Is Muscular Atrophy a Contraindication in Laparoscopic Abdominal Wall Defect Repair? A Prospective Study

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Laparoscopic surgery for abdominal wall hernias improves short-term results as compared with open hernia surgery. However, no evidence exists to recommend this approach for pseudohernias, which are abdominal wall defects postsurgery caused by denervation and muscular atrophy. The purpose of this study is to analyze whether the laparoscopic approach benefits patients with a pseudohernia. A prospective nonrandomized, single-center clinical study was conducted of 24 patients operated on for pseudohernia. This study was designed with the basic principle of one unit, one surgeon, one mesh, and two techniques (laparoscopic or open double prosthetic repair). The primary end point was assessment of the abdominal wall according to: 1) abdominal perimeter; 2) computed tomography scan; and 3) degree of satisfaction. The secondary end points were intraoperative parameters and comorbidity. Laparoscopy offered no benefits in patients with pseudohernias. Open surgery offered no significant differences in intra- and postoperative morbidity, but if the initial weakness improved with a decrease in abdominal perimeter and visceral content, then there was more than 90 per cent satisfaction ($P < 0.05$). The laparoscopic approach does not improve the bulge caused by abdominal muscle atrophy. The option of a muscular and prosthetic reconstruction provides better clinical and cosmetic results.

LAPAROSCOPIC SURGERY BECAME the technique of choice for abdominal wall repair, because it improves the results in the short and medium term in relation to open surgery.[1–6] It is common sense that the benefits of this technique are not the same for all patients and so its recommendation should be made carefully depending on the merits of each individual case. The situation is different when treating abdominal wall defects postsurgery caused by denervation and muscular atrophy. This condition is named "pseudohernia."

Surgical incisions can cause nerve injury of the muscular group and subsequent atrophy and weakness of the abdominal wall. Over time these patients can develop a bulge in the incision area; clinically similar to fascia rupture, but image diagnosis shows the soundness of the wall and thus no future complications such as incarcerated hernia can be expected.[7–11] The treatment, laparoscopy or open repair, in these cases is controversial. At present no evidence and no references in the literature related to this problem exist.

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Our hypothesis is to discover whether the fibrosis and abdominal wall retraction produced by intraperitoneal mesh can improve the bulge and the abdominal asymmetry and to verify if the laparoscopic approach can resolve pseudohernia postsurgery muscular atrophy.

Methods

Patients

This was a prospective nonrandomized, descriptive, single-center clinical study, between January 1998 and December 2008, of 26 patients diagnosed with pseudohernias. As part of the preoperative evaluation, computed tomography (CT) was requested to reconstruct the lateral abdominal wall. In 24 cases, unilateral severe muscle atrophy was observed, whereas in two cases, muscle loss (transrectus abdominal myocutaneous [TRAM]) was observed. Thus, pseudohernia was diagnosed. These patients were followed up between 1 and 3 years in the outpatient unit to optimize their health using the following guidelines: no smoking (greater than 1 year), weight control (body mass index less than 30 kg/m^2), rehabilitation and physiotherapy (2 to 3 years maintenance times per week), and establishing healthy

lifestyles. After detailed information about the procedures, possibilities, and risks of surgery, the patients accepted laparoscopic or open surgery and signed the appropriate consent form. The investigation plan was submitted and approved by the ethics committee. A database (Microsoft Excel; Microsoft Corporation, Seattle, WA) was used to follow up all the patients enrolled. Data were analyzed by an independent data manager (A.C.-A.).

Surgical Technique

A standardized surgical technique was used by a single senior surgeon specialized in laparoscopic hernia repair (A.M.-E). Repair was performed under general endotracheal anesthesia. Pneumoperitoneum was established using a Veress needle and three trocars were placed depending on the defect site (two 5 mm and one 10 mm) using the principles of triangulation. The patient was placed in a lateral decubitus position. Omental and visceral adhesions to the abdominal wall were sectioned using an ultrasonic dissector. The dissection was begun with a peritoneal incision, usually superior and lateral to the wall defect (no hernia sac). The surrounding fascia was exposed, keeping the peritoneal flap distally out of the defect. The entire preperitoneal space was dissected to identify the pubis bone, the Cooper ligament bilaterally, and the inferior epigastric vessels. This allowed the mesh to be placed with good overlap and avoidance of neurovascular injuries. A 35-g/m^2 mesh (TiMesh Light$^{TM®}$; pfm Medical ag., Cologne, Germany) was kept in place with two guide points on the medial side or closer to the trocars (p1 and p2) and another one near the center of the lower shaft (C point). A Gore suture passer instrument (Gore-Tex®, Flagstaff, AZ) was used to puncture the abdominal wall at the two predetermined sites, grasp the threads, and pull them out through the abdominal wall. Once the mesh was placed over the defect, it was fixed with helical staples no more than 1 cm apart (Protack^R; Tyco, USA). The placement starts at the bottom (C point) alternating sides before finishing at the top (p1 and p2). During the mesh placement, the intra-abdominal pressure was decreased (6 to 8 mm Hg). After further inspection, all ports were removed under direct visualization and the abdominal entry sites were closed.

For the open technique, a double prosthetic repair was performed as previously published.[12] The operation was performed with general or regional anesthesia as determined by the anesthetist. The scar was resected and two wide flaps of skin and subcutaneous tissue were dissected with electrocautery. A mesh was placed in the preperitoneal space covering the entire dissected space and fixed with nonreabsorbable sutures. The muscles forming the defect boundaries were approximated loosely over the mesh. A second lightweight polypropylene mesh measuring 30 × 30 cm was placed supra-aponeurotically, in the subcutaneous space, to cover the previous repair and sutured in place with just four to six sutures (Timesh®). A drain was placed in the subcutaneous tissue (depending on the amount of dissected tissue and resulting dead space) and removed when the debit was 50 mL/day or less. The cutaneous flaps and skin were closed carefully to avoid dead spaces (subcutaneous layer with absorbable continuous suture, cutaneous layer with wound clips).

Follow-up

All patients were included in a monitoring protocol and checked in the outpatient unit at 1, 3, and 6 months and 1 year. The end point of the study was to assess the quality of the abdominal wall, defined and quantified by three parameters: 1) clinical evaluation—quantified by abdominal perimeter, measurement pre- and postsurgery with a millimeter measuring tape. The measurements were taken below the 12th rib for the subcostal incision, at the umbilical level for the paramedian incision, and at the anterosuperior iliac spine for the flank incision (lumbar and iliac defect). This parameter was evaluated by an independent observer (M.S.-E.) (Fig. 1); 2) radiological evaluation—Atrophy was defined in visual terms as marked decrease in the size or thickness of the lateral abdominal wall muscles on at least three contiguous 10-mm thick axial sections. The grade of muscle atrophy was measured on the basis of findings on CT scans, before surgery and again 12 months after surgery (0 = no significant modifications; 1 = shortening and decreased gut content). Image selection

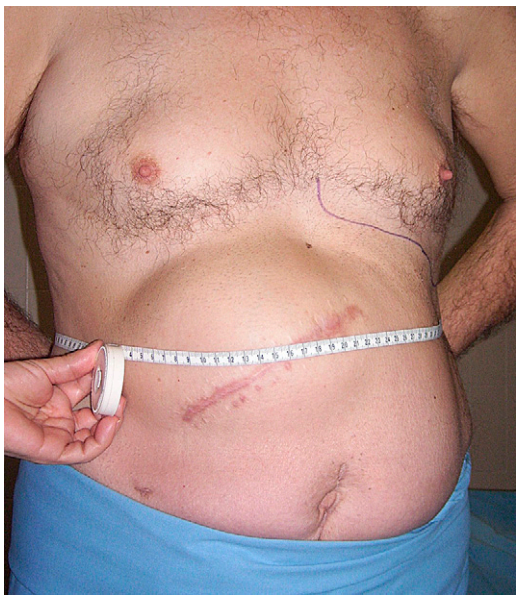

FIG. 1. Clinical evaluation of the abdominal perimeter.

and measurements were made by a single observer (E.P.DA.); and 3) welfare assessment—measured with a patient satisfaction survey, which rates type 0 to 1 (0 = not satisfied, 1 = satisfied).

As secondary end points, patient clinical data (age, comorbidity, previous surgery, etc.) and morbidity (seroma, hematoma, infection, pain, prolonged ileus, bowel obstruction, etc.) were evaluated. No patients were lost to follow-up.

Data Analysis

The results were expressed as means ± SD and as numbers (%). Despite finding a normal distribution for all the continuous variables, we decided to use a nonparametric test to compare quantitative variables (Wilcoxon test) because of the small number of cases. The comparison between two qualitative variables was performed using the McNemar test. All comparisons were performed using two-tailed analysis and a P value < 0.05 was taken as significant. The analysis was done using the Statistical Package for the Social Sciences (SPSS) software package for Windows (Version 15.0; SPSS Inc., Chicago, IL). All data were processed by an independent observer (A.C.-A.).

Results

The clinical characteristics of patients are presented in Table 1. There was a predominance of women (64%), many of whom were obese. All 24 patients had undergone ipsilateral abdominal surgery 12 months to 20 years before the initial CT scan (average 6 years). Atrophy was confined to the lateral muscle group (external and internal oblique and transversus abdominis) in 14 patients and anterolateral abdominal muscle groups (+ rectus abdominis) in 10 patients. The patients' abdominal incisions were transverse with the exception of two patients who had a paramedian incision (aorta vascular procedure).

TABLE 1. *Clinical Characteristics of Patients with Muscular Atrophy*

Patient Demographics	(n = 24)
Age (years)	61.3 ± 8.5
Gender	
Male	11 (45.8)
Female	13 (54.1)
Body mass index (kg/m^2)	33.5 ± 5.3
Comorbidity	10 (41.6)
Prior surgery	
Nephrectomy	13 (54.1)
Cholecystectomy	9 (37.5)
Vascular surgery	2 (8.3)
Abdominal bulge	
Posterolateral muscle atrophy	
Flank (iliac–lumbar)	14 (58.3)
Anterolateral muscle atrophy	
Lateral (paramedian)	2 (8.3)
Subcostal	8 (33.3)
Size defect	
Diameter (cm)	17.5 ± 4.5
Area (cm^2)	180.1 ± 61.5

Data are presented as absolute value (percent) and median ± SD.

Laparoscopic Repair

The morbidity is shown in Table 2. No conversion to open surgery was required. In two cases with multiple previous surgeries during adhesiolysis, bowel injury was noted that was repaired immediately with intracorporeal stitches. Extensive preperitoneal dissection to achieve adequate overlap of the mesh was the cause of two cases of bleeding that were controlled by clip placement. The only postoperative complications were the presence of hematomas and seromas, which resolved spontaneously within 3 months. Clinical examination was carried out after 1 month and showed no improvement in the measurement of the abdominal perimeter in three cases and after 6 months in none of the patients. At 1 year, the imaging study showed no modification with respect to the preliminary screening and the satisfaction survey also failed to find any patients with personal improvement.

Open Repair

The surgical data and annual check are compared in Tables 2 and 3. In all patients with similar morbidity and operating time ($P > 0.05$), open surgery improved initial wall weakness as demonstrated by a decrease in abdominal girth and a lower gut content in the abdominal wall defect and satisfaction in more than 90 per cent ($P < 0.05$) (Fig. 2).

Discussion

Abdominal wall defects caused by surgery, tumor resection, or trauma represent a patient group that is difficult to resolve by surgery. The aim of surgery is to restore the functionality of the abdominal wall with minimal morbidity while providing better aesthetic results.

The muscles of the lateral abdominal wall are innervated by the ventral branches of the lower six intercostal nerves, subcostal, the first lumbar nerve, iliohypogastric, and ilioinguinal nerves. These nerves run between the internal oblique and transversus abdominis muscles, supplying branches to the oblique muscles and entering the rectus abdominis muscle in its middle portion.[13–16] The multiple anastomosis between them acts similar to protective muscle mechanisms; consequently, an extensive incision affecting various dermatomes can produce denervation of the specific muscular group by

TABLE 2. *Morbidity after Laparoscopic and Open Surgery*

	Laparoscopy (n = 12)	Double Prosthetic Repair (n = 12)	*P*
Intraoperative morbidity			NS
Bleeding	2 (16.6)	0	
Intestinal injury	2 (16.6)	0	
Hospitalization			
Operation time (minutes)	76.7 ± 30.8	88.4 ± 19.1	NS
Hospital stay (days)	2.7 ± 1.3	4.5 ± 1.4	0.012
Postoperative morbidity			
Seroma	4 (33.3)	2 (16.6)	NS
Hematoma	2 (16.6)	6 (50)	NS
Chronic pain	1 (7.1)	2 (16.6)	NS

Data are presented as absolute value (percent) and median ± SD.
NS = nonsignificant.

TABLE 3. *Surgical Treatment Options: Comparative Study at 1 Year*

	Laparoscopy (n = 12)	Double Prosthetic Repair (n = 12)	*P*
Computed tomography scan			
0 = no modifications	12	0	
1 = modifications	0	12	
Abdominal perimeter			
Before surgery (124 ± 15.4)	123 ± 6.1	113 ± 7.8	0.002
Satisfaction survey (1 year)			0.004
0 = not satisfied	10 (83.3)	1 (8.3)	
1 = satisfied	2 (16.6)	11 (91.6)	

sectioning the muscle motor and nerve branches. This injury produces progressive muscle atrophy with thinning and weakness of the homolateral section muscle and with decreased abdominal compliance.[17, 18] Nevertheless, many patients who have similar incisions may not develop muscular atrophy, indicating individual anatomic variations.[7, 19] Goodman and Balachandran have demonstrated that the atrophy from denervation is a result of the surgical incision. It appears months after surgery and the morphology remains the same for years.[20] Furthermore, it can contribute to the formation of an incisional hernia. The morphology of this postsurgical complication is a bulge at the incisional site and obvious asymmetry when the patient is standing up, but complete fascial and muscular disruption does not exist. This condition is termed "pseudohernia." A similar clinical situation has been described after nerve injury by neuropathy in diabetic patients or after herpes zoster infection.[21–24]

One of the more common surgical approaches in renal pathology is the lumbotomy position. According to Yamada, this incision produces different degrees of muscular atrophy in the rectus abdominis and lateral muscle groups but less than with the paramedian incision.[7] The follow-up of these patients shows two surgical complications: fascial and muscular disruption and incisional hernia formation in 10 to 20 per cent of cases[25–27] or the formation of a bulge in the scar area resulting from wall weakness although there is no loss of the continuity solution between aponeurotic muscle layers according to the radiological diagnosis.

Another specific situation appears after breast reconstruction by moving the rectus anterior abdominal muscle (TRAM). The transverse rectus abdominis musculocutaneous flap is an appealing option for women choosing between various breast reconstructive techniques, because it results in an autologous reconstructed breast that mimics a natural breast. Despite these benefits, there are complications with this procedure such as pain at the donor site, longer scars, and most frequently the occurrence of an abdominal wall hernia or bulge, which has been reported in up to 20 to 40 per cent of patients. Jansen and Shaw published laparoscopic repair as an optional treatment for those patients who present abdominal wall hernia or bulge after TRAM flap surgery and advise this approach as first-line treatment.[8, 28, 29] Our personal experience in two cases is discouraging.

Because it is minimally invasive, laparoscopic surgery has become the approach of choice for many surgical operations. In relation to abdominal wall hernias, it has demonstrated better results than open surgery in the short and medium term.[30–34] This approach tries to avoid future complications and mortality, which may occur from incarcerated hernias. No clear justification exists, however, in the case of pseudohernias because there is no parietal disruption and no future complications are expected. Thus, the main reasons for parietal

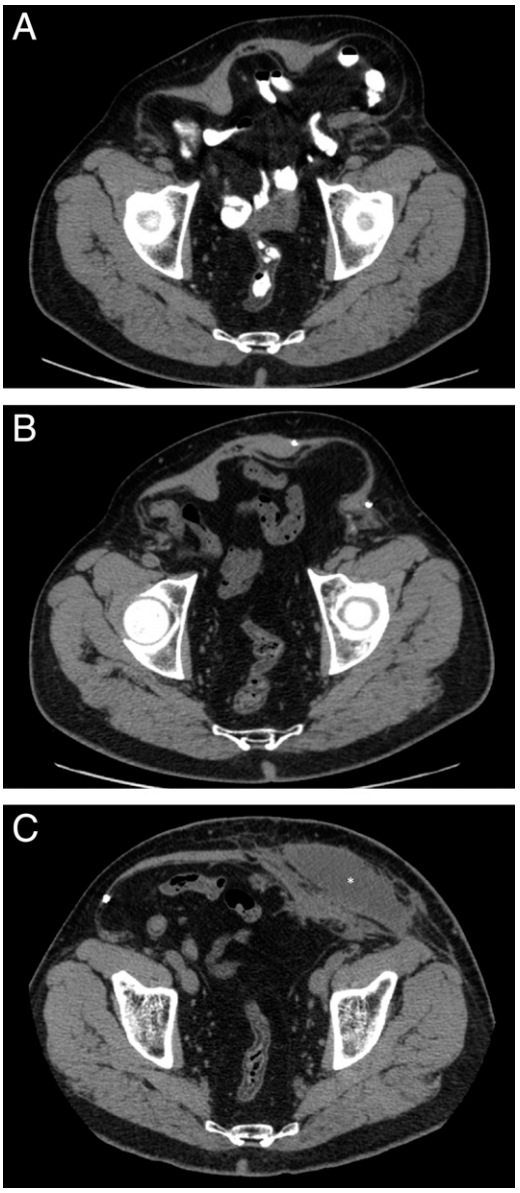

FIG. 2. Computed tomography (CT) scan of the abdomen without intravenous contrast medium. Weakness of the left anterolateral abdominal wall with protrusion simulating a hernia containing small bowel loop (A). After laparoscopic mesh repair, the deformity persists (B). CT scan 1 month after open surgery (C) showing improvement in the intermuscular space. A seroma was observed in the subcutaneous fat (*).

repair are local discomfort and pain as well as cosmetic improvement.

This leaves us with two questions: Can the laparoscopic approach reduce the abdominal bulge? Do the fibrosis and retraction produced by the intraperitoneal mesh improve the quality of the abdominal wall? No evidence exists to answer these questions. The controversy remains from a time before the use of CT. Bolkier, Staerman, and Palanivelu, considered this as an indication for surgery but do not provide outcome data.[35–37] Furthermore, Salameh and Yavuz advise performing a CT scan to avoid surgery.[38, 39] Tobias-Machado et al., in 2005, published the results from experience with seven patients with lumbar hernias treated by the laparoscopic approach and admitted that one patient who presented with muscle atonia at the anterior part of the incision before surgery was the only one who was not satisfied with the aesthetic result.[40] As far as we know, ours is the first prospective study that tries to resolve this problematic situation. The low morbidity of the laparoscopic approach is not an argument, in our opinion, to justify its indiscriminate use in patients with incisional or post-TRAM surgery pseudohernias.

The laparoscopic approach tries to repair the hernia by bridging the defect from well-defined and solid muscular edges. In open surgery, this technique is associated with the highest rate of recurrences. Breuing and colleagues consider that laparoscopy has an obvious limitation because of the impossibility of reconstructing the functional abdominal wall.[41] Because of that, and the lack of well-defined and solid muscular edges, one can explain the unsuccessful results of this technique in patients with pseudohernias.

The mesh is an important factor in this technique. It is placed in the posterior part of the abdominal wall to induce moderate fibrosis (because there is no break, a heavy mesh that would cause intense fibrosis and pain to the patient is not necessary) and retraction, which may improve the distension caused by the muscular atrophy without losing abdominal wall distensibility.[34] The mesh used in this study is integrated into the posterior abdominal wall in a controlled way (this reduces the reaction a foreign body, the inflammatory reaction, and the final cicatricial tissue, increasing cellular growth), minimizes the intestinal adherents, and decreases the shrinkage rate (18% intraperitoneally, 5% preperitoneally) and gives the implant a hydrophilic charge.[42–47] However, the results of this study show that the laparoscopic hernia repair without tension (and no muscular plicature) does not improve the situation clinically or radiologically in patients with a pseudohernia. Our study is of interest because in comparing both approaches, one can observe that the laparoscopic approach does not cause less morbidity than open surgery. This study does not find statistically significant morbidity differences, but it does find the real possibility of potential serious injury in the laparoscopic approach, although not in open surgery. At present, if the patient requests surgery and accepts proper consent, we recommend open surgery for a pseudohernia with musculoapponeurotic reconstruction under controlled tension and remodelling with double mesh to obtain more fibrosis and hardening of the injured wall.[12, 48]

We know the limitations of this study are diverse. First, there is the small number of patients, although pseudohernias are not a common process and neither are their

surgical treatment. We therefore believe that despite having a series of only 24 patients, our contribution can be useful in assessing the potential therapeutic approach to this process. Second, the observational nature of the study data prevents us from reaching a real conclusion as to the effectiveness of the treatment options. However, the failure of the laparoscopic approach and the success of the open approach, in all the cases of pseudohernia, means that we can support our conclusion. Lastly, the fact that the study has been performed at a single center may affect the extrapolation of results to other centers. The strength of the present study is that variation was minimized by using only one surgeon and one unit. While waiting for future studies with more patients to provide the results with greater evidence, we can conclude that the laparoscopic approach does not improve the abdominal bulge caused by muscular atrophy postsurgery, and an open repair/plication is the option that provides the best clinical and aesthetic results.

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