20.3 Technical Factors Predisposing to Recurrence After Minimally Invasive Incisional Herniorrhaphy

C.T. Frantzides, L.E. Laguna, M.A. Carlson

Introduction

Since 1993, experience in minimally invasive incisional hernia repair has accumulated such that we now have some basic understanding of how to optimize the technical outcome of this procedure. In this review we will summarize technical maneuvers which we believe will minimize the risk of recurrence after minimally invasive incisional herniorrhaphy. The conclusions and recommendations of this review are based on our own clinical experience [1] and a review of the surgical literature. As is the case in most areas of surgery, the recommendations given in this review are based on uncontrolled clinical series and expert opinion; there are little to no data available from randomized controlled trials in the field of minimally invasive incisional hernia surgery.

Methods

An internet search of the literature was performed (PubMed/National Library of Medicine, www.ncbi.nlm.nih.gov/entrez/) using various combinations of the following keywords: minimally invasive, laparoscopic, ventral, incisional, hernia. The inclusion criteria were papers that contained adequate data on > 10 patients undergoing minimally invasive incisional or ventral herniorrhaphy. To be included, a paper needed to describe patient demographics, surgical technique, perioperative events, and some follow-up/recurrence data. In addition to internet search, the references of selected papers were searched manually to identify any possible manuscripts that were missed (none were found with this secondary search). In some instances, a group of authors had multiple publications on the same series of patients; in these cases only the most recent update of a given patient series was included in the present review.

Results for Hernia Recurrence

A total of 53 manuscripts met the inclusion criteria (◘ Table 20.4); these papers described 5227 minimally invasive incisional or ventral herniorrhaphies (a comprehensive analysis will be submitted for later publication.) Certain aspects of herniorrhaphy technique were virtually identical among all 53 manuscripts: intraperitoneal sublay of prosthetic mesh which extended beyond the margins of hernia in all directions, with no excision of the hernia sac. The papers differed in the type of mesh used, the amount of mesh overlap of the defect, and in the technique of mesh fixation (see discussion below). The rate of hernia recurrence in these 5227 published procedures was 3.98%. Of course, this result is mostly the product of specialty centers in which minimally invasive surgery is prominent, so the recurrence rate for all operators is likely to be higher. The results from the 53 manuscripts of this review also is subject to publication bias (i.e., better results have a greater likelihood of being submitted than mediocre results). The reported recurrence rate from open in-

lay technique; we cannot call the onlay a bad operation. Secondly, I think it is very versatile; the best place for the sublay technique is only in the upper abdomen because you can then put it in front of the posterior rectus sheath; once you get below the linea arcuata, you then only have peritoneum, that often tears and then you have mesh in direct contact with bowel, so I think in the lower abdomen the onlay technique maybe advantageous. We must give the onlay technique a chance, it is more versatile, it is easier, and general surgeons are capable of using it under more circumstances than the sublay technique.

Schumpelick: *I would also like to say something in favour of the onlay technique, even as a sublay man. In the recurrent cases, where the retromuscular space is already obliterated by a mesh, it is sometimes very difficult to place another mesh in the same space. With the new meshes you can do an onlay repair. The main problem with the old meshes in the onlay position was infection, something we don't see with the new large pore meshes that are better integrated. And even in the case of infection there is no need for explantation. We have done some in this technique with good results.*

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Table 20.4. Papers included in review of minimally invasive incisional/ventral hernia surgery

Ref. no.	Year	Authors	Institution	Procedures
[7]	1997	Holzman et al.	Duke	21
[8]	1998	Toy et al.	Multicenter	144
[9]	1998	Tsimoyiannis et al.	Hatzikosta General Hospital, Ioannina	11
[10]	1999	Koehler et al.	Martha's Vineyard Hospital	32
[11]	1999	Kyzer et al.	Tel Aviv Univ	53
[12]	1999	Sanders et al.	Tulane Univ, Henry Ford Hospital	12
[13]	2000	Chari et al.	Meridia Huron Hospital, Cleveland	14
[14]	2000	Chowbey et al.	Sir Ganga Ram Hospital, New Delhi	202
[15]	2000	DeMaria et al.	MCV, Richmond	21
[16]	2000	Farrakha	Abu Dhabi, UAE	18
[17]	2000	Reitter et al.	UI Peoria, IL	49
[18]	2000	Szymanski et al.	Scarborough Hospital, Canada	44
[19]	2001	Birgisson, Park et al.	UKY	64
[20]	2002	Andreoni et al.	UNC Chapel Hill	13
[21]	2002	Aura et al.	Aulnay-Sous-Bois, France	86
[22]	2002	Bageacu et al.	Saint-Etienne, France	159
[23]	2002	Ben-Haim et al.	Tel Aviv Univ	100
[24]	2002	Berger et al.	Baden-Baden	150
[25]	2002	Gillian et al.	Southern Maryland Hospital	100
[26]	2002	Kirshtein et al.	Ben Gurion Univ, Beer Sheva, Israel	103
[27]	2002	Kua et al.	Royal Brisbane Hospital, Queensland, Austral	30
[28]	2002	Lau et al.	Univ Hong Kong Med Ctr	11
[29]	2002	Parker et al.	Univ South Carolina	50
[30]	2002	Raftopoulos et al.	UI Chicago	50
[31]	2002	Salameh et al.	Baylor, Houston TX	29
[32]	2002	van't Riet et al.	Erasmus U Med Ctr, Rotterdam	25

Table 20.4. *Continued*

Ref. no.	Year	Authors	Institution	Procedures
[33]	2002	Wright et al.	Hennepin County Med Ctr, Minneapolis	90
[34]	2003	Carbajo et al.	Valladolid, Spain	270
[35]	2003	Chelala et al.	Univ Hosp Tivoli, Belgium	120
[36]	2003	Chowbey et al.	Sir Ganga Ram Hospital, New Delhi	34
[37]	2003	Eid et al.	UPitt, VAMC Pitt, UMN	79
[38]	2003	Heniford et al.	Carolinas Medical Center, UKY, Emory, UTN	850
[39]	2003	LeBlanc et al.	Min Invas Surg Inst, Baton Rouge	200
[40]	2003	McGreevy et al.	Dartmouth-Hitchcock Med Ctr, VAMC VT	65
[41]	2003	Mizrah et al.	Ben Gurion Univ, Beer Sheva, Israel	231
[42]	2003	Rosen et al.	Cleveland Clinic	114
[43]	2004	Bamehriz and Birch	McMaster Univ, Hamilton, Can	28
[44]	2004	Bencini and Sanchez	Florence, Italy	64
[45]	2004	Bower et al.	East Carolina Univ, Greenville	100
[46]	2004	Franklin et al.	Texas Endosurgery Institute, MGH, Monterrey	384
[1]	2004	Frantzides et al.	NWU, UNMC, UTN	208
[47]	2004	Gal et al.	Bugat Pal Hosp, Hungary	15
[48]	2004	Kannan et al.	Changi General Hosp, Singapore	20
[49]	2004	McKinlay and Park	Univ Maryland	170
[50]	2004	Moreno-Egea et al.	Murcia, Spain	90
[51]	2004	Muysoms et al.	Ghent, Belgium	52
[52]	2004	Sanchez et al.	Florence	90
[53]	2004	Ujiki et al.	NWU, UHawaii, Hines VA	100
[54]	2004	Verbo et al.	Catholic Univ, Rome Italy	45
[55]	2005	Angele et al.	Ludwig-Maximilians Univ, Munich	28
[56]	2005	Johna	Loma Linda Univ, CA	18
[57]	2005	Olmi et al.	Monza, Italy	50
[58]	2005	Perrone et al.	Washington Univ	121

cisional herniorrhaphy (not reviewed here) is widely variable, from several percent to 20% or more. Needless to say, a prospective randomized comparison of open vs. minimally invasive incisional hernia repair has not been done. Considering the inherent advantages of minimally invasive surgery, however, it would be reasonable to predict that the overall results (including recurrence, infection, pain, patient satisfaction, etc.) of the minimally invasive approach would be as least as good, if not better, than the open approach.

Technical Factors: Entry and Exposure

For any laparoscopic procedure, the surgeon can minimize the risk of port-site hematoma by transilluminating the abdominal wall prior to trocar insertion. This maneuver minimizes the risk of abdominal wall vessel laceration. It is not clear, however, whether a port site hematoma predisposes a patient to recurrent hernia. In order to prevent port-site hernia, the surgeon should close all port sites for trocars > 5 mm, and for 5mm if the site has become stretched or enlarged [2].

Probably the first major technical issue that the surgeon encounters during a minimally invasive incisional hernia is intra-abdominal exposure. Retrospective analysis has determined, not surprisingly, that inadequate dissection of the hernial defects will increase the risk of hernia recurrence [3]. Nearly all authors of the 53 manuscripts of the present review stress complete exposure of the ventral abdominal wall with takedown of all adhesions to the viscera. The entire incision needs to be visualized. Such a maneuver will prevent the surgeon from missing a small, asymptomatic defect which later could enlarge into a symptomatic one. This is especially important with long midline incisions closed with running nonabsorbable suture, in which the so-called Swiss cheese abdomen (i.e., multiple small hernias deriving from the cutting action of the suture) can develop. Small hernias can be hidden in a mass of dense adhesions, so complete adhesiolysis is essential.

Technical Factors: Mesh Type

The next choice of potential consequence during minimally invasive incisional hernia repair is the mesh type. Expanded Polytetrafluoroethylene (ePTFE) was the prosthetic material used in the majority of procedures in 41 (77%) of the 53 manuscripts; of these 41 papers, 33 (62%) specified their ePTFE as the dual-surface construct available from W. L. Gore and Associates, Inc. (i.e., DualMesh). This mesh has a closed structure surface on the side facing the viscera; this is intended to reduce tissue attachment. The other side (facing the abdominal wall) has a macroporous structure (corduroy), which is intended to enhance tissue attachment. Interestingly, an improvised dual-surface mesh for minimally invasive incisional herniorrhaphy already was in use by the early 1990s [4]. This was a bilaminar prosthesis consisting of a sheet of ePTFE and a sheet of polypropylene sewn together; the polypropylene side was applied to the abdominal wall while the ePTFE side contacted the viscera. This dual-surface arrangement encouraged tissue ingrowth on the abdominal wall side, thereby increasing the robustness of the repair, yet minimized intestinal reaction to the mesh. So far, published clinical experience with the dual-surface mesh configuration has shown it to be safe. To our knowledge, there have been no published cases of primary erosion of ePTFE into the viscera after incisional herniorrhaphy with ePTFE. In laparoscopic incisional hernia repair the prosthesis is typically placed in direct contact with the viscera which, in the case of heavy-weight polypropylene mesh, introduces the risk of visceral erosion. The dual-surface mesh configuration appears not to have this risk.

The use of ePTFE has undergone a resurgence with the advent of minimally invasive incisional hernia repair. This material was less popular in open hernia repair because it was more prone to infection and incorporated less well than other materials (e.g., polypropylene). Since mesh infection appears to be less of a problem with the minimally invasive approach, and with the introduction of the dual-surface product which incorporates strongly into the abdominal wall yet is benign to the viscera, dual-surface ePTFE has become the material of choice for the majority of the authors in this review. It should be noted, however, that there are a number of light-weight/composite polypropylene hernia meshes now available which may be suitable (or even better) alternatives to ePTFE. Long-term comparative data in patients are not available.

Technical Factors: Mesh Overlap

As indicated above, the universal approach to minimally invasive repair of hernia of the ventral abdominal wall in manuscripts of this review is sublay positioning of prosthetic mesh, a technique originally described in open surgery by Rives and Flament [5] and also by Stoppa in the groin [6]. For repairs of this type, one

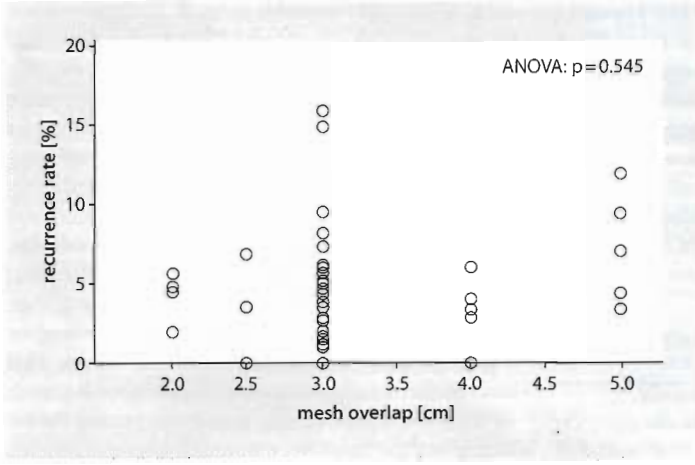

Fig. 20.4. Plot of hernia recurrence rate vs. minimum mesh overlap of the hernial defect for minimally invasive incisional/ventral herniorrhaphy. Complete data were available from 45 of the 53 manuscripts shown in Table 20.4

requirement for the mesh is that it should have adequate overlap (a more accurate term would be underlap) of the hernial defect [3]. That is, the margin of the mesh should extend beyond the margin of the defect by an appropriate amount throughout the defect's entire circumference. The range of mesh overlap in the 53 manuscripts of this review is shown in Fig. 20.4. Most (60%) of the authors favoured a minimum of 3cm of overlap; 24% indicated 4cm or more. One might hypothesize that the recurrence rate would decrease as the overlap increased, but this is not supported by plotting these two variables, as shown in Fig. 20.4 (it should be admitted that this is a relatively unscientific manipulation of uncontrolled data). The final answer to an appropriate amount of mesh overlap during minimally invasive incisional herniorrhaphy is not known, although 3cm most commonly is chosen. The optimal distance most likely is dependent on multiple variables, and may not be simply defined by "more is better."

Technical Factors: Mesh Fixation

One of the more controversial issues in minimally invasive incisional herniorrhaphy is the technique of mesh fixation. At a minimum, the laparoscopically performed sublay technique requires some fixation to keep the mesh anterior while pneumoperitoneum is present. Further fixation beyond this would be intended to prevent mesh migration/slippage with subsequent reherniation. The basic choices for fixation are (1) tacking/stapling, (2) transabdominal fixation sutures, or (3) a combination of both. Of the 53 manuscripts in this review, 44 contained sufficient details regarding mesh fixation; 69% of the papers utilized a combination of tacking/stapling and fixation sutures, while 29% utilized tacking/stapling alone (one paper used sutures alone). A plot of fixation technique vs. recurrence rate is shown in Fig. 20.5; there was no statistical difference in recurrence with respect to fixation. Nevertheless, given that a common cause of recurrent herniation is mesh slippage, it would seem reasonable to use the maximum amount of mesh fixation (i.e., lots of tacks/staples + lots of fixation sutures). Unfortunately, fixation sutures are associated with long-term abdominal pain, and they also require additional stab incisions in the skin and more operating time. We have spoken with surgeons who anecdotically claim that their recurrence rate is less with the combined use of tacks/staples and sutures, but controlled data are lacking. Furthermore, there are details of fixation technique (e.g., spiral tacks vs. straight staples, single vs. multiple rows of tacks, spacing between tacks and/or sutures, etc.), which further complicate the fixation issue. One of us (C.T.F.) utilizes a single row of straight staples at 1cm intervals (having obtained a 1.4% recurrence rate [1], while the other (M.A.C.) has changed his technique to a single row of spiral tacks at 1cm intervals with 2–0 polypropylene transabdominal fixation sutures placed every 5–7cm. The first author (C.T.F.) places each staple radially so that one end is buried into the PTFE while the other end takes tissue. In addition, he is careful that each staple enters the abdominal wall perpendicularly (using the two-handed stapling technique) to ensure maximum tissue penetration. It is this type of technical detail that could make the difference between a 1% vs. a 5% recurrence rate. In any event, it is difficult to recommend one fixation technique over another without

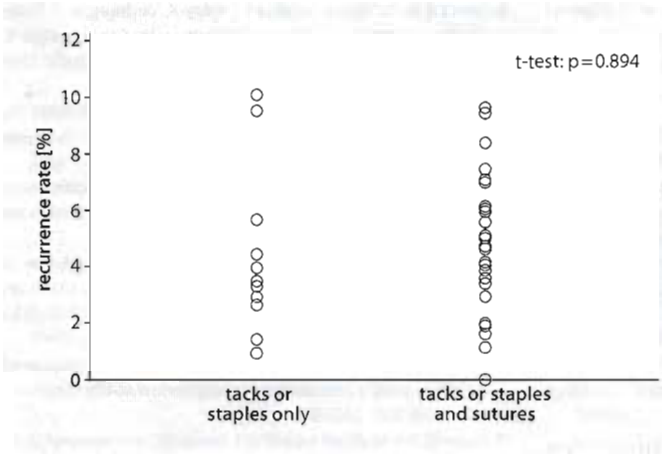

Fig. 20.5. Plot of hernia recurrence rate vs. technique of mesh fixation for minimally invasive incisional/ventral herniorrhaphy. Complete data were available from 44 of the 53 manuscripts shown in Table 20.4

controlled data. This is another area of surgery which will continue to be dictated by training environment, local experience, and so forth.

Technical Factors: Infection

Wound infection has been shown to be an independent risk factor for recurrence after open incisional hernia repair in numerous clinical series (data not reviewed here). Port-site infection after laparoscopic incisional hernia repair usually can be handled with antibiotics and local care without endangering the mesh; infection of ePTFE mesh itself, however, invariably means mesh removal with subsequent hernia recurrence. Although seemingly less common with the minimally invasive approach, mesh infection still had an incidence of 0.89% in the 5227 procedures of this review. There are a number of recommendations (expert opinion, not necessarily standard of care) to minimize the risk of major wound/mesh infection in minimally invasive incisional herniorrhaphy:

- pre-operative bowel preparation (mechanical and oral antibiotics);
- appropriate use of antibiotic prophylaxis;
- use of an antimicrobial-impregnated adhesive drape;
- avoidance of ePTFE contact with skin;
- changing surgical gloves prior to handling the mesh;
- careful surgical dissection with minimal blood loss;
- deferral of operation in the presence of incisional inflammation or stitch abscess.

Smoking should be minimized/eliminated pre-operatively, as this has been shown to be a risk factor for failure in open incisional herniorrhaphy. If the patient develops a large seroma postoperatively, then the surgeon should avoid the temptation of aspiration/drainage. The vast majority of these seromas will resolve without intervention; unnecessary violation of the space may introduce bacteria.

An issue related to infection is the management of intra-operative small bowel perforation. This complication occurred in 81 (1.6%) of the 5227 cases of this review. Details on the management of these cases were not available for all of them. In general, however, a surgeon has at least three options when a small bowel perforation is recognized intra-operatively: (1) convert to an open procedure, repair the enterotomy, and close the hernial defect primarily without a mesh; (2) if there is no enteric spillage, then repair the enterotomy laparoscopically and complete the mesh herniorrhaphy as planned; (3) repair the enterotomy laparoscopically, place the patient on IV antibiotics for several days, and then perform the minimally invasive incisional herniorrhaphy with mesh (usually the authors choice). There are variations to these options, but the essential choice is conversion vs. laparoscopic bowel repair and herniorrhaphy vs. laparoscopic bowel repair with delayed herniorrhaphy. The idea of placing a piece of PTFE in the face of potential enteric contamination (option 2 above) may not seem safe, but there are numerous successful examples of this management in the 53 articles of this review. Since the incidence of this complication is relatively low, it will be difficult to ascertain the optimal management, especially with respect to patient comorbidities. Consequently, treatment for each case

of intra-operative small bowel perforation will depend on the characteristics of the injury, surgeon's bias and experience, patient comorbidities, and so on. Intra-operative colon injuries are more rare; since the bacterial concentration in the colon is at least a millionfold of that in the small bowel, however, one should be wary of simultaneous repair of a colon injury and mesh placement.

Summary

At this relatively early stage in the history of minimally invasive repair of ventral/incisional hernia, a few recommendations for optimizing technique and reducing recurrence may be given:

1. Completely, yet carefully, expose the entire incision and anterior abdominal wall.
2. For intraperitoneal mesh placement, a dual-surface mesh which incorporates into the abdominal on one side while remaining relatively nonreactive to the viscera on the other appears optimal.
3. The ideal amount of mesh overlap of the defect is not known; a 3cm overlap seems reasonable.
4. The optimal form of mesh fixation needs to be studied by a carefully designed and controlled trial. At this point tacks/staples ± fixation sutures are the most popular techniques.
5. Minimize the risk of mesh infection; have a plan ready in the event of an intra-operative small bowel enterotomy.
6. Close all port sites for trocars >5mm.

Acknowledgements. Supported in part by a grant to MAC from the United States National Institutes of Health (K08 GM00703).

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Discussion

Itani: *One of the issues that nobody addresses with laparoscopic surgery is the issue of cosmesis. As you know, in open surgery in all these deformed abdominal walls it is very easy to remove the scar, doing an abdominal plasty if needed, remove excess skin, but you cannot do that with the laparoscopic procedure.*

Frantzides: *You can do that with a laparoscopic procedure at the latest stage, which means a second operation later on.*

LeBlanc: *One thing that you didn't mention when you look at the fixation, and I know that you are not a proponent of suture as I am, there is no good consensus, but a lack of adequate follow-up in the majority of series that allow anyone to make a firm determination. There are only two or three series that have followed up beyond 2 or 3 years, so there are just not enough data; we need more prospective randomized trials to answer that question.*