35 days and a median time to overall wound healing of 73 days.[11]

6.2 | Treatment of incisional hernia

Incisional hernia repair in kidney transplant recipients is a complex surgical procedure, as these patients usually present a significant alteration of the native tissue layers caused by previous abdominal surgeries and for the specific large nonmidline incision required for the kidney transplant. Consequently, a full understanding of the anatomic layers that are involved in such defects is mandatory before proceeding to hernia repair. Moreover, efficacious hernia repair may be limited by the presence of the graft itself and by the proximity to the inguinal area and iliac bones, which could render fixation of the mesh difficult, thus increasing the repair complexity.[108,109]

In a kidney transplant with IH, the different layers of the lateral abdominal wall have retracted, which results in a wall defect along the inguinal ligament.[109] In most cases, the internal oblique and transversus abdominus muscles retract laterally and caudally. Careful dissection of the muscular layers to expose the fascia of the external oblique muscle is mandatory to prepare for mesh placement. When the internal oblique and the transversus abdominus muscles could not be reapproximated, the external oblique must be utilized as the primary fascia coverage of the mesh.[109] The mesh should be anchored to all four quadrants of the abdominal wall defects, including the inguinal ligament inferiorly.[109] For larger defects, the anterior superior iliac spine and pubic symphysis may be used as additional points of fixation.[109]

There is no consensus on the optimal therapeutic strategy for patients with IH,[9,10,82] with the alternatives ranging from conservative treatments (weight loss, abdominal binder) for patients unsuitable for surgery[110] to surgical treatment.[111]

A surgical repair of IH in kidney transplant recipients is usually required in 52–71% of patients, with a recurrence rate of 4–33%,[7,10,30–32] and it is associated with better patient survival compared to patients receiving a conservative treatment.[112] Many surgical procedures have been proposed, either with open and laparoscopic approaches, including the primary suture, the use of synthetic mesh or biological mesh, the component separation technique, or autologous free tissue transfer, such as tensor fascia lata grafts or flaps from the thighs[98,112,113] (Table 1).

A recent meta-analysis[114] demonstrated that hernia repair using a prosthetic mesh is associated with a significant reduction in recurrence compared to primary closure alone. This was confirmed even in the transplant population, where the recurrence rate of 4–33%[7,30–32,115,116] is comparable to that observed in the nontransplant population.[18,108] Chang et al.,[32] among 42 kidney and pancreas recipients treated for IH, found an overall recurrence rate of 33%; the recurrence rate was higher in patients treated with primary suture repair (46.6%) than in those treated with mesh repair (29.1%) or with the component separation technique (0%). Of the 577 transplant patients with IH analyzed in the systematic review of Shahrestani et al.,[10] 221 (38.%) underwent hernia repair; 42 underwent primary repair via herniorrhaphy, and 179 underwent mesh repair. The rate of recurrence after mesh repair was 14.8%, while the rate of recurrence after the primary suture was 23.7%. Other complications reported in the 221 patients undergoing herniorrhaphy (with or without mesh) included two cases of seroma, five abdominal wall abscesses, three hematomas and eight mesh infections.[10]

An increased risk of recurrence is associated with the male sex, primary repair, tacrolimus use, smoking history, and diabetes.[32] Posthernia repair infections are more frequently associated with the male sex, mesh repair, tacrolimus and sirolimus use, and diabetes,[32] and infection is a significant risk for the failure of IH repair.[32]

Although mesh repair is potentially the best option for IH repair in kidney transplant recipients, it may expose, in principle, the patient to

TABLE 1 Incidence, surgical repair, and complications of incisional hernia in kidney transplant recipients

Author	Year	Number of patients with IH	Time from transplant to IH repair	Risk Factors	Treatment (n)	Complications (n, %)	Comments
Mahdavi[5]	2004	16/589 (3%)	48 months (median)	Obesity	Primary repair (4)	Seroma (2, 15.2%)	No hernia recurrence in the entire series
				Age > 50 years	Mesh repair (9)		
				Female Gender	No treatment (3)		
Antonopoulos[6]	2005	13/462 (2.8%)	14 days (median)	Obesity			
				Complications from transplant surgery	Mesh repair (13)	Recurrence (1, 7.6%)	Infected or contaminated herniations
				Diabetes			
Ooms[7]	2015	50/1564 (3.2%)	68 weeks (median)	Concurrent Abdominal hernia	Synthetic mesh repair (19)	Recurrence (6, 23%)	9 (35%) patients required emergency repair due to small bowel incarceration
				Female sex	Biological mesh repair (1)		
				History of smoking	Primary suture (6)		
				Obesity	Observation alone (24)		
				Multiple re-exploration			
				Duration of surgery			
Varga[29]	2011	28/1067 (2.6%)	17.5 months (median)	Surgical site infection	Primary repair (8)	Recurrence (4, 20%)	No wound complications
				BMI > 25 kg/m^2	Mesh repair (20)		
				Delayed graft function			
Mazzucchi[30]	2001	14/371 (3.8%)	3 to 840 days	White race	Mesh repair (14)	Wound infection (1, 7.1%)	No IH recurrence
				Deceased Donor transplant			
Luc[31]	2014	61	47± 60 months	NA	Mesh repair (61):	Recurrence (6, 9.8%)	Recurrence occurred sooner in non transplant patients than in kidney transplant recipients
					retromuscolar (53)	Wall Abscess (3, 4.9%)	
					intrabdominal (8)	Hematoma (2, 3.3%)	

(Continues)

TABLE 1 (Continued)

Author	Year	Number of patients with IH	Time from transplant to IH repair	Risk Factors	Treatment (n)	Complications (n, %)	Comments
Chang[32]	2011	42/3289 (1.3%)	36.4 months (mean)	NA	Primary repair (15)	Recurrence (total) (14,33%):	Increased risk of recurrence was associated with primary repair, smoking history and diabetes
					Mesh repair (24)	Primary repair (7, 46.6%)	
					Component separation technique (3)	Mesh repair (7, 29.1%)	
						Mesh removal (2, 8%)	
Buggs[81]	2019	83/1138 (7.29%)	1 year	Chronic obstructive pulmonary disease	Not specified	Recurrence (total)(3, 4.47%)	Survival was significantly better in patients with IH who underwent surgical repair
				Obesity		Primary suture (7.3%)	
				Length of stay		Mesh Repair (0%)	
						Biologic mesh repair (0%)	
Petro[82]	2015	11	NA	NA	Component separation	Recurrence (1, 9%)	No mesh infection or explantation
					and retromuscular mesh reinforcement (11)		
Brewer[112]	2011	84 (104 IH)	NA	NA	Biological Mesh repair with HADM (34)	Recurrence:	Increased risk of repair failure was associated with tobacco use, with rapamune use and diabetes
					Synthetic mesh repair (26)	Synthetic mesh (76.9%)	
					Primary repair (25)	Primary repair (36%)	
					TFL graft (9)	HADM (23.5%)	
					Component separation (5)	Wound infection:	
					HADM and synthetic mesh (4)	Synthetic mesh (65.4%)	
					TFL graft and HADM (1)	Primary repair (8%)	

(Continues)

TABLE 1 (Continued)

Author	Year	Number of patients with IH	Time from transplant to IH repair	Risk Factors	Treatment (n)	Complications (n, %)	Comments
						HADM (14.7%)	
						Removal of mesh:	
						Synthetic mesh (69.2%)	
						Primary repair (0%)	
						HADM (11.8%)	
Yannam[115]	2011	36 kidney and/or pancreas transplant patients	NA	NA	Laparoscopic mesh repair (36)	Recurrence (5, 16%)	Higher incidence of recurrence in patients with polycystic kidney disease
						Mesh explant (2, 6.4%)	
						Bowel perforation (1,3.2%)	
Li[116]	2005	41/2499 (16.4%)	NA	NA	Midline defects (15):	Wound infection and necrosis (2,4.8%)	Recurrence was more frequent with TFL and component separation techniques
					Component separation (8)	Urine leak (2,4.8%)	
					TFL (4)	Recurrence (total) (9, 22%):	
					Mesh Repair (2)	Midline defect (3,20%)	
					Primary repair (1)	Lower quadrant defect (6, 23%)	
					Lower quadrant defects (26):		
					Mesh repair (4)		
					TFL (14)		
					Component separation (6)		
					Primary repair (2)		

(Continues)

TABLE 1 (Continued)

Author	Year	Number of patients with IH	Time from transplant to IH repair	Risk Factors	Treatment (n)	Complications (n, %)	Comments
Gowda[119]	2016	87	NA	NA	Biological mesh repair with HADM (34)	Wound infection:	Lower rate of complications with biological mesh repair
					Biological mesh repair with PADM (27)	PADM (14.8%)	
					Synthetic mesh repair (26)	HADM (14.7%)	
						Synthetic mesh (65.4%)	
						Recurrence:	
						PADM (13.3%)	
						HADM (23.5%)	
						Synthetic mesh (76.9%)	
						Mesh removal:	
						PADM (7.4%)	
						HADM (11.8%)	
						Synthetic mesh (69.2%)	
Black[121]	2019	19 SOT (7 kidney)	31.6± 26.4 months	NA	Open component separation and biological mesh repair (19)	Recurrence (3,15.8%)	52.6 % of patients had a prior IH repair
						Seroma (2,10.2%)	
						Hematoma (1, 5.3%)	
Lambrecht[123]	2014	31 liver or kidney trans-plants	NA	NA	Laparoscopic mesh repair (31)	Recurrence (3, 9.7%)	No intestinal perforation or omental bleeding was observed in the entire series
						Bladder perforation (1, 3.2%)	
						Reoperation (1, 3.2%)	

IH, incisional hernia; SOT, solid organ transplant; NA, not available.

an increased risk of infection. However, recent studies demonstrated that IH repair with mesh is associated with a low risk of postoperative infections and complications,[88,109,117,122] with an incidence similar to that observed in the general population,[18,30,31] with an overall morbidity and recurrence rate comparable to that observed in the nontransplant population.[18,30,31]

In kidney transplant recipients, the use of biological mesh is associated with a lower risk of recurrence compared to IH repair without a mesh[118] or with synthetic mesh,[112] thanks to a better integration into the abdominal wall, consequently minimizing the risk of bacterial colonization and other complications,[9] and to a better vascularization, thus reducing the risk of infectious wound complications[95]; indeed, it has been demonstrated that the use of synthetic mesh in kidney transplant recipients causes an increased risk of recurrence, infections and further surgery.[112] In the study of Gowda et al.,[119] 87 kidney and kidney-pancreas recipients underwent IH repair. In 27 patients, porcine acellular dermal matrix (PADM) was used, and they were compared with 34 patients repaired with human-derived acellular dermal matrix (HADM) and 26 patients repaired with synthetic mesh. Patients treated with PADM had a lower incidence of wound infection (14.8%) than those repaired with HADM (14.7%) and synthetic mesh (65.4%). The rates of recurrence were 13.3%, 23.5%, and 76.9% for the PADM, HADM, and synthetic mesh groups, respectively, and the rate of mesh removal was lower in the PADM group (7.4%) than in the HADM and synthetic mesh groups (11.8% and 69.2%, respectively).[119]

Some authors suggested that a modified component separation technique combined with biologic mesh repair may be a good option for abdominal wall reconstruction in renal recipients[109,120,121]; in the series of Zolper et al.,[109] only two of nine kidney transplant recipients undergoing a component separation technique with biologic mesh repair for IH experienced a complication, and no patients underwent a reoperation within 90 days.

In kidney transplant recipients, laparoscopic repair has the potential advantage of reducing tissue trauma[122] and reducing fluid accumulation causing seroma and potential infections, finally contributing to a reduced recurrence rate.[115,122,123] Moreover, transplant patients are less prone to develop peritoneal adhesion, probably due to immunosuppressive therapy,[124] which could make adhesiolysis easier compared to nontransplant patients, reducing the risk of small bowel injury. Furthermore, laparoscopic repair may be useful for IH repair close to bony prominences, which are frequently encountered in kidney transplant recipients[122]; finally, laparoscopic repair could be used even in obese patients with reasonable perioperative complications or recurrence rates.[115]

In their large series, Yannam et al.[115] compared 36 kidney transplant recipients undergoing laparoscopic incisional hernia repair with 62 nontransplant patients. Midline incisions were the dominant type in both groups; transplant patients experienced a higher rate of conversion to open surgery (15%), mainly due to uncontrolled omental bleeding and severity of adhesion. Two patients required early reintervention due to an acute abdomen, and one small bowel perforation was identified. Two meshes were explanted due to infection. The recurrence rate was 16% at a median of 2.2 years after repair, and it was not significantly different from those observed in the nontransplant population; interestingly, recurrence occurred more frequently in patients with autosomal dominant polycystic kidney disease.[115] In a more recent study by Lambrecht et al.,[123] 31 patients, including 16 kidney transplant recipients, underwent laparoscopic hernia repair for incisional hernia. Most kidney transplant recipients were affected by polycystic kidney disease, and when compared with a nontransplant population, there was no difference in operating time, time to normal activity, hematoma, reoperation, or infection rate; however, a male majority, longer admission time, and larger hernias with less mesh overlap were found in the transplant group. There was a tendency toward a lower incidence of seroma in the transplant group, but transplant patients displayed a higher incidence of mesh protrusion, while the rate of recurrence was similar between the two groups (9.7% vs 4.2%, $P = .368$).

Taken together, these data suggest that mesh graft repair, either open or laparoscopic, may be considered a valid therapeutic option in renal recipients with IH,[31] resulting in a significantly lower recurrence rate compared with the use of primary sutures alone,[27] although the hernia recurrence rate remains high.[19]

There is no consensus on the correct positioning of mesh during IH repair, and very few studies have reported the position of mesh in IH repair in kidney transplant recipients.[5,6,29–31]

The underlying position of the mesh, although it exposes patients to a higher risk of bowel occlusion and enterocutaneous fistula, is considered a valid option, as it may reduce the risk of infections,[125] and it requires limited dissection with a consequent lower morbidity rate.[126] The onlay mesh position should be used cautiously because superficial wound infections can contaminate the mesh graft, and differentiation of a superficial wound infection from a mesh infection could be challenging.[31] However, when underlay and onlay mesh positioning are compared, there are no significant differences in terms of morbidity, infectious complications, or recurrence.[127,128]

In summary, mesh repair is the gold standard for the treatment of IH in kidney transplant recipients, since it is associated with a low rate of postoperative complications. Conservative treatment may potentially increase the morbidity and mortality of such patients,[81] particularly when urgent IH repair is required for hernia complications.[129]

7 | CONCLUSION

Immunosuppression and transplant-specific factors may increase the risk of abdominal wall complications in kidney transplant recipients. Superficial wound infections are usually managed conservatively, while surgical treatment is usually required for deep infections. Negative pressure wound therapy could be an appropriate and safe therapeutic approach for wound infections or for difficult-to-heal wound complications. Incisional hernia after kidney transplantation is a challenging surgical condition, since an appropriate definition and diagnostic approach in kidney transplant recipients are lacking. Very few studies have investigated the risk factors and surgical approaches in transplant patients with IH, so treatment standardization is lacking.

The Rutherford-Morison incision with double-layer closure seems the preferred method for the prevention of IH, although the data are inconclusive. Prophylactic mesh closure should be considered in patients at higher risk of wound complications. For patients with IH, mesh repair, either open or laparoscopic, is safe and is associated with a low rate of postoperative complications and with an acceptable recurrence rate. The component separation technique is associated with a very low rate of recurrence. Biological mesh repair is a useful alternative for patients with larger defects, infected wounds, or recurrent hernias.

Strategies to reduce the risk factors in kidney transplant recipients should be implemented with a multidisciplinary approach by reducing the modifiable patient-related risk factors, as with a considerable preoperative weight reduction and smoking cessation, a careful surgical technique and tailored management of immunosuppression. This would result in better early postoperative management, finally reducing the overall incidence of abdominal wall complications.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

All authors contributed to the review conception and design. Massimiliano Veroux and Claudio Sanfilippo had the idea for the review. Rossella Gioco, Francesca Privitera, Francesco Ciarleglio, and Alberto Brolese performed the literature search and data analysis. Rossella Gioco, Claudio Sanfilippo, and Massimiliano Veroux made the original draft preparation of the manuscript. Massimiliano Veroux, Pierfrancesco Veroux, and Rossella Gioco critically revised the manuscript.

DATA AVAILABILITY STATEMENT

All data related to this review are reported in the manuscript.

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