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Original Article

Eight-point Compass Rose Underlay Technique in 72 Consecutive Elderly Patients with Large Incisional Hernia

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SUMMARY

Background: Repair of incisional hernia (IH) in the elderly is a challenge for the surgeon. Primary closure is preferable but is not always possible because of high recurrence rates of IH repaired without a prosthesis and/or possible respiratory and cardiovascular complications due to extreme tension of the margins. We report our experience with underlay mesh placement in elderly patients with large IH.
Methods: A total of 72 patients from January 2003 to December 2009 underwent IH repair involving placement of an intraperitoneal Gore® DualMesh® prosthesis. The prosthesis was first anchored at eight points in a compass rose pattern using a Gore® suture passer and then firmly secured to the abdominal wall with a 360° internal crown running suture.
Results: Two intraoperative intestinal tears occurred during debridement and were immediately sutured. Postoperative complications included seven seromas, four hematomas, and two infections, one of which was resolved with conservative treatment while one required prosthesis removal.
Conclusion: This surgical procedure, like laparoscopic treatment, allows the surgeon to avoid dissection of the abdominal layer and improves prosthesis adhesion with reinforcement of the incisional area near the abdominal defect. The reduction in operation time is remarkable. Despite good results in terms of safety and minimal recurrence for laparoscopy in the management of IH, the use of minimally invasive techniques for large incisional wall defects, especially in elderly patients, is still controversial and practiced by few surgeons. This open technique avoids cardiopulmonary complications arising from pneumoperitoneum in the elderly.

1. Introduction

The incidence of incisional hernia (IH) is 1–15% and the risk of its recurrence increases with patient age, wound infection, obesity and improper suture closure[1–3]. Therapeutic problems accompanying giant IH of the abdominal wall are frequently difficult to resolve in elderly patients because they are often obese, they have a history of several previous operations, they suffer from multiple comorbidities, their abdominal wall musculature is of poor quality and, in certain cases, the visceral mass is so herniated that the abdominal domain is lost. These various factors can mean that primary repair may be difficult or even impossible. The resulting tension can lead to early recurrence and possibly deterioration beyond the state of the original herniation[4,5]. Cardiac and pulmonary complications must not be overlooked in elderly patients, because they can result from forced reintegration of viscera from a large IH into a diminished abdominal cavity[6,7]. Surgical repair is required to resolve any abdominal wall losses and re-establish the function of the abdominal musculature. Despite efforts to highlight these problems, many surgeons continue to treat giant IH with inadequate procedures such as simple inlay of a piece of mesh into the fascial defect following a long and difficult dissection, which often increases operative time and post-operative complications.

In elderly patients (age >65 years)[8] with large IH (parietal defect >10 cm)[9] we performed a simple and rapid technique involving implantation of an intraperitoneal Gore® DualMesh® expanded polytetrafluoroethylene (ePTFE) prosthesis. When placed in the

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Table 1
Patient characteristics according to the Chevrel and Rath classification[9].

Medial incisional hernias		Lateral incisional hernias		Width		Recurrence	
M_1	19	L_1	11	W_1	—	R	—
M_2	9	L_2	—	W_2	—	R_1	36
M_3	—	L_3	2	W_3	69	R_2	28
M_4	31	L_4	—	W_4	3	R_3	8

M_1 = supraumbilical; M_2 = juxtaumbilical; M_3 = subumbilical; M_4 = xifo-pubic; L_1 = subcostal; L_2 = trasverse; L_3 = iliac; L_4 = lumbar; W_1 = <5 cm; W_2 = 5–10 cm; W_3 = 10–15 cm; W_4 = >15 cm; R = no recurrence; R_1 = first recurrence; R_2 = second recurrence; R_3 = third recurrence.

abdominal cavity, a prosthesis induces the formation of adhesions to an extent that depends on the material it is made of.

The ePTFE prosthesis has poor plastic memory and is thus harder to mould, but it has the advantage of lower rates of adhesions, fistulae and visceral erosion, so further abdominal intervention is much safer. The visceral interface side of the Dual Mesh® prosthesis has a porosity of <3 μm and it has been clinically documented that minimal tissue attachment occurs. The fascial interface features geometric roughness that stimulates tissue fixation to the host fascia. The DualMesh® prosthesis can be placed intraperitoneally in contact with the viscera. Proper surface orientation is essential for function of the Gore® DualMesh® biomaterial as intended. The smoother surface should be placed adjacent to the tissues or structures to which adhesion is not desired. The geometric rough surface has an open microstructure that stimulates host tissue incorporation and should be placed adjacent to the abdominal wall where incorporation is desired.

Consequently, it is not necessary to dissect the muscular layer from subcutaneous tissues around the wall of the defect. In our experience, broad apposition of the prosthesis over the hernial ring can be obtained using a Gore® suture passer, a small tool used in laparoscopic surgery to exteriorize sutures through a transabdominal puncture[10–13]. The suture passer is similar to a large biopsy needle (Fig. 2B). It has a cylinder whose tip (Fig. 2C) has a small tongue that opens when the spindle is moved inwards through the grip ring of the instrument. Appropriate opening and closing of the tongue catches the sutures so that they can be taken outside.

This approach can be used to repair the loss of abdominal wall without tension of the opposite edges, re-establish abdominal musculature interplay and decrease the operating time, all of which are of benefit to patients[14].

2. Materials and methods

From January 2002 to December 2009, 72 patients (33 men and 39 women) underwent surgery for large postoperative IH. The average age was 73.7 ± 4.58 years (range 66–82 years). The IH characteristics according to the Chevrel and Rath classification[9] and comorbidity, demographic and perioperative data are summarized in Tables 1–3[9]. Data for continuous variables are presented as mean ± standard deviation.

Preoperative preparation of patients was started a few months prior to intervention to obtain good metabolic control of glycemia, lipemia and electrolytes, with remarkable weight loss. All patients were trained in self-motivated respiratory physiotherapy. Fifty percent of the patients had already undergone at least one previous surgical procedure for IH recurrence (R_1 = 36). Of 28 R_2 patients, 19 were treated with a primary repair and nine with a premuscular polypropylene mesh. All eight R_3 patients received a premuscular polypropylene mesh. Additional procedures were performed in seven patients. Cholecystectomy was carried out in five patients for

Table 2
Comorbidity data.

Condition	Patients	
	n	%
Obesity	24	36.9
Arterial hypertension	18	27.6
Heavy smoking	9	13.8
Chronic respiratory failure	6	9.2
Diabetes mellitus	8	12.3
Renal insufficiency	7	9.72
Thrombophlebitis	4	5.56
Hepatic disease	10	13.89
Ischemic heart disease	5	6.94

chronic cholecystitis and two small bowel tears that occurred during dissection were immediately sutured.

The technique is carried out as follows. After excision of the scar, the herniated sac is carefully opened from the surrounding subcutaneous tissue without dissection. The peritoneal herniated sac is subsequently used to cover the prosthesis under the skin. Adhesions are removed from the internal sac surface and near the hernia ring. Freeing the edge of the ring, the dissection continues internally, extending about 10–15 cm in all directions to allow broad placement of an intraperitoneal ePTFE prosthesis with sufficient overlap of the hernia defect to reinforce the weak area in the abdominal wall. Appropriate orientation of the patch is critical (the brown side is placed against the viscera and the rough surface against the abdominal wall). Once the patch size has been determined, it is cut to size. Eight small skin incisions of approximately 0.5 cm as far as the fascial plane are made with an 11 blade at a distance of 5 cm from the hernia ring at eight points corresponding to the cardinal points of an eight point compass rose pattern (Fig. 1C). The prosthesis is fastened to eight silicone-braided nylon non-absorbable 0 stitches placed in the eight incisions. The two ends of each stitch, previously tied to the prosthesis, are caught using the laparoscopic Gore® suture passer (Fig. 2), which is inserted twice through the same skin incisions. The surgeon brings the ends of the stitches above the fascial plane through two different routes (one end at a time via two separate insertions of the instrument at each cardinal point; this creates a fascial bridge over which the suture is tied). It is preferable to knot the stitches once all of them have been brought over the fascia to avoid tension on the edges (tension-free technique) and to place the mesh in the correct way. Another continuous non-absorbable 2-0 crown suture is then inserted 2 cm inside the intraperitoneal hernial ring (Fig. 1). Finally the previously fashioned sac is sutured over the prosthesis to separate it from the cutaneous layer. Subcutaneous tissues and the

Table 3
Demographic and perioperative data.

Male/female ratio	33/39
Age (y)	73.7 ± 4.58 (66–83)
Body mass index (kg/m^2)	35.16 ± 10.99 (20–51)
ASA classification	
II	5 (6.9%)
III	57 (79.16%)
IV	10 (13.8%)
Patients with failed previous repair	36 (50%)
Defect size (cm^2)	201.94 ± 51.61 (176–452)
Operating time (min)	62.16 ± 11.97 (45–110)
Median postoperative hospital stay (d)	6.4 ± 2.5 (4–20)

Data for categorical variables are expressed as *n* (%). Data for continuous variables are expressed as mean ± SD (range).
ASA = American Society of Anesthesiology.

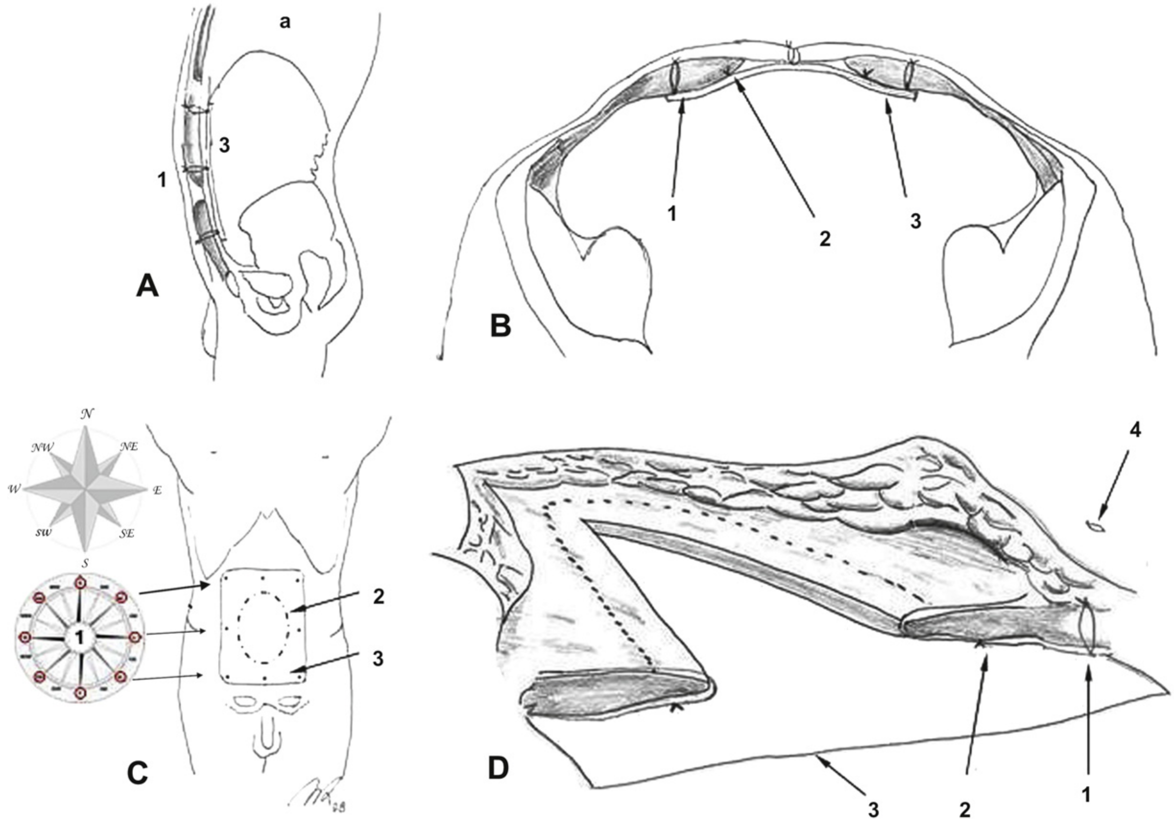

Fig. 1. Intraperitoneal prosthesis placement. (A) Abdominal sagittal plane. (B) Abdominal transversal plane. (C) Abdominal prosthesis placement highlighting the compass rose pattern for fascial anchorage points of sutures and the crown suture (dash ellipse). (D) Abdominal layers with internal crown suture outlined. 1 = over-fascial anchorage stitches at the cardinal points of a compass rose pattern; 2 = crown suture 3 = DualMesh® prosthesis 4 = 0.5-cm skin incision.

skin are closed over two aspiration drains. Antibiotics are given as a prophylactic measure up to the fourth postoperative day.

3. Results

No intraoperative complications occurred and the postoperative mortality rate was 0%. Postoperatively, seven seromas were resolved by repeated echo-guided aspiration and four small hematomas resolved without treatment. Deep wound infection occurred in two cases and removal of the mesh became necessary in one case despite treatment by incision, irrigation and drainage. The follow-up time ranged from 5 months to 45 months.

Three patients (4.1%) developed a recurrence. The recurrences were related to parietal infection treated by removal ($n = 1$) or lateral detachment of the mesh ($n = 2$) and took place at the start of our case series when the mesh had been sutured too close to the hernia ring.

In our experience mean operating time was 62.16 ± 11.97 minutes (range 45–110).

4. Discussion

In elderly patients with large IH, primary repairs generally yield poor results. Prosthetic materials have been used in wall defect repairs for more than 20 years. The ideal prosthesis is strong and inert, allows incorporation of connective tissue, forms only minimal adhesions, and resists infection. The problem is arrangement of the prosthesis within the abdominal wall. Essentially there are two sites for placement: extraperitoneal and intraperitoneal. The first involves artificial creation of a cleavage in the abdominal muscoloaponeurotic plane. The prosthesis is fixed within this pouch. In this technique, the prosthesis is not in contact with the viscera, but delicate peritoneal dissection into the aponeurotic muscle plane is required; this is not always easy or free from complications in large IH. For intraperitoneal repair, the prosthesis must have characteristics such as not to determine adhesions or erosion phenomena against the abdominal viscera. The prosthesis may have dimensions large enough to occupy the entire anterior abdomen perimeter with significant reinforcement of the structure of the wall beyond the edge of the great hernial ring. Scrupulous asepsis is mandatory and broad-spectrum antibiotics should be administered. This approach must be ruled out in cases of an infected surgical field.

The surgical procedure described here has several advantages over other open techniques. In general, prefascial, retromuscular, preperitoneal or premuscular sites require wide dissection and longer operating time[15–20]. We chose this simple technique for elderly patients because it does not require dissection of intermediate layers, a procedure that is associated with a greater risk of postoperative wound complications. Some authors have emphasized the risk of postoperative intestinal occlusion and bowel fistula in intraperitoneal positioning of a mesh[21,22], but the use of a hydrophobic material with reduced porosity, such as ePTFE, avoids this complication[23–25]. The technique we use involves minimal dissection, and aponeuroses, muscles and subcutaneous tissues can remain intact. Correct positioning of the ePTFE prosthesis is extremely important. The prosthesis must be placed intraperitoneally (Fig. 1A–C) so that it overlaps the hernia ring by at least 5–10 cm, and it must be anchored with transparietal stitches. For these reasons we adopted the laparoscopic technique of suture passing,

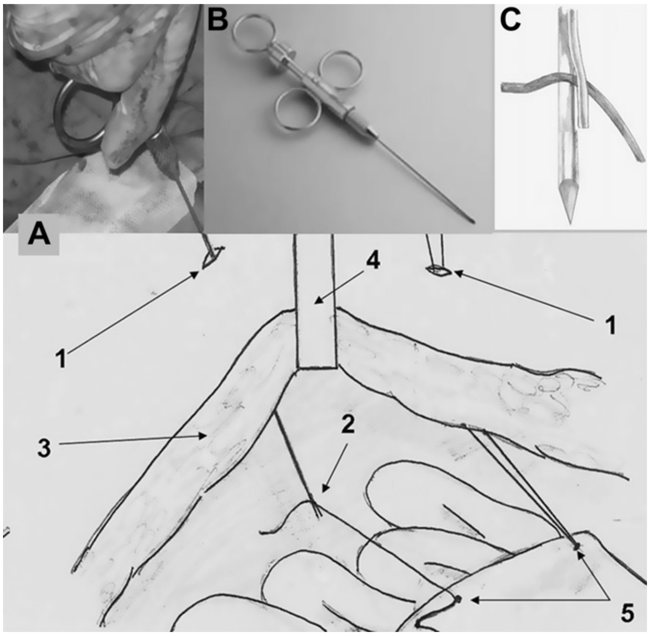

Fig. 2. Use of the laparoscopic Gore® suture passer for intraperitoneal prosthesis placement. (A) The two ends of each stitch are first tied to the prosthesis and then caught by the laparoscopic Gore® suture passer after it is inserted twice through the same skin incision. This permits the surgeon to bring the ends of the stitches above the fascial plane through two different routes (one end at a time via two separate insertions of the instrument at the same cardinal point). (C) Magnified image of the laparoscopic Gore® suture passer extremity after the stitch has been caught. 1 = two of the eight 0.5-cm skin incisions at the cardinal points of a compass rose pattern around the large incisional hernia; 2 = suture passer pulling out one of the two stitches above the fascial plane; 3 = section of the abdominal wall; 4 = retractor; 5 = DualMesh® prosthesis with two of eight stitches tied to its margins at the cardinal points of a compass rose pattern.

which facilitates rapid correct and tension-free positioning of the prosthesis with an abundant overlap. This aids reinforcement of the abdominal wall close to the giant defect via fibroblast colonization of the macroporous ePTFE and subsequent tissue incorporation, which improves muscular interplay. Conversely, when the prosthesis is simply anchored to the edges of the defect, there is poor incorporation of material into the fibrotic edge, which results in poor parietal reinforcement[25]. The incidence of seroma is related to the low porosity of the material, which can be prevented by proper drainage of accumulating fluid due to surgical dissection.

The advent of laparoscopic techniques has changed the management of IH in recent years, as these provide a valid alternative to open surgery through underlay placement of meshes[26–44]. Despite good results in terms of safety and minimal recurrence via laparoscopy in the management of IH, the use of minimally invasive techniques for large incisional wall defects is still controversial and practiced by few surgeons[35–37], and is overlooked or contraindicated by other authors who repair fascial defects >15 cm using only a conventional approach[24,27]. There is no unanimous definition of what surgeons actually mean by giant IH. Definitions such as major, large, very large, big, and massive IH are also found in Medline searches[34–40]. Some authors consider giant or large wall defects to have a surface area of approximately 170 cm^2 (range 100–225 cm^2)[29,34]. In general, the operating time is longer for laparoscopic ventral hernia repair than for the classic open approach[37,38], although some authors reported no difference in operation time when comparing the two techniques[43]. Others even reported a shorter operating time for laparoscopic repair[44], depending mainly on the experience of the surgeon, use of tackers, bowel or omental adhesions, site, size and the number or multilocularity of the hernia defect. The common approach to laparoscopic surgery is to use CO_2 insufflation, so-called pneumoperitoneum, to obtain a surgical view. It has been shown repeatedly that establishment of pneumoperitoneum is often associated with increased cardiac filling pressures and an increase in blood pressure and systemic vascular resistance[45–51]. Despite increases in preload and afterload indices, cardiac output remained unaffected during pneumoperitoneum in patients without heart or lung disease in many studies[45–52]. This could be because healthy patients can increase the contractility of their heart to overcome the increase in systemic vascular pressure. For elderly patients, and particularly those with cardiopulmonary comorbidities, it can be difficult or even impossible to increase the contractility of the heart and they are therefore prone to cardiac failure during pneumoperitoneum[53,54]. Our open surgical experience in elderly patients after rapid but careful debridment of viscera from the sac, hernia ring and anterior abdominal wall retains the advantages of underlay technique positioning typical of laparoscopic methodology, but avoids cardiopulmonary complications that can arise from pneumoperitoneum in the elderly.

The ease and speed of this tension-free technique facilitate adequate repair of abdominal wall defects and consolidation of the surrounding area within a short operation time. For these reasons, we consider our method to be preferred for the treatment of large IH in elderly patients. Finally, we want to emphasize the need for antibiotic therapy to prevent prosthesis infection. In fact, the only contraindication for our method is the presence of possible active infection. In our opinion, the presence of contamination precludes the use of permanent prosthetics. In these cases a possible alternative could be the use of porcine biological mesh[55–57].

References

1. Regnard JF, Hay JM, Rea S, et al. Ventral incisional hernias: incidence, date of recurrence, localization and risk factors. *Ital J Surg Sci*. 1988;18:259–265.
2. Mingoli A, Puggioni A, Sgarzini G, et al. Incidence of incisional hernia following emergency abdominal surgery. *Ital J Gastroenterol Hepatol*. 1999;31:449–453.
3. Hsiao WC, Young KC, Wang ST, et al. Incisional hernia after laparotomy: prospective randomized comparison between early-absorbable and late-absorbable suture materials. *World J Surg*. 2000;24:747–751.
4. Hesselink VJ, Luijendijk RW, de Wilt JH, et al. An evaluation of risk factors in incisional hernia recurrence. *Surg Gynecol Obstet*. 1993;176:228–234.
5. White TJ, Santos MC, Thompson JS. Factors affecting wound complication in repair of ventral hernias. *Am Surg*. 1998;64:276–280.
6. Rives J, Lardennois B, Pire JC, et al. Large incisional hernias. The importance of flail abdomen and of subsequent respiratory disorders. *Chirurgie*. 1973;99:547–563 [in French].
7. Stoppa R, Henry X, Canarelli JP, et al. Indications for selective operative procedures in the treatment of post-operative eventrations of the anterolateral abdominal wall. *Chirurgie*. 1979;105:276–286 [in French].
8. Cheng SP, Yang TL, Jeng KS, et al. Perioperative care of the elderly. *Int J Gerontol*. 2007;2:89–97.
9. Chevrel JP, Rath AM. Classification of incisional hernias of abdominal wall. *Hernia*. 2000;4:7–11.
10. Phillips E, Dardano AN, Saxe A. Laparoscopic repair of abdominal hernias using an ePTFE patch—a modification of a previously described technique. *J Soc Laparoendosc Surg*. 1997;1:277–279.
11. Golash V. Modification of Gore suture passer instrument. *Surg Endosc*. 2006;20:1619–1620.
12. Salameh JR. Suture passer tip breakage during laparoscopic ventral hernia repair. *Surg Laparosc Endosc Percutan Tech*. 2005;15:112–114.
13. Ponsky TA, Nam A, Orkin BA, et al. Open, intraperitoneal, ventral hernia repair: lessons learned from laparoscopy. *Arch Surg*. 2006;141:304–306.
14. Pedersen T, Eliasen K, Henriksen E. A prospective study of mortality associated with anaesthesia and surgery: risk indicators of mortality in hospital. *Acta Anaesthesiol Scand*. 1990;34:176–182.
15. Adloff M, Arnaud JP. Surgical management of large incisional hernias by an intraperitoneal Mersilene mesh and an aponeurotic graft. *Surg Gynecol Obstet*. 1987;165:204–206.
16. Arnaud JP, Eloy R, Adloff M, et al. Critical evaluation of prosthetic materials in repair of abdominal wall hernias: new criteria of tolerance and resistance. *Am J Surg*. 1977;133:338–345.
17. Cerise EJ, Busuttil RW, Craighead CC, et al. The use of Mersilene mesh in repair of abdominal wall hernias: a clinical and experimental study. *Ann Surg*. 1975;181:728–734.

18. Rath AM, Zhang J, Amouroux J, et al. Abdominal wall prostheses. Biomechanic and histological study. *Chirurgie*. 1996;121:253–265 [in French].
19. McLanahan D, King LT, Weems C, et al. Retrorectus prosthetic mesh repair of midline abdominal hernia. *Am J Surg*. 1997;173:445–449.
20. Temudom T, Siadati M, Sarr MG. Repair of complex giant or recurrent ventral hernias by using tension free intraperitoneal prosthetic mesh (Stoppa technique): lessons learned from our initial experience (50 patients). *Surgery*. 1996;120:738–744.
21. Kaufman Z, Engelberg M, Zager M. Fecal fistula: a late complication of Marlex mesh repair. *Dis Colon Rectum*. 1981;24:543–544.
22. Guzman De, Nyhus LM, Yared G, et al. Colocutaneous fistula formation following polypropylene mesh placement for repair of a ventral hernia: diagnosis by colonoscopy. *Endoscopy*. 1995;25:459–461.
23. Bonnamy C, Samama G, Brefort JL, et al. Long-term results of the treatment of eventrations by intraperitoneal non-absorbable prosthesis (149 patients). *Ann Chir*. 1999;53:571–576.
24. Van der Lei B, Bleichrodt RP, Simmermacher RK, et al. Expanded polytetrafluoroethylene patch for the repair of large abdominal wall defects. *Br J Surg*. 1989;76:803–805.
25. Bellón JM, Buján J, Contreras L, et al. Integration of biomaterials implanted into abdominal wall: process of scar formation and macrophage response. *Biomaterials*. 1995;16:381–387.
26. Ferrari GC, Miranda A, Di Lernia S, et al. Laparoscopic repair of incisional hernia: outcomes of 100 consecutive cases comprising 25 wall defects larger than 15 cm. *Surg Endosc*. 2008;22:1173–1179.
27. Topart P, Ferrand L, Vandenbroucke F, et al. Laparoscopic ventral hernia repair with the Goretex Dualmesh: long-term results and review of the literature. *Hernia*. 2005;9:348–352.
28. Heniford BT, Park A, Ramshaw BJ, et al. Laparoscopic repair of ventral hernias: nine years' experience with 850 consecutive hernias. *Ann Surg*. 2003;238:391–400.
29. Rudmik LR, Schieman C, Dixon E, et al. Laparoscopic incisional hernia repair: a review of the literature. *Hernia*. 2006;10:110–119.
30. Carbajo MA, Martín del Olmo JC, Blanco JI, et al. Laparoscopic approach to incisional hernia. *Surg Endosc*. 2003;17:118–122.
31. Navarra G, Musolino C, De Marco ML, et al. Retromuscular sutured incisional hernia repair: a randomized controlled trial to compare open and laparoscopic approach. *Surg Laparosc Endosc Percutan Tech*. 2007;17:86–90.
32. Novitsky YW, Cobb WS, Kercher KW, et al. Laparoscopic ventral hernia repair in obese patients: a new standard of care. *Arch Surg*. 2006;141:57–61.
33. Perrone JM, Soper NJ, Eagon JC, et al. Perioperative outcomes and complications of laparoscopic ventral hernia repair. *Surgery*. 2005;138:708–716.
34. Johna S. Laparoscopic incisional hernia repair in obese patients. *J Soc Laparoendosc Surg*. 2005;9:47–50.
35. Kirshtein B, Lantsberg L, Avinoach E, et al. Laparoscopic repair of large incisional hernias. *Surg Endosc*. 2002;16:1717–1719.
36. Parker HH 3rd, Nottingham JM, Bynoe RP, et al. Laparoscopic repair of large incisional hernias. *Am Surg*. 2002;68:530–534.
37. Park A, Gagner M, Pomp A. Laparoscopic repair of large incisional hernias. *Surg Laparosc Endosc*. 1996;6:123–128.
38. Cobb WS, Kercher KW, Matthews BD, et al. Laparoscopic ventral hernia repair: a single center experience. *Hernia*. 2006;10:236–242.
39. Earle D, Seymour N, Fellinger E, et al. Laparoscopic versus open incisional hernia repair: a single-institution analysis of hospital resource utilization for 884 consecutive cases. *Surg Endosc*. 2006;20:71–75.
40. Lomanto D, Iyer SG, Shabbir A, et al. Laparoscopic versus open ventral hernia mesh repair: a prospective study. *Surg Endosc*. 2006;20:1030–1035.
41. Olmi S, Magnone S, Erba L, et al. Results of laparoscopic versus open abdominal and incisional hernia repair. *J Soc Laparoendosc Surg*. 2005;9:189–195.
42. Ammaturo C, Bassi G. Surgical treatment of large incisional hernias with an intraperitoneal Parietex composite mesh: our preliminary experience on 26 cases. *Hernia*. 2004;8:242–246.
43. Muysoms F, Daeter E, Vander Mijnsbrugge G, et al. Laparoscopic intraperitoneal repair of incisional and ventral hernias. *Acta Chir Belg*. 2004;104:705–708.
44. Carbajo MA, Martín Del Olmo JC, Blanco JI, et al. Laparoscopic treatment vs open surgery in the solution of major incisional and abdominal wall hernias with mesh. *Surg Endosc*. 1999;13:250–252.
45. Kelman GR, Swapp GH, Smith I, et al. Cardiac output and arterial blood-gas tension during laparoscopy. *Br J Anaesth*. 1972;44:1155–1162.
46. Marshall RL, Jebson PJ, Davie IT, et al. Circulatory effects of carbon dioxide insufflation of the peritoneal cavity for laparoscopy. *Br J Anaesth*. 1972;44:680–684.
47. Kubota K, Kajiura N, Teruya M, et al. Alterations in respiratory function and hemodynamics during laparoscopic cholecystectomy under pneumoperitoneum. *Surg Endosc*. 1993;7:500–504.
48. Odeberg S, Ljungqvist O, Svenberg T, et al. Haemodynamic effects of pneumoperitoneum and the influence of posture during anaesthesia for laparoscopic surgery. *Acta Anaesthesiol Scand*. 1994;38:276–283.
49. Gannedahl P, Odeberg S, Brodin LA, et al. Effects of posture and pneumoperitoneum during anaesthesia on the indices of left ventricular filling. *Acta Anaesthesiol Scand*. 1996;40:160–166.
50. Myre K, Buanes T, Smith G, et al. Simultaneous hemodynamic and echocardiographic changes during abdominal gas insufflation. *Surg Laparosc Endosc*. 1997;7:415–419.
51. Myre K, Rostrup M, Buanes T, et al. Plasma catecholamines and haemodynamic changes during pneumoperitoneum. *Acta Anaesthesiol Scand*. 1998;42:343–347.
52. Andersson L, Wallin CJ, Sollevi A, et al. Pneumoperitoneum in healthy humans does not affect central blood volume or cardiac output. *Acta Anaesthesiol Scand*. 1999;43:809–814.
53. Uchikoshi F, Kamiike W, Iwase K, et al. Laparoscopic cholecystectomy in patients with cardiac disease: hemodynamic advantage of the abdominal wall retraction method. *Surg Laparosc Endosc*. 1997;7:196–201.
54. Ridings PC, Bloomfield GL, Blocher CR, et al. Cardiopulmonary effects of raised intra-abdominal pressure before and after intravascular volume expansion. *J Trauma*. 1995;39:1071–1075.
55. Chavarriaga LF, Lin E, Losken A, et al. Management of complex abdominal wall defects using acellular porcine dermal collagen. *Am Surg*. 2010;76:96–100.
56. Burns NK, Jaffari MV, Rios CN, et al. Non-cross-linked porcine acellular dermal matrices for abdominal wall reconstruction. *Plast Reconstr Surg*. 2010;125:167–176.
57. Shaikh FM, Giri SK, Durrani S, et al. Experience with porcine acellular dermal collagen implant in one-stage tension-free reconstruction of acute and chronic abdominal wall defects. *World J Surg*. 2007;31:1966–1972.