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Abdominal wall dynamics after component separation hernia repair

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ABSTRACT

Background: The component separation technique (CST) is an important technique now used frequently in complex ventral hernia repair (VHR). Although this technique has demonstrated superior success rates, there is a paucity of research describing how release of the external obliques coupled with rectus myofascial advancement alters the morphology of the abdominal architecture. In this study, we apply the new concept of analytic morphomics to describe the immediate changes in morphology of the abdomen that take place after VHR by CST.

Methods: We identified 21 patients who underwent VHR by CST and received both preoperative and postoperative computed tomography scans between 2004 and 2009 in our clinical database. The surgical technique involved incisional release of the external oblique muscle lateral to the linea semilunaris with rectus abdominis myofascial advancement in all patients. Using semiautomated morphomic analysis, we measured the pre- and postoperative dimensions of the abdominal wall including the anterior–posterior distance from the anterior vertebra-to-skin and fascia along with the circumferential area of the skin and fascial compartments. Paired Student *t*-tests were used to compare pre- and postoperative values.

Results: After hernia repair, there was a decrease in the anterior vertebra-to-skin distance (16.6 cm–15.8 cm, $P = 0.007$). There were also decreases in total body area (968.0 cm^2 –928.6 cm^2, $P = 0.017$) and total body circumference (113.6 cm–111.4 cm, $P = 0.016$). The distance from fascia to skin decreased as well, almost to the point of statistical significance (3.3 cm–2.9 cm, $P = 0.0505$). Interestingly, fascia area and circumference did not decrease significantly after the operation (578.2 cm^2–572.5 cm^2, $P = 0.519$, and 89.1 cm–88.6 cm, $P = 0.394$, respectively).

Conclusions: Morphomic analysis can be used to compare and pre- and post-operative changes in patients undergoing abdominal surgery. Our study demonstrates that component separation affects the dimensions of the entire abdomen, but leaves the fascia area and circumference relatively unchanged. These changes in the abdominal wall may help explain the muscular changes observed as a result of this operation and demonstrate that

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this is a functional operation that restores fascial area. By better defining the effects of this procedure, we can better understand the reason for its clinical success.

1. Introduction

Ventral, or incisional, hernias are one of the most morbid complications of midline abdominal surgeries, and occur in 2%–11% of all laparotomies [1]. Use of mesh closure is still an unsatisfactory solution, with complication rates of 9%–50% and recurrence rates ranging from 5%–11% [2,3]. Moreover, infection is an important consideration when using a synthetic material [4]. When mesh repair of hernias fails, more advanced surgical techniques are necessary. In such situations, the component separation technique (CST) allows for the advancement of the myofascial layers of the abdominal wall by dissecting the layers of the abdominal wall. By doing so, the anterior rectus sheath can be advanced to close the hernia defect [5]. Following CST repair, patients also report improvements in the functionality of their abdomen postoperatively relative to their preoperative state [6]. Ventral hernia repair (VHR) repair by CST is especially useful as it provides a single-stage repair for patients with infected mesh, with a seroma around a mesh, or whose mesh is exposed to an otherwise contaminated field [7,8]. By using the patient's native, well-vascularized tissue, CST avoids the risks of infection and extrusion inherent to a bridging prosthetic mesh closure [9,10].

Although component separation has demonstrated high clinical utility in patients with complex or large ventral hernias, our understanding of the changes in abdominal morphology associated with surgery is poor. Improving our understanding of abdominal morphology is important to developing adjunctive operative procedures to further improve outcomes in patients with this complex and costly disorder. One of the reasons that CST produces superior results compared with prosthetic closure is because it alleviates the tension placed on the hernia defect and restores the abdominal wall to a more physiologic morphology [11]. In this study, we use morphomic analysis, an anatomically indexed, semiautomated methodology to assess morphology based on computed tomography (CT) scans.

2. Methods

2.1. Study population

This study was approved by the Institutional Review Board at the University of Michigan. All patients who underwent complex VHR using the CST at the University of Michigan Hospital between 2004 and 2012 were identified. Both patients whose ventral hernias had and had not been repaired were included in this study. Through this process, we identified 93 patients. Individual patient data, surgical details, and information about complications were collected from the clinical records. This process has been previously described [12]. We selected patients with a body mass index (BMI) greater than 25. From this population, we identified 21 patients who underwent VHR by CST and received both preoperative and postoperative abdominal CT scans within 1 y before or after their operation.

2.2. Surgical approach

All patients in this series underwent exposure of the hernia sac, prosthetic material, and fascial margins of the defect through excision of preexisting scars or open wound. All exposed synthetic materials were removed, and purulent or infected collection pockets were drained, soft tissues were debrided, and wounds were vigorously irrigated before reconstruction.

In this series, the surgeon elevated skin and subcutaneous tissues in the prefascial plane above the anterior rectus sheath and over the external oblique muscle fascia. The external oblique fascia was incised parallel to the linea semilunaris, from the costal margin to the pubis. The avascular tissue plane was bluntly dissected between the external and internal oblique muscles to allow for separation of the myofascial layers and advancement of the rectus abdominis and internal oblique myofascial complexes. In this series of patients, no other releases were performed. Fascial edges spanned the midline after release, allowing for approximation and defect closure. Human and porcine dermal matrices and synthetic meshes were used as underlay materials in the repair of larger defects at the discretion of the surgeon. This surgical approach has been described previously [12].

Abdominal wall protocol CT scans were performed in the early postoperative period at the discretion of the primary surgeons to evaluate the abdomen.

2.3. Analytic morphomics

Preoperative and postoperative abdominal CT scans are processed in a semiautomated fashion, using algorithms programmed into MATLAB version 13.0, as previously described [12]. These algorithms rely on prespecified anatomic landmarks (Fig. 1). The initial processing step identifies individual vertebral levels on each patient's scan from T12 through L4, which serve as standard anatomic landmarks to allow for subsequent analyses. Next, the linea alba and the anterior abdominal skin are identified along the midline at each vertebral level, and the skin layer (Fig. 2, purple contours) and fascia layer (Fig. 2, yellow contours) are extrapolated from these lines. In patients where the hernia sac exists in the analyzed region, the fascia layer is extrapolated between the medial borders of the fascia adjacent to the hernia sac. The subcutaneous fat distance is the average distance from the linea alba to the anterior midline of the skin along T12 to L4. The visceral anterior–posterior (AP) distance is similarly calculated as the average distance between the anterior aspect of the vertebra and the linea alba at these vertebral