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The role of component separation in the treatment of severe diastasis recti abdominis: a new indication for a known technique

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Abstract. – OBJECTIVE: Diastasis of the rectus abdominis muscle (DRAM) is a widening of linea alba, it also could be accompanied by abdominal bulging. DRAM is often a cause of quality-of-life impairment, especially when it is of large dimensions.

Repair with direct rectus plication is the most common treatment for Diastasis Recti Abdominis (DRA), but it can result in high recurrence rates. The authors aimed to show their results in applying the component separation technique in wide DRA cases.

PATIENTS AND METHODS: From January 2015 to July 2018, 43 patients with DRA ≥ 10 cm at 3 cm over the umbilicus have been treated with component separation technique associated to panniculectomy. A biologic mesh was positioned onlay in cases of weakness along the semilunaris lines.

RESULTS: DRA repair was achieved in all cases. All patients completed the 1-year follow-up and no recurrence nor major complication were registered. Minor complications were observed in 12 (27.9%) cases.

CONCLUSIONS: This is the first study describing the component separation technique use in cases of DRA without hernia, associated to abdominoplasty surgery. Preliminary results were encouraging, but larger series are required.

Key Words:
Diastasis Recti Abdominis, Component Separation Technique, Standard Plication, Abdominoplasty.

Introduction

Diastasis of the rectus abdominis muscle (DRAM) is a widening of the inter-recti distance between the two bellies of the rectus abdominis muscle at the linea alba[1,2]. It is often characterized by bulging or sagging in the abdominal midline during muscle contraction. The condition is characterized by a gradual thinning and widening of the linea alba, combined with a general laxity of the ventral abdominal wall muscles[3]. Studies have demonstrated that the myofascial laxity associated with diastasis recti is both vertical and horizontal and in severe cases can involve the entire anterior abdominal wall including the linea alba and the linea semilunaris[4-6]. It occurs due to increasing intra-abdominal pressure in which the forces applied to the linea alba cause it to stretch, resulting in a widening of the interrectus distance. Diastasis recti is the most common condition following pregnancy; however, obesity, massive weight loss, prior abdominal operations and/or congenital disproportion of the collagen III/I can also be the cause[7].

There are many classification proposals for DRAM[8-11]. The indications for repair in patients with diastasis recti are based on symptoms and physical findings[12,13]. Many patients with diastasis recti will have discomfort at the level of the defect that is exacerbated with movement. In addition, the appearance of the abdominal wall is notice-

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ably distorted in patients with diastasis recti especially when there is contraction of the rectus abdominis muscles. DRA compromises the normal function of the anterior abdominal wall, resulting in muscle imbalance, pelvic instability and pathologic postural changes that may lead to chronic low back and pelvic girdle pain[4-6,14-16], resulting limitation in physical activity and chronic pain, along with aesthetic impairment, can negatively affect patients' quality of life[17-20]. An umbilical hernia is often associated with diastasis recti due to the progressive laxity of the midline fascia.

Apart from conservative therapy, physiotherapy and surgery are the most frequently reported treatments for DRAM. Based on the published literature, the surgical techniques available for DRAM repair are either plication-based or modified hernia repair techniques. The plication-based techniques include open plication, laparoscopic plication, or hybrid plication of either the anterior or posterior rectus fascia whilst maintaining the myofascial continuity of the ventral abdominal wall with or without mesh reinforcement. Hernia-based techniques for DRAM repair are often modifications of the original Chevrel or Rives-Stoppa techniques[21].

No consensus has been reached regarding the most appropriate surgical method or associated benefits. Data concerning recurrence rate of recti divarication after plication-based procedure are discrepant; they vary from 0% to 40% in the long-term follow-up studies[22]. Diastasis recurrence has been associated both with the type of surgical procedure and the severity of abdominal tension[23,24].

"Component separation" is a well-known technique used to provide adequate coverage for midline abdominal wall defects. This surgical technique is based on subcutaneous lateral dissection, fasciotomy lateral to the rectus abdominis muscle, and dissection on the plane between external and internal oblique muscles with medial advancement of the block that includes the rectus muscle and its fascia. This release allows for medial advancement of the fascia and free tension closure of defects in the midline area. Since its initial description by Ramirez et al[25] in 1990, the component separations technique has gained significant popularity[26,27]. At the same time, it has evolved to become less invasive in an effort to reduce morbidity associated with the surgery and to decrease the recovery period. However, the principles of the technique have remained the same throughout the years. The procedure can be done with or without the reinforcement of the fascia with mesh[28-32].

In this paper, we report our experience gained by applying the component separation technique in cases of severe DRAM (≥ 10 cm). As far as we know, this is the first study that describes the use of this technique to repair DRAM, associated to abdominoplasty surgery.

Patients and Methods

Patients' Data

A retrospective study (cohort study) was planned. The study received an ethical committee waiver given its retrospective and observational nature as it posed low risks to the patients.

From January 2015 to December 2018, 43 patients were treated in the Unit of Plastic and Reconstructive Surgery, Department of Surgery, University of Perugia and in Plastic Surgery Department "P. Valdoni" of Sapienza University Rome, for DRA repair and were then followed up. In all cases, the reason for surgery was the presence of DRA ≥ 10 cm.

All patients were female, and their baseline characteristics are listed in Table I. Age ranged

Table I. Demographic characteristics of the 43 patients.

Patients' characteristics	Value or average (range or %)
Age	Average 49 years (32-62 years)
BMI (Body Mass Index)	Average 27.7 kg/m^2 (19.2-34.6 kg/m^2) Normal weight: 24 cases (18.5-24.9 kg/m^2) (55.8%) Overweight: 16 cases (25.0-29.9 kg/m^2) (37.2%) I class Obesity: 2 cases (30.0-34.9 kg/m^2) (4.6%) II class Obesity: 1 case (35.0-39.9 kg/m^2) (2.3%)
1 previous pregnancy	7 (16.3%) Average DRA size 10.6 cm (range 10.1-11.1 cm)
2 previous pregnancies	13 (30.2%) Average DRA size 11.5 cm (range 11-11.9 cm)
3 previous pregnancies	19 (44.2%) Average DRA size 12.2 cm (range 11.1-12.8 cm)
4 previous pregnancies	4 (9.3%) Average DRA size 13 cm (range 13-15.2 cm)
Controlled Diabetes	4 (9.3%)
Smoking	8 (18.6%)

between 32 and 62 years (mean: 49 years old, median: 38 years 3 months). The patients' body mass index ranged from 19.2 kg/m^2 to 34.6 kg/m^2 (mean: 27.7 kg/m^2). All patients reported previous pregnancies: 7 had 1 previous pregnancy (16.3%), 13 had 2 previous pregnancies (30.2 %), 19 had 3 previous pregnancies (44.2 %) and 4 patients had 4 previous pregnancies (9.3%).

Some patients had at least one risk factor including overweight (16 patients 37.2%), obesity (3 patients 6.9%) and controlled diabetes mellitus (4 patients 9.3%). Eight patients (18.6%) had a history of smoking. None of the patients had severe asthma, chronic respiratory tract, cardiovascular and hepatic disorder.

The size of the defects was assessed preoperatively by means of computed tomography scan (Figure 1), measuring the distance between the medial borders of the two rectus muscles at 3 cm above the umbilicus (9). It ranged from 10.1 cm to 15.2 cm, the mean being 11.8 cm.

Surgical Procedure

Deep venous thrombosis prophylaxis with subcutaneous heparin injections and sequential compression devices[33] and intravenous cephalosporin were administered to all patients. Preoperative bowel preparation was routinely used. All the surgical procedures were performed under general anesthesia. Pre-operative markings were drawn by tracing a line between the anterior iliac crests, 4-5 cm above the anterior fornix. The surgeon incised with steel scalpel along this line and deepened until reached the rectus fascia. The abdominal flap was raised following the pre-aponeurotic plane and preserving the lateral intercostal blood supply, upwards to the level of subcostal margin. This initial skin flap elevation optimized exposure of the diastasis and the rectus musculature. If a concomitant umbilical hernia was found, it was directly closed and an intra-peritoneal drain was positioned, when necessary. Component separation was performed in the standard fashion by incising the aponeurosis of the external oblique muscle longitudinally about 2 cm laterally of the rectus sheath and dissecting the external oblique muscle until the internal oblique fascia was encountered. The external oblique muscle was then elevated to the level of the midaxillary line bilaterally. The myofascial rectus flaps were advanced. This mobilization allowed primary closure of the defect with minimal tension using an interrupted figure-of-eight 0 polypropylene suture (Prolene; Ethicon, Inc, Somerville, NJ, USA). Sagittal plication of the abdominal wall from xyphoid to pubis was performed. Thereby approximating adjacent fascia was repaired by direct approximation, reinforcing the repair, and improving the contour and tone of the lax abdominal wall using an uninterrupted 2/0 polydioxanone suture (Prolene; Ethicon, Inc, Somerville, NJ, USA) (Figure 2).

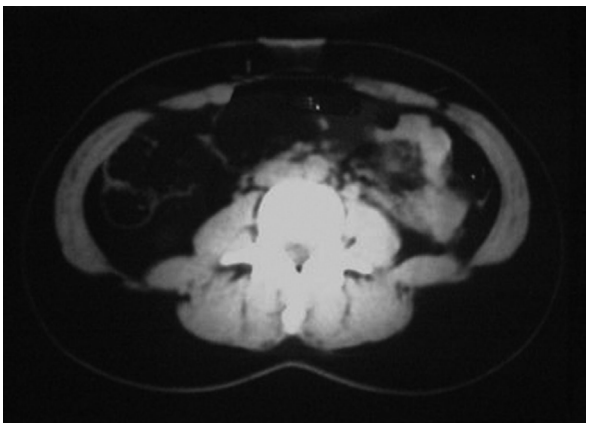

Figure 1. Pre-operative CT scan of the abdominal compartment, lumbar section. In the anterior side DIASTASIS RECTI is visible.

In cases where weakness in the abdominal wall was found, a synthetic mesh was positioned with 3/0 polypropylene interrupted stitches supra-fascially to add reinforcement (Figure 3).

Before closing, the skin flap was stretched caudally over the lower incision edge and fixated with surgical clamps. In this way, skin and subcutaneous excess was marked and removed. In cases where this maneuver appeared to be insufficient for the large amount of tissue excess, a vertical incision had to be performed, resulting in a final inverted-T surgical scar. Pannus specimens were sent to the pathology laboratory for weights and gross inspection. Subcutaneous suction drains were used routinely. After meticulous hemostasis, layered skin closure was performed. Skin closure was carried out with interrupted deep 2/0 polydioxanone sutures (Vicryl, Ethicon, Inc, Somerville, NJ, USA), dermal 3/0 poliglecaprone 25 (Monocryl, Ethicon, Inc.) and uninterrupted cutaneous 3/0 nylon (Ethilon, Ethicon, Somerville, NJ, USA).

Attention was paid to maintain physiologic placement and aesthetic appearance of the umbilicus[34], which was left attached to deep abdominal wall and customized skin inlet was created for its passage when possible. In cases where it had to be released from the deep abdominal wall, the umbilicus was repositioned along the skin flap.

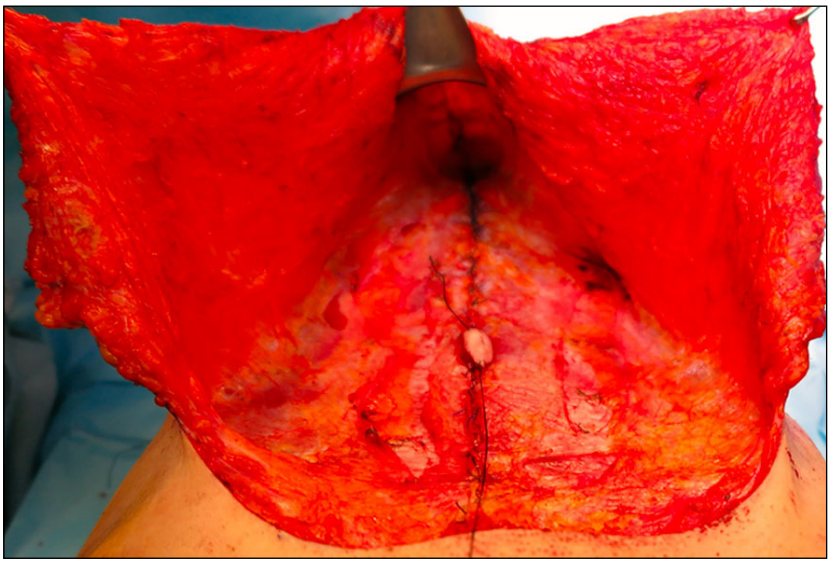

Figure 2. Intra-operative view. In the midline the plication of rectus sheath is visible.

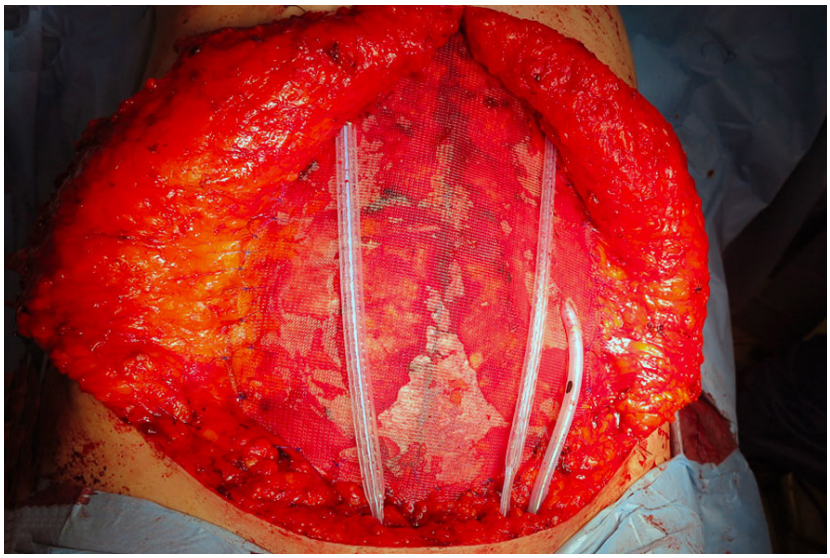

Figure 3. Intra-operative view, fixation of a synthetic mesh in a suprafascial onlay set.

The patients were maintained on nothing-by-mouth status postoperatively until the return of bowel function defined by the passage of flatus. Nasogastric tubes were used if extensive intra-abdominal dissection was required as part of the procedure. A pressure dressing was maintained during the immediate postoperative period and a pressure bandage was kept in place for 4 weeks.

Follow-up visits were scheduled at 1 month, 3 months, 6 months and 1 year after surgical procedure. Accurate physical examination was performed during the 1-year follow-up checks. If DRA recurrence was suspected, ultrasound evaluation or TC scan were carried out.

Patients' satisfaction has been valued at 1year follow-up control by a scale ranging from 0 to 2, where 0 meant no clinical improvement, 1 satisfaction with improvement and 2 complete satisfaction.

Statistical Analysis

Descriptive analysis was performed using Microsoft Excel (Microsoft, Redmond, WA, USA) spreadsheet calculations. Student's *t*-test was performed using R-software (The R foundation, Vienna, Austria). A p-value < 0.05 was deemed statistically significant.

Table II. Surgical outcomes.

Procedure	Value (range or %)
Skin and subcutaneous tissues resected	Average 580 g (range 250-1180 g)
Horizontal incision	29 cases (67.4%)
T-inverted incision	14 cases (32.6%)
Umbilicus re-attachement	15 cases (34.9%)
Umbilicus left in original position	28 cases (65.1%)
Mesh fixation	18 cases (41.9%)

Results

Surgical outcomes are summarized in Table II. Secure closure of DRA was achieved in all the patients. The extent of skin and subcutaneous tissues resected ranged from 250 g to 1180 g, (mean value: 580 g; median: 630 g). Fourteen patients (32.6%) presented large amount of adipose tissue excess and required a final inverted T abdominal incision.

In 7 cases (16.3%) a concomitant umbilical hernia was found and treated during surgery. Two of these 7 umbilical hernias were severe, and the posterior aspect of the abdominal wall required wide adhesion clearance, therefore intra-peritoneal drain was left positioned for 5 days.

Eighteen patients (41.9%) presented excessive weakness of abdominal wall and a synthetic mesh was positioned suprafascially with onlay technique. Thirteen devices were partially absorbable polypropylenepoliglecaprone monofilament lightweight meshes (ULTRAPRO® Partially Absorbable Lightweight Mesh, Ethicon, Johnson & Johnson company, Amersfoort, The Netherlands) and five were non-absorbable polypropylene monofilament heavyweight meshes (PROLENE® Polypropylene Hernia System, Ethicon, Johnson & Johnson company, Amersfoort, The Netherlands),

The umbilicus was released from deep abdominal wall in 15 patients (34.9%). In the other 28 cases (65.1%) it was left attached.

Patients were discharged at third/sixth post-operative days. The average length of hospital stay was 4.3 days. Subcutaneous drains were removed at an average of 7 post-operative days (range: 4-10 days). DVT prophylaxis lasted up to 30 days and heparin was administered for an average of 21 days. All the patients wore graduated compression stockings during surgery and until discharge or until they were fully mobile.

All patients completed the 1-year follow-up, and no recurrence was registered (Figure 4-5). In 5 cases TC scan was performed; no recurrence and no Spigelian hernia occurred (Figure 6)[35,36].

No major early (up to 3 months) complications occurred in any patients. Minor complications were observed in 12 (27.9%) cases (Table III): 5 patients presented seroma (11.6%), 4 suffered for dehiscence (9.3%), 2 presented umbilicus superficial skin necrosis (4.7%) and 1 patient had partial skin flap necrosis (2.3%).

All of them were treated as out-patients with oral antibiotics and local wound care with additional dressing changes, reaching complete wound healing in an average of 13 days (range 9-22).

Patients' satisfaction was assessed at the 1-year follow-up control. Twenty-five patients (58.1%) were completely satisfied with the appearance of their abdomen (score 2), whereas 18 (41.9%) were satisfied with the improvement (score 1). No patients reported an absence of improvement (score 0).

To quantify the effect of treatment a comparison between the means of the differences between the two paired samples (pre and post after the end of follow-up) was evaluated. A paired Student's test was performed by using R-software (the R foundation, Vienna, Austria). The results show that there is a statistically significant different between two samples (p-value $< 2*10^{-16}$). The t-test was evaluated also for each sub-group, based on amount of pregnancy. For each of them the results show the difference is highly significant (p-value $<1*10^{-10}$).

Discussion

Abdominal wall repair surgery is an insidious field for the reconstructive surgeon, in particular in cases with severe myoaponeurotic laxity, where recurrence and unsatisfactory results are common.

DRA implies an important clinical impairment that results in reduction of quality of life. Therefore, functional outcome is the major concern when addressing this disease[37,38].

As mentioned by Dibello and Moore[39], the ideal reconstruction of the abdominal wall should fulfill 4 requirements: prevent visceral eventration, incorporate the abdominal wall, provide dynamic muscular support, and provide a tensionless repair. Excessive tension during rectus plication is a problem that has been discussed widely in the past years. It is one of the main causes of failure in the treatment of DRA.

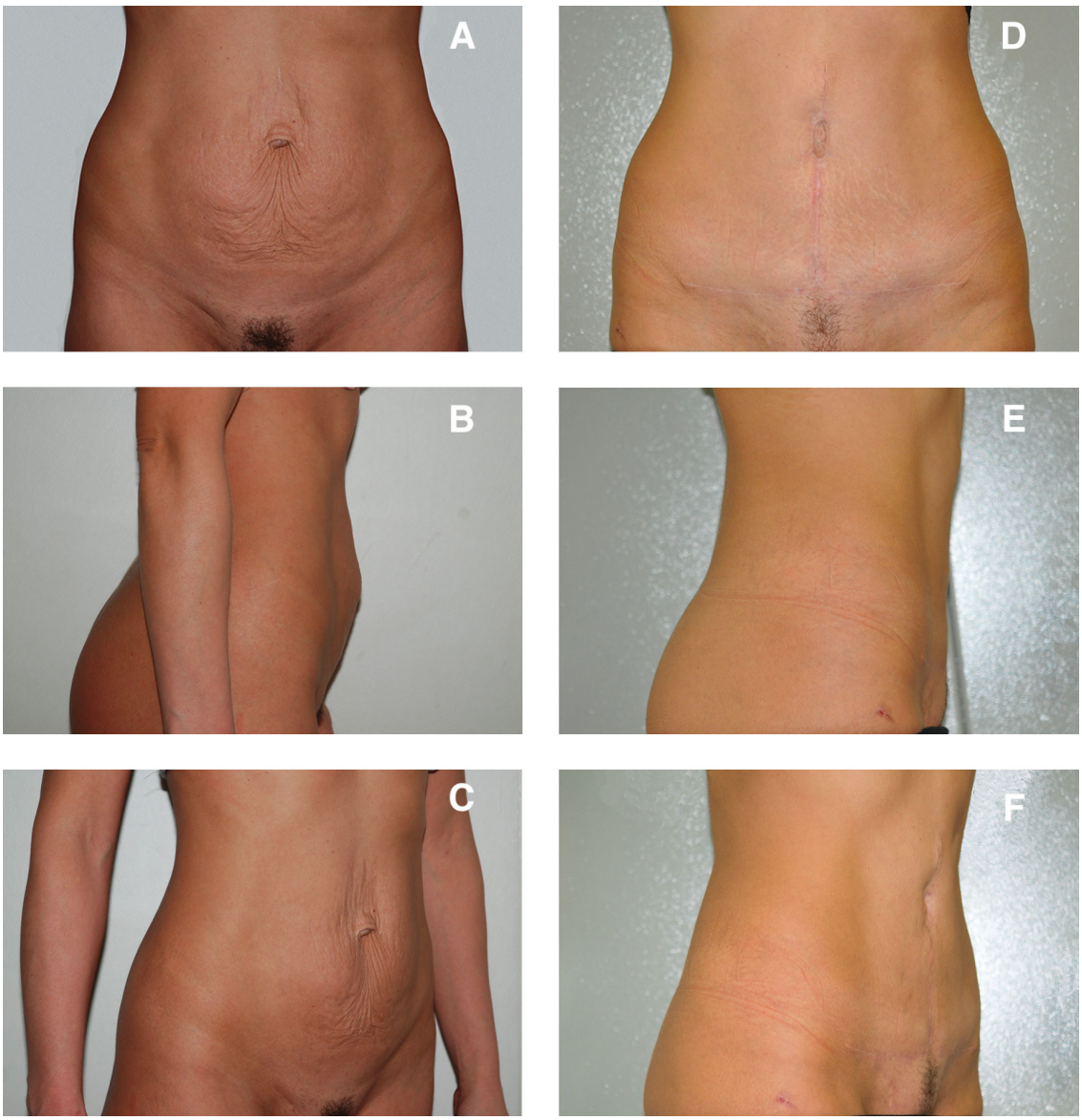

Figure 4. **A-C**, Patient 1 affected by Diastasis Recti with evidence of redundant skin. Pre-operative view, frontal and lateral projection. **D-F**, Patient 1, post-operative result 1 year after the surgical treatment. Frontal and lateral projection.

In patients with major post-pregnancy myoaponeurotic laxity, standard rectus sheath plication may not be sufficient. Van Uchelen et al[40] reported a 40% recurrence rate in their patients with a mean follow-up of 64 months. Al-Qattan[41] described a cohort of 20 multiparous women with critical musculoaponeurotic laxity that were subjected to disease relapse within one year from surgery, after being treated with only standard vertical plication.

When the defect on the abdominal wall is particularly severe, there is a higher risk of recurrence due to the increased tension along the sutures[42]. Various surgical methodologies have been proposed to address severe cases of DRA. Double plication technique comprehends undermining of the posterior rectus sheath followed by advancement of recti muscles towards the midline. The main indication of this approach is DRA in patients with lateral insertion of recti muscles[43]. Triple plication technique involves vertical rectus fascia suture along the xipho-pubic line and an elliptical plication of oblique fascia in order to cope with abdominal laxity[44]. Transverse plication technique consists of three transverse plications of the rectus sheath. Two adjunctive bilateral plications along the external oblique fascia may be realized in an effort to ameliorate waistline contour[45].

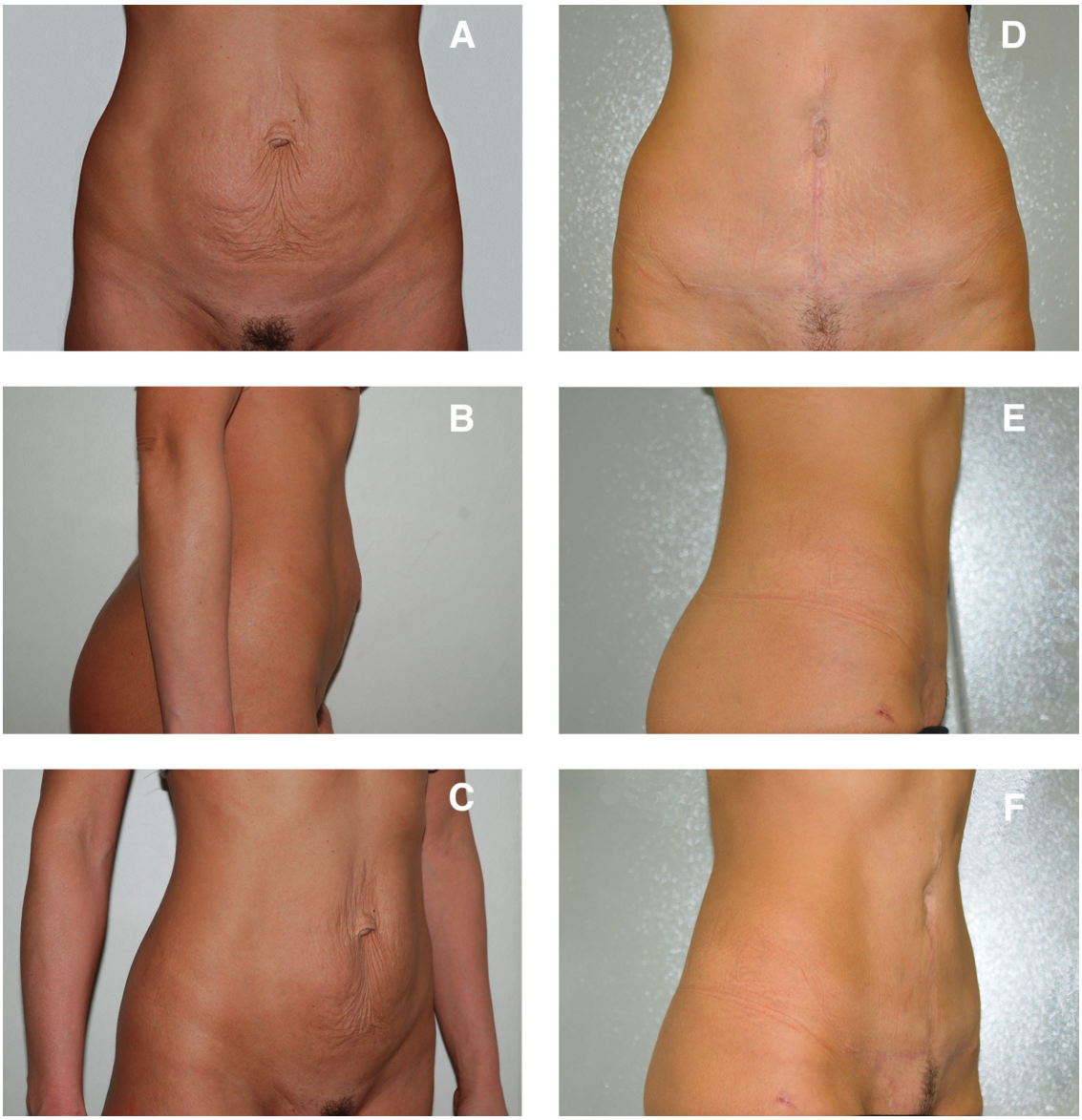

Figure 5. **A-C**, Patient 2 affected by Diastasis Recti, important presence of skin excess is visible. Pre-operative view. Frontal and lateral projection. **D-F**, Patient 2, post-operative result 1 year after the surgical treatment. Frontal and lateral projection.

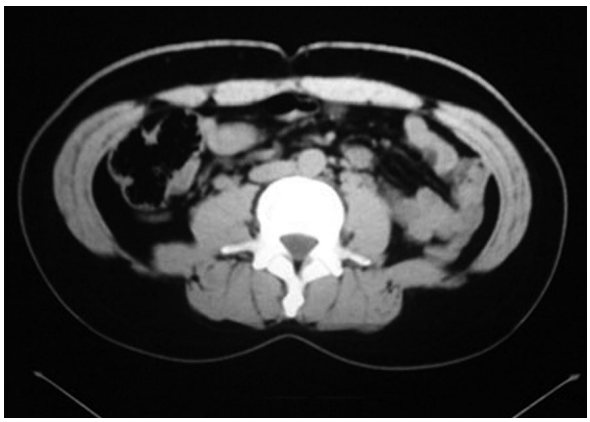

Figure 6. Post-operative CT scan of the abdominal compartment, lumbar section performed 1 year after the surgical procedure for other clinical reasons not related to our research.

Table III. Post-operative complications.

Procedure	Value
Total patients with complication	12 (27.9%)
Seroma	5 (11.6%)
Dehiscence	4 (9.3%)
Umbilicus superficial skin necrosis	2 (4.7%)
Partial skin flap necrosis	1 (2.3%)

When the abdominal wall defect is particularly wide, simple or multiple approximation of DRA edges carries the risk of high tension over sutures, with increased intra-abdominal pressure and high recurrence rates. In these cases, surgeons have to seek a tension-free abdominal closure that restores physiologic anatomy of abdomen wall with medialization of rectus abdominis muscles. Rectus abdominis myofascial release procedure allows midline closure with less tension, by letting to advance the lateral compound of the abdominis muscles[42]. According to the current literature, Spigelian hernias are the most commonly type occured after CST[46,47]. Component separation was first described by Ramirez et al[25] and it was proposed for wide incisional hernia repair. By using this technique, it is possible to mobilize the tissues, gaining up to 10 cm in the epigastrium, 20 cm at the waist, and 6 cm in the suprapubic region[25]. This procedure must be chosen when considered feasible after a through clinical assessment with respect to the complexity of the defect and the repeated complications[48].

Diastasis repair does not appear jeopardized when it is performed together with abdominal panniculectomy. It is accepted that skin resection decreases tension along the fascial closure, eliminates poorly vascularized tissue and removes subcutaneous and dead space[49,50].

It has been demonstrated that all the aponeurotic sites presented a decrease of the mean traction index after dissection of the rectus muscle from its posterior sheath. The difference became more significant when the aponeurosis of the external oblique muscle was released and undermined. Theses maneuvers were effective and reliable, decreasing aponeurotic tension in the midline[48].

In our study we aimed to show the same technique applied to treat selected DRA cases. Abdominal component separation has been demonstrated to diminish the risk for relapse and to provide a reliable reconstructive tool for large, challenging abdominal defects[39,46,47]. This procedure offers dynamic support to the abdominal wall and allows closure of the myofascial layers without tension[51]. The wide undermining that is generally required to achieve efficacious fascial closure may predispose to seroma formation. Seromas are related to higher risk of wound dehiscence, infection, flap necrosis, and reoperation[48]. In cases where severe abdominal wall laxity was found, a synthetic mesh was positioned suprafascially. The first 5 onlay mesh techniques of the series were carried out with non-absorbable polypropylene monofilament heavyweight devices, and seroma formation was observed in 2 patients. Therefore, partially absorbable polypropylene-poliglecaprone monofilament lightweight meshes were elected in the other cases, aiming to lower seroma risk[52].

The mesh was added as an onlay support. In fact, when possible, it should be placed over the muscular and aponeurotic layer of reconstruction. This avoids contact of the mesh with abdominal organs preventing complication[48,51]. In our experience, the component separation technique represents a useful tool in dealing with selected cases of wide DRA, in which a direct suture of abdominal midline appears to be limited in efficacy. Besides the reduced recurrence rates reported by our experience, the technique comes with a quick learning curve and an easy and time-saving execution.

In the current study, we aimed to describe our experience with component separation technique applied to patients presenting a wide abdominal wall diastasis, defined as $\geq$ 10 cm at 3 cm above the umbilicus. Previous twin pregnancy, multiparous pregnancies or DRA recurrences may be associated conditions that would recommend the use of this technique.

It is important to emphasize that the incision, release, and undermining should be made in planes that do not disturb the neurovascular bundles which are critical to innervation of the recti muscles. Dissection performed in this study maintain intact nerve and blood supply of the mobilized structures. It is important to stress that neurovascular bundles that penetrate laterally to the rectus muscles (intercostal branches) run between the internal oblique and the trasversus muscles and are not injured during this procedure. These nerves are particularly important because they have motor, sensory and autonomic fibers, any injury to them may decrease the function of the rectus[51,53].

On the other hand, despite its functional advantages, component separation technique does not reduce the waistline. Therefore, its aesthetic results are less visible than in standard plication techniques that do narrow the waistline. Thanks to an accurate selection, our patients reported high satisfaction rates, with no absence of improvement registered.

Limitations

Patients' population is selected and low in numbers, while the relatively short follow-up period may affect the assessment of recurrence rate. Nonetheless, we advocate the use of component separation technique over the standard plication in the treatment of severe diastasis recti in light of the good and stable results achieved in our series. Larger series with long-term follow-up are needed to validate the effectiveness of this surgical solution.

Conclusions

Component separation is a safe, versatile, easy-to- learn and reproducible technique that offers a reliable and long-lasting solution to complex abdominal wall hernia cases. The release of the external oblique is an effective maneuver that aids the advancement of rectus facial edge above the midline. The current study shows this surgical technique applied in patients presenting severe abdominal diastasis. Preliminary results show no recurrences and patients' high satisfaction rates, but larger series with longer follow-up are required to validate the effectiveness of this surgical solution.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethics Approval

The study was conducted in accordance with the Helsinki Declaration of 1964 (revised 2008).

Funding

None.

Conflict of Interest

The authors declare that they have no conflict of interest.

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