

Repair of large abdominal wall defects using the Proceed™ surgical mesh with open intra-peritoneum onlay method

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ABSTRACT

الأهداف: التقرير عن فعالية استخدام تقنية الشبكة الراضعة داخل الصفاق بواسطة الشبكة الجراحية بروسيد في علاج عيوب الجدار البطني.

الطريقة: أُجريت هذه الدراسة في قسم الجراحة العامة بالمستشفى الأول التابع لمستشفى جيش التحرير، بكين، الصين وذلك خلال الفترة من مايو 2007م إلى يونيو 2010م. شملت الدراسة 36 مريضاً ممن يعانون من عيوب جدار البطن الناتجة عن الفتق الجراحي أو تلك الناتجة عن استئصال الأورام. لقد تم اللجوء إلى تقنية الشبكة الراضعة داخل الصفاق باستخدام الشبكة الجراحية بروسيد (Proceed™, Ethicon)، إيثيكون، ألمانيا وذلك من أجل إصلاح وإعادة ترميم العيوب في جدار البطن، وبعد ذلك تم تقييم المقاييس المختلفة مع أخذ المضاعفات التالية بعين الاعتبار: التورم المصلي، والتورم الدموي، والتهاب الجروح، والتهاب الشبكة الجراحية، والألم المزمن، وتكون الجيوب التقيحية، ونسبة تكرار هذه المضاعفات.

النتائج: انتهت الدراسة بإصلاح كافة العيوب التي كان يعاني منها المرضى المشاركون في الدراسة وذلك باستخدام الشبكة الجراحية بروسيد. أشارت النتائج إلى أن معدل حجم العيوب وصل إلى 160 سم مربع (بتراوح ما بين 120-600 سم مربع). لقد عانى 11 مريضاً (30.6%) من مضاعفات العملية وقد كانت النتائج كالتالي: 6 حالات مصابة بالتورم المصلي، وحالة واحدة مصابة بالتهاب بسيط في الجروح، وحالة مصابة بالجيوب التقيحية، وحالتين مصابة بالتهاب الرئوي، وحالة مصابة بالتهاب المسالك البولية. لقد وصل معدل فترة المتابعة إلى 28 شهراً (بتراوح ما بين 6-36 شهراً). ولم تسفر نتائج الدراسة عن أي حالات مصابة بالناسور المعوي، أو أية مشاكل مرتبطة بالاتصالات المعوية وآلام الجروح المختلفة، بالإضافة إلى ذلك لم يكن هناك أي تكرار في حالات الفتق، أو حدوث التهابات في الشبكة الجراحية.

خاتمة: أظهرت هذه الدراسة مدى فعالية وسهولة تقنية الشبكة الراضعة داخل الصفاق باستخدام الشبكة الجراحية بروسيد في علاج وإعادة ترميم عيوب الجدار البطني، كما لم يكن هناك أية مضاعفات خطيرة مترتبة عن هذه التقنية.

Objectives: To report our experience with the use of Proceed™, Ethicon, Norderstedt, Germany surgical mesh in the management of large abdominal wall defects with the open intra-peritoneum onlay method.

Methods: Thirty-six patients with large incisional hernia or defects resulting from tumor resection carried out at the Department of General Surgery, the First Affiliated Hospital, General Hospital of People's Liberation Army, China between May 2007 and June 2010 were studied. The abdominal wall defect was repaired using Proceed™ mesh with the intra-peritoneum onlay method. Different parameters were evaluated considering the complications such as seroma, hematoma, wound infection, mesh infection, chronic pain, wound sinus, and recurrences.

Results: All 36 defects were repaired using Proceed™ mesh. The mean size of the defects was 160 cm² (range = 120-600 cm²). Eleven patients (30.6%) developed a complication (6 seromas, one minor wound infection, one wound sinus, 2 pulmonary infection, and one urinary tract infection). The mean follow-up period was 28 months (range 6-36 months). There were no cases of intestinal fistula or problems related to intestinal adhesion and chronic wound pain. No hernia recurrence, or mesh infection occurred.

Conclusion: The intra-peritoneum repair technique for a large abdominal wall defect using Proceed™ mesh is a feasible and safe method, with no major complications.

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Large abdominal wall hernia or defect is a common disease in general surgery, which usually results from trauma, tumor resection, and infection. Reconstruction of abdominal wall defects is a challenging problem. Many types of repair material have been used to solve the problem, but there is still no perfect material for reconstruction of abdominal wall defects up to date. Some types of meshes have been introduced to be used intra-abdominally with acceptable results.¹⁻⁶ However, adhesion formation and excessive fibrosis or shrinkage of the mesh, as well as possible resistant infection, requires further improvement of the mesh.⁷⁻¹² The Proceed™ mesh was a composite mesh, which consisted of a nonabsorbable polypropylene layer and an absorbable layer of oxidized regenerated cellulose (ORC), with a layer of polydioxanone (PDS) between them. The absorbable ORC side can contact the viscera directly, so the mesh could be used intra-abdominally. In this study we report our experience with the use of Proceed™ mesh in the management of large abdominal wall defects with intra-peritoneum onlay method.

Methods. Between May 2007 and June 2010, 36 consecutive patients with large abdominal wall defects at the Department of General Surgery, the First Affiliated Hospital, General Hospital of People's Liberation Army, China, were included in this study. The Institutional Ethics Committee believed this study was only a retrospective study, and therefore did not need formal ethical approval. Our inclusion criteria were patients with abdominal wall defects arising from a large incisional hernia, extensive soft-tissue loss resulting from tumor resection, and the Max diameter of the defect was larger than 10 cm. The exclusion criteria were that the Max diameter of the abdominal wall defect was less than 10 cm. Overall 36 abdominal wall defects were repaired using Proceed™ mesh. All the defects were closed without tension using Proceed™ mesh. Preoperatively, all patients were evaluated by full history and physical examination. Site and size of the defects were carefully assessed. Preoperative bowel preparation was routinely used. All patients received broad-spectrum antibiotic prophylaxis preoperatively intravenously 30 minutes before incision. All procedures were performed under general anesthesia. We used Proceed™ mesh to reconstruct abdominal wall defects. An appropriate size mesh was selected depending on the size of the defect.

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Surgical technique. All patients with abdominal wall defects underwent exposure of the hernia sac and fascial margins of the defect through preexisting incision lines, and the cutaneous scars were excised. In all cases the fascial margins were defined clearly. Lysis of adhesions and any intra-abdominal procedures were performed as appropriate. For abdominal wall cancer metastasis or desmoids tumor, the tumor excision with 3-cm healthy margins including the peritoneum invaded was performed. And the intraoperative margin biopsy was performed to insure negative margin. The patch overlapped the defect and its border exceeded the defect edge upwards of 5 cm in all directions. The Proceed™ mesh was affixed as an intra-peritoneum onlay method, and it was fixed with interrupted sutures with intervals of 3 cm using 0 polypropylene sutures by 2 circles, which were circumferentially along its peripheral edge and along the defect edge. Two subcutaneous drains attached to a closed suction collection device were used over the mesh to minimize seroma formation (Figure 1). Subcutaneous tissue was reapproximated with interrupted absorbable sutures and skin was primarily closed with clips in all patients. The operating time and intraoperative blood loss were recorded. Any intraoperative complications were also recorded.

Postoperative protocol. Patients were assessed closely for any postoperative complications. Patients were

Table 1 - Characteristics of patients with large abdominal wall defects at the General Hospital of People's Liberation Army, China (n=36).

Parameters	Total
Age (year)	19-76
Gender (male/female)	20/16
Incision	
Midline	29
Other	7
Types of abdominal wall defect	
Initial incisional hernia	22
Recurrent incisional hernia	4
Incarcerated incisional hernia	2
Abdominal wall cancer metastasis	2
Desmoids tumor resection	6
Risk factors	
COPD	1
Diabetes mellitus	5
Obesity (BMI ≥30)	8
Contaminated factor	
Cholecystectomy	2
Intestinal resection	4
Pancreatic fistula and pancreaticoenterostomy	1
Enterocutaneous fistula	1
Size of the defects (cm ²)	160 (120-600)
Operation time (minutes)	100 (60-210)
Postoperative length of hospital stay (days)	11 (7-32)

Values are given as median (range) or number (n) unless specified, COPD - chronic obstructive pulmonary disease, BMI - body mass index



Figure 1 - The hernia repaired with Proceed™ mesh and 2 drains placed over the mesh.



Figure 2 - Anterior view of the huge abdominal wall tumor.



Figure 3 - The large defect repaired with 2 meshes sutured together.



Figure 4 - The patient received pancreaticoenterostomy and incisional hernia repaired using Proceed™ mesh.

further evaluated and documented at 3 weeks, 3, and 6 months postoperatively in the outpatient clinic. Postoperative incidences of seroma and hematoma, wound and/or mesh infections, and the number of recurrences were also checked at these visits. Follow-up at 12 months and yearly thereafter was performed by telephone using a standardized checklist. Only patients with complaints suggestive of recurrence were invited for further hospital visit. The incidence of complications was determined by using homogeneous definitions. We defined seroma as fluid collections that required drainage or caused symptoms. The definition of wound infection was based on clinical signs of infection and microbiological culture. Chronic pain was evaluated by the intake of oral analgetics 6 months postoperatively. Recurrence was defined as any abnormal protrusion at the site of the prior repair.

Results. Demographic characteristics of the patients in our series include a median age of 54 years (range = 19-76 years), a male: female ratio of 20:16, and a median weight of 70 kg (range = 54-109 kg).

The mean defect size was 160cm² (range 120-600 cm²). Details of the patient characteristics are shown in **Table 1**. In 2 patients the defects resulting from abdominal wall tumor resection were so large that one Proceed™ mesh was not large enough, so another piece of polypropylene patch was sutured with the Proceed™ mesh (**Figures 2 and 3**), and the greater omentum was spread between the polypropylene mesh and viscera. Of the 36 patients, 22 had first-time repair of a large incisional hernia, 4 had 2 or more previous repairs, 2 had incarcerated incisional hernia, 2 had abdominal wall cancer metastasis, and 6 were from desmoids tumor resection. Eight patients had a contaminated wound, in which 2 underwent cholecystectomy because of cholelithiasis, 4 underwent intestinal resection, and anastomosis because of tumor invasion, one with enterocutaneous fistula underwent intestinal resection, and one with pancreatic fistula received pancreaticoenterostomy (**Figure 4**). All patients had an uneventful recovery.

There was no death in this series. Eleven patients (30.6%) developed complications. Six patients with seromas were managed by percutaneous aspiration and

pressure dressing. One patient with localized wound infection was managed conservatively with antibiotics and physical therapy without removing the mesh. One patient developed a wound sinus and managed by wound dressing and albumin gel perfusion. Two patients with pulmonary infection were treated by systemic antibiotic therapy. One patient developed urinary tract infection and received oral antibiotics. The median follow-up was 28 months (range= 6-36 months). There were no hernia recurrences, and mesh infections. Intestinal fistulae, or chronic wound pain.

Discussion. Surgeons often encounter the challenge of repairing large abdominal wall hernias, or defects mostly resulting from trauma, tumor resection, infection, and electric burns. In this study, the abdominal wall defect consists of incisional hernia and full thickness abdominal wall defects resulting from tumor resection. Tension-free hernia repair technique has gained wide acceptance for repairing abdominal wall defects, and surgeons have developed various techniques to achieve this purpose, such as prosthetic mesh repair, autologous tissue grafts repair, acellular dermal matrix patch repair, and components separation technique.¹³⁻¹⁷ Currently, most defects, especially large defects, are repaired using synthetic mesh material. Mesh augments the strength of the weakened abdominal wall and achieves a tension-free repair manner.

Polypropylene mesh is the most commonly used type of synthetic mesh, but the intra-abdominal placement of this material is generally not recommended because it can increase the risk of adhesions to intra-abdominal viscera and enterocutaneous fistula formation.¹⁸ Peritoneal preservation is important for the repair of abdominal wall defects, and the polypropylene mesh could be used in this situation. However, if the defect is so large, especially resulting from tumor resection, the peritoneum has to be resected with the tumor en bloc so as to acquire negative margins. Therefore, the large abdominal wall repair, especially without entire peritoneum covering the mesh would be in contact with viscera, and a different type of mesh is needed.

Expanded polytetrafluoroethylene (ePTFE) has also been used for abdominal wall defects. This material is strong and biocompatible and less likely to stimulate adhesions to the viscera. However, it is largely intolerant of infection and its use in the presence of contamination, infection, and enteric fistulae is limited.^{19,20} Autologous tissue grafts can be used to repair abdominal wall defects in contaminated area, but the prosthetic materials were contraindicated in this situation.²¹ However, autologous tissues are not always sufficient, especially for large abdominal wall defects, and acquiring the autologous tissues is an added trauma for patient, which can greatly

increase operative time, complexity, and morbidity. Ko et al¹³ described the technique of the “component separation method” for repair of abdominal wall defects. Using this technique the abdominal wall defect can be repaired without prosthetic materials, as well as without autologous tissue grafts. But, this technique also has its disadvantages, such as the extensive tissue dissection, and just like autologous tissue grafts technique, it is also not always sufficient especially for large defects, requiring additional prosthetic mesh.²² Moreover, de Vries Reilingh reported a 32% reherniation rate in a series of 43 patients following component separation repairs.²³

Proceed™ mesh consists of a non-reabsorbable polypropylene mesh layer and an absorbable tissue-separating layer of ORC. The polypropylene part is separated by a layer of PDS polymer film. The intent of the polypropylene side of the mesh is to allow adequate tissue ingrowth,¹¹ whereas the ORC should provide a bioresorbable layer that physically separates the polypropylene from the underlying tissue and organ surfaces in order to minimize tissue attachment. The PDS film provides a thin flexible bond between the mesh and the ORC. The PDS film around the polypropylene provides additional handling comfort during repairs by creating extra mesh flexibility. As the ORC and PDS layers are bioresorbable, namely, after ingrowth of the polypropylene, the mesh contains much less polypropylene and can be considered as a “light (er) weight mesh” or maybe better as a “large-pore” mesh. Large-pore polypropylene meshes should still be strong enough to resist maximal physiological stress of the abdominal wall, despite reducing the amount of foreign material, but it will be associated with less of the above mentioned side effects. Obviously, the type of polymer, the weight of the mesh, the proportion of pores in percentage, the size of the pores, and, therefore, the surface area in contact with the recipient tissues plays key roles in the evaluation of both biocompatibility and host reaction.²⁴ Reducing the amount of introduced material and enlarging the pore size adapt the mesh to the physiological demands and result in a significant improvement in biocompatibility.^{25,26} This property allows its use in contaminated wounds. In this series, 2 patients had cholecystectomy, 4 intestinal resection, one pancreatic fistula and pancreaticoenterostomy and one enterocutaneous fistula, these circumstances resulted in wound contamination. So, using the prosthetic mesh is a challenge. In our department, we have gained a lot of successful experiences using prosthetic mesh repairing contaminated abdominal wall defects or hernia. Approximately 30 minutes before the operation prophylactic antibiotics were administered. During

the operation, the incisional area should be carefully preserved from intestinal contents contamination. A lot of normal saline and metronidazole solution are used to rinse the abdominal cavity before mesh repair. Subcutaneous drainage catheters attached to a closed suction collection device should be placed over the mesh. Antibiotics should be continuously applied adequately for prolonged time after operation. In this study Proceed™ mesh was used successfully in potentially contaminated wounds, and no mesh infection or major complication occurred.

Mesh shrinkage is a common disadvantage for most prosthetic meshes, which may be the most possible reason for hernia recurrence after mesh repair. Burger¹¹ found that the shrinkage of meshes used intra-peritoneum could be up to 50% in animal models. More compliance and less shrinkage are an important characteristic for Proceed™ mesh because of its composite construction. The ORC layer without loss of memory makes placement and spreading the mesh easier. This aspect is especially beneficial when the mesh is used intra-abdominally. It is documented that seroma formation is increased in ventral hernia repair.²⁷⁻³⁰ Seroma formation has been reported in 1-15% of cases following incisional hernia repair. In this series, wound seroma occurred in 6 patients proved by ultrasound inspection. They received 3 to 5 times percutaneous drainage and pressure dressing. According to our experience, it is necessary and effective to place drainage catheters over the mesh to avoid seroma formation and mesh infection. Ultrasound is a very convenient and sensitive method for wound seroma inspection.

Wound infection is another common complication (4-12%), in some cases requiring removal of the synthetic mesh.^{31,32} Stremitzer et al¹⁴ reported a 6.5% incidence of deep surgical site infection involving the implanted mesh graft, and Martin-Duce et al³² reported persistent pain beyond 6 months in 28% of patients. Wound infection occurred in one of our cases and resolved with antibiotics. No mesh infection occurred, and none of our patients required removal of the implant due to complication. Mesh infection seems to be no problem when using this mesh.

There were no disabling complications directly related to the use of Proceed™ mesh, such as wound contracture, adhesions, fistula, and intestinal obstruction in this study. With open techniques, the incidence of chronic pain is reported to be as high as 30%.^{33,34} There was no chronic pain reported in our study, and there was no hernia recurrence or hernia appearance in our series.

Another problem that should be mentioned was the elevated intra-abdominal pressure after large mesh repair, which could result in abdominal hypertension and

compartment syndrome. To avoid this complication, the patients should be treated pre-operation with an abdominal bandage to gradually increase the intra-abdominal pressure. Therefore, the patient has the chance to adapt to the change in the intra-abdominal pressure. In our series, no complication of abdominal compartment syndrome occurred.

In conclusion, the open intra-peritoneum repair technique for a large abdominal wall defect using Proceed™ mesh is a feasible and safe method. There were no major complications related to the mesh. The mesh seems to be safe and efficient, and seems to be associated with a low complication rate. Confirmation of its effectiveness requires further studies with a greater number of patients, and long-term follow-up.

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