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ORIGINAL ARTICLE

Persistent posterior seroma after laparoscopic repair of ventral abdominal wall hernias with expanded polytetrafluoroethylene mesh: prevalence, independent predictors and detached tacks

Retrospective review

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Abstract

Purpose A persistent seroma located posterior to a mesh (PPS) remains a little known complication after laparoscopic ventral hernia repair (LVHR). The aim of this large case series was to analyse the prevalence and clinical course as well as identify related factors and independent predictors of PPS.

Methods All 1288 adult patients who underwent a LVHR with an expanded polytetrafluoroethylene mesh (ePTFE) between January 2003 and July 2014 were reviewed. Those who underwent an abdominal computed tomography (CT) scan more than 3 months afterwards ($n = 166$) were included and their scans were analysed. The primary outcome measure was the prevalence of a PPS and its characteristics. The secondary outcome measures were identification of significantly related factors and independent predictors of PPS.

Results A PPS was observed in 14 of 166 analysed CT scans (8.4%). Eleven patients were symptomatic; conservative treatment (wait-and-see policy) was successful in eight. Three underwent relaparoscopy with removal of a thick neoperitoneum. Several instances of tack and/or mesh detachment were identified on CT scans and during relaparoscopy. Independent predictors were: > 3 trocars (RR 5.0, 95% CI 1.6–15.8) and use of a mesh larger than > 300 cm^2 (RR 9.9, 95% CI 1.9–51.2).

Conclusions A PPS is a relatively common complication after LVHR with an ePTFE mesh of usually larger hernias. A "wait-and-see" approach seems justified in most cases. Some require laparoscopic excision of the thick neoperitoneum. A PPS can cause tack and mesh detachment but the clinical consequences are unclear. Recurrences have not been observed in this series.

Keywords Posterior seroma · Ventral hernia · Laparoscopic repair · Tack detachment

Introduction

A persistent seroma located posterior to a mesh remains a little known complication after laparoscopic ventral hernia repair (LVHR). It has been first described in 2003 by Heniford et al. [1] who defined a persistent posterior seroma (PPS) as "a fluid collection [developed] under the mesh, in association with extensive peel or rind that separated the mesh and underlying fluid from the abdominal contents". Not more than one case series [2] and one case report [3] have addressed a PPS specifically since. More reliable information on early posterior seroma was provided by a recent prospective cohort study limited to the first 3 months postoperatively [4].

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Herein, we present the largest case series of PPS described so far. The aim of this study is to determine its prevalence, identify related factors and independent predictors, and discuss the clinical consequences of this complication. In addition, a novel observation of tack and mesh detachment as a result of PPS has been described.

Materials and methods

The medical records of all 1288 adult patients (≥ 18 years) who underwent a LVHR at a teaching hospital between January 2003 and July 2014 were reviewed. Patients who underwent an abdominal computed tomography (CT) scan more than 3 months after LVHR—for whichever indication—were identified and included in this study.

The primary outcome measure was the prevalence and characteristics of a PPS. A PPS was defined as a fluid collection located at the visceral side of a mesh that is separated from the abdominal contents by a neoperitoneal membrane and lasting beyond 3 months after LVHR.

The secondary outcome measures were identification of significantly related factors as well as independent predictors of a PPS. After reviewing all abdominal CT scans, patients were divided into two groups and compared to each other—the first with PPS and the second without.

The operative technique has previously been described in detail [5]. In all cases, a 1-mm thick expanded polytetrafluoroethylene (ePTFE) mesh (DualMesh™, WL Gore and Associates, Flagstaff, AZ, USA) was used. Fixation was achieved with either a combination of transabdominal sutures (TAS) and tacks or a double crown of tacks. For tacking, nonabsorbable titanium tacks (Protack™, TycoUSS, Norwalk, CT, USA) were used.

The patient characteristics, operative data and postoperative complications of the LVHR cohort were prospectively registered in an electronic database at the moment of presentation. Approval from the institutional review board was not required for this study. The procedure was recorded and representative photographs were taken for all patients with a PPS who underwent subsequent relaparoscopy.

Statistical analyses were performed using the Statistical Package for Social Sciences for Windows, version 20.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were compared by the Chi-square test, and continuous variables were compared using the Mann–Whitney *U* test. A univariate analysis was performed to identify factors significantly related to a PPS. A multivariate analysis (logistic regression) was performed to obtain independent predictors of a PPS. It included all factors likely to influence development of a PPS with a univariate $P \leq 0.10$. A P value ≤ 0.05 was considered statistically significant.

Results

A total of 166 patients were identified who underwent an abdominal CT scan more than 3 months [median 15 months, interquartile range (IQR) 26, range 3–121 months] after LVHR. The indication for a CT scan was LVHR-related in 122 patients. They presented with swelling, pain or both. Other indications ($n = 44$) were related to gastro-intestinal oncology, abdominal aorta reconstruction, urology, gynaecology and others.

In fourteen patients (8.4%), a PPS was detected on a CT scan after LVHR (median 6 months, IQR 7, range 4–18 months). On average, the anteroposterior thickness of a PPS as measured on an axial CT scan was 36 mm (range 11–131 mm). In two patients (14%), a PPS was accompanied with a ventral seroma. In six patients (43%), several tacks were detached from the abdominal wall and the mesh. No radiological recurrences were observed in conjunction with PPS. Median followup was 11 months (IQR 13, range 9–55).

Three of the 14 patients were asymptomatic. Eleven patients were symptomatic and had complaints of pain, swelling or both. Conservative treatment—wait-and-see policy together with analgesia—was successful in eight patients in whom physical complaints resolved spontaneously within a few months upon detection (mean 3 ± 2, range 2–5 months). Percutaneous drainage was not considered as a treatment option. Three patients retained physical complaints and they underwent relaparoscopy.

During relaparoscopy, the PPS was covered by a thick neoperitoneum that resembled a "pseudocystic wall". After opening the thick neoperitoneum and aspirating clear fluid, introduction of the camera allowed unhindered inspection of the mesh and the neoperitoneum from the inside. Two types of tack detachment were observed. First, tacks were detached from the mesh but held firmly in the thick neoperitoneum (Fig. 1). The imprint of their previous position in the mesh remained visible. The tacks that were detached from the inner ring were consistent with those visibly detached on the CT scan. The tacks that were detached from the outer ring at the very edge of the mesh were not distinctly visible as detached on the CT scan. Second, the periphery of the mesh was detached from the abdominal wall with the tack still attached to the mesh itself (Fig. 2). Also this type of detachment can be difficult to recognise on a CT scan. In general, there were always more tacks detached than was apparent beforehand on a CT scan. In rough estimation, the proportion of detached tacks was 5–10% of their total number. Regardless, there were no recurrences observed during the relaparoscopies. The thick neoperitoneum was excised and histological examination mostly showed lymphoid and collagen tissue

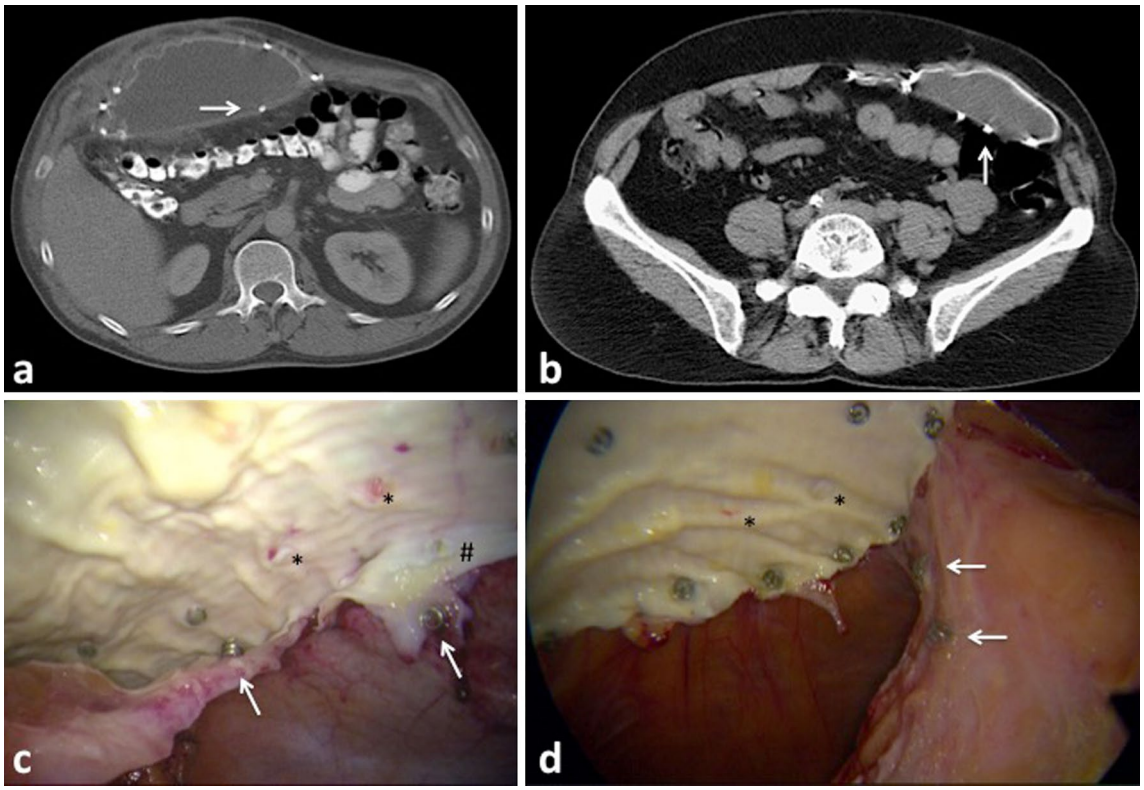

Fig. 1 **a**, **b** Loose tacks from the inner ring as seen on a CT scan (arrows). **c**, **d** Tacks still held firmly in the thick neoperitoneum (arrows). Their imprint on the mesh was still seen at the inner ring (asterisk) as well as the outer ring (hash symbol)

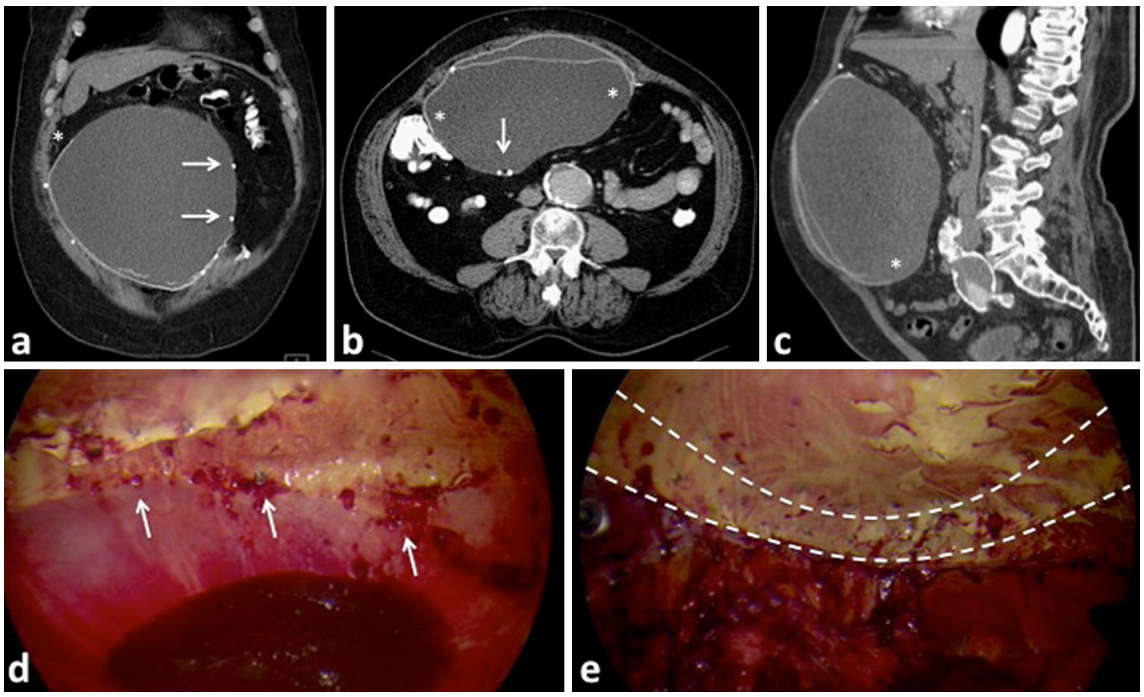

Fig. 2 Posterior seroma in one single patient presented on an abdominal CT scan and during relaparoscopy. **a**–**c** Different cross sections with loose tacks (arrows) and loose periphery of the mesh (asterisk). **d** View from inside the posterior seroma with the thick neoperitoneum still attached to the circumference of the mesh. Several detached tacks can be seen (arrows). **e** Detachment of the periphery of the mesh from the abdominal wall (in between dotted lines)

resembling a foreign body reaction. Recovery was uneventful in all three patients and they remained pain-free thereafter. No posterior seroma recurrences were detected in this small group.

Patient- and surgical-specific factors of both groups are presented in Table 1. A univariate analysis identified five significant factors related to a PPS and which were subjected to a multivariate analysis (Table 2). Two independent predictors of PPS were found: the use of > 3 trocars (RR 5.0, 95% CI 1.6–15.8) and the use of a mesh larger than > 300 cm^2 (RR 9.9, 95% CI 1.9–51.2).

Discussion

Recently, Morales-Conde et al. [4] investigated early posterior seroma in a prospective case series of 50 patients who underwent a CT scan at 1 week, and 1 and 3 months after LVHR. They reported an incidence of 44, 33 and 16%, respectively. The clinical evolution beyond 3 months of an early posterior seroma into a PPS was not described.

Reported prevalence of PPS in the literature ranges from 0.35% ($n = 3/850$) [1] to 1.3% ($n = 6/442$) [2]. In both studies, only patients who returned with symptoms such as swelling and pain were investigated and it remains unknown how many cases of asymptomatic PPS went unnoticed.

The estimated prevalence of PPS observed in this series (8.4%) was much higher than previously estimated but it is not surprising since Morales-Conde et al. [4] detected a posterior seroma in 16% of patients at 3 months after surgery. However, the influence of a selection bias in this series cannot be excluded: it remains unknown how many cases of PPS remained unnoticed in those who had no CT scan after LVHR.

The ePTFE mesh and titanium tacks were easily distinguished on all CT scans regardless of study protocol [6]. The unique radiopaque feature of mesh and tacks simplified the identification of a PPS and has made it unlikely that a PPS has been missed during the review of CT scans. This radiopaque feature also proved useful in detecting the detachment of tacks from the mesh as well as detachment of the mesh from the abdominal wall itself.

Whether a PPS is exclusively related to ePTFE meshes remains unclear but it seems probable. There seems to be an association between the two and we could not find a comparative group with a different type of mesh. With the anecdotal exception of two single cases, all the reported cases of PPS in the literature and in this study occurred after implantation of ePTFE meshes [1, 2, 4]. In a single case, O'Brien et al. described a fluid collection located posterior to a biologic implant (Permacol™, Covidien, Mansfield, MA, USA) 23 months after LVHR [7]. However, it is questionable whether it was a case of a PPS because the authors used the terms "hematoma" and "bursa". In another single case, Tseretelli et al. briefly mentioned a posterior seroma formation after implantation of a hydrophilic mesh (Parietex Composite™, Covidien, New Haven, CT, USA) without commenting on the time frame of the complication or describing the CT scan characteristics after LVHR with this radiotransparent mesh [2]. Remarkably, a recent cohort study reporting the long-term outcomes of 1326 patients after LVHR with the same hydrophilic mesh does not mention the occurrence of a PPS at all [8].

There are several possible explanations for the possibly exclusive association of PPS with ePTFE meshes. First, the ePTFE mesh seems to be predestined for the development of a PPS due to its non-porous mesh construction. All other currently used meshes (e.g. polypropylene and polyester) have a knitted mesh structure.

The secretory properties of the neoperitoneum are modulated by a local inflammatory response to the ePTFE mesh. Interestingly, the inflammatory response is more pronounced with polypropylene and polyester meshes which have not shown an association with PPS so far [9]. This might indicate that another characteristic of ePTFE mesh, such as its structure, plays an important role. Unlike the woven or

Table 1 Patient- and surgical-specific factors

Variable	Posterior seroma ($n = 14$; 8%)	No posterior seroma ($n = 152$; 92%)	*P* value
Gender			
Male	8 (57%)	90 (59%)	0.88
Female	6 (43%)	62 (41%)	
Mean age, years ± SD	55.10 ± 11.86	56.48 ± 14.45	0.73
ASA, mean ± SD	1.86 ± 0.77	1.86 ± 0.69	0.98
Trocars, mean ± SD	3.71 ± 1.20	3.11 ± 0.83	0.006
Hernia size (cm^2), mean ± SD	69 ± 73	24 ± 36	0.004
Mesh size (cm^2), mean ± SD	504 ± 171	368 ± 257	0.016
Length of procedure, min, mean ± SD	86 ± 40	74 ± 50	0.10

SD standard deviation, *ASA* American Society of Anaesthesiologists

Table 2 Univariate and multivariate analysis of predictive factors of postoperative seroma

Variable	Seroma		UV *P*	MV *P*	RR (95% CI)
	Yes, *N* = 14	No, *N* = 152			
Patient factors					
Gender					
Male	8 (57%)	90 (59%)	0.88	–	–
Female	6 (43%)	62 (41%)			
Age at operation					
≤ 50 years	5 (33%)	50 (33%)	0.84	–	–
> 50 years	9 (67%)	102 (67%)			
ASA score					
1–2	11 (79%)	125 (82%)	0.73	–	–
3	3 (21%)	27 (18%)			
Incisional hernia					
Yes	11 (79%)	96 (63%)	0.25	–	–
No	3 (21%)	56 (37%)			
Operative factors					
Number of trocars					
≤ 3	7 (50%)	128 (84%)	0.003*	0.006	5.0 (1.6–15.8)
> 3	7 (50%)	24 (16%)			
Hernia size					
≤ 15 cm^2	2 (14%)	94 (62%)	0.003*	NS	–
> 15 cm^2	12 (86%)	58 (38%)			
Mesh size					
≤ 300 cm^2	2 (14%)	90 (59%)	0.002*	0.006	9.9 (1.9–51.2)
> 300 cm^2	12 (86%)	62 (41%)			
Adhesiolysis					
Yes	11 (79%)	90 (59%)	0.15	–	–
No	3 (21%)	62 (41%)			
Operation time					
≤ 50 min	1 (7%)	55 (36%)	0.03*	NS	–
> 50 min	13 (93%)	97 (64%)			
Current operation for hernia recurrence					
Yes	4 (29%)	7 (5%)	0.001*	NS	–
No	10 (71%)	145 (95%)			

UV univariate, *MV* multivariate, *RR* risk ratio, *CI* confidence interval, *ASA* American Society of Anaesthesiologists

*Factors entered in logistic regression model

knitted characteristics of other meshes, ePTFE is a single seamless structure. Despite being microporous, ePTFE has a low friction coefficient making its surface smooth and hydrophobic. Whereas the neoperitoneum paving over the ePTFE mesh is attached firmly to the tacks and the edges of the mesh, it is very loosely attached to the smooth surface of the mesh [10]. Actively secreted fluid by the neoperitoneum has a potential to separate itself from the ePTFE mesh and thus create a posterior seroma. All other meshes (e.g. polypropylene and polyester) are knitted and are embedded with strong interlinking connective tissue through the mesh pores, possibly making separation of the neoperitoneum from the mesh less likely [9].

Several factors seem to influence the occurrence of a PPS after implantation of ePTFE meshes. The results of the statistical analyses indicate that laparoscopic repair of larger ventral hernias carries a higher risk for the development of a PPS. Larger hernias require the utilisation of more resources such as a larger mesh, approach from both sides of the abdomen with more trocars, and a longer procedure. Two independent predictors of PPS were identified; the use of > 3 trocars (RR 5.0, 95% CI 1.6–15.8) and the use of a mesh larger than > 300 cm^2 (RR 9.9, 95% CI 1.9–51.2).

Based on these observations, a PPS could cause two types of detachment, a phenomenon described in this report for the first time. First, tacks may become detached from the mesh,

which remains attached to the abdominal wall. Second, the periphery of the mesh—together with the tacks—may become detached from the abdominal wall itself. Although technically inappropriately placed tacks at the initial LVHR cannot be completely excluded, other mechanisms seem to be more probable. The accumulation of actively secreted serous fluid between the thick neoperitoneum and the mesh creates a rise of hydrostatic pressure inside that closed space. This force acts in all directions and separates the thick neoperitoneum and the mesh from each other. This process progresses gradually from a plate-like seroma into a spherical seroma (Fig. 3). It can be assumed that during this transition a tack may become detached if the strength of the attachment in the thick neoperitoneum exceeds that of the connection with the mesh and with underlying abdominal wall. At a later stage, this process increases detachment forces of tacks at the periphery of the mesh where the thick neoperitoneum is more firmly attached than elsewhere and may pull the edge of the mesh away from the abdominal wall.

A median followup period of 11 months was not long enough for a meaningful calculation of recurrence rate after LVHR. Nonetheless, in those cases with tack detachment no recurrences were observed. It might well be that the mesh becomes sufficiently incorporated at the abdominal wall side earlier than a PPS develops and eventual detachment takes place. Also, the increasing hydrostatic pressure induced by the PPS might on the one hand have a tendency to detach the very edges of the mesh and some of its tacks, but on the other hand it also pushes the rest of the mesh towards the abdominal wall and in that way prevents the occurrence of a recurrence.

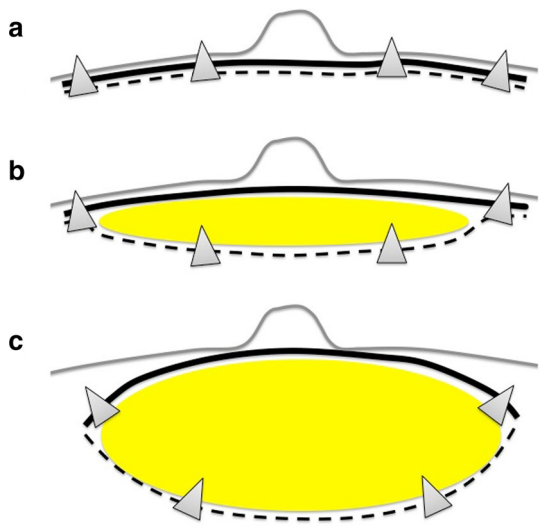

Fig. 3 **a** Normal situation, **b** plate-like posterior seroma with inner circle tacks detached, **c** spherical posterior seroma with also the periphery of the mesh with tacks detached. Peritoneum (grey line). Mesh (black line). Thick neoperitoneum (dotted line). Tack (triangle). Posterior seroma (yellow sphere)

It remains unclear in what way mesh shrinkage influenced tack detachment after LVHR. The little available clinical literature on mesh shrinkage after LVHR report low contraction rates and no instances of tack detachment [11–14]. However, its role could not be ruled out.

Asymptomatic patients are likely to stay asymptomatic. In those with minimal symptoms, a "wait-and-see" policy proved to be appropriate in this series. This policy is in accordance with the proposed treatment guidelines of Tseretelli et al. [2].

Percutaneous drainage was not considered as a treatment option for two reasons. First, it carries the risk of infection of the mesh. Second, it does not offer a definitive solution for the fluid would most likely accumulate again after percutaneous drainage. Percutaneous drainage of a posterior seroma failed in all attempts according to two studies [1, 2].

Surgical treatment was indicated in approximately 21% of cases due to persisting and/or progressive symptoms. In those cases, an extensive laparoscopic excision (deroofing) of the thick neoperitoneal membrane provided definitive treatment of PPS. Tsereteli et al. reported that > 50% of patients with a PPS required surgical treatment [2]. The probable explanation for this difference is that latter study included only patients who returned with significant symptoms related to PPS and did not include asymptomatic cases of PPS.

A PPS seems to be a relatively frequent complication after laparoscopic repair of usually larger ventral hernias with ePTFE meshes. An initial wait-and-see policy seems justified. A subset of symptomatic patients may require laparoscopic excision of the thick neoperitoneum that provides a good outcome. That PPS causes detachment of a significant number of tacks and the periphery of the mesh itself is a novel observation and has been described here for the first time. Clinical consequences of this phenomenon are not completely clear but recurrences have not been observed in this series.

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Compliance with ethical standards

Conflict of interest VS declares no conflict of interest. RH declares no conflict of interest. JR declares no conflict of interest. SR declares no conflict of interest.

Ethical approval Approval from the institutional review board was not required for this study.

Human and animal rights This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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