

Eighty-five redo surgeries after 733 laparoscopic treatments for ventral and incisional hernia: adhesion and recurrence analysis

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Abstract

Introduction This report reviews the clinical and functional outcomes of implanted meshes during a second-look evaluation of 85 cases after a large number (733) of laparoscopic incisional and ventral hernia repairs (LIVHR), of which 608 were controlled throughout a period of 5 to 10 years. This report demonstrates a minimal occurrence of adhesions and a low rate of recurrences and other complications related to mesh usage.

Methods Eighty-five re-operated cases after LIVHR were reviewed retrospectively. In every redo surgery, the first trocar was always inserted on a lateral side, external to the previous skin incisions of the transabdominal fixations. Mueller's adhesion scale was used to estimate adhesion severity (Mueller 0 indicates no adhesion; Mueller I indicates adhesion of the omentum; and Mueller II indicates serosal adhesions). The mechanism of recurrence is of paramount interest and is analyzed herein. If recurrence was observed, the defect was closed and a larger mesh of ParietexTM was implanted under the previous one, with transparietal fixation achieved by pulling the threads with the Endoclose[®] device.

Results In all of our "second-look" surgeries, the neoperitoneum perfectly covered the mesh. In 47.05% of the cases, we observed no adhesions (Mueller 0), 42.3% had adhesions of the omentum (Mueller I), and 10.58% had serosal adhesions (Mueller II). There was no shrinking or wrinkling of the prosthesis in any of the cases, confirming

its total peritonization on the anterior abdominal wall. Within the first 3 years, only 4.1% of the controlled patients contracted recurrences, with a mean follow-up of 52 months.

Conclusion With the double-suturing technique used for LIVHR and the use of a composite mesh, we observed a low rate of recurrences and limited side effects as compared with the use of tacks intra-abdominally. Redo surgeries after LIVHR are feasible, but care must be taken due to unpredictable mesh adhesions.

Keywords Ventral hernia · Laparoscopy · ParietexTM Composite prosthesis · Mesh outcomes · Incisional hernias · Second-look

Introduction

Based on mid-term results within 5 to 10 years [1–8], laparoscopic incisional and ventral hernia repairs (LIVHR) reduce the overall complications, recurrence rates, and length of hospital stay. In his meta-analysis of mid-term LIVHR follow-up, performed less than 3 years from the time of the first surgery, LeBlanc showed that the cumulative recurrence rate is, at most, 5.6% [9].

The present study explores the postoperative adhesions on prosthetic meshes and staples resulting from inflammatory reactions to foreign materials with the use of intra-abdominal meshes implanted by laparoscopy. These adhesions can cause intestinal obstruction [10–12], chronic abdominal pain [13–15], enterocutaneous fistulas [16–19], and female infertility [2, 20]. The potential visceral adhesions may jeopardize the redo surgery, especially in young LIVHR patients who might be candidates for repeat abdominal surgeries.

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Our main goal in the laparoscopic approach to abdominal hernia repair was to decrease the recurrence rate and related mesh complications, such as potential visceral adhesions. We, thus, developed a double-suturing concept involving trans-abdominal mesh fixation associated to routine closure of the parietal defect using a validated composite mesh (ParietexTM Composite, made by Sofradim (Covidien), Trevoux, France). The present study analyzes the absence or grade of adhesions present with a polyester composite mesh, and the low recurrence rate using our technique, in 85 redo surgeries after a large number (733) of LIVHR with a mean follow-up period of 52 months.

Materials and methods

We retrospectively reviewed 85 patients having undergone repeat surgery after LIVHR for different reasons and diagnoses. We gathered the findings from the second-look surgeries. Mueller's adhesion scale was used to estimate adhesion severity. They were graded according to a standardized score of I–III, while a score of 0 was given to cases free of adhesions: a score of I (mild) indicated thin and avascular lesions; II (moderate) indicated thick and avascular lesions; III (severe) indicated very dense and vascular adhesions [20]. The overall patient and hernia characteristics are listed in Table 1.

Materials

All of our patients who had previously undergone laparoscopic and ventral hernia repair had received the same ParietexTM Composite mesh and underwent the same surgical technique. However, 24 cases (3.2%), essentially in the early stage of our study, and in large defects, had a “no-closure” defect repair.

This innovative mesh was selected due to its hydrophilic absorbable film, which protects the viscera from direct

contact with the mesh during the process of integration, thereby, minimizing adhesions and visceral erosion on the intra-abdominal side [3, 21–23].

Surgical technique

Full details of the LIVHR surgical technique have been presented in previous reports [3, 23]. Three trocars are introduced on the right anterior axillary line. All adhesions on the parietal defect and the former incision, if present, are released, with an additional area to allow sufficient overlap of the mesh. The systematic closure is mandatory in our policy and is done either extra-corporeally or intra-corporeally with non-absorbable monofilament threads, with laparoscopic trans-parietal U reverse stitches: this involves making a small skin incision of 2 mm on the left lateral edge of the defect. A Surgipro 1 needle is passed trans-abdominally with a classic needle holder. Then, a U reverse bite is made on the contralateral edge of the defect (right side) posteriorly. Sometimes, we try to invaginate the sac by fixing it medially, and then cutting the thread and retrieving it with the Endoclose[®] device (USSC, Covidien) through the same left skin incision. This maneuver should be repeated as needed vertically at “1-cm intervals,” depending on the size and length of the defect. All of the suspended threads are tied after total exsufflation, subcutaneously and susaponevrotically closing anteriorly the defect. For defects greater than 7 cm in width and 14 cm in length, a minilaparotomy with external conventional closure can be combined. Once hydrated, cardinal stitches, distant of 4 cm in a circumference and two stitches in the center, are applied on the polyester side of the mesh, while taking care not to perforate or damage the underlying hydrophilic film.

Next, the mesh is unrolled. Both threads are retrieved trans-abdominally by the introduction of the Endoclose[®] needle device through a small skin incision of 2 mm over each knot and 1 cm from the peritoneal side of the prosthesis. All of the threads are retrieved before closing and knotting. We start to tie different knots on the lateral side subcutaneously, susaponevrotically under a low pressure of 8 mmHg, thus, fixing the mesh to the anterior abdominal wall, without overextension.

The final positioning is made and does not necessitate any additional stapling fixation. The protective hydrophilic film is intact and is the only component remaining in contact with the viscera, hence, limiting potential adhesions.

In the redo LIVHR surgery, the first trocar is always inserted on the left or right lateral side, external to the previous trans-abdominal fixation skin incisions.

If adhesions exist, meticulous adhesiolysis is undertaken either by gentle lateral blunt dissection with “peanut-

Table 1 Patients characteristics

Oct 2000 to Oct 2008	85 second-looks
Mean age (years)	61
Female	78%
Male	22%
Mean body mass index (BMI)	36.3
Type of initial surgery (% of total patients)	% of the second-looks
Incisional ventral hernia (IVH) (46.05%)	32
Primary ventral hernia (40.54%)	61
Recurrent IVH (13.41%)	7

Table 2 Observations and results—re-operations

Controlled patients: 608/733, 83%		Follow-up second-looks: 85, 11.6%
Period from LIVHR to second-look	Type of procedure	Number (%)
1–12 months	9 recurrences	43 (50.5%)
	17 cholecystectomies	
	10 miscellaneous (non-morbid cases)	
	7 emergencies	
12–36 months	10 recurrences	31 (36.6%)
	3 Nissen	
	3 gastric bypass; 4 laparotomies	
	11 miscellaneous	
36–84 months	6 recurrences	11 (12.9%)
	2 redo gastric bypass; 1 cholecystectomy	
	2 miscellaneous	
Observations on mesh-related adhesions	Number	Percentage
Adhesion-free	40	47.05
Minor adhesion (Mueller I)	36	42.35
Serosal adhesion (Mueller II)	9	10.58
Mean follow-up	52 months (range 1 to 101 months)	

gauze” or via the use of scissors and minimal coagulation, in order to avoid damaging the neoperitoneum present on the initial mesh. If no recurrence is found, the procedure is performed by standard positioning of the trocars, and even through the mesh if needed. If recurrence is observed, the defect is closed in the same manner described above, and a larger mesh of ParietexTM Composite is implanted underlying the previous one with transparietal fixation, performed by pulling the threads with an Endoclose[®] device. At the end of the procedure, the closure of 10-mm trocar orifices is mandatory, whether or not it has been passed through the initial mesh.

Results

Among the 733 patients who had undergone an LIVHR, 608 (83%) were controlled and 85 were re-operated for various reasons (11.6%), allowing for a second look. The mean time from initial mesh implantation to re-operation was 13.4 months (range 1 to 84 months). On a scientific basis, all of these 608 LIVHR patients have had a computed tomography (CT) scan within 3 months for a “control point” after surgery (mesh positioning and closure reference).

The present investigation was a clinical and scientific retrospective study designed to observe the implanted meshes. The second-look operations were performed for patients who had previously undergone LIVHR and were

then submitted either to another abdominal procedure or simple exploration associated with another elective parietal surgery. Twenty-five of them presented with a recurrence diagnosed before the redo surgery.

The observations and the results obtained from the re-operation are shown in Table 2.

A total of 47.05% of the 85 re-operated patients were found to be adhesion-free, classified as Mueller 0 (Fig. 1). A total of 42.3% demonstrated loose adhesions of the omentum, classified as Mueller I (Fig. 2). The last 10.58% had easily cleavable or mild serosal intestinal adhesions, classified as Mueller II (Fig. 3).

There were four inadvertent injuries of the epigastric vessels (invisible above the previous mesh) that resulted in perioperative bleeding. These were immediately secured by simple ligation with the Endoclose[®] device. No enterotomies occurred during adhesiolysis. Since only 83% (608/733) of the patients with LIVHR were controlled, the overall recurrence rate of 3.4% (25/733) was corrected to 4.1% (25/608).

Among these 608 patients controlled, 25 (4.1%) had recurrences diagnosed 1 to 84 months postoperatively, with three cases exhibiting medium or large defects on incisional ventral hernia, due to an extrusion of the mesh into the cavity or residual sac, because the defect had not been closed during the first surgery. Another six cases of primary ventral hernia demonstrated inadequate mesh fixation and insufficient mesh overlapping for the corresponding body mass index (BMI) of obese patients.

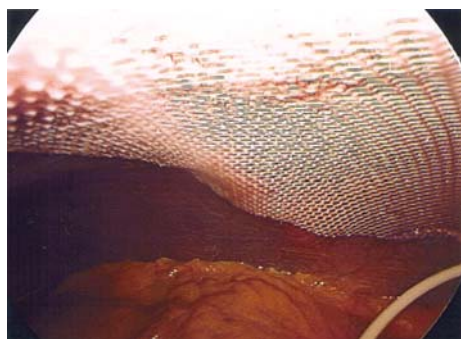


Fig. 1 Second-look laparoscopy: adhesion-free mesh

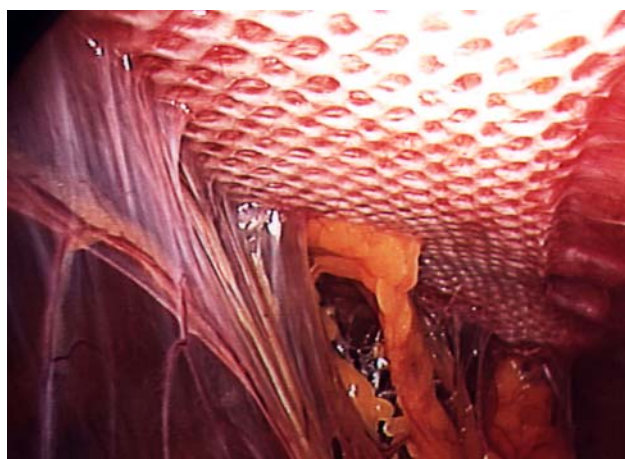


Fig. 2 Loose adhesions

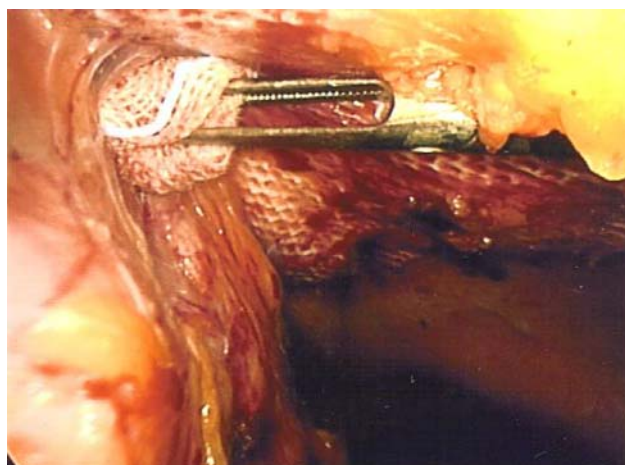


Fig. 3 Blunt dissection on serosal bowel adhesion

Essentially, six cases of incisional ventral hernias were considered as recurrences because the defect appeared in either the suprapubic zone just beneath the previously implanted mesh or, in three cases, as a subxiphoid defect immediately above the previous mesh. Three incisional ventral hernias due to inadequate fixation or dislocation of

the lateral and inferior portion of the mesh were also encountered, with intestinal loop interpositioning between the mesh edges. The last four cases of IVH were for recurrence outside the edge of the mesh which was not covering the former incision.

The following is a brief description of the major complications encountered after the initial 733 LIVHR surgeries.

Early postoperative transient pain in LIVHR was reported by 20 patients (2.72%) and chronic pain (>3 months) in 18 patients (2.4%). Neither acute nor chronic mesh-related infections were encountered, and no occurrences of enterocutaneous fistula were detected. Only two major infections were notified, unrelated to mesh use. One involved a parietal hematoma with secondary infection and abscess in a diabetic patient that had to be removed by surgery after unsuccessful percutaneous drainage. The second one involved a “serosal breakdown” on the second postoperative day with peritonitis, necessitating the removal of the mesh and a primary closure over a Vicryl mesh. Minor infections included six cases of cellulitis, described in the LIVHR, which were superficial and treated locally. Four superficial acute abscesses in combined LIVHR were spontaneously drained by retrieving two threads on the periumbilical wound and covered by intravenous antibiotics for 10 days without the need for mesh retrieval.

In our redo surgeries, no residual pain or infection was encountered.

Discussion

Our observations on the 85 “second-look” interventions corroborated the initial findings on the LIVHR suturing technique. Our analysis revealed a low rate of complications compared to studies of other techniques using intra-peritoneal mesh reinforcement.

Previous studies on the use of ParietexTM mesh in LIVHR show encouraging preliminary results. This is supported by follow-ups using routine CT scan controls at least within 3 months from the operation, and the positive second-look observations made whenever the opportunity for redo surgery was possible. Based on these previous results and observations, we continued to use our technique of defect closure with trans-abdominal anchoring of the ParietexTM Composite mesh with non-absorbable threads.

The findings and observations from the current study show that the establishment of the pneumoperitoneum and the safe introduction of the first trocar are crucial in order to avoid iatrogenic visceral perforation.

In all cases assessed herein, the pneumoperitoneum was initiated under the left subcostal margin and the first trocar was placed bluntly on the lateral side, without the need of a

Visiport, external to the limit of the previous abdominal skin incisions, if observed. This was performed in consideration of the 42.3% potential risk of medial omental adhesion on the mesh and the 10.58% risk of serosal bowel adhesion, which could lead to accidental intestinal perforation. A total of 47.05% of cases studied did not show any adhesion.

In very few cases of previous multiple surgeries, and specifically in right colectomies, a Visiport or an open Hassan technique was secured.

Adhesion formation

The choice of biomaterial, its laparoscopic handling and sturdiness, and the type of fixation used are all important in order to avoid significant visceral adhesion formation in LIVHR. In the present study, CT scan controls are performed for scientific purposes in order to control the efficiency of the parietal closure and the mesh repositioning, providing us with a reference point for better future evaluation. Unfortunately, the scans did not provide any sensitive or conclusive data regarding the rate of intra-abdominal adhesions. Knowing the effectiveness of ultrasound in detecting intra-peritoneal digestive organ adhesions, this method was used to assess the presence of adhesions following LIVHR with ParietexTM Composite prosthesis. It showed a low rate of 14% of cases with adhesions one year from surgery. It, thus, confirmed the previously published preclinical data [21, 22, 24–26].

Adhesions may increase the risk of potential enterocutaneous fistula [16–18] and female infertility [2, 20], and can complicate re-operations [10–12, 16, 27].

Due to the risk of complications related to these digestive adhesions, such as chronic abdominal pain [13–15, 20] and intestinal occlusion, the collagen film covering the entire polyester side of the mesh, which is fixed by threads, should be handled carefully and left undamaged. The protective hydrogelic film should be intact at the end of the procedure and should be the only component in contact with the viscera.

Among the 85 cases in this study, 47.05% were found to be adhesion-free. We observed perfect integration of the polyester layer into the anterior abdominal wall. It was covered with total neoperitoneum and was well vascularized, without any apparent sign of shrinking or wrinkling of the mesh. The second-look showed, in 42.3% of the patients, simple adhesions of the omentum, classified as Mueller I, within the temporary barrier, which ensures a cleavage plane between the textile reinforcement and the omentum. In all of our second-look patients, we observed a well-vascularized peritoneum that perfectly covered the entire mesh, as described by Koehler et al. and Bellón et al. [27, 28].

We observed only two cases with internal stricture and intestinal loop adhesion without occlusion or bowel necrosis, and without any correlation to the mesh. Two cases of chronic abdominal pain, caused by severe adhesions in a large combined LIVHR, were resolved after large adhesiolysis.

Lysis of mild visceral adhesions, as in 10.58% of Mueller II classifications, arguably one of the most challenging aspects of LIVHR redo, should be performed by gentle blunt dissection with “peanut-gauze,” or by the use of scissors and thermocoagulation, with the utmost care so as to not damage the bowel serosa, and to avoid excision of the neoperitoneum on the previously implanted mesh. If spillage of the gastrointestinal contents and abdominal contamination occurs during adhesiolysis, the insertion of a new composite mesh, if needed in case of recurrence, should be delayed for 6 months, after negative biopsies.

In patients for whom a partial stapling method was used for mesh fixation, more adhesions were present on the protacks, which were responsible for chronic abdominal pain and mesh migration. This critical observation has been previously reported in the literature [19, 22, 23, 27–29].

Conversely, resorbable clips (Sofradim, Covidien) were used for ParietexTM Composite mesh fixation in the last two second-look cases (4 to 6 months) of lateral incisional hernias, and these cases were completely free of adhesions. Creating and developing a new model with more anchoring absorbable staples such as AbsorbaTack[®] (Covidien) would be very useful in reducing the number of transfascial suturing, for additional fixation of the mesh in ventral and incisional hernias.

One female patient observed bladder bleeding after sexual intercourse 6 months after infraumbilical LIVHR. In this patient, two lateral intravesical protack fixations were retrieved by “rendezvous” cystoscopy and laparoscopy. These protacks were responsible for adhesions with protack preperitoneal fixation on Cooper’s ligaments and peritoneal flap closure laterally.

We recommend in infraumbilical incisional hernia, a preperitoneal flap dissection with a Foley catheter in all cases, associated to thread fixation on a visible Cooper ligament, while leaving the peritoneal flap unfixed beneath the mesh. This method has become our technique for treating infraumbilical and suprapubic incisional hernias.

Ninety-seven percent of our controlled patients were pain-free 3 months postoperatively, with no infection and no residual pain from either the trans-abdominal suture fixation or closure of the defect.

The very low infection rate in LIVHR (1.62%, of which 0.6% had cellulitis and were treated medically, 0.75% needed external wound drainage, and 0.27% needed re-operation) and the absence of chronic mid- to long-term mesh-related infection or enterocutaneous fistulas are

contradictory with the criticism and assumption of multifilament and polyester-related long-term infection reported by Leber et al. [18].

The follow-up of those patients was regular and did not show evidence of any residual sign of infection or fistulas.

Adhesion on intraperitoneal onlay mesh (IPOM) is generally multifactorial, depending on the specification of the biomaterial, as well as the method of fixation by staples, resorbable or non-resorbable threads, fibrin glue, the manipulation of and damage to the composite part of the mesh, the bleeding field, and the potential hematomas or seroma formation into the cavity.

By giving each parameter meticulous attention, the amount of intra-abdominal adhesions on the mesh can be reduced substantially.

Recurrence

Recurrence rates can be established more accurately with longer mean follow-up times of over 36 months [9, 29]. Comparing our data, with a mean follow-up period of 52 months, with the results obtained by others, proves that trans-abdominal mesh fixation with closure of defects results in a similar low recurrence rate (3.4%: 25/733 to 4.1%: 25/608) and a reduced incidence of overall related complications (18%).

Of the 25 patients that recurred, 19 (76%) had failure of an incisional hernia repair and 6 (24%) had failure of a primary ventral hernia repair.

In the early stage, two cases of recurrence were observed in patients with tack dislocation and extrusion of the mesh into the unclosed cavity with a tension-free repair. Furthermore, the skin bulging and disappointing results (in our hands) caused us to switch to the routine suturing and closing defect concept.

We consider that total LIVHR with “defect closing” is safer and more feasible when the defect’s width is less than 7 cm and the length is less than 14 cm. For the others, a combined external closure and laparoscopic mesh reinforcement is preferred.

Many obese patients presented with recurrences in less than 24 months, in agreement with several findings by other authors [30]. This was due to the inappropriate use of small mesh size in a high BMI patient. In light of these results, the use of larger meshes, by a 5-cm overlap, is advisable.

Our observations allow us to suggest a few reasons as to the occurrence of the recurrences. One hypothesis involves the tissue ingrowth on the polyester side that causes significant fibrosis and solidity of the anterior abdominal wall, thus, hypothetically increasing parietal fragility and generating a suture fracture or a new hernia outside the edges of the implanted mesh [29]. Another hypothesis is the

potential medial contraction of the mesh also adding to that risk. Insufficient coverage of the incision scar is also considered to be a risk factor for a higher recurrence rate after LIVHR, as in our ventral hernia repair data. In fact, those recurrences appeared in five cases at 6, 8, 11, 25, and 36 months either in the upper (for the first two cases) or lower midline due to inadequate fixation or weakening of the anterior wall just beneath the previous mesh. When observed, the defect was closed laparoscopically and a second composite mesh was placed underlying the previous one, with larger overlapping and circumferential trans fascial sutures. The suprapubic and subxiphoid locations are known for high incidence of recurrences, which made us change our technique to a preperitoneal mesh reinforcement and accurate fixation. As described in the literature, more than 80% of our recurrent hernias were diagnosed within three postoperative years [3, 29, 30]. However, this statement is evoked here with caution in light of the report by Flum et al., in which they demonstrate a possible increase in the rate of recurrences with time beyond 5 years [31].

Redos

As shown in Table 2, a second look was enabled for various reasons. Some patients returned for an elective abdominal surgery, others for an emergency, among which were an appendectomy, an ovarian cyst torsion, inguinal incarcerated hernias, perforated ulcers, and adhesiolysis for occlusion, all not directly related to the mesh.

All of the 25 patients that recurred had previously presented with recurrences that were clinically or iconographically diagnosed before redo surgery, which was then performed accordingly. No misdiagnosed recurrence was found after the second look in the other 60 patients.

A number of our LIVHR patients were morbidly obese, and five were selected by a large multidisciplinary team to undergo bariatric surgery: There were three gastric bypasses and two redo gastric bypasses, from 1 to 5.5 years after the LIVHR procedure, allowing the second look to be carried out.

Laparotomies were performed in two cases of abdominal aortic aneurysm replacement and two cases of colonic resections on elective surgery. After the laparotomy, the abdominal wall closure was performed in a conventional manner by reapproximation of the two edges of the mesh with unresorbable running sutures.

A total of 83% of patients were controlled by standard clinical examination at 3-month intervals in the first year and then once every year. The 17% of patients who were not controlled caused a loss of follow-up, thus, reducing the sensitivity of this study, and possibly underestimating the true recurrence rate.

Conclusion

The major improvement observed in this method of laparoscopic incisional and ventral hernia repair (LIVHR) is highlighted by the absence of prosthesis migration, limited adhesions, and a low recurrence rate.

Re-operations after LIVHR should be practiced with the utmost care due to the risk of unpredictable dense adhesions at the midline. Adhesion risk is minimized with a lower rate of recurrence by using the suturing concept and an efficient polyester-protected mesh. Circumferential transfascial suturing is highly recommended for redo LIVHR. However, a long-term prospective analysis of these issues will be needed to validate these conclusions.

References

- Ramshaw BJ, Esartia P, Schwab J et al (1999) Comparison of laparoscopic and open ventral herniorrhaphy. *Am Surg* 65:827–832
- Cassar K, Munro A (2002) Surgical treatment of incisional hernia. *Br J Surg* 89:534–545
- Chelala E, Gaede F, Douille V et al (2003) The suturing concept for laparoscopic mesh fixation in ventral and incisional hernias: preliminary results. *Hernia* 7:191–196
- Franklin ME Jr, Gonzalez JJ Jr, Glass JL et al (2004) Laparoscopic ventral and incisional hernia repair: an 11-year experience. *Hernia* 8:23–27
- Heniford BT, Park A, Ramshaw BJ et al (2003) Laparoscopic repair of ventral hernias: nine years' experience with 850 consecutive hernias. *Ann Surg* 238:391–400
- Raftopoulos I, Vanuno D, Khorsand J et al (2003) Comparison of open and laparoscopic prosthetic repair of large ventral hernias. *JSLs* 7:227–232
- van't Riet M, Vrijland WW, Lange JF et al (2002) Mesh repair of incisional hernia: comparison of laparoscopic and open repair. *Eur J Surg* 168:684–689
- Olmi S, Scaini A, Cesana GC et al (2007) Laparoscopic versus open incisional hernia repair: an open randomized controlled study. *Surg Endosc* 21:555–559
- LeBlanc KA (2004) Laparoscopic incisional and ventral hernia repair: complications—how to avoid and handle. *Hernia* 8:323–331
- Ellis H (1997) The clinical significance of adhesions: focus on intestinal obstruction. *Eur J Surg Suppl* 577:5–9
- Chuback JA, Singh RS, Sills C et al (2000) Small bowel obstruction resulting from mesh plug migration after open inguinal hernia repair. *Surgery* 127:475–476
- Bellón JM, Rodríguez M, García-Hondurilla N et al (2007) Peritoneal effects of prosthetic meshes used to repair abdominal wall defects: monitoring adhesions by sequential laparoscopy. *J Laparoendosc Adv Surg Tech A* 17:160–166
- Fränneby U, Gunnarsson U, Wollert S et al (2005) Discordance between the patient's and surgeon's perception of complications following hernia surgery. *Hernia* 9:145–149
- Carbonell AM, Harold KL, Mahmutovic AJ et al (2003) Local injection for the treatment of suture site pain after laparoscopic ventral hernia repair. *Am Surg* 69:688–692
- Wassenaar EB, Raymakers JT, Rakic S (2007) Removal of transabdominal sutures for chronic pain after laparoscopic ventral and incisional hernia repair. *Surg Laparosc Endosc Percutan Tech* 17:514–516
- Losanoff JE, Richman BW, Jones JW (2002) Entero-colocutaneous fistula: a late consequence of polypropylene mesh abdominal wall repair: case report and review of the literature. *Hernia* 6:144–147
- Bageacu S, Blanc P, Breton C et al (2002) Laparoscopic repair of incisional hernia: a retrospective study of 159 patients. *Surg Endosc* 16:345–348
- Leber GE, Garb JL, Alexander AI et al (1998) Long-term complications associated with prosthetic repair of incisional hernias. *Arch Surg* 133:378–382
- DeMaria EJ, Moss JM, Sugerman HJ (2000) Laparoscopic intraperitoneal polytetrafluoroethylene (PTFE) prosthetic patch repair of ventral hernia. Prospective comparison to open prefascial polypropylene mesh repair. *Surg Endosc* 14:326–329
- Mueller MD, Tschudi J, Herrmann U et al (1995) An evaluation of laparoscopic adhesiolysis in patients with chronic abdominal pain. *Surg Endosc* 9:802–804
- Mutter D, Rodeheaver GT, Diemunsch P et al (1998) A new composite mesh (collagen-polyester) for intra-abdominal laparoscopic hernia repair. *Surg Endosc* 12:595
- Duffy AJ, Hogle NJ, LaPerle KM et al (2004) Comparison of two composite meshes using two fixation devices in a porcine laparoscopic ventral hernia repair model. *Hernia* 8:358–364
- Chelala E, Thoma M, Tatete B et al (2007) The suturing concept for laparoscopic mesh fixation in ventral and incisional hernia repair: mid-term analysis of 400 cases. *Surg Endosc* 21:391–395
- Balique JG, Benchetrit S, Bouillot JL et al (2005) Intraperitoneal treatment of incisional and umbilical hernias using an innovative composite mesh: four-year results of a prospective multicenter clinical trial. *Hernia* 9:68–74
- Lermite E, Pessaux P, Tuech JJ et al (2004) Visceral adhesion after intraperitoneal ventral hernia treatment: monocentric study comparative of protected versus unprotected meshes. *Ann Chir* 129:513–517
- Vrijland WW, Bonthuis F, Steyerberg EW et al (2000) Peritoneal adhesions to prosthetic materials: choice of mesh for incisional hernia repair. *Surg Endosc* 14:960–963
- Koehler RH, Begos D, Berger D et al (2003) Minimal adhesions to ePTFE mesh after laparoscopic ventral incisional hernia repair: reoperative findings in 65 cases. *Zentralbl Chir* 128:625–630
- Bellón JM, García-Carranza A, Jurado F et al (2001) Peritoneal regeneration after implant of a composite prosthesis in the abdominal wall. *World J Surg* 25:147–152
- LeBlanc KA (2007) Laparoscopic incisional hernia repair: are transfascial sutures necessary? A review of the literature. *Surg Endosc* 21:508–513
- Anthony T, Bergen PC, Kim LT et al (2000) Factors affecting recurrence following incisional herniorrhaphy. *World J Surg* 24:95–101
- Flum DR, Horvath K, Koepsell T (2003) Have outcomes of incisional hernia repair improved with time? A population-based analysis. *Ann Surg* 237:129–135