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Long-Term Complications of Mesh Repairs for Abdominal-Wall Hernias

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ABSTRACT: The use of prosthetic materials in repair of abdominal-wall hernias can lower the risk of hernia recurrence. Therefore, large numbers of meshes are used worldwide every year. All types of meshes on the market have the potential to cause certain complications, such as fistula formation, migration, infection, and rejection. These long-term, clinical complications, although rare, can be serious. For this reason, we aim to provide a systematic review on these adverse effects. A PubMed search covering the last 20 years was done to obtain articles reporting these long-term effects. After searches with selected keywords, and careful evaluation of the resulting articles, 64 articles reporting specific long-term complications were selected and set aside for analysis. Most of the articles were case reports and retrospective analyses (61/64). No evidence-based data exist regarding prevention of these late complications.

KEY WORDS: hernia, mesh, infection, fistula, rejection, migration

I. INTRODUCTION

Hernia is defined as a bulge at a tissue junction and most commonly occurs within the abdominal wall.[1] Repair of abdominal hernias is one of the most common operations in surgery. To date, numerous repair techniques have been described for abdominal-wall hernias. Data from randomized controlled trials support the claim that use of prosthetic mesh in abdominal-wall hernia repair can lower the risk of hernia recurrence.[2,3] However, an ideal mesh has not been produced yet, and all meshes on the market have the potential to cause certain complications, such as infections, chronically draining sinuses, enterocutanous fistulas, and intestinal obstructions.[4]

The choice of mesh type is based on many factors, including surgeon's preference, knowledge, type of hernia, and cost. In fact, there is currently no consensus on when or how to use meshes, and data regarding long-term adverse effects of their implantation are scarce. Groin hernia repairs compose the largest portion of all abdominal-wall hernia repairs. A standard polypropylene mesh is the most frequently used material, with a low complication rate in general.[5] Even domestic mosquito nets have been used with success in some regions where resources are limited, although the long-term results have not been obtained yet.[6] Recent data indicate that some characteristics of the meshes, e.g., porosity, are of importance, and that

different operative techniques require different mesh materials. Klinge et al. stated that complications can manifest even after many years, and that any thorough quality control program should include an assessment of explanted implant failures in addition to clinical experience.[7]

While the late complications of meshes are rather rare, they are challenging. Complications such as late infection and migration may cause not only hernia recurrence, but also life-threatening sepsis and intestinal fistulas.[8] New papers reporting these complications appear every year, although only a few studies exist on the comprehensive analysis of late complications of hernia meshes. Clinical research on late complications requires long follow-up periods. Therefore, there are no specific prospective controlled trials on the late complications of meshes in the English-language literature, although two papers have mentioned late complications as a secondary outcome measure.[9,10]

We herein present a systematic review on late complications of mesh use in elective repair of abdominal-wall hernias.

II. MATERIALS AND DATA COLLECTION

To conduct a comprehensive search of the medical literature, we selected a well-known medical electronic bibliographic database with free and easy access: PubMed. The publication period chosen for this research was from December 1991 to March 2011 (the previous 20 years). We evaluated only the papers that were published in the English language. The key words were *hernia*, *mesh*, *late infection*, *migration*, *fistula*, *rejection*, and *mesh related infection*. The Boolean operator used was "hernia AND mesh AND migration." The research was limited by "adult" and "human studies" using the "Limits" function of PubMed. Papers that mentioned the selected key words were saved for further evaluation. Since chronic pain is a subjective complaint, the origin of which is not fully understood, this complication was not included in our study.

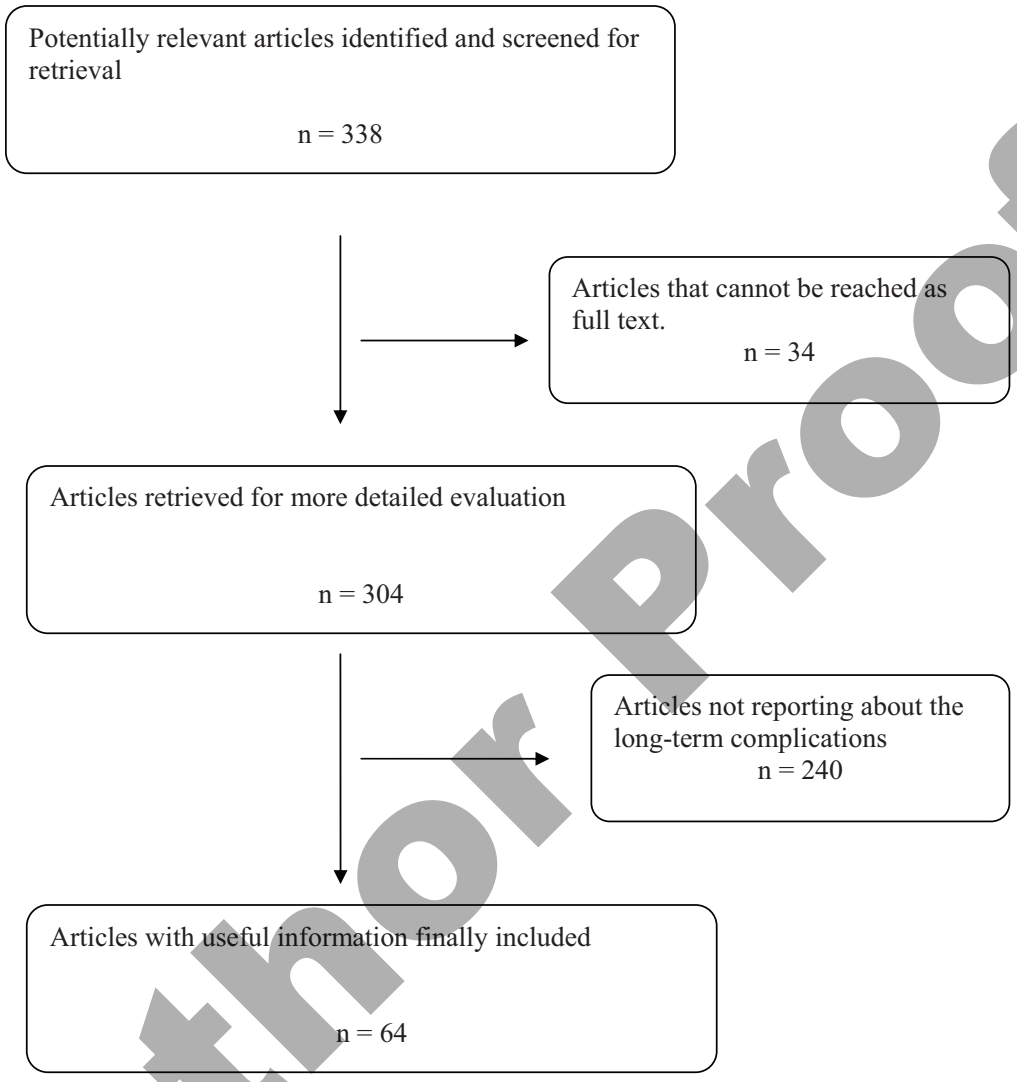
After reviewing full text versions of the papers that appeared in the PubMed search, we selected for the study only those that included series and cases for elective repairs. Emergency repairs, hiatal hernia repairs, mesh use in infected areas, and abdominal-wall reconstructions in patients with domain loss were exclusion criteria. All types of abdominal-wall hernia repairs were taken into consideration. Papers that mentioned "late complication" were included. When the authors did not describe a specific complication as "late," we focused on the interval between the index operation and the appearance of the complication, if cited. Late complication was defined as any of four complications (late infection, migration, fistula, rejection) that occurred 6 months or more after the mesh repair.

The type of hernia, the repair technique, the type of mesh material, and the exact interval were recorded, if mentioned in the publications.

III. RESULTS

Initially, our search yielded a total of 2130 articles in PubMed, by using the keywords *hernia* and *mesh*, and limiting with *humans* and *adult* and with the interval between 1991 and 2011. Further limiting the search results with the selected keywords revealed a total of 333 publications. The proportion of the articles that mentioned long-term complications within all "hernia and mesh" publications was 15.6%. There were 124 papers for late infection, 112 for fistula, 21 for rejection, and 76 for migration; 304 of the 333 papers could be retrieved as full text (91.3%). Only 64 of those 304 papers (21%) were directly related to our search aim and reported on the defined late complications. A summary of the inclusion and exclusion of the papers from the PubMed database search is presented in Table 1. These publications are listed in Tables 2, 3, and 4 according to the complication types. There were only three prospective trials. The primary outcome measures in these prospective studies were (i) comparison of Maloney darn and Lichtenstein hernia repair,[9] (ii) usage of synthetic composite mesh in open ventral hernia repair,[11] and (iii) determination of whether laparoscopic intraperitoneal polytetrafluoroethylene (PTFE) prosthetic patch (LIPP) repair of ventral hernia is superior to open prefascial polypropylene mesh repair.[12] Most of the remainder were individualized case reports (45/64), while there were some retrospective series (16/64). Five articles were listed in more than one table of complications because they described more than one type of

TABLE 1: Summary of the Exclusion and Inclusion of the Articles Found after Database Search



complication. These were the articles reporting migration, and fistula formation as the result of migration. There were a total of 69 cases with long-term complications included in 64 different articles. The distribution of these complications is as follows: 17 cases for fistula formation, 17 cases for late infection, 29 cases for migration, and 6 cases for rejection. Migration appears to be the most common late complication. The lists of these long-term complications, such as fistula formation, late infection, migration, and rejection, are given in Tables 2, 3, 4, and 5, respectively.

The time interval between the index operation and the recognition of a particular complication differed greatly among the reports. The longest interval was 30 years, for a case with wire mesh migration.[13] Also, fistulas may develop even after 14 years.[14] Late infection could be observed 5 years after mesh repair.[15]

IV. DISCUSSION

The use of prosthetic material for repair of hernias considerably decreased their recurrence. With the more common use of prosthetic materials for hernia repair, late complications have been observed more frequently. As "foreign" to the human body, meshes may cause certain adverse reactions. First, the rate

TABLE 2: List of Articles Reporting Fistula Formation

Author	Publication year	N of cases (%)	Hernia type	Repair type	Mesh type	Interval (months)	End result
Losanoff JE[41]	2010	1	incisional	nr	polypropylene and high-density polyethylene	300	Small intestinal fistula
Ishiguro Y[42]	2009	1	inguinal	mesh plug	nr	36	Colocutenous fistula
Foda M[43]	2009	1	incisional	nr	ePTFE	72	Small intestinal fistula
Zubaidi AM[44]	2006	1	inguinal	nr	polypropylene	48	Colocutenous fistula
Murphy JW[45]	2006	1	inguinal	nr	Perfix-plug	24	Sigmoid colon fistula
Acar T[38]	2002	1	incisional	nr	polypropylene	132	Small bowel fistula
Ott V[46]	2005	1	incisional	nr	polyester	108	Cuteneo-jejunocolic fistula
Costa D[47]	2004	1	umblical	nr	polypropylene	12	Small bowel fistula
Lauwers P[39]	2003	1	inguinal	Stoppa	nr	24	Colocutenous fistula
Losanoff JE[48]	2002	1	incisional	nr	polypropylene and high-density polyethylene	120	Small bowel and co-lonic fistula
Rieger N[40]	2002	1	inguinal	TAPP	polypropylene	72	Colovesical fistula
Fernandez LR[49]	2001	1	incisional	nr	polypropylene	108	Colocutenous fistula
Steele SR*[50]	2003	2/58 (3%)	parastomal	Stove pipe hat	polypropylene	Average 4.4 years	Enterocutenous fistula
Vanclooster P*[41]	2001	1/1259 (0.08%)	inguinal	TEP	polypropylene	24	Sigmoidocutenous fistula
Basoglu M*[51]	2004	2/246 (0.8%)	incisional	open	polyester/ polypropylene and high-density polyethylene	Mean 50.6	Enterocutenous fistula
Chew DK[14]	2000	1	incisional	open	polypropylene and high-density polyethylene	168	Enterocutenous fistula
Miller K[53]	1997	1	inguinal	TAPP	polypropylene	12	Enterocutenous fistula

*Retrospective studies
nr: not reported

TABLE 3: List of Articles Reporting Late Infection

Author	Publication year	Number of affected cases (%)	Hernia type	Repair Technique	Mesh type	Interval (months)
Genc V[12]	2010	1	inguinal	open	polypropylene	61
Tolino MJ[19]	2009	32	inguinal / incisional	open	nr	4–60
Lüning TH*[46]	2009	1/16 (6.2%)	parastomal	open	polyethylene	Mean 33
Swenson BR*[13]	2008	42/506 (8.3%)	incisional and ventral	Open and laparoscopic	nr	Up to 947 days
Iannitti DA**[44]	2008	2/455 (0.4%)	ventral	open	polypropylene mesh and ePTFE	nr
Hasegawa S*45	2006	1/367 (0.26%)	inguinal	open	Prolene Hernia System	24
Singh-Ranger D[47]	2007	1	inguinal	TEP	Prolene	10
Delikoukos S*[48]	2007	5/1452 (0.35%)	inguinal	open	polypropylene	2–4.5 years
Bliziotis A[49]	2006	1	incisional	open	nr	6
Fawole AS*[50]	2006	14/2017 (0.69%)	inguinal	nr	polypropylene	Mean 11
Jezupovs A*[51]	2006	4/423 (0.94)	mix	open	polypropylene	Mean 15
De Ruiter P*[52]	2005	2.3%	paracolostomy	open	polypropylene	nr
Basoglu M*[42]	2004	13/264 (4.9%)	incisional hernia	open	polypropylene and high-density polyethylene/polyester	Average 4.4 years
Petersen S*[53]	2000	8/121(6.6%)	incisional	open	Polypropylene/polyester/ePTFE	Up to 16
DeMaria EJ**[54]	2000	1/21 (4.7%)	ventral	LIPP	PTFE	8
Avtan L[55]	1997	3	inguinal	TAPP	nr	#
Gillion JF*[56]	1997	5/158 (3.1%)	incisional	open	ePTFE	Mean 37

*retrospective studies
**prospective studies
nr: not reported
TAPP: transabdominal pre-peritoneal
ePTFE: expanded polytetrafluoroethylene
15 days, 3 months, 10 months

TABLE 4: List of Articles Reporting Migration

Author	Publication year	Number of affected cases (%)	Hernia type	Repair technique	Mesh type	Interval (months)	End Result
Chen MJ[62]	2010	1	inguinal	mesh plug	polypropylene	24	Bowel perforation
El Hakam MZ[63]	2010	1	inguinal	nr	nr	app156	Persistent left lower abdominal pin
Hamouda A[64]	2010	1	inguinal	TEP	nr	144	Erosion into urinary bladder
Rettenmaier MA[65]	2009	1	inguinal	nr	polypropylene and high-density polyethylene	App 48	Right adnexial mass
Liang X[66]	2008	1	inguinal	mesh plug	nr	App 48	Bowel obstruction
Lo DJ[67]	2008	1	inguinal	PHS	polypropylene	18	Bowel perforation and obstruction
Kurukahvecioglu O[68]	2007	1	incisional	IPOM	polytetrafluoroethylene	App 48	Migration into the bladder
Goswami R[69]	2007	1	inguinal	TAPP	polypropylene	App 120	Mesh erosion into caecum
Stout CL[70]	2007	1	inguinal	mesh plug	nr	na	Small bowel volvulus
Di Muria A[71]	2008	1	umblical	nr	polypropylene	App 72	Small bowel obstruction
Borchert D[72]	2006	1	obturator	mesh plug	polypropylene	App 84	Small bowel obstruction
Ojo P[73]	2006	1	inguinal	nr	nr	App 96	Intra-abdominal mass
Murphy JW[36]	2006	1	inguinal	Plug and patch	polypropylene	24	Sigmoid fistula

*retrospective study
App: appoximately
TAPP: transabdominal pre-peritoneal
TEP: totally extra-peritoneal
PHS: prolene hernia system
IPOM: intraperitoneal onlay mesh

TABLE 4: (Continued)

Author	Publication year	Number of affected cases (%)	Hernia type	Repair technique	Mesh type	Interval (months)	End Result
Chowbey PK[74]	2006	1	inguinal	TEP	nr	12	Migration into bladder
Agrawal A[23]	2006	1	inguinal	TAPP	nr	72	Migration into bladder
Celik A[75]	2005	1	inguinal	TAPP	nr	6	Migration into colon
Jensen JB[76]	2004	1	inguinal	laparoscopic	polypropylene	App 84	Erosion intobladder
Acar T[14]	2002	1	ventral	nr	polypropylene	App 132	Enterocutenous fistula
Benedetti M[77]	2005	1	inguinal	plug and mesh	polypropylene	App 24	Sigmoid colon perforation
Ott V[37]	2005	1	abdominal	intraperitoneal	polyester	App 72	Cuteneo-jejunocolic fistula
Nowak DD[78]	2005	1	inguinal	intra abdominal?	nr	App 18	Bowel strangulation
Moorman ML[79]	2004	1	inguinal	nr	polypropylene	18	Intraabdominal mass
Lauwers P[15]	2003	1	inguinal	Stoppa	nr	24/48	Small bowel obstruction
Riaz AA[80]	2004	1	incisional	sublay	nr	App 60	Erosion into bladder
Ferrone R[81]	2003	1	inguinal	nr	polypropylene	App 36	Small bowel obstruction

*retrospective study
App: appoximately
TAPP: transabdominal pre-peritoneal
TEP: totally extra-peritoneal
PHS: prolene hernia system
IPOM: intraperitoneal onlay mesh

TABLE 4: (Continued)

Author	Publication year	Number of affected cases (%)	Hernia type	Repair technique	Mesh type	Interval (months)	End Result
Ismail W[82]	2002	1	inguinal	nr	polypropylene	60	Protrusion of mesh from skin
Rieger N[16]	2002	1	inguinal	TAPP	nr	72	Colovesical fistula
Napier T*[83]	2008	1/141 (0.7%)	inguinal	TEP	polypropylene and high-density polyethylene	≥24	Recurrence
Majeski J[10]	1998	1	ventral	open	Wire mesh	360	Small bowel obstruction

*retrospective study
App: appoximately
TAPP: transabdominal pre-peritoneal
TEP: totally extra-peritoneal
PHS: prolene hernia system
IPOM: intraperitoneal onlay mesh

TABLE 5: List of Articles Reporting Rejection

Author	Publication year	N of affected cases (%)	Hernia type	Repair type	Mesh type	Interval (months)
Jani K[57]	2005	1	inguinal	TAPP	nr	36
Kucuk HF**[8]	2010	3/130 (2.3%)	inguinal	Lichtenstein	polypropylene	6, 7, 13
Misra S*[58]	2008	1/70 (1.2%)	midline	nr	Alloderm	12?
Sakorafas GH*[59]	2001	2/510 (0.39)	inguinal	Lichtenstein	polypropylene	10, 48
Hofbauer C*[60]	1998	3/500 (0.6%)	inguinal	TAPP	nr	5–19
Foschi D[61]	1998	1	inguinal	TAPP	polypropylene	36

*retrospective studies
**prospective studies
nr: not reported
TAPP: transabdominal pre-peritoneal

of early surgical-site infection may be increased in comparison with that of tissue repairs done without a prosthetic material. In general, this particular complication can develop in as high as 8% of the patients who undergo incisional hernia repair with mesh,[16] and in 5% of patients who undergo open inguinal hernia repair with mesh.[17] Most of these infections are superficial, and they respond well to antibiotics.[18] However, some patients with an uneventful recovery may ultimately present with a late infection that requires mesh removal.[19]

Many different factors may contribute to the occurrence of complications after mesh use for hernia repair. These possible factors are the type of mesh, repair technique, experience of the operating surgeon, fixation type of the mesh (suture vs. tucker), pressure exerted on the mesh by body movements, and anatomical location of the mesh. The present review revealed that long-term adverse effects of prosthetic meshes can be seen after almost all kinds of repair techniques, done by either anterior or posterior approach. Mesh type as a factor in the reported late complications seems to be more common when a standard heavyweight polypropylene mesh is used. Nevertheless, it should be kept in mind that this mesh type is also the most commonly used prosthetic material in hernia repairs worldwide. Biologic meshes are not immune to long-term adverse effects. However, no long-term complication report was found in the present search related to use of the large-pore, lightweight, partially absorbable meshes, which were recommended by some authors for their possible advantages of better tissue incorporation, less shrinkage, and less foreign-body reaction.[20,21,22,23]

The exact mechanisms that lead to long-term adverse events are still unclear. Also, any complication such as infection or migration can trigger a chain reaction ending with serious complications, including organ invasion and fistula formation.

Specifically, the exact mechanism of late infection after mesh repair is still not well understood. Early wound complications (seroma, hematoma) may be the origin of late manifestations.[24] Also, late infection may be related to the implantation site of the mesh. Moon et al. agree that preperitoneal placing of the mesh may delay the symptoms of infection.[25] It is possible that an untreated local infection can cause a clinically significant late infection. Biological meshes have some theoretical advantages, such as resistance to infection, avoidance of a permanent foreign body, and reconstruction that results in the formation of natural tissue, but they have not gained popularity because of their high cost.[26]

Mechanical migration is mere displacement of the mesh. Inadequate fixation or probably external displacing forces may be the cause. Other mechanisms, however, are slow and gradual movements of the mesh through trans-anatomic places. These mechanisms are secondary to erosion induced by a foreign-body reaction.[27] Whatever the mechanism is, mesh may move through trans-anatomic places, even into bowel or vascular lumens. Erosion is an important adverse effect of the mesh. Stiffness of the meshes and their adhesive character may cause erosion whenever a mesh is placed in close proximity to a viscus. In addition, improperly fixed (by suture or any kind of tucker) meshes could lead to erosion followed by displacement. Meshes are generally cut along their edges to fit the size and shape of the anatomical area where they are to be placed. This leads to formation of sharp edges that can cause erosion or fistula formation. In a questionnaire study, Le Blanc reported that 3% of the patients treated with a mesh plug for inguinal hernia suffered from morbid complications due to migration of the plug.[28]

Fistula formation can occur either by direct contact of the mesh with a visceral organ and erosion, or by migration and later erosion by direct contact, or by an improperly placed fixation material that can cause fistula by itself. Any unrecognized violation of the peritoneum during surgery promotes a direct contact of the mesh with visceral organs. Even if the peritoneum is intact, the plug itself may cause erosion through the peritoneum as a result of body movements. Intraperitoneal mesh placement is another potential cause for fistula formation. In 1981, Kaufman first reported enterocutaneous fistula formation as a late complication of intraperitoneal placement of mesh.[29] Intraperitoneal mesh replacement also increases the risk of mesh migration.[30–32]

Rejection is another problem of mesh hernia repair, also with a poorly understood mechanism: the exact cause or causes of rejection are still unknown. Whatever the type, mesh is a potential foreign body

for human beings. As suggested by Wang et al., the host-versus-mesh reaction may be the cause.[33] The same principles seen in graft-versus-host reactions in transplant patients may apply to mesh rejection. The authors who reported rejection in their articles described the rejection as formation of a productive sinus[34] or slow growth of a pseudoabscess, with bacterial cultures showing no bacterial growth.[35] Some authors merely noted the rejection without providing any description. Use of biological materials in hernia repair may help to overcome this problem. Biological materials are considered to be a better alternative than synthetic mesh, based on the rate and type of complications. These include chronic foreign-body response, intestinal fistulas, mesh erosion into viscera, and migration.[36]

Standard polypropylene mesh is the most frequently used material in mesh repairs. It is totally non-absorbable and strong. However, this material has been suspected of adhesion formation to bowels, thereby causing fistulas. Therefore, newer meshes with low weight, more flexibility, and a non-adhesive inner side have been developed to lower the rate of mesh-related complications. Indeed, these newer meshes have provided some better results in clinical studies. However, the present review revealed that including fistula formation, every type of late complication can be developed following use of all kinds of meshes. The frequencies may decrease but the risk persists in certain incidences.

Probably millions of mesh hernia repair surgeries are performed yearly worldwide. There is no doubt that hundreds or even thousands of mesh-related late complications are observed. However, possibly, only a small proportion of those are reported in journal articles. The various percent rates for particular complications found in the present review may reflect many more actual cases with late complications. In fact, Robinson et al. reported that 252 adverse effects related to the use of surgical mesh for hernia repair were among events that were recorded in the Food and Drug Administration's (FDA) Manufacturer User Facility Device Experience Database, between January 1996 and September 2004.[37]

Since the use of prosthetic material in hernia repair is increasing, we should not be surprised to encounter these late complications more frequently in the near future. Since every type of mesh, whatever the operation and technique in which these meshes are used, has the potential for causing such complications, we need to know not the probable but the exact mechanisms and biological processes so that we can overcome these problems scientifically. Currently, there are no evidence-based preventive solutions described in the biomedical publications.

V. CONCLUSION

Prosthetic mesh use in treatment of abdominal-wall hernias can result in serious long-term complications. Every surgeon who deals with the repair of abdominal-wall hernias should be aware of late complications of meshes and how to manage them. In addition, studies for development of the ideal mesh should be ongoing. The ideal mesh may be a better synthetic mesh with better tissue compatibility, or a biologic mesh with low cost. In conclusion, the evolution of hernia repair is not yet complete. It is possible that today's surgeons will be asked the following question by their grandchildren: Why did you put those plastic patches into people's tummies?

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