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CASE REPORT

Central rupture and bulging of low-weight polypropylene mesh following recurrent incisional sublay hernioplasty

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Abstract A recurrent incisional hernia resulting from the rupture of low-weight polypropylene mesh is rarely reported in the literature. Three patients with recurrent incisional hernia due to low-weight polypropylene mesh central rupture were operated 5, 7 and 13 months after initial sublay hernioplasty. The posterior myofascial layer was fully reconstructed in all patients during the hernioplasty, whereas the anterior myofascial layer was only partially reconstructed. The recurrent hernia was managed using heavy-weight polypropylene mesh; in two patients, a new sublay hernioplasty was performed and in one patient an "open preperitoneal flat mesh technique" was performed under local anaesthesia as a day case procedure. If closing of the anterior myofascial layer cannot be ensured during the incisional hernioplasty, the use of low-weight polypropylene meshes should be avoided; preference should be given to the heavy-weight polypropylene meshes.

Keywords Low-weight polypropylene mesh · Central mesh rupture

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Introduction

The use of non-resorbable prostheses for incisional hernia repair significantly reduced the incidence of recurrence [1]. Heavy-weight polypropylene meshes are several times stronger than the maximum tensile strength of the abdominal wall [2]. However, they can induce an intense inflammatory response, scar plate formation and increased stiffness of the abdominal wall, causing loss of the abdominal wall compliance [3].

In contrast, the low-weight polypropylene meshes cause less inflammation and fibrosis due to the presence of large pores and less amount of foreign body material [4, 5]. Advocates of low-weight large pore polypropylene meshes claim that these meshes ensure greater flexibility of the abdominal wall compared to heavy-weight polypropylene meshes, while maintaining adequate strength of the incisional hernioplasty [6].

The recurrence of incisional hernias after hernioplasty usually occurs at the mesh edges, while recurrences caused due to a central mesh rupture are rare. The mesh manufacturers claim that the tensile strength of synthetic meshes exceeds the bursting strength of the abdominal wall. However, it has not been precisely established what actually happens with the mesh after the implantation in different anatomical conditions of tissue support or hernia defect bridging. It is unknown for how long the mesh maintains enough strength after the implantation irrespectively of the abdominal wall movements and intra-abdominal pressure.

Case report

The three patients developed recurrent incisional hernia due to central low-weight polypropylene mesh rupture after a

Table 1 Details on patients' age, gender, BMI, ASA score and previous operations

	Case 1	Case 2	Case 3
Age	68	54	37
Gender	Female	Male	Male
BMI	44.4	26.3	27.8
ASA score	III	I	I
Previous operations	A tension herniorrhaphy for umbilical hernia repair A tension herniorrhaphy for umbilical hernia recurrence A midline superior laparotomy, cholecystectomy and onlay hernioplasty using low-weight polypropylene 10 × 10 cm mesh (Ultrapro) for gallbladder stones and umbilical hernia recurrence.	A right subcostal cholecystectomy for gallbladder stones A tension herniorrhaphy for right subcostal incisional hernia repair.	An appendectomy via oblique incision A right subcostal cholecystectomy for gallbladder stones; A tension herniorrhaphy for right subcostal incisional hernia repair.

sublay hernioplasty: one of the patients was operated for midline recurrent incisional hernia, whereas two of them were operated for subcostal recurrent incisional hernia. The central mesh rupture was associated with a mesh bulging in the first patient; in the second patient with mesh bulging and a gap in the mesh; and in the third patient a gap in the mesh covered with thin and weak fascia was found. In all patients, the posterior myofascial layer was fully reconstructed during the initial hernioplasty while the anterior myofascial layer was only partially reconstructed due to the size of hernia defect and numerous previous operations. The same surgeon performed all sublay hernioplasties using low-weigh polypropylene mesh (Ultrapro, Ethicon, Inc, Somerville, NJ) for managing the recurrent incisional hernias. The heavy-weight polypropylene mesh was used in all re-operations for recurrent incisional hernias. Details on patients' age, gender, BMI, ASA score and previous operations are presented in Table 1.

Case 1

The first patient had three previous operations (in 1982, in 1992 and in 2009) performed in other hospitals (Table 1). Finally, the patient was operated for the recurrent incisional hernia at the First Surgical Clinic, Clinical center of Serbia, Belgrade in September 2010. The hernia recurrence was managed by excision of the low-weight polypropylene mesh placed in the onlay position and then Rives sublay hernioplasty was performed using the new 30 × 30 cm low-weight polypropylene mesh (Ultrapro).

Five months later, a small asymptomatic recurrent incisional hernia appeared in the midline, 3 cm below the xyfoid. Over the next 10 months, the hernia defect increased in the caudal direction extending up to a few centimetres above the navel. The hernia became symptomatic. The abdominal CT demonstrated a large recurrent hernia in the midline above the umbilicus, containing part of the transverse colon, small bowel and omentum.

The patient was re-operated at the First Surgical Clinic, Belgrade in October 2011. The recurrent incisional hernia, caused by the low-weight polypropylene central mesh rupture, was managed by utilising Rives sublay technique using a 30 × 30 cm heavy-weight polypropylene mesh. The rupture of the mesh occurred in the midline, 3 cm below the xyfoid down to 3 cm above the navel. The separated parts of the low-weight polypropylene mesh were found along the edges of the hernia defect (Fig. 1a, b). Furthermore, below the lower end of the mesh rupture, a "pseudohernia" (mesh bulging) of 3 cm in size was found. The mesh below the navel was fully intact and preserved with no signs of herniation or bulging (the part of the mesh fully covered by the anterior myofascial layer).

The patient was discharged 7 days after the operation following an uneventful postoperative course. During the 18-month follow-up period, the patient had no complaints and no signs of recurrent incisional hernia were detected.

Case 2

The second patient had two previous operations (in 2009 and in 2011) performed in another hospital (Table 1). The patient was operated for recurrent subcostal incisional hernia utilising the sublay technique using a low-weight 30 × 20 cm polypropylene mesh (Ultrapro) at the First Surgical Clinic, Belgrade in September 2011.

A low-weight polypropylene mesh bulging along the whole right subcostal incision occurred 5 months after the surgery. Seven months after the operation, a small recurrent incisional hernia was found in the central part of the mesh. The abdominal ultrasonography and abdominal wall CT demonstrated a very thinned and bulged abdominal

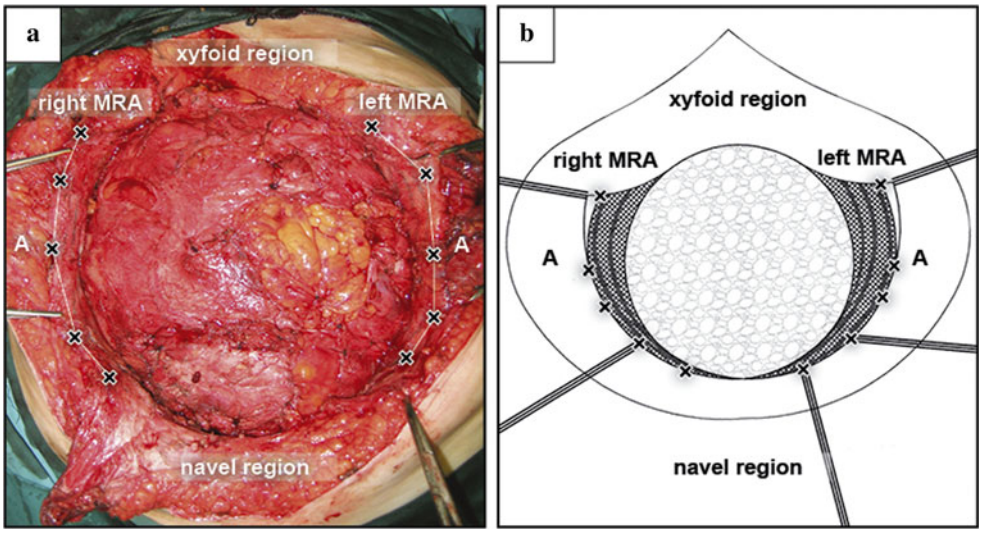

Fig. 1 Intra-operative picture of a central low-weight mesh rupture resulting in recurrent incisional hernia. **a** The X's on the picture demonstrate a direction of the mesh rupture

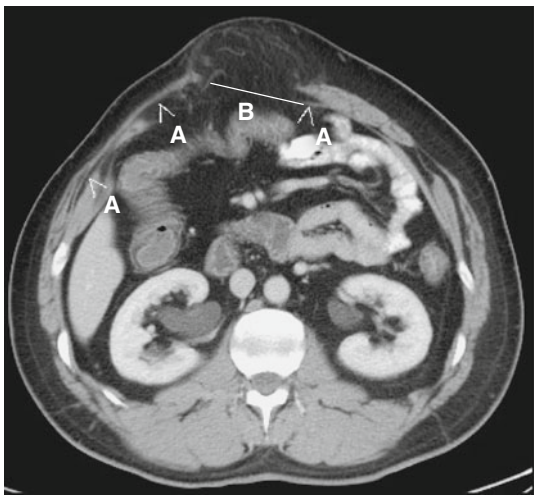

Fig. 2 Abdominal CT demonstrating the area of the mesh rupture. *A* position of the mesh, *B* Area of defect

wall in the right subcostal incision area ("pseudohernia"—mesh bulging) and a small-sized incisional hernia in the central part of the mesh (Fig. 2). The mesh bulging was not perceived as an aesthetic problem by the patient who disagreed to a new sublay hernioplasty along the whole subcostal incision under general anaesthesia. The small recurrent incisional hernia (3 × 3 cm hernia defect) was managed by the "open preperitoneal flat mesh technique" using a piece of 6 × 6 cm heavy-weight polypropylene mesh under local anaesthesia, as a day case procedure. The separated parts of the mesh were found along the edges of the hernia defect. Additionally, a gap in direction of the blue fibbers was found in the remaining parts of the mesh suggesting the possible mechanism of the low-weight polypropylene mesh rupture (Fig. 3a, b). The operation was performed at the First Surgical Clinic, Belgrade in March 2012.

The patient was discharged after 2 h following an uneventful postoperative course. During the 13-month follow-up period, the patient had no complaints and demonstrated no signs of recurrent incisional hernia.

Case 3

The third patient had three previous operations (in 1998, in 2006, and in 2007). The recurrent incisional hernia repair at the site of right subcostal and oblique incision was performed in January 2011 at the First Surgical Clinic, Belgrade using the sublay technique with low-weight 30 × 20 cm mesh (Ultrapro).

The recurrent incisional hernia occurred 13 months after the surgery. This was confirmed by an abdominal ultrasonography and CT.

The patient was re-operated at the First Surgical Clinic, Belgrade in October 2012, using 30 × 20 cm heavy-weight mesh in sublay position. During surgery, the 6 × 6 cm hernia defect was found in the central part of the low-weight mesh. The distance between the border of the mesh rupture and lateral mesh edges was 5–15 cm. The rupture occurred in the central part where the mesh was not covered by the anterior myofascial layer during the previous surgery. The entire area of the mesh was intact except at the right-side of the defect, where gap in the mesh with a length of 4 cm in direction of blue fibbers, covered with a very thin and weak fascial layer, was found (Fig. 4a, b).

The postoperative course was uneventful and the patient was discharged 6 days after the surgery. During the

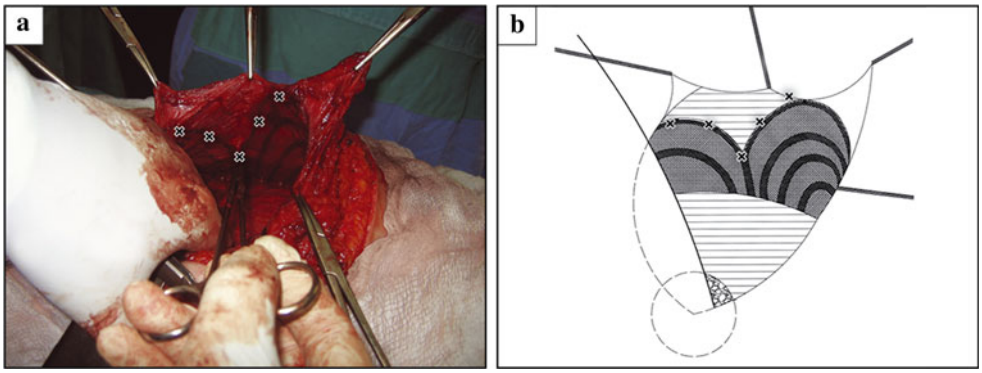

Fig. 3 Intra-operative picture of a mesh rupture showing the gap in the mesh in direction of blue fibbers (the X's on the picture)

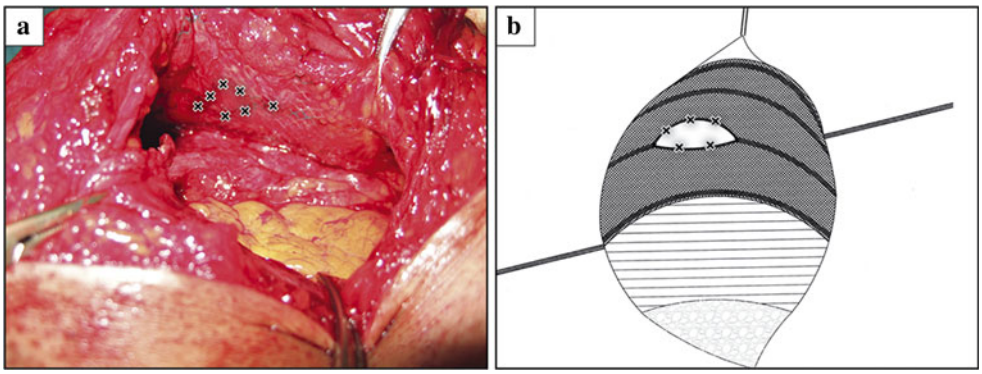

Fig. 4 Intra-operative picture showing the separation of mesh fibbers (blue fibbers —the X's on the picture) distant from the zone of the mesh rupture

6-month follow-up period, the patient had no complaints and no signs of recurrent incisional hernia were observed.

Discussion

Contemporary management of large incisional hernias is based on a tension-free prosthetic hernioplasty, i.e. sublay hernioplasty, utilising polypropylene or polyester meshes [7, 8]. It has been calculated that the maximum tensile strength of the abdominal wall is 16 N/cm^2 [9]; it needs to be underlined that the prosthetic materials used in the abdominal wall hernioplasty have a tensile strength of more than 32 N/cm^2 [3]. Heavy-weight polypropylene meshes are over-engineered with regard to the maximal tensile strength of the abdominal wall due to having a 6–10 times greater bursting strength [2]. Schumpelick et al. [10, 11] pointed out that the amount and the structure of the mesh material influence the level of inflammatory response and extension of the scar tissue formation, as well as the abdominal wall compliance. Heavy-weight polypropylene meshes due to a large amount of foreign body material and small pore size induce an intense inflammatory response, resulting in scar plate formation, shrinkage of the prostheses, increased stiffness of the abdominal wall and loss of abdominal wall compliance. Low-weight polypropylene meshes as a result of the reduced amount of material and large pore size induce less inflammatory reaction, less prostheses shrinkage and they improve the abdominal wall compliance [3, 4]. Surgeons, favouring large pore low-weight polypropylene meshes in incisional hernioplasty, claim that these meshes are sufficiently strong to resist maximally physiological stress of the abdominal wall [9, 12].

The recurrences after sublay incisional hernioplasty occur at mesh edges due to inadequate mesh-tissue overlapping, mesh shrinkage, inadequate mesh fixation or infection [13, 14]. Reports on recurrent incisional hernias in the central part of the mesh induced by mesh rupture are extremely rare in literature [15–18]. Morris-Stiff [15] reported in 1999 on heavy-weight polypropylene mesh central rupture at the Incisional Hernia Symposium in Aachen (Marlex, C.R. Bard, Billerica, Massachusetts, USA). As it was impossible to definitively ascertain what the actual cause of the central mesh rupture was (the mesh was re-sterilized before the implantation), this case was not reported in the literature. In 2001, Langer et al. [15] were the first to report on heavy-weight polypropylene mesh (Marlex) central rupture after sublay hernioplasty. The patient was obese, with BMI of 35, and developed recurrent hernia following a sublay hernioplasty without anterior rectus fascia complete closure. In 2005, Klinge et al. [16] reported on three central ruptures in large pore meshes (Vypro, Ethicon, Inc, Somerville, NJ) in the sublay position

without a previous complete anterior fascia closure. The patients were obese with a pathological BMI. In 2006, Schippers [17] reported on a central rupture of large pore mesh (Vypro) in sublay position with anterior fascia closure. The patient was obese with a BMI of 33 and was operated for re-recurrent incisional hernia. In 2012, Muysoms [18] reported on a central rupture and bulging of a low-weight large pore polypropylene mesh (Ultrapro) in a patient, operated for re-recurrent incisional hernia with sublay hernioplasty. There have been no reports on mesh rupture following laparoscopic mesh hernioplasty.

It cannot be defined what the actual cause of the polypropylene mesh central rupture was. In all reported cases, the central rupture occurred after sublay hernioplasty, used to treat recurrent incisional hernia. Most patients were obese, with a high BMI [15–17]. The central mesh rupture occurred after the use of Marlex heavy-weight small-pores meshes [15] and low-weight large pores meshes (Vypro [16, 17] and Ultrapro [18]), without [15, 16] or with [17] closure of the anterior fascia. In this context, central rupture associated with mesh bulging was reported only with Ultrapro mesh [18] and occurred early after the surgery. In Muysoms [18] report, complications developed after 14 months and in the three presented cases the central mesh rupture occurred after 5, 7 and 13 months, respectively.

Langer et al. [15] presented a theory explaining the central rupture of the Marlex heavy-weight polypropylene mesh after sublay hernioplasty without anterior rectus fascia suture. They claim that the Marlex mesh is too strong and rigid whereby the main problem relates to the transitional zone between the lateral part of the mesh, positioned behind the rectus muscle that is fully covered by myofascial tissue, and the central part of the mesh which is not protected by the anterior rectus fascia. Under such conditions, during the abdominal wall movements the two mesh parts, the central mobile mesh part and the other lateral immobile part of the mesh demonstrate opposing forces which possibly lead to mesh damage, and eventual mesh rupture in the transitional zone. In situations where the mesh is not protected with the anterior fascia in its central part, Langer et al. [15] conclude that the heavy-weight meshes are at a greater risk for rupture, compared to low-weight meshes.

Deeken et al. [19] stated in their study that the polypropylene, polyester, poly-tetrafluoroethylene and partially absorbable meshes, such as low-weight Ultrapro mesh, differ significantly in view of their physicomechanical properties. The authors claim that Ultrapro mesh and Infinit mesh use (WL Gore and Associates) is not safe for hernioplasty in extremely obese patients or for hernioplasty without tissue support in patients with a very large incisional defect, in cases where the required mesh tensile strength is above 50 N/cm^2.

In three presented cases, the low-weight large pores polypropylene mesh (Ultrapro) was positioned between the anterior and posterior myofascial layers of the abdominal wall. In all patients, the posterior myofascial layer was completely sutured; however, the anterior myofascial layer was not completely reconstructed due to the hernia defect size and previous operations. The lateral part of the mesh, behind the rectus muscles or external oblique muscle, being fully supported by tissue was in the sublay position, while the central part of the unprotected mesh only bridged the hernia defect and was in the onlay position. This central mesh rupture in the above-mentioned three patients confronts the surgeon with certain dilemmas: it raises the question why the low-weight large pores polypropylene mesh was not sufficiently strong to withstand the bursting strength of the abdominal wall after the sublay hernioplasty and it was not fully protected by the anterior myofascial layer, although the low-weight meshes have a much higher bursting strength compared to the maximum tensile strength of the abdominal wall. In all patients, meshes were completely preserved in the lateral part, protected by the myofascial layer, and ruptured in their central part, not protected by the myofascial layer. Questions that need to be addressed are: (1) What was the reason for mesh bulging at the navel level in the first patient?; (2) What was the reason for the entire bulging of mesh in the second patient; (3) Why did the split of mesh lateral to the hernia defect, covered with a thin and weak fascia, occur in direction of the blue fibbers.

Based on our three presented cases, it cannot be determined what the main causes of the central mesh rupture were. However, the common for the three patients was: (a) multiple recurrences; (b) the posterior myofascial layer was fully reconstructed and the anterior could not be reconstructed completely; and (c) a low-weight large pores polypropylene mesh was used. It is indicative that in all patients the mesh rupture occurred at places where the low-weight mesh was not protected by the anterior fascia. In line with this, the central mesh rupture in the three above-mentioned patients does not support the theory presented by Langer et al. [15]. The authors view that the low-weight large pores polypropylene mesh, in the sublay position without anterior fascia closure, does lack the necessary tensional strength required under the extreme conditions that are present in large incisional hernias (in vivo) and it is corroborated by the occurrence of mesh bulging or gap of the mesh in our patients. A similar intra-operative finding is reported by Muysoms [18]. If the theory of Langer et al. [15] is proved to be true, then the sublay hernioplasty, which is used to address central low-weight mesh rupture

in the first patient, is prone to a repeated central rupture since the myofascial layer was not fully sutured.

Klinge et al. [16] recommended a selective approach for mesh types when addressing large incisional hernias, depending on the anatomical situation. They recommended the use of large pore polypropylene mesh only for incisional hernias where the anterior fascial layer can be completely sutured. In cases when this is not possible, the use of the technique with a double layer of large pore meshes or the use of heavy-weight polypropylene meshes is suggested by Klinge et al. [16] to which the authors fully agree.

Based on the presented study cases, the authors believe that the anterior myofascial layer should be sutured, whenever possible, when performing the Rives sublay technique. In extreme cases of obese patients with large incisional hernia, the closure of anterior, and in some cases even the posterior myofascial layer, is not possible. In these patients, the authors suggest the use of omentoplasty, hernia sac reconstruction and partial posterior rectus fascia suture. Inlay composite mesh positioning, followed by sublay hernioplasty using heavy-weight polypropylene mesh in combination with components separation technique [20], is also an option to achieve the best possible approximation of the anterior myofascial layer.

In conclusion, the use of low-weight polypropylene meshes should be avoided if closing of the anterior myofascial layer cannot be ensured during the incisional hernioplasty, instead preference should be given to the heavy-weight polypropylene meshes. Although manufacturers claim that the meshes are sufficiently strong to withstand the maximum abdominal bursting strength, great efforts should be made, whenever performing sublay hernioplasty, to ensure anterior tissue support to prevent central mesh rupture.

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Conflict of interest MZ declares no conflict of interest. DG declares no conflict of interest. ADS declares no conflict of interest. IP declares no conflict of interest. MP declares no conflict of interest. MM declares no conflict of interest.

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