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ORIGINAL ARTICLE

Are mesh anchoring sutures necessary in ventral hernioplasty? Multicenter study

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Abstract
Background Avoiding mesh fixation to the surrounding tissue in ventral hernioplasty would simplify the operation, decrease the time of the procedure, and decrease the risk of suture-related complications.
Methods Four hospitals included 111 patients according to the common protocol for prospective clinical evaluation of sutureless ventral hernioplasty. Surgical technique involves placement of the polypropylene mesh with flat-shape memory in either the retromuscular or preperitoneal space without suture anchoring.
Results Local complication rate was low (12.6%, 14 patients), postoperative pain measured according to the visual analogue scale was minimal (mean 4, range 1–8). Three recurrences (3%) were recorded. Mild scar discomfort, which did not require treatment nor limit physical activity, was recorded in 28 (25%), 18 (17%), and 11 (14%) patients at 6-month, 1- and 2-year follow-up, respectively.
Conclusions Results of the study suggest that the sutureless sublay technique is safe and effective in the treatment of ventral abdominal hernia, especially in small and medium defects.

Keywords Ventral hernioplasty · Sutureless repair · Polypropylene mesh · Stoppa-Rive's operation

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Introduction

There is common agreement that prosthetic material should be used for abdominal hernia repair including for small defects [1–3]. There are several techniques for mesh implantation, but most involve sutures to anchor a mesh in position and prevent migration, wrinkling, and curling. Such suture placement is time consuming and often challenging, leaving room for technical mistakes and failure as was suggested in a recent trial [4]. Additionally, the sutures that anchor the mesh are blamed for extensive tissue tension and nerve entrapment leading to prolonged postoperative pain after Stoppa-Rive's as well as laparoscopic operations [5–7]. Even the application of absorbable sutures instead of nonabsorbable ones does not solve the problem [5].

In order to avoid the above disadvantages, it was proposed that Stoppa-Rive's technique be modified and flat-shape memory polypropylene mesh be applied without suture fixation to the surrounding tissue [8]. Because it has been suggested that such sutureless mesh implantation is

effective for inguinal hernia repairs, it may also be useful for ventral hernioplasty [9]. The potential advantages and simplicity of the approach encouraged us to test the technique in our clinical settings.

The aim of this study was a clinical evaluation of the safety and effectiveness of the sutureless ventral hernioplasty as a modification of the Stoppa-Rive's technique [10].

Materials and methods

After establishing a common protocol, one designated surgeon from the participating hospitals personally supervised the study following practical training in Catanzaro, Italy. Results from the participating centers were periodically collected and analyzed in the coordination center. From September 2003 to September 2005, 111 patients who were referred for elective ventral hernia repair to the participating hospitals were enrolled in the study after signing informed consent. Exclusion criteria included the following: age under 35 years old, pregnancy or planning to become pregnant, active skin infection, or symptoms of respiratory insufficiency or hernia incarceration. Patients with extremely large ventral hernias with extensive loss of abdominal wall tissue were also excluded.

Surgical technique

Ventral hernia repair was performed with implantation of a polypropylene mesh without suture anchoring (Fig. 1). For midline hernias, the dissection of the hernia sac was first carried out; the posterior layer of the rectus sheet was then dissected on both sides of the rectus muscles to create a space for the mesh. Similarly, preperitoneal space was prepared in the case of hernia in the lateral aspects of the abdomen. Thorough hemostasis was carried out. The peritoneum and posterior fascial sheet were closed with either monofilament nonabsorbable polypropylene or delayed resorption sutures. In cases of excessive tension, the hernia sac tissue or omentum was used to cover the defect gap and separate visceral organs from the mesh. Next, a specially designed monofilament polypropylene mesh was placed in a sublay position in the retromuscular or preperitoneal space.

One of two types of prosthesis was used: Hertra 0 (thickness 0.71 mm, medium porosity 281 μm, 242 g/m^2, size 20 × 20 cm or 30 × 30 cm) or Oval Patch (thickness 0.83 mm, medium porosity 449 μm, 223 g/m^2, size 14 × 18 cm) (Herniamesh, Turin, Italy). Both are macroporous, have optimal rigidity, and maintain flat-shape memory due to the knitting technique and thermal processing. Oval Patch was preferred in thinner patients with smaller defects, whereas Hertra 0 was used in larger hernias or in obese patients. Implanted mesh was trimmed to the proper shape before insertion in order to fit the tissue space and exceed the hernia gap by at least 5 cm. The mesh reached the lateral edge of the rectus muscle on both sides in large (diameter 10–15 cm) or medium (5–10 cm) midline hernias. Then, the anterior fascial sheet was reapproximated with the same sutures. Relaxing incisions of this fascia layer were made whenever necessary to decrease the fascial tension. One suction drain was placed over the mesh and another put in subcutaneous tissue as necessary. Suction drainage was discontinued 1–2 days after operation or prolonged in cases of robust fluid collection.

Each procedure was carried out under general or spinal anesthesia with antibiotic (cephalosporin 1 dose iv) and thromboembolic prophylaxis (low fractionated heparin s.c). The time of operation was measured from first incision to the last suture; and the time required for mesh placement including closure of the posterior fascia, dissection of the retromuscular or preperitoneal space, hemostasis, and closure of the anterior abdominal fascia was noted. Pain was assessed by using the visual analogue scale (VAS) ranging from 0 to 10, on the first postoperative morning (VAS_1) while patients were moving before analgesics administration. Pain management was applied based on medical routine established in participating centers. Patients were encouraged to engage in unrestricted physical activity after the operation and were discharged from the hospital as soon as they felt comfortable. Follow-up was scheduled at 6, 12, and 24 months after surgery.

Statistical analysis

Chi-square analysis and Fisher's exact test were used to compare the relationship among categorical variables. A P value less than 0.05 was considered to represent statistical significance for all comparisons.

Results

Patient and hernia characteristics are presented in Table 1. The number of patients included in the study varied among centers due to the local logistics. Incisional hernia was the indication for surgery in 85 (76%) of the patients with a mean defect area of 103 ± 49 cm^2. Midline defects were the most common. The hernia sac tissue was used in four (6%) patients and omentum in one (1.4%) in order to close the posterior abdominal fascia. In the remaining 106 cases (92%), the posterior fascia along with peritoneum was reapproximated with sutures without tension. In large hernias (defect diameter above 10 cm), relaxing incisions of the anterior fascia were made in 12 (11%) patients based on the surgeon's judgment. Suction drainage was applied in 103 (93%) patients.

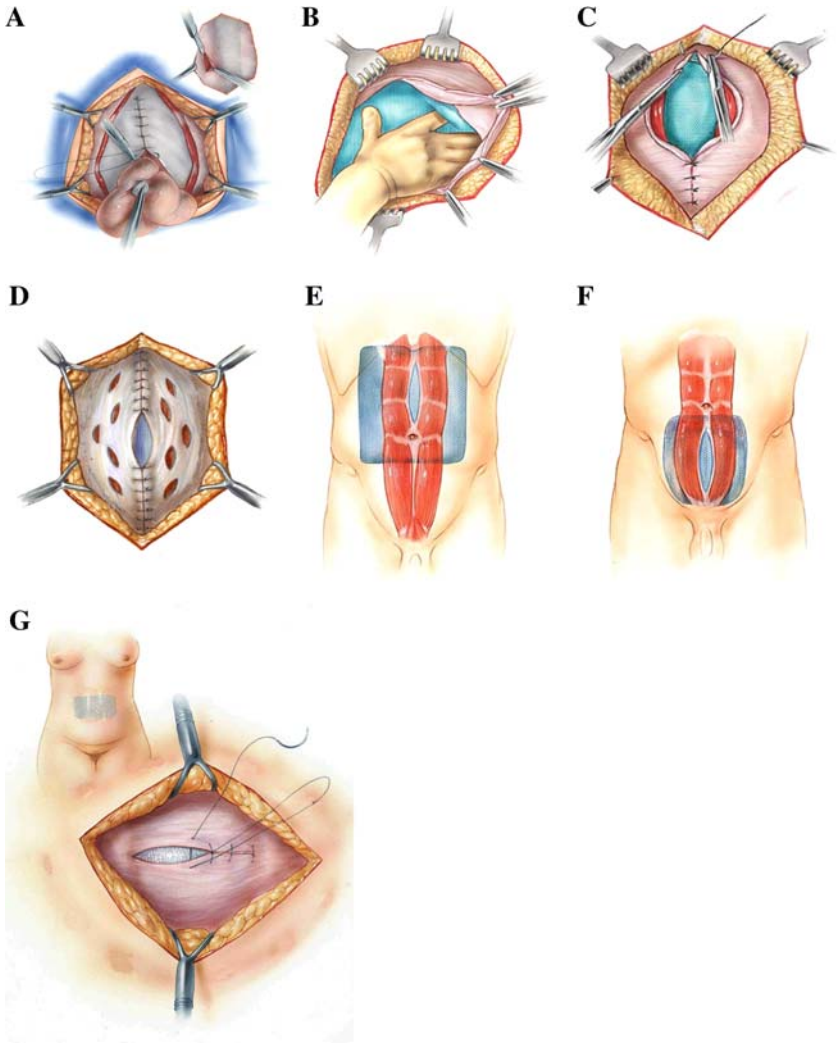

Fig. 1a–g Sutureless technique with no need for mesh suturing to the surrounding tissue. **a** Closure of the posterior abdominal fascia. **b** Placement of the mesh in retromuscular or preperitoneal position. **c** Complete closure of the anterior abdominal fascia. **d** Relaxing incisions, if necessary, to decrease the tension. **e–g** Final mesh position **e** in epigastric, **f** in hypogastric, and **g** in paraumbilical hernia repair

Table 1 Patient and hernia characteristics

	Italy	Poland	Russia	Serbia	Total
Number of patients	52	8	27	24	111
Age (years)	63 ± 13	67.5 ± 11	60 ± 9	60 ± 7	62 ± 10
Sex	39F, 13M	4F, 4M	23F, 4M	16K, 8 M	81F, 30M
BMI	31 ± 4	33 ± 6	24 ± 2	27 ± 4	28 ± 5
Hernia type and size					
Incisional hernia	37 (71%)	7 (87%)	20 (74%)	21 (88%)	85 (76%)
Primary defect[a]	15 (29%)	1 (13%)	7 (26%)	3 (12%)	26 (24%)
Midline hernia	39 (75%)	6 (75%)	27 (100%)	19 (79%)	91 (82%)
Lateral hernia	13 (25%)	2 (25%)	0 (0%)	5 (21%)	20 (18%)
Area of defect (cm^2)	120 ± 60	109 ± 56	80 ± 40	90 ± 60	103 ± 49
Diameter < 5 cm	6 (11%)	1 (12%)	4 (15%)	3 (12%)	13 (12%)
Diameter 5–10 cm	11 (21%)	1 (12%)	21 (78%)	9 (37%)	42 (38%)
Diameter 10–15 cm	23 (44%)	4 (50%)	0	7 (29%)	34 (30%)
Diameter > 15 cm	12 (23%)	2 (25%)	2 (7%)	5 (20%)	21 (19%)

[a] Umbilical/para or epigastric hernia

Early results are shown in Table 2. The average time of the operation was 96 ± 32 min but varied broadly from 30–185 min. However, the time of mesh implantation was similar in all centers, with a mean of 23 ± 12 min ($P > 0.05$). Mesh was placed in retromuscular position in 76 (68%) patients and in the preperitoneal space in the other 35 (32%).

Table 2 Early results

	Italy	Poland	Russia	Serbia	Total
Time of operation (min)	115 ± 26 (30–185)	116 ± 54 (40–180)	70 ± 32 (35–160)	80 ± 33 (35–120)	96 ± 32
Time of mesh implantation (min)	23 ± 8	33 ± 17	23 ± 16	18 ± 5	23 ± 12
Retromuscular mesh (*n*)	34 (65%)	5 (62%)	21 (78%)	16 (67%)	76 (68%)
Preperitoneal mesh (*n*)	18 (35%)	3 (38%)	6 (22%)	8 (33%)	35 (32%)
Postoperative period					
VAS_1[a] median (range)	3 (1–8)	5 (3–6)	5 (2–6)	4 (3–7)	4 (1–8)
Pain treatment	Tramal and NSAID iv	Tramal 3 (37%)	Petidine 5 (19%)	Tramal 19 (79%)	27 (46%)
		NSAID 5 (63%)	Banalgin 22 (81%)	NSAID 5 (21%)	32 (54%)
Duration of pain treatment (days)	2 (1–2)	4 (2–6)	3 (2–9)	3 (1–4)	3 (1–9)
Early complications					
Wound hematoma	1 (2%)	1 (12%)	0	1 (15%)	3 (3%)
Seroma and aspiration	2 (4%)	1 (12%)	1 (4%)	0	4 (3.6%)
Wound infection	0	1 (12%)	3 (11%)	3 (12.5%)	7 (6%)
Early follow-up 2 weeks after surgery[b]					
VAS	1 (0–3)	2 (0–3)	4 (0–7)	3 (0–4)	2 (0–7)
Return to normal home activity (weeks)	2 (1–3)	1 (1–2)	3 (2–4)	1 (1–2)	2 (1–4)

VAS Visual analogue scale, range 0–10

[a] VAS_1 was assessed on day +1 after surgery before analgesics administration

[b] Early follow-up rate: 98% (range 96–100%)

The median of postoperative pain expressed as VAS_1 was 4 (range 1–8), and discomfort was controlled with analgesics for an average of 3 (1–9) days. Wound hematoma or infection required revisions in three (3%) and seven (6%) patients, respectively. Seroma was aspirated in four (3.6%) cases. No mesh was removed due to complications. Low levels of postoperative pain and low complication rates allowed for prompt physical recovery. Patients resumed their daily home activities within 2 (1–4) weeks of the operation.

Follow-up examination

Follow-up was obtained mainly by phone, since most of the patients (50–70%) did not comply with scheduled visits. Follow-up rate at selected time points ranged from 100% at 6 months after surgery to 66% at 2 years, as shown in Table 3. Three recurrences were found. The first was found 2 weeks after suprapubic incisional hernia repair as the result of the implantation of inadequately sized mesh and limited dissection of Retzius space due to a prior cystocutaneous urinary fistula and postsurgical adhesions. This recurrence was treated effectively with a larger Hertra 0 mesh placed in the preperitoneal space, also without suture fixation. The recurrence in the second patient was found in the epigastrium, where a previous defect had been repaired in the midline of the hypogastric region 4 months earlier. Another recurrence was found in the midline of the suprapubic region after paraumbilical repair.

After large-hernia operations, 21 (19%) patients reported mild discomfort located at the level of the scar, another 7 (6%) at the lateral edges of the mesh and the Spigelian line 6 months after surgery. The recorded discomfort did not interfere with their life activities nor require pain-relief treatment. Discomfort at the Spigelian line resolved within 1 year after operation. Eighteen (17%) and 11 (14%) patients still reported discomfort in the scar at 1- and 2-year follow-up examinations, respectively.

It is interesting to note that the percentage of patients with such pain at each time point was statistically higher in the Russian center compared to other hospitals and higher compared to the average from all centers ($P < 0.05$). One patient reported moderate and periodic abdominal pain for over 1 year, which resolved after releasing an intra-abdominal adherence and partial bowel obstruction through the laparotomy. None of the patients reported limitation of physical activity due to the rigidity of the abdominal wall after surgery, which could be related to wound scar or connective tissue infiltration of the mesh. The average patients' satisfaction score was high 4.8 (range 4–5), indicating improvement in quality of life after surgery.

Discussion

Although the laparoscopic approach is gaining popularity, the open Stoppa-Rive technique remains a valid operation for ventral hernia repair [1, 2, 4]. Therefore, we aimed to

Table 3 Follow-up results

	Italy	Poland	Russia	Serbia	Total
n	52	8	27	24	111
Long-term follow-up rate					
6 months	52 (100%)	8 (100%)	27 (100%)	24 (100%)	111 (100%)
1 year	46 (88%)	7 (87%)	27 (100%)	23 (96%)	103 (92%)
1.5 year	40 (77%)	7 (87%)	22 (77%)	22 (91%)	91 (82%)
>2 year	35 (67%)	5 (62%)	14 (51%)	20 (83%)	74 (66%)
Long-term follow-up results					
Recurrence	3 (6%)	0	0	0	3 (3%)
Limitation of physical activity due to abdominal wall rigidity	0	0	0	0	0
Pain[a] 6 months after surgery					
Mild	8 (15%)	2 (25%)	14 (51%)	4 (17%)	28 (25%)
Moderate	0	0	1 (4%)	0	1 (1%)
Pain 1 year after surgery					
Mild	3 (6%)	1 (14%)	12 (44%)	2 (9%)	18 (17%)
Moderate	0	0	1 (4%)	0	1 (1%)
Pain 2 years after surgery					
Mild	2 (6%)	0	7 (50%)	2 (10%)	11 (14%)
Moderate	0	0	1 (4%)	0	1 (1%)
Satisfaction score[b]	4.9 (4–5)	4.9 (4–5)	4.5 (4–5)	4.9 (4–5)	4.8 (4–5)

[a] *Mild* pain was defined as periodical, not limiting physical activity. *Moderate* was defined as periodical, limiting physical activity

[b] Patient satisfaction: *5* very good, *4* good, *3* fair, *2* bad, *1* very bad

optimize this technique in order to limit risk of postoperative pain and recurrence. Since the sutureless hernioplasty has proven to be an efficient method of inguinal hernia repair, we hypothesized that this technique can be successfully applied to most types of ventral defects. Our goal was to assess the safety and efficacy of this approach before a randomized prospective study is designed to compare the results of this technique with other current approaches.

Different types and sizes of ventral hernias were included in the study in order to obtain a wide spectrum of clinical data within the assigned time period to assess the applicability of the approach. We aimed to include at least 50 patients from each center, but failed due to local logistic reasons. Our patient population was similar to patients presented in literature. Age, gender, type and size of the defect were typical for the series of consecutive patients [2, 4, 11, 12].

Sutureless ventral hernioplasty is based on the Stoppa-Rive's (sublay) technique in which monofilament polypropylene mesh is placed in the optimal space for this material in the retromuscular or preperitoneal compartment [10]. The main difference in the sutureless technique is to refrain from suture anchoring the mesh to the surrounding tissue.

The sutureless technique takes advantage of the rigidity, flat-shape memory, and good adhesive features of the mesh placed in the closed anatomical space, which prevents wrinkling, curling, folding, and mesh migration. Moreover, after the operation intrabdominal pressure, along with abdominal wall elasticity, compresses the mesh within the fascia and muscle compartment additionally securing its position and creating optimal conditions for immediate connective tissue ingrowth. This leads to a prompt and full integration of the prosthesis into the abdominal wall, which is essential for repair and allows the tension caused by the intrabdominal pressure to be controlled. In contrast to the traditional suture repair technique, fully integrated mesh binds both sides of the abdominal wound together, releasing tension from fascial midline sutures, both below and above the mesh. The midline sutures are not critical for the repair; therefore, delayed resorption sutures instead of non-absorbable can safely be used. Since the process of connective tissue ingrowth is prompt, robust and progresses quickly, sutures are only required to support wound integrity (tissue repair) during the initial postoperative days until the mesh is incorporated into abdominal wall (Fig. 2).

Compared to the Stoppa-Rive's technique, the sutureless procedure has several practical and clinical advantages. First, skipping anchoring the mesh to the surrounding tissue allows the surgeon to save work thus decreasing the time of the operation and the level of technical difficulty. The surgical dissection is limited, making the procedure less traumatic for the tissue and the patient. This is especially

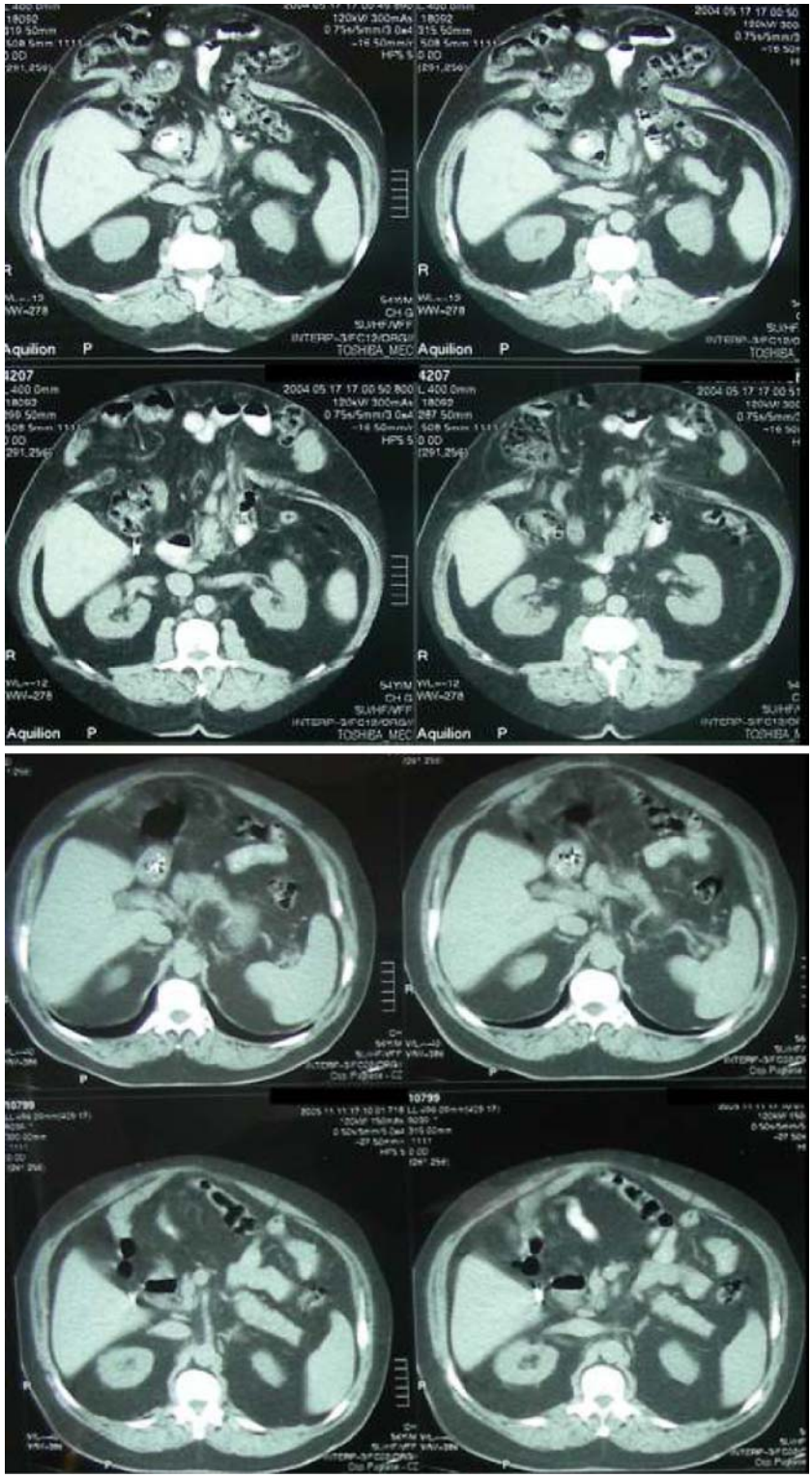

Fig. 2 CT scan before and after operation of large ventral hernia

advantageous with small defects such as umbilical and paraumbilical hernias.

The average time of the entire operation (1.5 h) was similar to those obtained when using the Stoppa-Rive's or the laparoscopic approach [4, 11]. The time ranged widely depending on the type of the hernia and the extent of the hernia sac dissection. However, the mesh placement along with the dissection and closure of the anatomical space only took 20 min. The retromuscular position of the mesh was more common than the preperitoneal position, since midline hernias dominated series presented here. The level of pain on the first postoperative day, $VAS_1 = 4$, was similar

to that reported after open and laparoscopic approaches [11]. When the soft polypropylene mesh is sutured in the Stoppa-Rive's technique, malformation of the mesh tension can lead to dead space formation and subsequent chronic fluid collection, hematomas, or infections. Therefore, the theoretical risk of such complications should be lower in the sutureless technique since flat-shape-memory mesh lies flat without tension caused by fixation to the surrounding tissue. However, our rate of early complications such as wound infections, seromas, or hematomas requiring intervention was 13%, comparable to that of other approaches in the literature [2, 4, 11].

Complications related to anchor suturing are described as the main disadvantages of the Stoppa-Rive's technique [4, 5, 12]. The high level of postoperative pain at the wound and also at the edges of the prosthesis due to tissue damage and tension prolongs patient recovery [5]. In contrast, the sutureless procedure is without such tension, thus pain results only from the tissue incision. At 2 weeks, the average pain level in our series was 2 (range 0–7) in VAS scale. Long-term discomfort in the region of the scar was reported in 20-28% of patients after mesh implantation [5, 12]. Interestingly, a similar rate and level of pain was observed in the scars after traditional suture as in the mesh procedure indicating that the pain may not be related to the type of repair [2]. Our results were similar: the rate of long-term pain decreased from 25% after 6 months to 14% after 2 years, however the pain was only mild discomfort, which did not limit the patients' daily activities. Differences between the mild discomfort rate reported by the Russian and the other centers may be attributed to the differing attitudes of the interviewing doctor and patients to differing perceptions of pain. They reported discomfort at any level, numbness, or even slight strange sensations at the operation site compared to the other parts of the abdomen. We did not find any difference in surgical technique or patient characteristics that could explain the differences.

According to the literature, as much as 27% of patients might complain about long-term pain at the Spigelian line, which may be the result of sutures used to anchor the mesh, creating tension [5, 12]. In some cases, sutures may trap the nerves making scar revision indispensable for relief [6]. Interestingly, even though we did not observe such neuralgia nor did we use sutures to fix the mesh in our series, some patients (6%) still described mild discomfort at the edges of the mesh. This pain resolved without treatment and was probably related to chronic interaction between the edges of the polypropylene mesh and the tissue at that line. None of the patients complained about extensive rigidity of the scar or anything that limited their physical performance such as bending or tying shoe laces.

Our recurrence rate was 3% and comparable to the results of studies with similar 2-year follow-ups [4, 11, 12]. Telephone interviews are a less sensitive tool for the diagnosis of recurrence than physical examination, and this could have resulted in an underestimation of the recurrence rate in the presented series. As was the case in our series, recurrence usually develops in lower resistance areas of the abdominal wall around the mesh. Since polypropylene shrinks, extensive dissection beyond the edges of the defect should be performed to create sufficient space for a mesh much larger then the defect, thus covering the area of potential herniation. Mesh suturing holds the mesh flat during scar tissue ingrowth but does not protect from mesh shrinkage or the development of a hernia next to the prosthesis [4]. Therefore, mesh suturing is not essential for recurrence prevention as long as the mesh is flatly incorporated into the tissue.

We consider the sutureless approach extremely useful for surgeons who use the Stoppa-Rive's operation. Since the technique is very effective when closure of the peritoneum, posterior, and anterior fascia is feasible without excessive tension on the suture line, this approach is especially attractive for small-defect repairs, offering limited dissection and suturing. There is no doubt that mesh implantation is superior to suture repair in such cases [2, 3]. Sutureless umbilical hernia repair can be considered as a minimally invasive procedure since the area of dissection is limited, and placement of the mesh is quick and easy without the need for suture anchoring.

Overall, our results were comparable with those presented in the literature after the Stoppa-Rive's operation. The sutureless approach has the potential to be a convenient modification, simplifying the procedure without compromising the outcome. A randomized, prospective trial can more objectively answer the question of whether we still need to suture the mesh in ventral hernioplasty.

Conclusions

Preliminary results suggest that the sutureless sublay ventral hernioplasty is a safe and effective procedure especially in small and medium defects. It simplifies the Stoppa-Rive's operation without compromising outcome.

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