This retrospective study reveals the results of our approach to the treatment of complex ventral hernias. A single-center, single-surgeon retrospective chart review on 68 consecutive patients who underwent abdominal wall reconstruction for incisional herniation on the midline between January 2012 and December 2016 is presented. The Bonheiden technique is based on anterior component separation in combination with preperitoneal retromuscular mesh reinforcement of the midline. Data of 68 consecutive cases of incisional midline abdominal wall defects treated electively with the mesh reinforced anterior component separation technique were analyzed. Demographics, patient characteristics, and hernia properties were evaluated. Postoperative complications included 28% of wound infections/dehiscence, 25% seromas, and 7% hematomas. No recurrences have been seen. We conclude this technique to be safe and reliable for large midline defects in patients suffering with several comorbidities.
Reconstruction of complex abdominal wall defects accounts for a challenging task within the field of abdominal reconstructive surgery. Incisional hernia is a common problem seen in daily practice. Even though hernia formation has already been described in ancient times, incidence rises as survival after major abdominal surgery increases. The aim of this article is not to propose a new technique, but to provide tips and tricks to implement this surgical technique safely in current clinical practice.

Materials and Methods

We performed a single-center, single-surgeon retrospective chart review on 68 consecutive patients who underwent abdominal wall reconstruction for incisional herniation on the midline between January 2012 and December 2016. Inclusion criteria for this review were patients suffering from incisional midline hernia treated with anterior component separation in combination with retromuscular, preperitoneal midline mesh reinforcement. Exclusion criteria were hernias treated with different reconstruction techniques, including laparoscopic hernia repair, the use of mesh reinforcement without component separation, the sandwich technique, and combined procedures to treat midline and lateral hernia (such as posterior component separation). Hernia properties were measured and described using the European Hernia Society guidelines.

Surgical Technique

Preoperatively, the abdominal wall defect was properly indicated with a black marker, using the Valsalva maneuver, in the patient in the upright position. Skin incision was performed on the midline and deflected around the umbilicus. The length of the incision ranged in the largest defects from xyphoid to pubis. Using electrocautery, the dissection of the subcutaneous fatty layer was started on the midline above the hernia until the hernia sac was reached. The dissection was further extended cranially and caudally until the midline fascia was exposed. A progressive release of the hernia sac out of the subcutis was continued until the proper borders of the hernia were visualized. In this case review, care was taken not to open the hernial sac. The dissection was then continued laterally in a plane superficial to the anterior fascia of the rectus muscle. This midline-to-lateral dissection was performed until the aponeurosis of the external oblique muscle was exposed. When a complete dissection of the subcutaneous plane was obtained, the medial borders of the rectus muscle were determined. This could be done by visual...
inspection or by gentle coagulation on the anterior fascia, from medial to lateral, until muscle contractions were evoked. At that point, the anterior fascia was incised on the medial side of the rectus muscle to reach the retromuscular plane (Fig. 1). The anterior fascia was grasped with Kocher forceps and lifted up to facilitate the retromuscular dissection. Dissection was continued laterally in the relatively avascular retromuscular space until the lateral border of the rectus muscle, also referred to as the linea semilunaris, was identified (Fig. 2). In this phase of dissection, care should be taken not to damage the inferior epigastric vessels and its perforants. The posterior rectus fascia was preserved conscientiously to avoid damage to the underlying intestines. Tailored to the abdominal wall defect, the retromuscular plain could be extended cranially to expose the subxiphoid fatty triangle by incising the posterior sheath at the level of the palpable xiphoid. Caudally, dissection should be proceeded towards the Retzius space. Subsequently, the anterior component separation was started to release the external oblique aponeurosis. At this stage, the surgeon placed his hand in the retromuscular plane and gently pushed the posterior fascia downwards. By moving his hand laterally and implementing sufficient tension posteriorly, he allowed reliable visualization of the linea semilunaris. Alternatively, the pinch test was used to identify linea semilunaris. Hereby, one can feel the margin of the rectus abdominal muscle laterally. Subsequently, a clear-cut release could be performed approximately 1cm lateral to the edge of the rectus muscle exposed by this maneuver (Fig. 3). The release should extend from the inguinal ligament inferiorty up to the costal margin superiorly. If need be, the release of the external oblique aponeurosis could even extend in the upper part anteriorly to the rib cage. After mobilization of the myofascial rectus flaps bilaterally, the retromuscular plane was measured and the mesh was adjusted. Defects in the posterior fascia were sutured to prevent bowel contact. Sometimes, a razing of the posterior sheath was performed when too much laxity was seen. The polypropylene mesh, VentraLight™ ST (C. R. Bard, Inc., Murray Hill, New Jersey) in our series, was positioned, reaching up to the retroxipoid area superiorly, the space of Retzius inferiorly, and the transverse abdominal muscle laterally. Transfascial sutures were used at the surgeon’s discretion but, in most cases, 12 stitches were used. Two drains were left in the peritoneal space until the subxiphoidal suction drainage system.

**RESULTS**

Data on 68 consecutive cases of incisional midline abdominal wall defects treated electively with the mesh reinforced anterior component separation technique between January 2012 and December 2016 were analyzed. We present demographics, patient characteristics, and hernia properties in Table I. The patient’s mean age was 62 ±12.8 years old and 53% of the study population was male. Twelve patients (18%) had a normal weight, 28 patients (41%) were overweight, and another 28 patients (41%) were obese as seen in Table II. In the group with obesity, seventeen patients (61%) had class 1 obesity, six patients (21%) had class 2 obesity, and five patients (18%) had class 3 obesity. Six patients were active smokers, seven patients had diabetes mellitus, three patients had frequently increased intra-abdominal pressure due to coughing (asthma, COPD), and one patient had ascites. Seven patients (10%) had a recurrent hernia after previous repair. Complex hernia repair was defined by grouping patients in patient severity classes based on these comorbidities. Ten we represent hernia properties in Table III as proposed by the European Hernia Society (EHS), subdividing abdominal midline defects into five groups in accordance with location and into three groups in accordance with width of the hernia. Hernia location was subxiphoidal (M1) in 3%, supraumbilical (M2) in 65%, umbilical (M3) in 28%, infra-umbilical (M4) in 3%, and suprapubical (M5) in 1%. The size was <4cm (W1) in 21%, 4–10cm (W2) in 54%, and >10cm (W3) in 25% of cases.

Mean hospitalization time was 8±4 days (range 2–24 days) and mean follow-up time was 15±14 months (range 1–52 months).

Nineteen patients (28%) suffered a certain amount of wound dehiscence on the midline. Wounds were treated either with local wound care (n=7, 10%) or vacuum-assisted wound therapy (VAC) (n=8, 12%). Wounds were considered to be clean in 18 cases and clean contam-
inated in one case. The latter patient was treated with antibiotics. Re-operation with debridement and secondary closure of the wound was performed under general anesthesia in three patients (4%) and using local anesthesia in one patient (2%). One patient developed evisceration which was treated with urgent revision.

Postoperative seroma formation was seen in 16 patients (25%) and hematoma was developed in five cases (7%). This finding was detected on ultrasound in five patients without clinical symptoms. For symptomatic patients, watchful waiting with no further treatment was performed for four patients and 12 patients required puncture of the hematoma/seroma.

Hernia recurrence was detected clinically. For these follow-up periods, no hernia recurrence was seen.

Discussion

The formation of incisional hernia is based on laparotomy wound healing failure. In the vast majority, this wound failure already appears to develop in the initial phase of wound healing and results from early-phase myofascial defects rather than scar failure following successful initial wound healing. Incidence reports show that half of cases of incisional hernia are diagnosed within 12 months after initial surgery. Additionally, herniation and re-herniation risk factors (e.g., age, diabetes, obesity, smoking, surgical-site infection) affect early wound healing and contribute to the concept of poor wound healing resulting in hernia formation.

In midline incisional hernia development, the functional and dynamic entity consisting of normal abdominal wall anatomy, is lost. Dulay et al. showed in a rat model that the lateral abdominal wall muscles undergo atrophic and fibrotic changes due to passive unloading following midline hernia formation. Since the abdominal wall functions under a constant equilibrium of miscellaneous forces, decreased lateral abdominal wall compliance results in a disruption of this equilibrium, which might interfere with abdominal wall reconstruction and may explain hernia recurrence. Hernia recurrence within three years after hernia reconstruction occurs in one quarter of patients treated with mesh repair and even up to 43% of patients treated with suture repair alone. Therefore, the concept of midline reconstruction aiming
for tension-free repair remains a fundamental principle in midline hernia reconstruction.\(^{13,14}\)

For large midline defects, obtaining a tension-free midline repair by using primary closure often is impossible. In 1990, the technique of component separation was introduced by Ramirez et al.\(^{15}\) This technique relies on the uniform anatomical features of the abdominal wall. By using relaxing incisions lateral to the rectus muscles, the concept of mobilizing the rectus muscles medially toward the midline to allow tension-free midline closure was introduced. Because both rectus muscles are used as well-vascularized and innervated myofascial advancement flaps, this technique contributes to a dynamic abdominal wall repair.\(^{3,4,15}\)

Disadvantages, however, include the large wound surfaces, which might result in skin necrosis, infection, hematoma, and seroma.\(^{3,4}\) In combination with reported recurrence rates up to 23%, widespread use and adaptation is low in current practice and a search for alternative solutions to prevent complications has been initiated.\(^{3,4,7,17}\) In terms of preventing hernia recurrence, midline mesh reinforcement is a key concept.\(^{16}\)

The best location for mesh placement remains an issue of debate, but recent literature favors a retro-rectus (sublay) mesh placement, as described by Rives and Stoppa in the 1970s.\(^{18,19}\)

In this report, we introduce a technique which appears to be a safe and reliable method for reconstruction of large midline abdominal wall defects. This technique combines component separation and retromuscular mesh reinforcement of the midline. Our results show acceptable complication rates, which could be managed relatively quickly and easily. The most common complications seen were superficial wound problems, which is consistent with existing literature.\(^{3,4,7,17}\)

We believe that this technique offers several advantages, obviating it to be a useful tool in the armamentarium of the abdominal reconstructive surgeon.

First of all, using an open approach, this method allows working in a proper workspace with extensive exposure of the abdominal wall and permits the application of a combined procedure of component separation with mesh reinforcement of the midline. This is paramount since the incisional herniation is often associated with weakening of the entire abdominal midline. Awad et al. described that technical factors (infection, lateral mesh distraction, and missed hernia), besides patient factors, account for 75% of ventral hernia recurrence.\(^{20}\)

Our technique grants proper inspection and resection of scarred tissue before repairing both the hernia and entire weakened midline. Good visualization permits proper indication of the anatomical structures and allows a clear overlap of muscle and mesh. Moreover, the quality of life after hernia repair has been demonstrated to be similar in open and laparoscopic repair techniques.\(^{21}\) Secondarily, we believe that searching for the right anatomical planes, even in severe scarred tissue, is one of the key elements for obtaining good reconstruction outcomes. By using a large workspace, it is easier to jump from one plane to the other. This enables identification and subsequently avoids of damaging nerves and vessels. The entire hernia sac is also exposed properly to avoid possible damage. Furthermore, an extraperitoneal approach reduces the risk of intra-abdominal adhesions or visceral damage. The mesh is surrounded by fascia posteriorly and muscle anteriorly, which promotes ingrowth and reduces the risk of infection.\(^{22,23}\)

## CONCLUSION

In conclusion, we present a technique based on anterior component separation combined with retromuscular mesh reinforcement for complex incisional hernia reconstruction. This technique proves to be safe and reliable for large midline defects in patients suffering several comorbidities. Fundamentals for using this technique for abdominal wall reconstruction consist of proper preoperative patient assessment, anatomical consciousness, obtaining proper workspace, and providing large mesh overlap.\(^{31}\)

The authors have no conflicts of interest to disclose.