A study of intraabdominal pressure modification in "component separation" technique for repair of incisional hernia

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INTRODUCTION: *Incisional hernias can be treated with laparoscopic and laparotomic surgery. Laparoscopic surgery can be made without the use of mesh when performing component separation technique. This technique allows to limit the adverse effects to foreign body and promotes a tension-free closure. We studied intravescical pressure changes during intervention in order to quantify intrabdominal pressure.*
MATERIAL AND METHODS: *A prospective, non-controlled study (cohort study), was made on thirty patients, treated to repair incisional hernia. Standard panniculectomies and component separation technique were performed in all patients. A standard Foley catheter was inserted in to the bladder in order to measure pressure modification in the peri-/post-operative phases. Statistical significance of modifications of pressure values was evaluated with the Wilcoxon's sum* rank test.
RESULTS: *Bladder pressure increased after hernia repair and skin closure and decreased in the first day after surgery, but without returning to the original values, and these modifications were statistically significant.*
DISCUSSION: *We study intravescical pressure changes as an indirect measurement of intrabdominal pressure. Intrabdominal pressure cut-off for the arise of complications is 20 mmHg. This technique allows to maintain pressure under dangerous limits and to limits complications.*

KEY WORDS: Component separation technique, Incisional hernia, Intrabdominal pressure.

Introduction

Complex abdominal wall defects result from a variety of causes: previous surgery [1], trauma [2], congenital defects [3], and infection [4]. Chronic hernias can result in morbidity or mortality related to incarceration, strangulation, or obstruction of abdominal viscera. The objectives of abdominal wall reconstruction include restoring structural support, providing stable soft-tissue coverage, and optimizing aesthetic appearance. The options the surgeon has are open primary repair, open repair with mesh, laparoscopic repair, or autologous tissue transfer or mobilization. Laparoscopic technique is based on the use of mesh, laparotomic one can be made without mesh placement. The complication rate accompanying the use of synthetic mesh is significant, however, with the most dreaded complications being infection, extrusion, and enterocutaneous fistula formation, and intra-abdominal hypertension [5-6]. Increased intraabdominal pressure is common after the major operation and after closure of the not compliant abdominal wall under tension [7-8]. The intraabdominal hypertension may result in elevation of

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intrathoracic pressure and may affect the thoracic hemodynamics, leading to inadequate ventilation with hypoxia and hypercarbia [9]. It is therefore essential that the diaphragm occupies its physiological level and allows a normal respiratory excursion [10]. In 1990, Ramirez, Ruas and Dellon introduced the "components separation technique" to bridge the fascial gap without the use of prosthetic material [11]. The technique is based on the enlargement of the abdominal wall surface by separation and advancement of the muscular layers. By using this technique, up to 10 cm of unilateral advancement can be achieved, thus permitting a tension-free abdominal closure with medialization of the rectus abdominus muscle in large ventral hernias. Purpose of the study is to demonstrate a better intra abdominal pressure control related to compont separation technique.

Material and Methods

A prospective, non-controlled study (cohort study) was planned. From January 2006 to July 2010, 30 patients were treated in the Department of Plastic Surgery of "La Sapienza" University of Rome for incisional hernia repair and were then followed up. The reasons for surgery were recurrent incisional hernia in 18 cases (60%) and incisional hernia in the remaining 12 (40%).

Twenty patients were women (66.6%) and ten patients were men (33.4%). The patients' age ranged between 46 and 74 years (median: 60 years and 4 months).

The patients' body mass index ranged from 19.2 to 59.8 kg/m^2 (mean: 43.7 kg/m^2).

Some patients had at least one risk factor for recurrence, including morbid obesity (11 patients, 37%), diabetes mellitus (six patients, 20%), recent massive weight loss after bariatric surgery (seven patients, 23.3%). Five patients (16.7%) had a history of smoking. None of the patients had severe asthma or a chronic respiratory tract disorder.

The size of the defects was assessed preoperatively by means of computed tomography scan. All defects were localised in the midline; according to Chevrel's classification [11], they were supraumbilical (M1) in 4 cases, juxtaumbilical (M2) in 7 cases, subumbilical (M3) in 6 cases and xypho-pubic (M4) in the remaining 13 cases. All the defects were longer than 11 cm transversally and varied in length vertically. According to Chevrel's classification [11], they were 10 to 15 cm wide (W3) in 16 cases and > 15 cm in the remaining 14 cases (W4). The size of the defects ranged from 112 cm^2 (11x13 cm) to 499 cm^2 (24x26 cm), the mean being 348 cm^2.

Standard panniculectomies and component separation were performed in all thirty patients. Intra-abdominal pressure was measured through urinary bladder pressure measurements.

A lower abdominal incision was made in all the patients. A vertical incision was added only in the patients with a previous midline scar, resulting in an inverted T incision (41%). Care was taken to elevate the skin flaps only as far as necessary to clearly identify the hernial defect and the semilunar lines in order to preserve as many perforators as possible.

The abdomen was opened, the posterior aspect of the abdominal wall was cleared of adhesions,. 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 (Fig. 1). The external oblique muscle was then elevated to the level of the midaxillary line bilaterally. After debridement of the scar and separation of the tissue from the medial edges of the rectus muscle, the myofascial rectus flaps were advanced. This mobilization allowed primary closure of the hernia defect with minimal tension using interrupted figure-of-eight 0 polypropylene suture (Prolene, Ethicon, Inc., Somerville, N.J.). Plication of the midline abdominal wall from the xyphoid to pubis was performed, thereby approximating adjacent fascia over the hernia repair, reinforcing the repair and improving the contour and tone of the lax abdominal wall using uninterrupted 2/0 polydioxanone suture (Vicryl, Ethicon, Inc., Somerville, N.J.) (Fig. 2). Suction drains were used routinely.

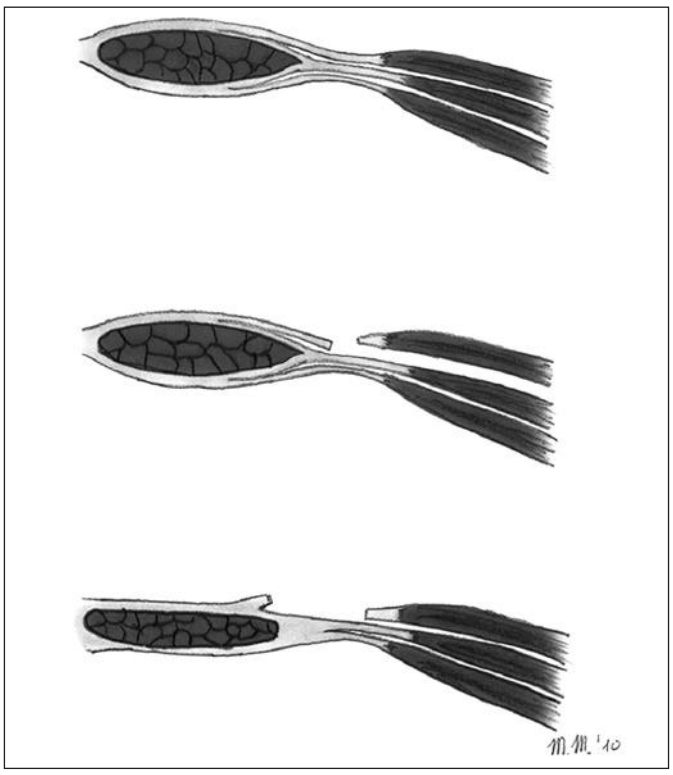

Fig. 1: Component separation performed in the standard fashion by incising the aponeurosis of the external oblique muscle longitudinally lateral to the semilunar line. The plane has to be dissected carefully to avoid dissecting down the internal oblique fascia. The tissues can be mobilized, gaining as much as 10 cm in the epigastrium, 20 cm at the waist and 6 cm in the suprapubic region.

Fig. 2: Following the component separation, primary closure was accomplished easily, thereby approximating adjacent fascia over the hernia repair, reinforcing the repair and improving the contour and tone of the lax abdominal wall.

After meticulous hemostasis, layered skin closure was performed.. If the umbilicus had previously been released from the abdominal wall, it was reattached.

Following the induction of general anaesthesia, a standard Foley catheter was inserted and the bladder emptied as best as possible by gravity. Upon the return of four muscular twitches, 100 ml of sterile saline was instilled into the emptied bladder and the catheter tubing clamped distally to the aspiration port. A Stryker compartmental pressure monitor (Stryker-Leibinger, Kalamazoo, Mich.) was used to measure intravesical pressure, at the end of expiration, through the catheter aspiration port. Measurements were taken at the following intervals: preoperatively (T0), after hernia repair (T1), after skin closure (T2), postoperative day one (T3). Any differences between these measurements were compared by means of Wilcoxon's matched pairs signed rank sum test; statistical significance was set at $p < 0.05$.

Results

Secure closure of the abdominal defect with midline approximation of the fascia was achieved in all the patients.

The average preoperative pressure was 7.4 mmHg, intravesical pressure recording showed an increase in the rectus abdominis muscle (hernia repair) (T1) following repair, when it reached a mean value of 14.7 mmHg, another slight increase following complete skin closure and application of the dressing (T2) (mean value: 15.63 mmHg) and, lastly, a slight drop in intravesical pressure 1 day postoperatively (T3) (mean value: 13.43) (Tab. I). The differences in intra-abdominal pressure values were highly significant (P<0.01) between T0 and T1, T2 and T3 as well as between T1 and T2, T2 and T3, and T1 and T3 (Tab. II).

TABLE I - *Intravesical pressure values (measured in mm Hg) assessed at four different time-points during the surgical repair of laparocele: preoperatively (T0), after hernia repair (T1), after skin closure (T2) and 1 day post-operatively (T3).*

	Preop.	Hernia repair	Skin closure	1 Day postop.
1	6	17	17	16
2	8	16	16	14
3	9	18	19	17
4	10	19	20	18
5	7	18	16	12
6	9	21	21	18
7	6	11	13	11
8	5	15	17	15
9	6	13	13	9
10	3	9	11	10
11	8	14	16	16
12	9	14	14	12
13	6	12	13	10
14	10	19	19	17
15	8	13	14	13
16	9	19	20	17
17	10	20	21	19
18	9	14	17	17
19	9	15	16	16
20	7	12	12	10
21	8	14	15	13
22	3	10	11	8
23	7	15	16	13
24	5	11	11	9
25	8	13	14	10
26	4	10	12	9
27	6	11	13	10
28	9	14	15	13
29	10	19	21	18
30	8	15	16	13
Mean	**7.4**	**14.7**	**15.63**	**13.4**

TABLE II - *Intravesical pressure (measured in mm Hg) assessed at four different time-points during surgical repair of laparocele. The statistical significance of the differences between values was determined by Wilcoxon's test.*

	M ± SD (mmHg)
Preop (T0)	7.5 ± 2.064
Hernia repair (T1)	15.14 ± 3.371
Skin closure (T2)	15.95 ± 3.124
1 day postop (T3)	14 ± 3.338

M, mean: SD, standard deviation.

Wilcoxon test	*p*-value
Preop (T0) - Hernia repair (T1)	< 0.0001
Preop (T0) - Skin closure (T2)	< 0.0001
Preop (T0) -1 day postop (T3)	< 0.0001
Hernia repair (T1)- Skin closure (T2)	< 0.001
Hernia repair (T1) -1 day postop (T3)	< 0.01
Skin closure (T2) -1 day postop (T3)	< 0.0001

p, probability.

Discussion

The ideal abdominal wall reconstruction should fulfill the criteria of DiBello and Moore [13] (1) prevent visceral eventration; (2) incorporate with the remaining abdominal wall; (3) provide dynamic muscle support; (4) provide a tension-free repair, and (5) endure over time. Primary fascial repair satisfies the four of these three criteria, but cannot be achieved in a tension-free environment when the fascial defect is large [14]. The role of primary repair in moderately large hernias is therefore limited; moreover, numerous efforts have been made to reduce tension on the repair, including expansion of the abdominal wall with prosthetic materials. Although techniques that use mesh, or other prosthetic materials, can eliminate tension on the closure, they are not ideal owing to the risk of infection, mesh migration, erosion into the bowel and enterocutaneous fistula. Another functional drawback of mesh is that since it does not provide dynamic support, problems occur where the static mesh meets the dynamic abdominal wall tissue.[15-16]
Abdominal component separation has been shown to decrease the risk of recurrence and to provide a reliable autologous reconstructive option for complex ventral abdominal defects [13]. This is an abdominal wall reconstruction technique that uses local tissue to provide dynamic support for the abdominal wall and permit tension-free closure of the myofascial layers[17]. Another relevant benefit of the component separation technique compared to techniques using mesh is to allow a tension-free closure. This type of closure limits the likelihood of intra-abdominal hypertension and the risks related to this.
Increased intraabdominal pressure is common after the major operation and after closure of the noncompliant abdominal wall under tension [7,8]. Normal intra-abdominal pressure in adults is less than 10 mmHg, whilst intra-abdominal pressure values over 15 mmHg are indicative of intra-abdominal hypertension [18,19]. Prolonged increased intra-abdominal pressure over 20 mmHg is known to cause serious conditions such as acute renal failure, pulmonary impairment and reduced blood flow to the gastro-intestinal organs [20]. Moreover, increased intra-abdominal pressure causes elevation of the diaphragm, which is in turn followed by increased intrathoracic pressure [21], this leading to a global loss of respiratory excursion, and a lack of tidal volume per breath [10]. There is evidence suggesting that increased intra-thoracic pressure results in increased intra-cranial pressure and functional obstruction of the cerebral venous outflow via the jugular venous system [22,23].
The abdomen has a dynamic muscular wall that can accommodate marked variations in volume, which are accompanied by changes in intra-abdominal pressure [24,25]. Repair of the incisional hernia causes extrinsic compression of the abdominal content and elevation of intra-abdominal pressure, as observed in our series. Although intra-abdominal pressure increased in all of our patients following repair of the rectus abdominis muscle, and increased even slightly further after complete skin closure and application of the dressing, it remained well below the danger level. Indeed, intra-abdominal pressure was below 20 mmHg in all the patients the day after surgery, and no cases of prolonged increased pressure were reported.
The three most reliable methods of indirectly measuring intra-abdominal pressure are gastric, inferior vena caval and urinary bladder pressure measurements [25-26]. In this study, intravesical pressure was measured on account of the simplicity of this measurement in catheterized patients. An alternative approach is to evaluate intrathoracic tidal volumes as an indirect indicator of intra-abdominal pressure [10]. This method, using the automatic respirator during surgery, allows to monitor intra-abdominal pressure in a fast and ingenious way.
The data in this study confirm that component separation technique allows a tension-free closure ensuring a good post operative control of intra-abdominal pressure. The results were statistically significant ($p<0,01$) for all pressure ranges (T0-T1;T1-T2;T2-T3;T0-T3). The pressure was below 20 mmHg in all cases one day after surgery.

Conclusion

In our study, component separation results as an optimal technique in incisional hernias surgery. Besides avoiding typical side effects of the interventions with mesh placement, allows a tension-free closure. The tension-free closure prevents the development of intra-abdominal hypertension and the serious complications resulting from this.

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Riassunto

La tecnica presa in considerazione è la “component separation” che permette la riparazione di laparoceli, anche di ingenti dimensioni, senza l’utilizzo di protesi e con una chiusura priva di tensione. Per valutare l’efficacia e la sicurezza della tecnica abbiamo monitorato le modificazioni di pressione intraddominale nelle diverse fasi del peri e post-operatorio su trenta pazienti.
Il risultato dello studio è stato un aumento della pressione intraddominale, che si è stabilizzata nel post-operatorio a livelli fisiologici.

La tecnica si è dimostrata efficace nel risolvere il problema dell'ipertensione intraddominale post-intervento tipica, invece, delle tecniche basate sull'utilizzo di mesh.

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