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Abdominal wall reconstruction with dual layer cross-linked porcine dermal xenograft: The "Pork Sandwich" herniorraphy☆

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Summary *Introduction:* The repair of large ventral hernias is a challenging problem. This study investigated the use of decellularized, chemically cross-linked porcine dermal xenograft in conjunction with component separation (a.k.a. the "Pork Sandwich" Herniorraphy) in the repair of abdominal wall defects.
Materials and methods: We prospectively collected data over a 3-year period. Primary or near-total primary fascial closure was our goal in operative repair. A cross-linked porcine dermal xenograft mesh underlay and overlay were used to provide maximal reinforcement of the repair. Outcomes were compared with a case-controlled cohort of 84 patients who underwent ventral hernia repairs with alternative methods at our institution.
Results: Nineteen patients were included. Mean age was 55 years old, and mean body mass index (BMI) was 30 kg/m^2. Mean defect size was 321 cm^2. Post-operative complications were observed in ten out of 19 patients. Complications included seroma ($n = 2$), wound infection ($n = 2$), abscess ($n = 1$), skin necrosis ($n = 6$), and fistula formation ($n = 3$). Seven patients required re-operation. Statistically significant factors ($p < 0.05$) that contributed to increased post-operative complications or re-operation rates included smoking, presence of pre-operative enterocutaneous fistulae, extended post-operative hospital stay (>2 weeks), and a defect size greater than 300 cm^2. There were no hernia recurrences in our "Pork Sandwich" group, which contrasted favorably to the retrospective case-control group in which the hernia recurrence rate was 19% ($p = 0.038$).
Discussion: For the repair of abdominal hernias, primary closure, with component separation as needed, with an underlay and overlay of cross-liked porcine xenograft should be considered

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to minimize risk of recurrent herniation. Additional long-term prospective comparative studies are needed for further validation of the optimal method and material for repair.

Introduction

Reconstruction of abdominal wall hernias and defects is a challenging problem. Ventral incisional hernias can occur in up to 11% of initial laparotomies.[1,2] Although most primary hernias can be closed with primary fascial repair with or without synthetic mesh, recurrence rates can be as high as 44–46%, depending on the technique.[3,4] In many complicated cases the surgeon is presented with a patient who has already endured numerous unsuccessful operations, leaving skin and fascia that is attenuated, unreliable, or missing. The patient requiring hernia repair often has local and systemic issues such as the presence of infection, mesh, enterostomy, enterocutaneous fistulae, obesity, diabetes, cancer, and other comorbidities that complicate reconstructive planning. Various techniques exist that attempt to achieve the primary goals of abdominal wall reconstruction: to restore the functional integrity of the abdominal wall, to provide support, to protect the abdominal viscera, and to minimize complications.

Theoretically, autogenous tissue would be preferable in hernia reconstruction, especially in the setting of infection or contamination. This can involve direct primary closure in small defects, while using fascial grafts, local composite flaps, and free flaps for more complicated repairs.[5,6] However, these techniques are not without limitations and add potential donor site morbidity when reconstructing extensive wounds.[7] Component separation as initially described by Ramirez et al. can be employed and involves a series of bilateral fascial incisions to bring about sequential advancement and primary, functional closure of the abdominal wall defect.[8] However, recurrence rates can occur in up to 32% of these cases.[9] Furthermore, in up to 33% of component separation procedures there may still be a persistent fascial defect, which necessitates the use of synthetic or biosynthetic material.[10]

The use of biologic mesh in hernia repairs has had favorable results. In aggregate, biologics have published evidence showing success rates greater than 90% overall, though outcome and recurrence rates depend highly on material source and processing.[11] Human-derived mesh has been studied most extensively, with *in vivo* studies showing that human dermal graft has excellent integration and tissue formation.[12] However, investigations have shown that the use of acellular human dermal matrix can result in hernia recurrence rates up to 80%.[13] In our report, we preferentially used decellularized chemically cross-linked porcine dermis (Permacol, Covidien, Mansfield, MA) in the repair of large abdominal defects, which has been described previously in small case series.[14–19] The chemical cross-linking of collagen in Permacol may confer additional strength and resistance to rapid degradation,[20–22] although studies are not entirely conclusive.

The purpose of our study was to examine the efficacy of a specific technique in repairing abdominal hernias using component separation, as needed, to achieve total or near-total primary fascial closure followed by a Permacol underlay and overlay to provide maximal reinforcement of the suture line. The outcomes of 19 consecutive patients who underwent our "Pork Sandwich" herniorraphy were then compared with a retrospective case-controlled cohort of patients at our institution who underwent abdominal wall reconstruction using alternative techniques.

Materials and methods

Institutional Review Board approval was obtained for this study. Data were collected prospectively on patients who consecutively underwent abdominal wall reconstruction with cross-linked dermal xenograft (Permacol, Covidien, Mansfield, MA) in a "sandwich" fashion over a 3-year period (February 2007 to March 2010). Factors evaluated included age, body mass index (BMI), comorbidities, previous hernia repairs, previous use of mesh, length of hospital stay, defect size, post-operative complications, hernia recurrences, and re-operations. Only patients who had repair with mesh were included in the study. Exclusion criteria included defect size < 100 cm^2, or repairs performed laparoscopically, without mesh, or in a "bridging" fashion with mesh.

Primary tension-free fascial closure was always the goal for surgical repair of hernias. For massive defects not readily closed primarily, a component separation technique was performed to achieve total or near-total primary fascial closure. In all cases, placement of a Permacol underlay and overlay (a.k.a. the "Pork Sandwich" herniorraphy, as illustrated in Figure 1) was used to provide optimal reinforcement of the repair.

The outcomes of the "Pork Sandwich" group were then compared with a retrospective cohort of 84 patients who underwent large ventral hernia repairs at our institution from February 2004 to August 2009. These patients underwent repair using a non-"sandwich," single-mesh technique as either an underlay or an overlay. Mesh used in this retrospective group included Permacol (Covidien, Mansfield, MA), Strattice (Lifecell, Branchburg, NJ), DermaMatrix (Synthes, West Chester, PA), Alloderm (Lifecell, Branchburg, NJ), Prolene (Boston Scientific, Boston, MA), or Parietex (Covidien, Mansfield, MA), or Goretex (W.L. Gore & Associates, Flagstaff, AZ). The "Pork Sandwich" group and the retrospective case-controlled group were matched for age, BMI, pre-operative comorbidities, length of follow-up, and defect size. Stata/IC 11 software (StataCorp, College Station, TX) was utilized for statistical analysis. Two-tailed Fisher's exact test and Student's *t-test* (unequal variance) were used, with $p < 0.05$ indicating statistical significance.