Repair of a laparostomy using biological mesh, topical negative pressure therapy and skin graft

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Abstract

The management of an open abdomen may present client and wound care challenges until the abdomen is closed[1]. This case study describes a client who had a laparostomy and extensive tissue debridement of the abdominal wall on a background of small bowel perforation, peritonitis and life-threatening sepsis. The abdomen remained open for over three weeks from initial emergency surgery prior to commencing repair of the abdominal wall with a biological mesh, Surgisis®. Of interest was the concurrent use of topical negative pressure therapy (TNPT) with the biological mesh until the wound bed was suitable for a skin graft to complete wound closure. At the time, clinical practice guidelines or published literature to guide wound practice, in the context of the exposed biological mesh and TNPT, was not available and is therefore discussed.

Introduction

Management of the open abdomen utilising topical negative pressure therapy (TNPT) is reported in the literature and acknowledges risks and benefits of such therapy[1-5]. Primary closure of the open abdomen is not always possible and the defect may be repaired with a split-thickness skin graft or local tissue flap[6]. If the abdominal muscle layers have not been closed, a secondary consequence is herniation and ongoing tension on the skin graft. In the author's practice, laparostomy and necessity for secondary closure with a skin graft directly over the small bowel is relatively uncommon, with fewer than 10 cases performed at the 550-bed tertiary adult hospital in the last 10 years. The use of a biological mesh on an open abdomen had only been performed once before at this hospital and the wound was later able to be closed primarily. Observations and experience gained in utilising a known therapy, TNPT, with a biological mesh will be outlined in this case where the abdominal defect was too extensive to expect delayed primary closure.

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Literature review

When surgery is undertaken to manage the acute abdomen, primary wound closure may not be achievable where there is a risk of abdominal compartment syndrome or there is a physical inability to close the abdominal layers and skin. Advancements in TNPT have seen the development of specific dressings to interface with the abdominal contents[2]. In the case of the open abdomen, however, there are mixed reports as to its risks and benefits which may include fistula formation[7-9]. The use of TNPT on fenestrated or meshed grafts is well documented and manufacturers of TNPT systems provide guidelines for use[10]. Current clinical guidelines recommend a non-adherent interface dressing and continuous suction at 75–125 mmHg[10].

Various mesh products have been used over the years to repair abdominal hernias[11]. The development and subsequent use of biological mesh instead of synthetic mesh has gained favour due to the lower risks of infection, particularly if contamination has occurred[11-13]. Biological mesh has been described by Peppas *et al.*[13] as a three-dimensional acellular, reabsorbable, extracellular matrix (ECM) comprised mainly of collagen, elastin fibres and other molecules such as proteoglycans and growth factors. Most commonly, they are of bovine or porcine origin and may be non-crosslinked meshes or chemically crosslinked. Surgisis® is a four-layered, laminate, non-crosslinked, hydrated porcine small intestine submucosa with perforations[13]. The mesh provides a scaffold for the constructive remodelling of fibrous tissue and the

mesh biodegrades and is completely replaced four months after implantation[12]. This process is consistent with ECM remodelling, leading to fibrosis[14] and, therefore, splinting of the abdominal contents.

At the time of the case in question, the author was unable to find specific literature concerning cases where this biological mesh was used in an open wound scenario or where TNPT was used as a secondary wound therapy.

Case presentation

A 68-year-old woman underwent surgery of bilateral salpingo-oopherectomy and vaginal hysterectomy at a metropolitan hospital for women. She had a past history of type 2 diabetes mellitus, hypertension, hypercholesterolaemia and tubal ligation. Medications prior to admission included atorvastatin, ezetimibe, aspirin, olmesartan medoximil and the client also took fish oil capsules. Prior to surgery, the client was active and independent and lived with her husband. She had adult children and grandchildren. Her body mass index was estimated to be 31 prior to surgery.

It is understood that the surgery was performed for benign pathology and symptom management. The procedure was undertaken laparoscopically and the client was discharged within 48 hours of surgery. Two days post-discharge, the client was readmitted to the hospital feeling unwell and complaining of abdominal discomfort. Following a diagnosis of constipation, a phosphate enema was administered. Shortly after this, the woman collapsed and was found to have septic shock, necessitating immediate transfer to a nearby tertiary hospital emergency department. Following initial resuscitation, an emergency laparotomy was undertaken, with findings of peritonitis, strangulated small bowel, perforation of the mid-jejunum and gas gangrene of the soft tissue extending from the sub-costal region to the iliac crest. The primary infection and injury was located at the laparoscopic port site in the left flank. The affected loop of bowel was resected and reanastomosed side to side. Extensive debridement and lavage was undertaken and the client was transferred to the intensive care unit (ICU) sedated and intubated. As a result of the significant sepsis, the client developed acute renal failure and multi-organ failure. Other supportive therapies included dialysis and total parenteral nutrition.

Following initial emergency surgery, there were daily returns to the operating theatre over the next six days for exploration and lavage with sequential debridement of non-viable skin, subcutaneous tissue, muscle and fascia. Further second-daily lavages in the theatre setting occurred over the next 10 days. Throughout this time, the wound dressing consisted of moistened gauze packs and a film dressing, which was left intact between surgical procedures.

An additional complication presented in the form of distal digital ischaemia affecting fingers and toes, likely to be the combined effects of inotropes and concurrent sepsis. Her antibiotic therapy consisted of meropenem, linezolid and vancomycin.

At day 20, the wound management nurse practitioner (NP) was invited to join the colorectal surgeon and surgical fellow to attend the scheduled theatre lavage (Figure 1). The intent was to view the abdominal defect and for the team to determine requirements for planned first-stage repair with biological mesh and TNPT. At this stage, the NP's prior experience had been with abdominal TNPT but not with biological mesh. The surgeon had no prior experience in applying TNPT to the abdomen but had observed the use of biological mesh in peer practice. Preparations were then made to have the necessary equipment and staff in attendance for the next scheduled theatre visit.

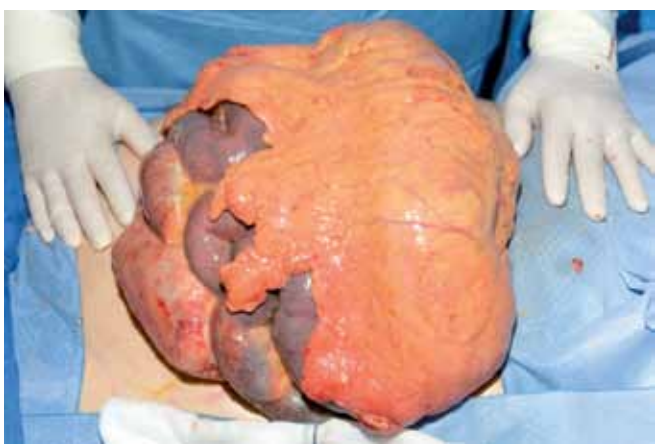

Figure 1. Open abdomen three days prior to inserting biological mesh.

At this stage, the author conducted a limited review of the literature and was unable to locate clinical guidelines to direct practice in relation to application and settings for TNPT use with biological mesh. There had been peer reports of two similar surgical procedures within the previous six months but no existing clinical experience by the author. One case report was later found describing the use of TNPT in the case of Permacol™ biodegradable mesh used to repair abdominal wound dehiscence[6].

At day 23 post-initial laparotomy, the abdominal defect was repaired with a biological mesh (Surgisis®). The wound defect was measured intraoperatively was 67 by 36 cm. As

the maximum available mesh size was too small to cover this defect, a total of four pieces of mesh were sewn together by the surgeon to ensure adequate coverage for repair (Figure 2). Advice from the manufacturer's clinical representative was to manage the open mesh with TNPT at 75 mmHg continuous suction. A non-adherent interface dressing was deemed essential and a large, custom TNPT dressing designed for abdominal wound defects was utilised.

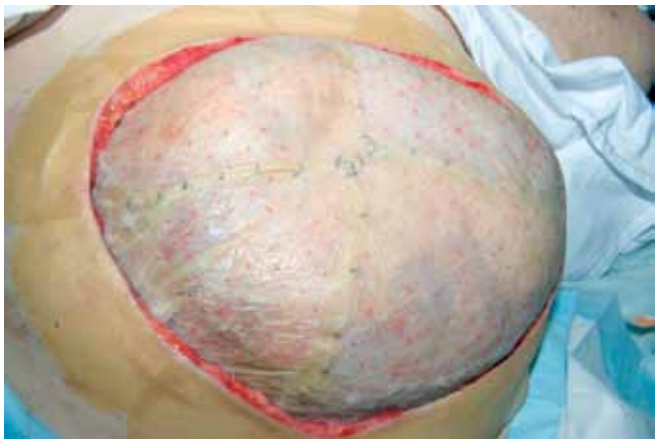

Figure 2. Sutured mesh pieces two weeks post-insertion.

The first dressing change was undertaken in the operating theatre by the NP and a senior nursing colleague with oversight by the surgical fellow; however, all subsequent dressings were undertaken in the ICU or ward, usually with two nurses gowned and gloved and a third nurse assisting. The NP and/or her deputy undertook the dressing initially; however, with the client's pending transfer from ICU to the ward at day 26, it was deemed necessary to train staff how to undertake the procedure. Once the client was extubated, she was provided with information about the abdominal wound and the procedure. Understandably, she was anxious about the procedure and pain management and she was provided with an explanation of the procedural information which was critically important. For the first week post-mesh insertion, her positioning was limited to supine only to avoid tension on the mesh attachments. Subsequently, she was allowed to be rolled on her side for short periods and an abdominal support garment (corset) was applied.

A series of photographs were taken at each step and a photographic care plan was documented with an itemised list of requirements and detailed procedural instructions. A key group of nurses was allocated to care for the client and undertake the procedure with a train-the-trainer focus. Subsequent dependence on the Wound Management Service was reduced and the NP maintained a supervisory role with

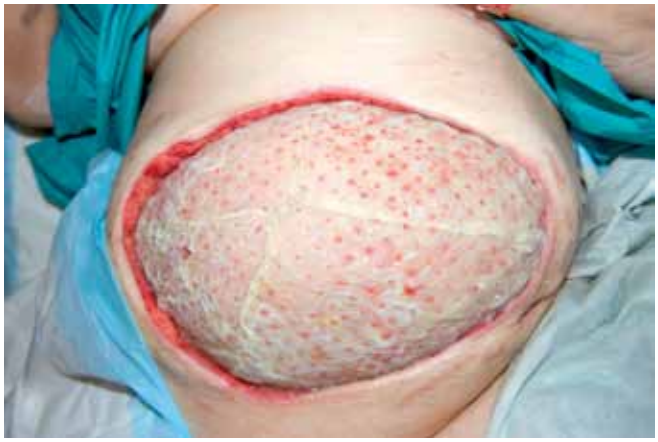

Figure 3. Buds of granulation becoming evident through the mesh at week six.

weekly review and serial clinical photographs were taken. The client came to know the dressing procedure and nuances well and at times advised less experienced nursing staff with instructions.

Over time, the buds of granulation tissue became visible through the mesh (Figure 3) and it eventually sloughed off over a period of approximately 12 weeks (Figures 4–6). The mesh retained a creamy appearance although advice by the manufacturer's representative was that it might take on a greenish hue. The TNPT dressings were changed twice per week during week days to ensure nursing staff had adequate clinical support available if needed. Once the edges of the abdominal wound no longer had gullies present, the custom abdominal TNPT dressing was replaced with a polyvinyl alcohol foam TNPT (Figure 7) dressing to prevent adherence to the wound bed and mesh. As the dressing became more manageable and the client's overall condition and independence improved, she was discharged from hospital

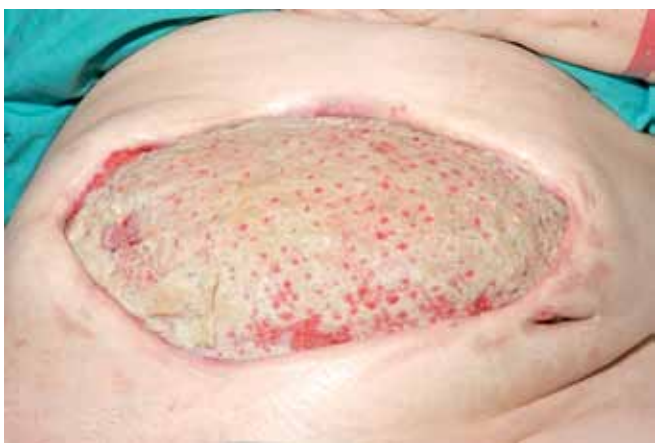

Figure 4. Week nine, early degradation of mesh.

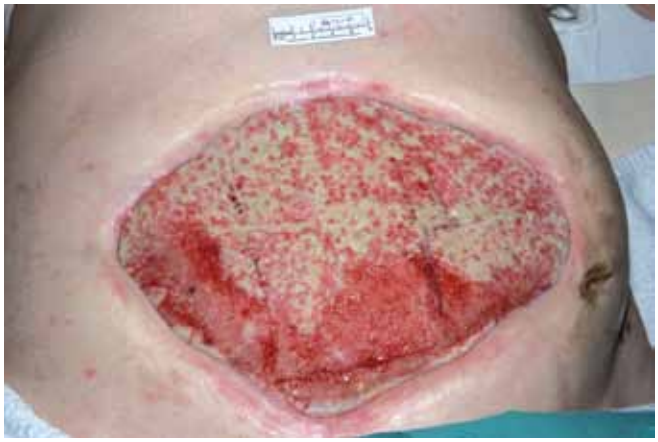

Figure 5. Week 12 prior to discharge.

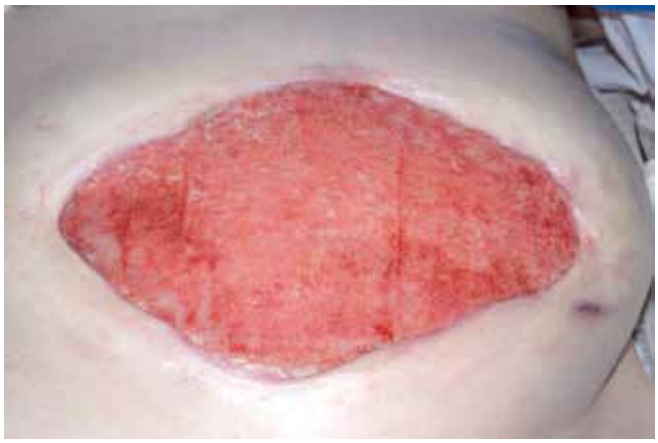

Figure 6. Week 16 prior to SSG.

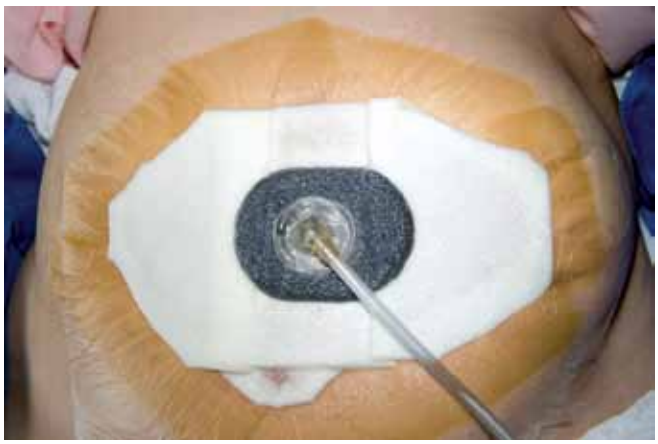

Figure 7. Polyvinyl alcohol foam TNPT dressing in situ with polyurethane foam under TRAC pad.

106 days after admission. A staged discharge plan was implemented and TNPT was continued with hospital in the home nursing services.

Unfortunately, the client required admission 15 days later due to osteomyelitis of her right second toe, secondary to the earlier ischaemic injury, and intravenous antibiotics were recommenced and the toe amputated below the proximal interphalangeal joint. After another six days, a meshed, split-thickness skin graft was applied to the abdominal defect (Figure 8). This was also managed in the initial postoperative period with TNPT and was left intact for five days. Graft

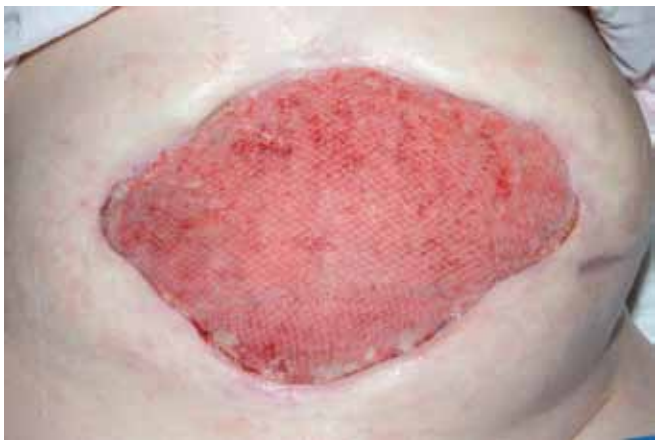

Figure 8. Mesh split-thickness skin graft.

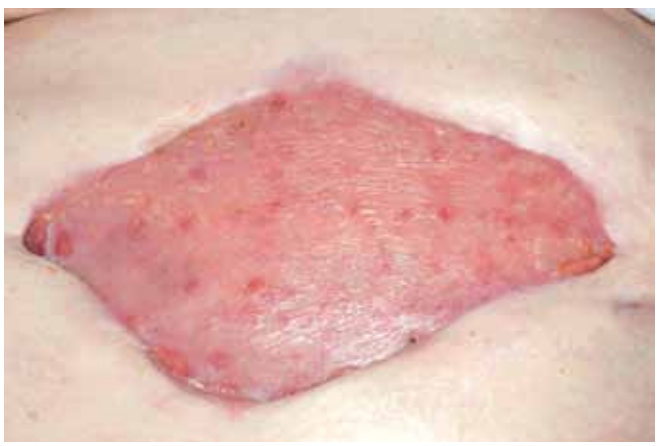

Figure 9. Skin graft three weeks post application.

take overall was approximately 95% (Figure 9). The client was discharged a few days later with periodic review by the infectious diseases physician and plastic surgical team. Abdominal support continued to be utilised with either a Velcro corset or custom-made garment. The corset was the client's preferred option as it was easier to apply and more comfortable.

Discussion

This case highlights the challenges that present with new or novel uses of therapies. The use of biological mesh for hernia repair, in the context of a closed abdominal wound, was known to the surgeon. The use of TNPT in the case of an open abdomen or split-thickness skin graft and clinical practice was established practice and clinical guidelines have been readily available[2,3,10,15]. A transference of knowledge and experience from one clinical scenario to another in a different context is possible when products are used in novel ways. However, the evidence to guide practice is often limited in the first instance and experiential knowledge can assist others until such time that there is a cumulative review of treatments and their outcomes. Follow-up is also important as long-term outcomes in terms of the wound might include dehiscence, pain, fistulae, foreign body reaction or latent infection[12,13,16].

Observations of the behaviour and disintegration of the biological mesh were of interest to the author, particularly in the context of wound repair and regeneration principles and the role of the extracellular matrix. The use of TNPT in a manner that would be appropriate to an open abdominal wound needed to be combined with that of TNPT use with a graft. Key elements were to ensure that the interface dressing did not adhere to the biological mesh; that the exudate from such a large wound was managed; and that no trauma occurred to the underlying bowel until the meshed wound was successfully grafted.

Clinicians calculate, to some degree, that the treatments employed will behave in an expected fashion. It is critical when undertaking variations to treatment that there is clear accountability, clinical leadership, team communication and accurate records of treatment and outcomes. Equally, experiences need to be shared and skills developed amongst a range of clinical staff to ensure that in the absence of established clinical practice guidelines for specific conditions, that knowledge and clinical skills are disseminated for future use.

Conclusion

Evidence-based practice is widely promoted in health care. In instances where there are small numbers of cases and novel therapies, it is often difficult to find the appropriate documented guidance for clinical practice. As new products and devices are introduced, there is often a lag in the cumulative evidence to direct clinical practice. At times then, the clinician or team may need to trial novel uses of therapies to optimise client outcomes, particularly where the risks of not doing so may have significant implications for the client. Apart from achieving closure in a large and complex wound with the use of biological mesh, TNPT and skin graft, this client's eventual return to independence at home would not have been possible without the support of a vast range of health professionals who contributed to the restoration of her health.

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