Mesh or no mesh: a hamletic dilemma to prevent Renal Allograft Compartment Syndrome (RACS)

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Tension-free muscle closure is essential in kidney transplantation, both in adult and pediatric patients. Tight muscle closure may lead to renal allograft compartment syndrome either due to compression of the renal parenchyma or due to kinking of the renal vessels. It may also cause kinking of the transplant kidney ureter, wound dehiscence and incisional hernia. Many techniques have been proposed in an attempt to achieve tension-free closure. There is a wrong belief among surgeons that using prosthetic mesh may increase the incidence of infective complications in these immunosuppressed patients. Also, there is fear that one is not able to monitor the renal graft by ultrasound and perform biopsy in the presence of a mesh. Other alternative techniques to mesh closure include subcutaneous placement and intraperitonealization of the kidney transplant. These techniques however, are valuable when mesh closure is unfavorable or contraindicated as in case of a potential source of infection, like a stoma. Abdominal wall fasciotomy can be adjunctive to the various techniques of muscle closure.

KEY WORDS: Abdominal mesh closure, Post transplant incisional hernia, Renal transplantation, Renal Allograft Compartment syndrome (RACS).

Introduction

Successful muscle closure following renal transplantation in adults is usually straightforward. However, in some cases, it could represent a challenging dilemma for the transplant surgeon. The renal allograft experiences favour insult after wound closure: ureteral kinking and obstruction, vascular kinking and obstruction or thrombosis, and a possible compartment syndrome secondary to limitation of the retroperitoneal space. These problems are not uncommon in pediatric recipients receiving adult kidneys. It is also encountered in small adult recipients receiving large adult kidneys. A restricted volume of the recipient pelvic cavity and a discrepancy in size between recipient's pelvis and donor's kidney may lead to either diffuse renal parenchymal compression or narrowing and/or kinking of the renal veins within a tight compartment causing RACS and subsequent graft thrombosis.[1]

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Pressure on the graft may be exacerbated by edema secondary to ischemia and/or reperfusion injury in the postoperative period. In both scenarios, the final result is a decrease in renal plasma flow and glomerular filtration rate, outflow obstruction with increased intrarenal vascular resistance and edema with subsequent ischemia.[2] There is a strong belief that difficult muscle closure commonly occurs in male peritoneal dialysis patients undergoing retroperitoneal kidney transplantation due to male android pelvis and noncompliance of the peritoneum due to scarring, but this has been proved to be wrong as it also occurs in hemodialysis female patients.[3] Many techniques have been proposed to deal with difficult muscle closure without creating tension and causing compression of the transplanted kidney, both in adult and pediatric transplants. Abdominal wall fasciotomy can be added to the various types of repair to achieve a tension-free closure.

Mesh closure

Many surgeons are reluctant to place synthetic mesh near the renal transplant for fear of infection after ureteroneocystostomy, fistulae, wound dehiscence, interference with biopsy procedure or imaging of the renal graft postoperatively, or inflammatory reaction with resultant perinephric collection. Many types of synthetic mesh closure techniques have been proposed.

Porcine Mesh Closure

Richards e coll.[4] described the use of a porcine collagen graft (Permacol) to facilitate closure of the abdominal wall following intraperitoneal transplantation of an adult cadaveric kidney in a two-year-old male infant weighing 12 kg. The sheet implant was inserted between the recti muscles and sutured to the sheath on either side using continuous PDS. Skin was subsequently closed in the usual fashion. The postoperative course was uncomplicated and the infant was discharged 12 days later. Eighteen months later, the abdominal wound was well healed with no evidence of incisional hernia. Following this successful outcome, this technique has been used in two further cases of pediatric recipients with good results and no evidence of abdominal wall hernia. Pentlow e coll. [5] demonstrated a three-year follow-up of five patients aged 5-12 years who received kidneys from adult donors. In four recipients, the kidney was transplanted onto the aorta and vena cava intra-abdominally using a midline incision. In the fifth patient, the kidney was anastomosed onto the iliac vessels. The skin overlying the implant was closed normally. In all cases, primary closure was achieved. One child received a second intra-abdominal transplant as an emergency, which failed later on. The other kidneys are functioning well. One recipient developed a small incisional hernia three years post-transplant. Another developed a skin dehiscence over the implant 23 days post-operatively. The implant was removed and the skin was closed. The other two recipients recovered well. They concluded that porcine dermal collagen implant is a helpful adjunct to abdominal wall closure following organ transplantation in children with donor size discrepancy. Permacol (Tissue Sciences Laboratories plc, Aldershot, UK) is an acellular sheet of porcine dermal collagen and elastin fibers maintained in their original three-dimensional forms and in which the collagen fibers have been cross-linked using diisocyanate, in order to protect the graft from biodegradation. Porcine dermis is the closest to human dermis in structure and appearance. It is not cytotoxic, hemolytic, pyrogenic or allergenic, does not elicit a foreign body response and is readily colonized by host tissue cells and blood vessels, thus minimizing the risk of infection [6]. It is soft and flexible, yet has high tensile strength and has bilateral smooth surfaces. These properties make it ideal for implantation into sensitive regions. The implant is sold in sheet format in various sizes, allowing it to be cut to shape. The major advantage of porcine dermal collagen implant over conventional synthetic meshes is that it can be used in direct contact with bowel without causing fistulation and causes minimal intraperitoneal adhesions [4,7].

Polytetrafluoroethylene (PTFE) Dual-Mesh Prosthesis

Our group reported the use of a PTFE dual-mesh prosthesis by a tension-free surgical technique in elderly patients' giant abdominal incisional hernia [8]. We utilized this technique in a giant incisional hernia after kidney transplantation [9] and in a successful management of RACS in a 42-year-old renal transplant recipient secondary to extrinsic compression of a large kidney placed extraperitoneally in a small iliac fossa[10]. Prompt re-exploration during the immediate postoperative period resulted in salvage of the graft with restoration of kidney function. The abdominal wall was reconstructed using a PTFE mesh, which decreased the compartment pressure within the iliac fossa, enough to allow renal vein patency and kidney perfusion. We suggested that this technique should be the first choice when fascial closure requires excessive force especially in presence of graft with a considerable size, or in case of small pelvis and/or obesity of the recipient. Excessive tension of the aponeurotic edges with a small iliac fossa is a risk factor for incisional hernia or RACS. This surgical technique is easy to perform and does not preclude ultrasound evaluation or biopsy of the graft.

Polypropylene-Assisted Mesh Hood Fascial Closure (MHFC)

Nguan e coll.[3] presented their experience in 16 patients undergoing 17 renal transplants who underwent MHFC. The mean follow-up period was nine months. Primary MHFC was performed when fascial closure required excessive force, resulting in a change of graft turgor or color, diminished renal artery pulsation, or change in renal vein turgor. Secondary MHFC was performed when compartment syndrome was suspected postoperatively and confirmed during re-exploration. In most cases, the vessels were straightened by buttressing the hilum using several large folded pieces of gelfoam under the upper and lower poles of the kidney to prevent kinking of the transplanted renal vessels. A large ellipsoid piece of polypropylene mesh was draped loosely and without tension over the graft. The mesh was attached to the posterior fascial edges using interrupted polypropylene sutures. Skin closure was then completed over a closed suction drain placed in the retroperitoneal space lateral to the kidney. Allograft nephrectomy was performed in one patient without difficulty despite the presence of the previous mesh closure. Ultrasound guided renal biopsy examinations were performed through the mesh closure in five grafts without difficulty. In addition, the MHFC did not provide any hindrance in performing Doppler ultrasound studies on the allograft. Five (31%) patients had prolonged drainage of serous fluid through the wound, resulting in a temporary small area of skin dehiscence in one of the five patients. No wound infections occurred as a result of mesh placement. One patient developed a lymphocele which required drainage. They concluded that MHFC is safe and does not adversely affect the care of the transplant patient, apart from the potential of prolonged wound drainage. They therefore, recommend prolonged closed suction drainage of the subcutaneous space to minimize this complication.

Subcutaneous placement of the kidney transplant

Ball e coll.[11] used this technique in three patients diagnosed with RACS in the early postoperative period. No adverse events were reported with full recovery. All patients had hernia repairs with synthetic mesh (mean: eight months). No complications were associated with this type of definitive repair. The Authors also used this technique into two small renal transplant patients who received large adult cadaveric kidneys. Both kidneys were transplanted retroperitoneally into the right iliac fossa. Muscle closure could have cause compression of the graft and subsequent RACS. No wound-related complications were reported so far with excellent kidney function.

Intraperitonealization of the kidney transplant

Koss e coll.[12] reported successful salvage of kidney transplanted into right iliac fossa following tight closure causing RACS via intraperitoneal graft replacement. Ball e coll.[10] also reported eight patients who underwent intraperitonealization of their kidney to treat RACS. There were no complications associated with intraperitonealization of the renal allograft. Kidney function was recovered with no allograft loss in all cases of RACS.

Conclusions

The above techniques are valuable alternatives if tension-free muscle closure could not be achieved. In general, one of these techniques is used at a time. The use of synthetic non-biological mesh (Polypropylene and PTFE) is safe with good results. It is recommended to leave the peritoneum intact when closing with this type of mesh. The other non-mesh techniques or the use of biological meshes (Permacol) are valuable options when placement of a synthetic non-biological mesh is not favourable or contraindicated as in case of potential source of infection like a stoma.

Riassunto

La chiusura senza tensione dello strato muscolare è essenziale nel trapianto di rene, sia nel paziente adulto che in quello pediatrico. La chiusura sotto tensione di questo piano potrebbe comportare l'insorgenza di una sindrome compartimentale da trapianto renale dovuta alla compressione del parenchima renale o all'inginocchiamento dei vasi renali. Tale condizione potrebbe a sua volta comportare un inginocchiamento ureterale del rene trapiantato, una deiscenza di ferita o un laparocele. Vige l'opinione errata tra alcuni chirurghi che l'uso della rete protesica possa aumentare l'incidenza di complicanze infettive in questi pazienti immunocompromessi. Inoltre, c'è spesso il timore di non riuscire, in presenza della rete, a monitorare la funzione renale mediante ecografia o effettuare prelievi bioptici. Altre alternative alla tecnica tension-free riguardano il posizionamento sottocutaneo o intraperitoneale del rene trapiantato. Queste tecniche, comunque, sono utili quando la chiusura mediante rete protesica non è favorevole o è controindicata, come nel caso in cui vi sia la presenza di una sorgente infettiva come una stomia. La fasciotomia della parete addominale può considerarsi un approccio aggiuntivo alle varie tecniche di chiusura del piano muscolare.

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Commento e Commentary

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Gli AA presentano una sindrome da disfunzione renale acuta che si presenta nei trapiantati renali soprattutto di età scolare o prescolare in seguito all'instaurarsi di un gradiente tra la pressione che si crea nella cavità addominale e nel retro peritoneo e quella vigente all'interno del parenchima renale.
Questa sindrome definita come Renal Allograft Compartment Syndrome (RACS), la cui frequenza è sottostimata, si instaura a seguito di una riperfusione dopo ischemia prolungata ,ma soprattutto quando esiste uno squilibrio dimensionale tra il rene da trapiantare e la cavità ricevente, in particolare se l'intervento termina con una chiusura della parete comprendente la fascia [1,2].
Da tempo in effetti la chiusura primaria della fascia al termine di un intervento di chirurgia maggiore in cui si prevede una certa quota di leakage e di versamento sieroematico era stata associata ad un aumento della pressione endoaddominale di vario grado capace di determinare una disfunzione anche pluriorganica [3].
Se la pressione intraaddominale supera certi limiti soglia (12mmHg) si instaurano i tre eventi fisiopatologici critici che determineranno le alterazioni funzionali a cascata : da una parte l'innalzamento del diaframma, che riducendo lo spazio respiratorio aumenterà la tensione toracica, mediastinica, pleurica e di fatto anche cranica ; dall'altra la compressione vascolare che, gravando inizialmente sul versante venoso, promuoverà l'aumento dell'edema interstiziale da stasi, mantenendo il circolo vizioso ipertensivo endocavitario, e infine la compressione parenchimale con aumento delle resistenze periferiche, capace di inficiare la normale funzionalità organica [4].
Il rene in particolare era già stato da tempo indicato come l'organo più esposto all'aumento della pressione endoaddominale perché sottoposto contemporaneamente alla compressione parenchimale, alla diminuzione del flusso arterioso da insufficienza cardiaca e all'ostacolato deflusso venoso da stasi cavale. Tant'è che a suo tempo si coniò all'uopo anche la definizione di Sindrome compartimentale renale.
Queste premesse spiegano la frequenza con la quale nei casi succitati si presenti la temuta RACS, in particolare quando si proceda alla chiusura primaria della fascia. Peraltro la chiusura fasciale era stata individuata da tempo come fattore di rischio per la comparsa di una IAH, e lo stesso Ivatury tra il 97 e il 98 aveva dimostrato come la frequenza di una IAH dopo chirurgia maggiore si dimezzava (25% vs 52%) utilizzando una mesh protesi ca [5].
Oggi le possibilità di una ricostruzione protesica sono molteplici, da quelle biologiche, gravate di alti costi, a quelle sintetiche mono o bifacciali con possibilità di contatto con la matassa intestinale, senza rischi di fistolizzazione e con bassi tassi di ernie ventrali residue.

Il lavoro riporta una completa disamina dei metodi oggi utilizzati e delle tecniche sperimentate per scongiurare un evento drammatico come la RACS.
Conferma altresì come la disponibilità di materiali e tecnologie sempre più sofisticate ha finito per sconfiggere lo scetticismo di molti chirurghi riguardo alla adeguatezza della monitorizzazione e gestione postoperatoria di questi pazienti.

* * *

Acute kidney failure is showed in AA. This event occurs especially in infant or school age children who undergo a renal transplant because of the pressure gradient between the retroperitoneum, abdominal cavity, and renal parenchyma.
This condition, whose frequency is underestimated, is called Renal Allograft Compartment Syndrome (RACS). It is developed because of a prolonged reperfusion after ischemia, especially when the dimensions among kidney transplant and the receiving cavity are very different, and when the fascia too is sutured during abdominal wall closing [1,2].
It had been long time that medical literature shows that fascia primary closure at the end of major surgery, when capillary leakage and fluid collections is forecast, is associated with various degree intraabdominal pressure increase whose followed by multiorgan failure [3].
If the intraabdominal pressure exceeds certain threshold limits (12mmHg), three pathophysiological events occur. They determine a cascade of functional alterations: first of all the diaphragm elevation, that reducing respiratory volume will increase chest pressure, mediastinal pressure, pleural pressure and cranial pressure too. An other pathological event is vascular compression in venous compartment. This condition, at the beginning in venous compartment, will increase the interstitial edema and will keep the vicious cycle about endocavity hypertension. The last pathophysiological condition is parenchymal compression: it will increase peripheral resistences and will promote the organ disfunction [4].
Kidney was already indicated as the most exposed organ to endoabdominal pressure increase because it is contemporaneously subjected to: parenchymal compression,reduction of arterial bloodstream caused by heart failure and inhibited venous outflow due to caval stasis. In fact this pathology was called Kidney Compartmentl Syndrome.
These assumptions explain the high RACS frequency in the previously cases, particularly when arranging for the primary fascial closure. Moreover, the fascial closure had been identified by time as a risk factor for the occurrence of a IAH, and Ivatury, between '97 and '98, showed a halving (25% vs. 52%)of IAH after major surgery using a mesh [5].
There are many possibilities about prosthesis using today:the biological ones are very expensive.the synthetic ones, mono and double faced, especially PTFE mesh are very helpful, because they can contact the bowel, without fistulae risk and low rates of residual ventral hernias.
This data reports a complete examination about methods currently used and tested techniques to avoid a dramatic event as RACS.
It also confirms that the availability of materials and more sophisticated technologies has come to overcome the scepticism of many surgeons about the adequacy of monitoring and postoperative management of these patients.

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