Surgical Endoscopy (2024) 38:2826–2833
https://doi.org/10.1007/s00464-024-10801-2

Endoscopic-assisted repair of combined ventral hernias and diastasis recti: minimizing seroma incidence by quilting

Jean-Pierre Cossa[1] · Philippe Ngo[1] · Dominique Blum[2] · Edouard Pélissier[1] · Jean-François Gillion[3]

Received: 1 December 2023 / Accepted: 17 March 2024 / Published online: 10 April 2024

Abstract

Background To reduce the incidence of seromas, we have adapted the quilting procedure used in open abdominoplasty to the endoscopic-assisted repair of concomitant ventral hernia (VH) and diastasis recti (DR). The aim of this study was to describe the technique and assess its efficacy by comparing two groups of patients operated on with the same repair technique before and after introducing the quilting.

Methods This retrospective study included data prospectively registered in the French Club Hernie database from 176 consecutive patients who underwent surgery for concomitant VH and DR via the double-layer suturing technique. Patients were categorized into two groups: Group 1 comprised 102 patients operated before introducing the quilting procedure and Group 2 comprised 74 operated after introducing the quilting. To carry out comparisons between groups, seromas were classified into two types: type A included spontaneously resorbable seromas and seromas drained by a single puncture and type B included seromas requiring two or more punctures and complicated cases requiring reoperation.

Results The global percentage of seromas was 24.4%. The percentage of seromas of any type was greater in Group 1 (27.5%) than in Group 2 (20.3%). The percentage of Type B seromas was greater in Group 1 (19.6%) than in Group 2 (5.4%), when the percentage of Type A seromas was greater in Group 2 (14.9) than in Group 1 (7.9%). Differences were significant ($p=0.014$). The operation duration was longer in Group 2 (83.9 min) than in Group 1 (69.9 min). Four complications requiring reoperation were observed in Group 1: three persistent seromas requiring surgical drainage under general anesthesia and one encapsulated seroma.

Conclusion Adapting the quilting technique to the endoscopic-assisted bilayer suturing technique for combined VH and DR repair can significantly reduce the incidence and severity of postoperative seromas.

Keywords Seroma · Diastasis recti · Ventral hernia · Quilting · Endoscopic-assisted

A seroma consists of an accumulation of serous fluid in a dead space created by dissection. Seroma formation is particularly frequent after open abdominoplasty or endoscopic-assisted diastasis recti (DR) correction by subcutaneous access; the fluid collection is located between the skin flap and the anterior sheath. The supposed causes of seroma formation are the creation of a dead space by extended dissection, disruption of blood and lymphatic vessels, and an inflammatory response as well as the shearing effect of movements between the skin flap and the anterior sheath [1]. Some risk factors are mentioned in the literature, such as male sex [2] and high BMI [1, 3].

In most cases, seromas are considered minor complications—or even not accounted for as such—and are not reported. Nevertheless, seromas can also cause discomfort and require frequent outpatient visits and punctures; in rare instances, they can result in severe complications requiring reoperation, such as the formation of a pseudobursa or infection.

The incidence of seroma formation after DR correction varies across studies. According to a review on different techniques for DR repair [4], the percentage of seroma

✉ Edouard Pélissier
pelissier.edouard@gmail.com

1 Institut de la Hernie Paris, 15 Rue du Cirque, 75008 Paris, France

2 Établissement Français du Sang de Franche Comté, Besançon, France

3 Ramsay Santé Antony Private Hospital, 1 Place Velpeau, 92160 Antony, France

formation varies from 0 to 30% for open surgery techniques and from 3 to 27% for endoscopic techniques.

Quilting is one of the diverse methods proposed to reduce seroma incidence, and it has been shown to be effective in open abdominoplasty [5, 6]. We have adapted the quilting procedure used in open abdominoplasty to the endoscopic-assisted bilayer suturing technique introduced by Ngo et al. [7]. The aim of this study was to describe the endoscopic-assisted technique of quilting and assess its efficacy by comparing two groups of patients who underwent the same technique of repair before and after introducing the quilting procedure.

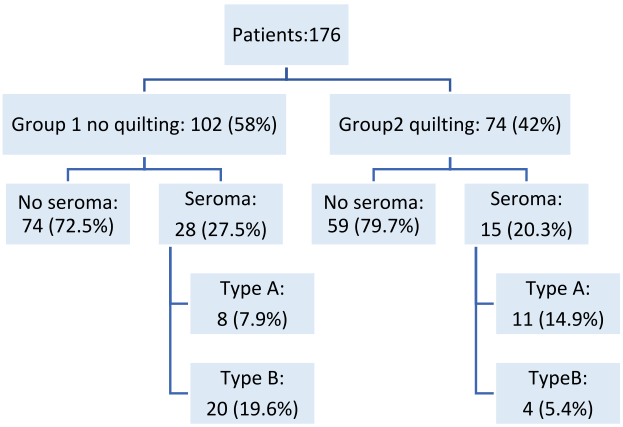

Fig. 1 Flowchart: patient allocation

Methods

Study design

This study was based on the data of a continuous series of patients who underwent surgery for concomitant ventral hernia (VH) and DR at the same institution by two expert surgeons using the same technique of endoscopic-assisted subcutaneous suturing repair.

All consecutive non-selected patients who underwent surgery from 2019/05/20 to 2023/10/31 were included. This retrospective study was based on data that were prospectively registered in the French Club Hernie database, which includes all cases of repair of any type of abdominal wall dehiscence, without any exclusion.

The study included two groups of patients: Group 1 included patients who underwent surgery before the introduction of the quilting method (up to July 2022) and Group 2 included patients for whom quilting was applied (from July 2022). Seromas were classified into two types: (1) Type A included seromas that were spontaneously resorbable and seromas that were drained by a single puncture and (2) Type B included seromas that required two or more punctures and complicated cases requiring surgical intervention (Fig. 1).

Surgical techniques

Group 1

The operation was performed according to the technique described by Ngo et al. [7].

The first step was performed through a short periumbilical skin incision using a 6-cm Alexis retractor. The umbilical hernia was reduced, and the orifice was closed by a transverse continuous suture of slowly absorbable material. The medial edges of both rectus muscles were sutured together 5–6 cm above and 5–6 cm below the umbilicus. Then, two 3.5-mm or 5-mm trocars were introduced on both sides of the Alexis retractor, the laparoscopic cap and the endoscope were placed on the retractor, and the endoscopic step was carried out. The insufflation pressure was 12 mmHg at dissection, and it was reduced to 4 mmHg for suturing.

Extended preaponeurotic dissection and approximation of the entire length of the medial edges of both rectus muscles by continuous suturing of 0 barbed slowly absorbable material (Stratafix, Ethicon) joining the previous suture line were carried out.

Group 2

The same technique of repair was performed, and it was completed with quilting sutures of 3/0 resorbable material (Vicryl, Ethicon).

The quilting stitches took a good depth of the subcutaneous tissue, although avoiding taking the dermis.

At the endoscopic step, 2–3 stitches were placed on the midline above the umbilicus (Fig. 2), and 1–2 stitches were placed on both sides at the lateral border of the rectus muscle (Fig. 3). Tying the knots was facilitated by the low insufflation pressure and by pushing down the skin flap with the finger.

After removal of the cap of the retractor, four more stitches were placed via the direct approach at the four cardinal points to form a circle around the umbilicus.

After removing the retractor, four additional cardinal stitches were placed within the previous circle.

Then, the umbilicus was fixed by one or two stitches. The positions of the quilting stitches are shown in Fig. 4.

In both groups, no drains were used, no concomitant procedures were performed, and abdominal binding was applied for 3 to 4 weeks.

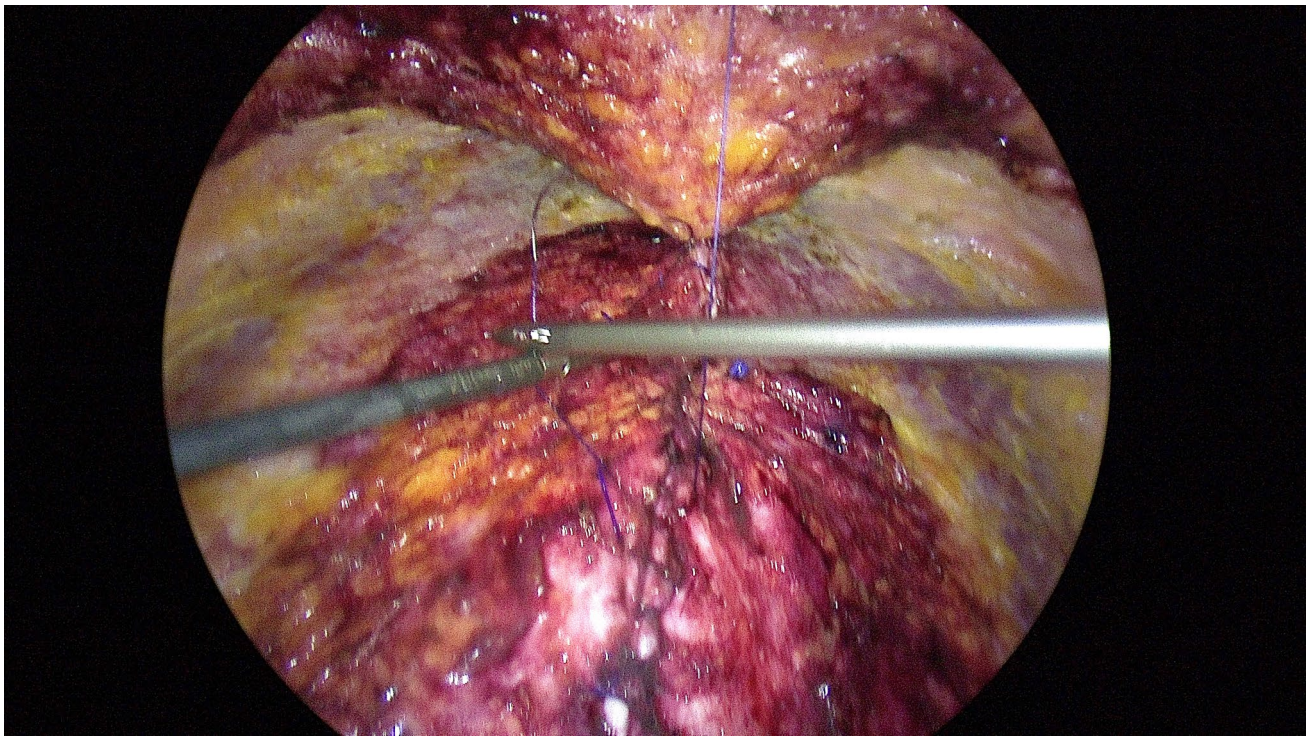

Fig. 2 Quilting, endoscopic view: midline quilting stitches, the upper already tied, and the lower being placed

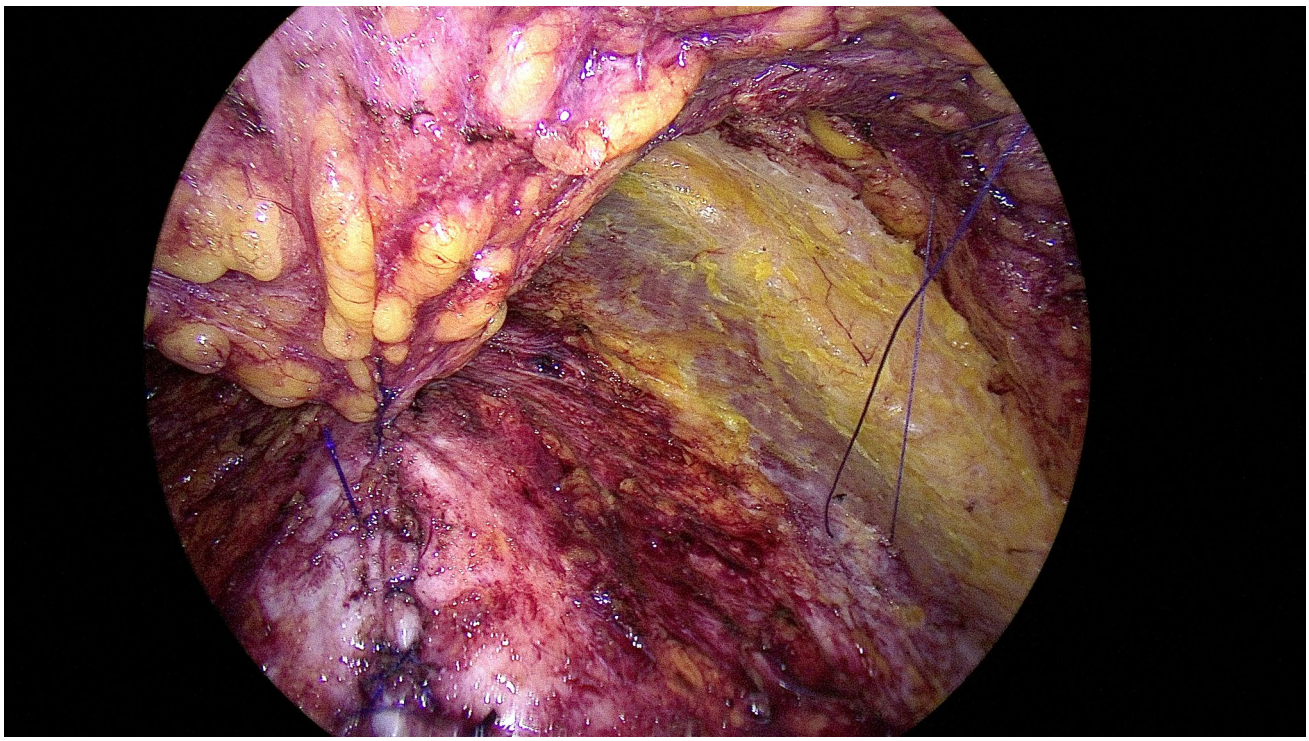

Fig. 3 Quilting, endoscopic view: midline stitches tied and left lateral stitch being placed

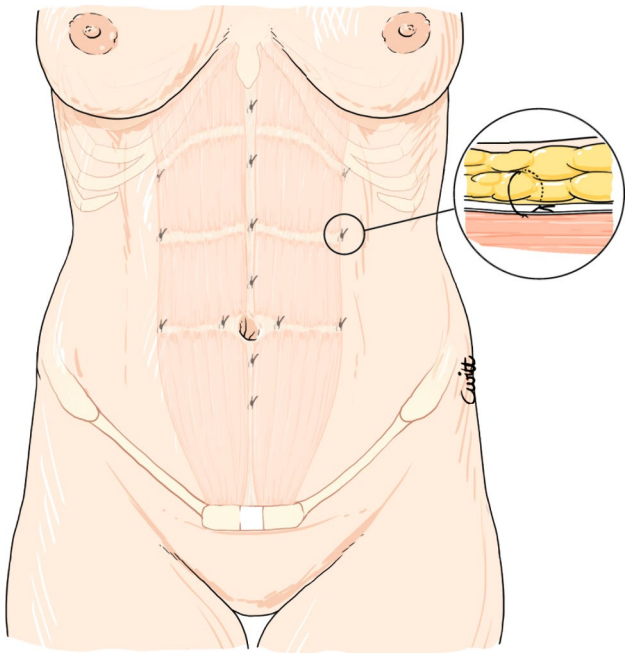

Fig. 4 Positioning of quilting stitches, the two lateral upper stitches (in dotted line) are optional

Collected data

The data collected included patient demographics, history of pregnancies for women, history of parietal surgery (abdominal scar, umbilical scar, liposuction, abdominoplasty), anticoagulant/antiaggregant therapy, VH hernia type and diameter, inter-rectus distance (IRD) at rest and on exertion, type of hospitalization, operation duration, postoperative pain at rest and on exertion assessed by visual analog scale (VAS), paracetamol and Class 2 analgesic consumption, time to resume daily activity and time off work, type of seroma, and other postoperative complications.

Seroma diagnosis and management

Using the above technique, the diagnosis of seroma was easy since fluid collection occurs in the subcutaneous space. Therefore, the diagnosis was made at the first postoperative visit, 8–10 days after the operation, by clinical examination, without resorting to imaging. It was based on the perception of a renitent swelling at clinical examination or a fluid collection that moved depending on the patient's position. It was our policy to drain every significant seroma via needle aspiration. Puncturing and draining are indeed considered advised treatment options in cases of significant fluid accumulation [8]. The puncture was performed by the surgeon at the outpatient visit in a sterile setting, except in the few cases where the surgeon expected spontaneous resorption due to the small volume of the seroma; the decision was left to the surgeon's discretion. Every patient with a seroma was advised to return 10 days later for control. The puncture was reiterated as many times as necessary to speed up adhesion of the pouch walls.

Endpoints

Comparison of the global incidence of seromas and the incidence of Type A and Type B seromas between Group 1 and Group 2 patients.

Statistics

Descriptive and comparison statistics were calculated using the "Statistical Package for Social Sciences" (SPSS) software. For quantitative data, means are presented with their standard errors (SE), which allows direct estimation of their confidence intervals. Comparisons of the means of the quantitative data between Group 1 and Group 2 were drawn by Student's t test, with a risk of 5%. The distributions of qualitative and categorical data were compared between the two groups using the Pearson Chi-square test, with a risk of 5%.

Ethics

The Club Hernie Registry complies with the RGPD and the French *Commission Nationale de l'informatique et des Libertés* (CNIL: MR004 N° 2,212,908), and the present study received an IRB agreement, N° COS-RGDS-2023-06-004, from IRB00010835.

Results

The study was based on the data of 176 consecutive patients categorized into two groups: Group 1 included 102 patients who underwent surgery without quilting (control group) and Group 2 included 74 patients in whom the quilting procedure was applied (interventional group).

The mean age was 43.6 (18–82) years, and the mean BMI was 22.74 (15.94–41.02). The mean hernia diameter was 1.6 cm (1–3). The mean IRDs at rest and on exertion were 6.55 (3–20) cm and 3.85 (2–10) cm, respectively.

The results of the comparisons between the two groups are given in Table 1. The characteristics of the patients included in Group 1 and Group 2 were comparable, except for the IRD at rest, which was significantly greater in Group 2.

The global percentage of seromas was 24.4%. The percentage of seromas of any type was significantly greater in Group 1 (27.5%) than in Group 2 (20.3%). The percentage of Type B seromas was greater in Group 1 (19.6%) than in Group 2 (5.4%), when the percentage of Type A seromas

Table 1 Comparison between Group 1 and Group 2

	Total		Group1		Group2		Significance
Patients: *n* (total %)	176	(100.0)	102	(58.0)	74	(42.0)	
							chi-square
Males: *n* (column %)	24	(13.6)	15	(14.7)	9	(12.2)	NS ($p=0.627$)
Females: *n* (column %)	152	(86.4)	87	(85.3)	65	(87.8)	
							t test
Age: mean (SE)	43.6	(0.8)	44.2	(1.2)	42.8	(1.1)	NS ($p=0.382$)
							t test
BMI: mean (SE)	22.7	(0.3)	22.4	(0.4)	23.3	(0.5)	NS ($p=0.163$)
							chi-square
ASA I: *n* (column %)	146	(83.0)	84	(82.4)	62	(83.8)	NS ($p=0.690$)
ASA II: *n* (column %)	29	(16.5)	17	(16.7)	12	(16.2)	
ASA III: *n* (column %)	1	(0.6)	1	(1.0)	0	(0.0)	
							chi-square
Anticoagulants-antiaggregants: *n* (column %)	10	(5.7)	6	(5.9)	4	(5.4)	N/A*
							chi-square
No pregnancy: *n* (column %)	6	(3.9)	5	(5.7)	1	(1.5)	N/A*
One pregnancy: *n* (column %)	18	(11.8)	10	(11.5)	8	(12.3)	
Two and more pregnancies: *n* (column %)	128	(84.2)	72	(82.8)	56	(86.2)	
							chi-square
Parietal surgery**: *n* (column %)	107	(60.8)	57	(55.9)	50	(67,6)	NS ($p=0.122$)
							chi-square
Umbilical hernia: *n* (column %)	143	(81.2)	82	(80.4)	61	(82.4)	NS ($p=0.846$)
Epigastric hernia: *n* (column %)	9	(5.1)	8	(7.8)	1	(1.4)	N/A*
Combined hernia: *n* (column %)	17	(9.7)	9	(8.8)	8	(10.8)	NS ($p=0.797$)
Trocar site hernia: *n* (column %)	4	(2.3)	1	(1.0)	3	(4.1)	N/A*
No hernia: n (column %)	3	(1.7)	2	(2.0)	1	(1.4)	N/A*
							t test
Hernia diameter (cm): mean (SE)	1.62	(0.04)	1.60	(0.06)	1.67	(0.06)	NS ($p=0.431$)
IRD at rest (cm): mean (SE)	6.55	(0.20)	5.93	(0.23)	7.39	(0.33)	$p=0.001$
IRD at exertion (cm): mean (SE)	3.85	(0.10)	3.78	(0.12)	3.94	(0.17)	NS ($p=0.419$)
							chi-square
Day surgery: *n* (column %)	158	(89.8)	88	(86.3)	70	(94.6)	NS (0.082)
Overnight stay: *n* (column %)	18	(10.2)	14	(13.7)	4	(5.4)	NS (0.082)
Unprogrammed hospitalization: *n* (column %)	9	(5.1)	1	(1.0)	8	(10.8)	N/A*
							t test
Operation duration (mn): mean (SE)	72.3	(1.5)	69.9	(1.1)	83.9	(2.6)	$p=0.001$
							t test
Pain at rest (EVA): mean (SE)	1.50	(0.11)	1.25	(0.13)	1.85	(0.18)	$p=0.005$
Pain on exertion (EVA): mean (SE)	3.50	(0.14)	3.18	(0.18)	3.95	(0.21)	$p=0.007$
							t test
Paracetamol consumption (days): mean (SE)			3.21	(0.27)	4.03	(0.25)	$p=0.029$
Class 2 analgesics consumption (days): mean (SE)			1.93	(0.26)	1.99	(0.23)	NS ($p=0.852$)
							t test
Resume daily activity (days): mean (SE)	2.28	(0.12)	2.18	(0.16)	2.41	(0.20)	NS ($p=0.367$)
Time off work (days): mean (SE)	9.89	(0.54)	9.96	(0.75)	9.82	(0.79)	NS ($p=0.898$)
							chi-square
No seroma: *n* (column %)	133	(75.6)	74	(72.5)	59	(79.7)	$p=0.014$
Seroma Total: *n* (column %)	43	(24.4)	28	(27.5)	15	(20.3)	
Seroma Type A: *n* (column %)	19	(10.8)	8	(7.9)	11	(14.9)	
Seroma Type B: *n* (column %)	24	(13.6)	20	(19.6)	4	(5.4)	

**NA* non-advisable due to small numbers

**Abdominal scar, umbilical scar, liposuction, and abdominoplasty

was greater in Group 2 (14.9) than in Group 1 (7.9%). These differences were significant ($p=0.014$).

The mean operation duration was significantly longer in Group 2 than in Group 1 (83.9 mn vs. 69.9 mn; $p=0.001$). The mean postoperative pain assessed by the VAS was greater in Group 2 than in Group 1 at rest (1.85 vs. 1.25; $p=0.005$) and during exertion (3.95 vs. 3.18; $p=0.007$). Paracetamol consumption was greater in Group 2 than in Group 1 (4.03 vs. 3.21 days; $p=0.029$), but the consumption of Class 2 analgesics was not different.

The time to resume daily activities and the time off work were not significantly different.

Two postoperative hematomas, one in each group, were drained by needle puncture. Four complicated cases requiring reoperation (included in Type B) were observed in Group 1: three cases of persistent seroma treated by surgical drainage under general anesthesia and one case of encapsulation in a patient who missed postoperative visits because of COVID-19 containment measures.

Only 14 patients (8%) did not attend the 3-month medical visit. Among the 162 patients (92%) who were observed, there were no seromas and one residual hematoma that was punctured (100 mL). This patient was one of the two patients who had a hematoma drained by puncture at the postoperative visit.

Discussion

The results suggest that the quilting procedure adapted to the endoscopic-assisted suturing technique for the repair of concomitant VH and DR can minimize the global incidence of seromas and the incidence of cases that require two or more punctures as well as complicated cases requiring surgical intervention (Type B). Conversely, there were more Type A seromas (spontaneously resorbable and requiring a single puncture) in the quilting group than in the control group. In other words, in addition to minimizing the global incidence of seromas, quilting results in a shift from severe cases to mild cases. Moreover, it should be noted that the four patients with complications who required reoperation were all included in Group 1.

In patients who underwent the quilting procedure, the operation duration was significantly longer (83.9 mn vs. 69.9 mn; $p=0.001$), postoperative pain assessed by the VAS score was greater, and the duration of consumption of paracetamol (but not Class 2 analgesics) was longer.

However, although the differences were statistically significant, they may not be considered clinically relevant due to the low level of pain in both groups at rest (1.85 vs. 1.25), with exertion (3.95 vs. 3.18), as well as the low paracetamol consumption (4.03 vs. 3.21 days).

The differences between the two groups in the time to resume daily activity and the time off from work, as well as the type of hospitalization, were indeed not significantly different, which means that adding the quilting procedure does not truly impact patient comfort.

The incidence of seroma formation varies considerably across studies. With the use of endoscopic-assisted and totally endoscopic techniques for DR correction via a subcutaneous approach, the incidence of seroma formation varied from 2.5 to 28.6% [7, 9–13] and even 81% in one study [14]. These large differences between similar techniques suggest that different teams do not talk about the same things. In fact, a systematic review of the incidence of seroma after ventral hernia repair revealed a difference between "significant seromas," which represent actual complications, and "incidental seromas," which disappear spontaneously [15]. According to the first Italian Consensus Conference on Laparoscopic ventral incisional hernia repair, only cases that are clinically evident and persist for more than 2 months meet the definition of seroma [16]. According to Dey, seromas should be considered complications only if they need any type of intervention [17]. In our study, all types of seromas were considered, from simple spontaneous resolution cases to complicated cases requiring reoperation, thus providing a realistic overview of this issue.

Different methods of seroma prevention following abdominoplasty have been proposed.

Drains have been used for a long time, but they are a cause of discomfort and pain as well as a risk of septic contamination; they are not well adapted to day-case surgery, and they have not proven effective in all cases, especially as seroma formation can occur 8–10 days after surgery [18]. We do not use drains because we share the same view. The effectiveness of glue has not been proven according to a systematic review [19]. Three methods have been shown to be effective, including preservation of the fascia of Scarpa [8], injection of 12% NaCl in the operative field through drains at the end of the operation to stimulate fibrotic reactions [20] and quilting. Quilting was first described by Baroudi and Ferreira in 1988 [21], and it was subsequently used by many other authors. The method consists of placing stitches between the subcutaneous layer and the aponeurotic layer to obliterate the dead space and avoid shear movements between both anatomic planes. The progressive tension suture (PTS), used for abdominoplasty, is a variant of quilting that has been shown to be effective in a large series [5] as well as in a comparative study [6]. Given the good results provided by quilting in previous publications, we decided to adapt the method to the endoscopic-assisted procedure, and the results of the present study are encouraging. The global number of seromas, as well as their severity, were indeed reduced without any inconvenience except for the slightly longer operation time. Only four complicated cases requiring

reoperation for surgical drainage or decapsulation occurred in the series, and all of these occurred in patients who did not undergo the quilting procedure.

From a technical point of view, when performing quilting, it is important that the number of stitches is sufficient and that the stitches are distributed on the entire surface of the dissection site. In most cases, 6–7 stitches were placed on the midline and 6–8 were placed laterally (Fig. 4). Tying the knots is facilitated by the low pressure of insufflation (4 mmHg) and by pushing down the skin flap with the finger. Although most authors recommend taking only the fascia of Scarpa to prevent dimpling, it is our practice to take full thickness of the subcutaneous tissue while avoiding taking the skin. A dimpling of the skin is usual expected as a result, but it disappears in 1 or 2 months when the absorbable sutures are resorbed. The patients were duly informed of this issue.

We have not applied either of the existing classifications to categorize seromas in this series.

The classification proposed by Morales Conde [22], though very exhaustive, was indeed not well adapted to our practice. For instance, Type 0a indicates "neither clinical nor radiological seroma," in other words, no seroma; Types IIIa, IIIb, and IIIc correspond to patients' complaints that should probably be alleviated by puncture, but in our practice, these types of cases were not observed because our policy is to perform needle aspiration without delay. The classification system proposed by Haskins et al. [23] is excellent for quantifying wound events following VH repair, but it is not well suited for describing different types of seromas.

In the present study, we classified seromas into two groups based on their severity in accordance with the Clavien−Dindo Classification (CDC) [24], considering that the CDC is indeed recognized worldwide, with the number of citations increasing from 1 in 2009 to 524 in 2017 [25]. Seromas that resorbed spontaneously and seromas that required a single puncture were grouped as Type A, corresponding to CDC Grade I (deviation of the normal postoperative course), because we believe that a single puncture simply performed at the surgeon's office at the first postoperative visit, without having to refer the patient to the imaging department, is not severe enough to be included in the same category as cases requiring many visits and punctures as well as cases requiring reoperation, which were included in Type B, corresponding to CDC Grade III (surgical, endoscopic, or radiological intervention). We did not observe any cases corresponding to CDC Grade II (requiring pharmacological treatment) or, fortunately, Grade IV (life-threatening complications), which is a level that would be highly unlikely in this kind of surgery.

A possible limitation of using the surgical technique applied in the series is not linked to the quilting procedure but to the technique of repairing the abdominal wall. The quilting does indeed simply consist of an adjunct aimed at reducing seroma incidence, which can be applied when large subcutaneous dissection is performed. Therefore, it may be expected that this technique is applicable to different endoscopic techniques involving subcutaneous approaches, including prosthetic techniques.

The main weaknesses of the study are its nonrandomized nature, the fact that the numbers of patients in both groups were different and also that the patients were operated on at two consecutive periods of time. Nevertheless, the data were prospectively collected, the global study period was short, the basic technique of repair was the same, and comparisons between both procedures took place during two consecutive periods.

Moreover, there were no significant differences between the groups of patients concerning the type or size of hernia, the type of hospitalization, the number of pregnancies, or the history of surgery on the abdominal wall.

The main strengths of the study are that it was carried out on a continuous series of non-selected consecutive patients operated on with the same technique of repair performed by the same two experienced surgeons and that no patient or seroma was excluded.

Conclusion

The quilting technique, adapted to the endoscopic-assisted bilayer suturing technique for the repair of combined VH and DR, can significantly reduce the incidence and severity of postoperative seromas.

Considering that seroma formation is essentially related to subcutaneous dissection, it may be expected that the endoscopic-assisted quilting procedure might be useful for reducing seroma formation after other types of endoscopic techniques for repairing the abdominal wall involving extended subcutaneous dissection.

Acknowledgements Mrs. Kaoutar Lahjar for secretarial assistance. Mr. Franck Daval for bibliography assistance.

Funding No funding was received for this work.

Declarations

Disclosures Drs Jean-Pierre Cossa, Philippe Ngo, and Dominique Blum have no conflicts of interest to declare. Edouard Pélissier declares a patent agreement with DAVOL that is not related to this work. Dr. Jean-François Gillion declares that he is an expert in DAVOL, Cousin surgery, Intuitive, Medtronic, Microval, and Swing THT but has no relation to this work.

References

1. Kim J, Stevenson TR (2006) Abdominoplasty, liposuction of the flanks, and obesity: analyzing risk factors for seroma formation. Plast Reconstr Surg 117:773–779
2. Signorini FJ, Chamorro ML, Soria MB, Salazar P, Marani M, Obeide L, Rossini A (2023) Preaponeurotic endoscopic repair (REPA) indication in men could be controversial. Hernia 27:431–438
3. Dong CT, Sreeramoju P, Pechman DM, Weithorn D, Camacho D, Malcher F (2021) Subcutaneous onlay endoscopic approach (SCOLA) mesh repair for small midline ventral hernias with diastasis recti: an initial US experience. Surg Endosc 35:6449–6454
4. Jessen ML, Öberg S, Rosenberg J (2021) Surgical techniques for repair of abdominal rectus diastasis: a scoping review. J Plast Surg Hand Surg 55:195–201
5. Pollock T, Pollock H (2004) Progressive tension sutures in abdominoplasty. Clin Plast Surg 31:583–589
6. Alhussini MA, Awad AT, Kholosy HM (2019) Using quilting sutures in decreasing seroma formation after managing large ventral hernias: a comparative study. Hernia 23:717–722
7. Ngo P, Cossa JP, Gueroult S, Pélissier E (2023) Minimally invasive bilayer suturing technique for the repair of concomitant ventral hernias and diastasis recti. Surg Endosc. https://doi.org/10.1007/s00464-023-10034-9
8. van der Sluis N, van Dongen JA, Caris FLS, Wehrens KME, Carrara M, van der Lei B (2023) Does Scarpa's fascia preservation in abdominoplasty reduce seroma? A systematic review. Aesthet Surg J. https://doi.org/10.1093/asj/sjad024
9. Köckerling F, Botsinis MD, Rohde C, Reinpold W (2016) Endoscopic-assisted linea alba reconstruction plus mesh augmentation for treatment of umbilical and/or epigastric hernias and rectus abdominis diastasis—early results. Front Surg 3:27. https://doi.org/10.3389/fsurg.2016.00027
10. Claus CMP, Malcher F, Cavazzola LT, Furtado M, Morrell A, Azevedo M, Meirelles LG, Santos H, Garcia R (2018) Subcutaneous onlay laparoscopic approach (SCOLA) for ventral hernia and rectus abdominis diastasis repair: technical description and initial results. Arq Bras Cir Dig 31:e1399. https://doi.org/10.1590/0102-672020180001e1399
11. Chang CJ (2013) Assessment of videoendoscopy-assisted abdominoplasty for diastasis recti patients. Biomed J 36:252–256
12. Bellido Luque J, Bellido Luque A, Valdivia J, Suarez Gráu JM, Gomez Menchero J, García Moreno J, Guadalajara Jurado J (2015) Totally endoscopic surgery on diastasis recti associated with midline hernias. The advantages of a minimally invasive approach. Prospect Cohort Study Hernia 19:493–501
13. Köhler G, Fischer I, Kaltenböck R, Schrittwieser R (2018) Minimal invasive linea alba reconstruction for the treatment of umbilical and epigastric hernias with coexisting rectus abdominis diastasis. J Laparoendosc Adv Surg Tech A 28:1223–1228
14. Kler A, Wilson P (2020) Total endoscopic-assisted linea alba reconstruction (TESLAR) for treatment of umbilical/paraumbilical hernia and rectus abdominus diastasis is associated with unacceptable persistent seroma formation: a single centre experience. Hernia 24:1379–1385
15. Beckers Perletti L, Spoelders F, Berrevoet F (2022) Association between surgical hernia repair techniques and the incidence of seroma: a systematic review and meta-analysis of randomized controlled trials. Hernia 26:3–15
16. Cuccurullo D, Piccoli M, Agresta F, Magnone S, Corcione F, Stancanelli V, Melotti G (2013) Laparoscopic ventral incisional hernia repair: evidence-based guidelines of the first Italian consensus conference. Hernia 17:557–566
17. Dey A (2022) Should seroma be considered a complication? Hernia 26:377–378
18. Salari N, Fatahi B, Bartina Y, Kazeminia M, Heydari M, Mohammadi M, Hemmati M, Shohaimi S (2021) The global prevalence of seroma after abdominoplasty: a systematic review and meta-analysis. Aesthetic Plast Surg 45:2821–2836
19. Nasr MW, Jabbour SF, Mhawej RI, Elkhoury JS, Sleilati FH (2016) Effect of tissue adhesives on seroma incidence after abdominoplasty: a systematic review and meta-analysis. Aesthet Surg J 36:450–458
20. Dudai M, Gilboa Ittah K (2019) Intraoperative hypertonic saline irrigation preventing seroma formation and reducing drain secretion in extended endoscopic hernia and linea alba reconstruction glue. Hernia 23:1291–1296
21. Baroudi R, Ferreira CA (1998) Seroma: how to avoid it and how to treat it. Aesthet Surg J 18:439–441
22. Morales-Conde S (2012) A new classification for seroma after laparoscopic ventral hernia repair. Hernia 16:261–267
23. Haskins IN, Horne CM, Krpata DM, Prabhu AS, Tastaldi L, Perez AJ, Rosenblatt S, Poulose BK, Rosen MJ (2018) A call for standardization of wound events reporting following ventral hernia repair. Hernia 22:729–736
24. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, de Santibañes E, Pekolj J, Slankamenac K, Bassi C, Graf R, Vonlanthen R, Padbury R, Cameron JL, Makuuchi M (2009) The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg 250:187–196
25. Bolliger M, Kroehnert JA, Molineus F, Kandioler D, Schindl M, Riss P (2018) Experiences with the standardized classification of surgical complications (Clavien-Dindo) in general surgery patients. Eur Surg 50:256–261