ELSEVIER

JMIG The Journal of Minimally Invasive Gynecology

Original Article

Assessment of Synthetic Glue for Mesh Attachment in Laparoscopic Sacrocolpopexy: A Prospective Multicenter Pilot Study

Gery Lamblin, MD*, Gil Dubernard, MD, PhD, Pierre de Saint Hilaire, MD, Franck Jacquot, MD, Philippe Chabert, MD, Gautier Chene, MD, PhD, and François Golfier, MD, PhD

From Hôpital Femme Mère Enfant, Service de Chirurgie Urogynécologique, Lyon-Bron, France (Drs. Lamblin, Chabert, and Chene), Hôpital de la Croix Rousse, Service de Chirurgie Gynécologique, Lyon, France (Drs. Dubernard and Hilaire), and Centre Hospitalier Lyon Sud, Service de Chirurgie Gynécologique, Pierre Bénite, France (Drs. Jacquot and Golfier).

ABSTRACT **Study Objective:** To assess the anatomic efficacy and safety of synthetic glue to fix prosthetic material in laparoscopic sacrocolpopexy.

Design: A 1-year follow-up in a prospective multicenter pilot study between November 2013 and November 2014 (Canadian Task Force Classification II-2).

Setting: An academic urogynecology research hospital.

Patients: Seventy consecutive patients with Pelvic Organ Prolapse Quantification stage ≥ 3 anterior and/or medial prolapse underwent laparoscopic sacrocolpopexy.

Interventions: All women underwent laparoscopic sacrocolpopexy with the same standardized technique using a synthetic surgical glue to fix anterior and posterior meshes.

Measurements and Main Results: Patients were followed up at 1 month and 1 year, with anatomic and functional assessment (Pelvic Floor Distress Inventory-20, Pelvic Floor Impact Questionnaire-7, and Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire-12). Anatomic success was defined as 1-year Pelvic Organ Prolapse Quantification stage ≤ 1. Sixty-six patients were included; the mean age was 56.7 $\pm$ 1.2 years. The mean operative time was 145 $\pm$ 5 minutes. The mean glue fixation time was less than 2 minutes for both anterior and posterior meshes. The 1-year anatomic success rate was 87.5% in the anterior compartment (Ba at -2.3 cm, $p < .0001$) and 95.3% in the medial compartment (point C at -6.1 cm, $p < .0001$). There were no intra- or postoperative complications and no cases of mesh exposure; 5 cases of mesh shrinkage (7.8%) were observed at 1 year. The postoperative urinary stress incontinence rate was 29.7% at 1 year. Eight patients (12.1%) underwent revision surgery with transobturator tape. All quality of life scores showed significant improvement ($p < .0001$) at 1 year.

Conclusion: Synthetic glue attachment of prosthetic material in laparoscopic sacrocolpopexy proved straightforward, safe, time-saving, and effective at 1 year. Prospective randomized studies will be needed to confirm the long-term benefit. Journal of Minimally Invasive Gynecology (2017) 24, 41–47 © 2016 AAGL. All rights reserved.

Keywords: Cyanoacrylate; Laparoscopic sacrocolpopexy; Pelvic organ prolapse; Vaginal prosthetic glue

Genital prolapse affects 1 in 3 women of all ages and more than 60% of women aged over 60 years. It has a negative impact on quality of life [1,2]. Between 11% and 20% of women undergo prolapse surgery with a procedure that is effective and reproducible [3]. Laparoscopic or laparotomic sacrocolpopexy is presently the reference treatment for the correction of medial compartment prolapse [4,5], allowing lower dissection and more precise mesh attachment. Its limitations comprise an indispensable learning curve (15–30 procedures) to master suturing and laparoscopic dissection and a longer operative time compared with prosthetic reinforcement using a vaginal approach [6–8].

Synthetic surgical glue is already used to repair parietal hernia and shows results comparable with those of suture or staple fixation [9]. Application to laparoscopic sacrocolpopexy should simplify and optimize the procedure by reducing the suture time and thus the overall operative

Dr. Lamblin declares an interest in Peters Surgical (France), which provided the IFABond synthetic glue for the study.

Corresponding author: Gery Lamblin, MD, Department of Urogynecology, Femme Mère Enfant University Hospital, 59 Boulevard Pinel, 69677 Lyon-Bron, France.
E-mail: gery.lamblin@chu-lyon.fr

Submitted July 26, 2016. Accepted for publication October 19, 2016.
Available at www.sciencedirect.com and www.jmig.org

1553-4650/$ - see front matter © 2016 AAGL. All rights reserved.
http://dx.doi.org/10.1016/j.jmig.2016.10.008

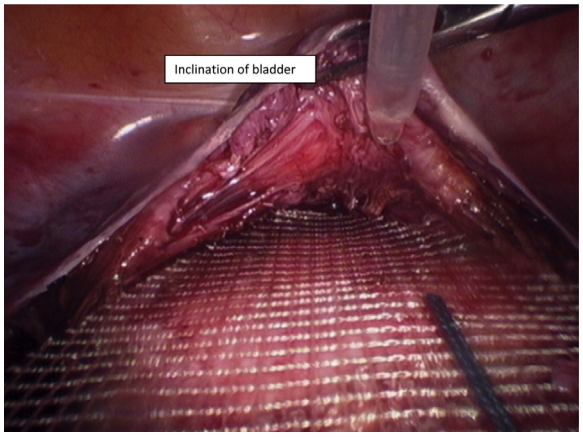
time. The main objective of the present pilot study was to assess 1-year anatomic success in laparoscopic sacrocolpopexy using synthetic tissue glue for mesh attachment. Secondary objectives were to assess 1-year functional results on quality of life, sexuality scores (Pelvic Floor Distress Inventory-20 [PFDI-20], Pelvic Floor Impact Questionnaire-7 [PFIQ-7], and Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire-12 [PISQ-12]), rates of complications (infection, erosion, and mesh shrinkage), and postoperative urinary stress incontinence.

Materials and Methods

A prospective multicenter study was performed between November 2013 and November 2014 in 3 University Urogynecology Centers: Hôpital Femme Mère Enfant, Centre Hospitalier Lyon Sud, and Hôpital de la Croix Rousse (all Hospices Civils de Lyon, France). The protocol was approved by the regional Institutional Review Board (Comité de Protection des Personnes Sud Est VI, Clermont Ferrand, France). The protocol was registered in the ClinicalTrials.gov registry under the following identifier: NCT02011373. All patients signed informed consent forms. The study data file was registered with the Commission Nationale de l'Informatique et des Libertés data protection commission. Seventy consecutive patients with Pelvic Organ Prolapse Quantification (POP-Q) stage ≥ 3 anterior and/or medial prolapse were eligible (Fig. 1). Exclusion criteria were POP-Q stage <3, an asymptomatic patient, previous total hysterectomy, pregnancy or pregnancy project during the study period, pelvic cancer or history of pelvic radiation therapy, and known cyanoacrylate hypersensitivity. Data were digitized and processed anonymously and confidentially. All patients underwent laparoscopic sacrocolpopexy with the same standardized technique in all 3 centers, with 2 gynecologic surgeons experienced in advanced laparoscopic surgery (more than 30 total laparoscopic hysterectomies) per center, using the same type of polyester mesh. IFABond synthetic surgical glue (Peters Surgical, Bobigny Cedex, France) was used in all cases following the same fixation procedure. Fixation time was assessed on 32 cases in the principal investigation center (Hôpital Femme Mère Enfant). Anatomic assessment was performed at 1 month and 1 year using the POP-Q terminology of the International Continence Society; concomitant quality of life assessment used the PFDI-20, PFIQ-7, and PISQ-12 questionnaires. Mesh shrinkage was defined as retraction of the stretched implant assessed on palpation during clinical examination according to the International Urogynecological Association classification [10].

Fig. 1

The anterior mesh glue fixation technique.



Surgical Technique

All patients underwent laparoscopic sacrocolpopexy with the same standardized technique in all 3 centers; all received anterior and posterior meshes using the same material—precut knitted polyester (Parietex; Covidien, Mansfield, MA). Second-generation cephalosporin antibiotic therapy was administered at the start of surgery. Three trocars (two 5 mm and one 10 mm) were positioned under visual control. The vagina was exposed using a rectangular vaginal valve held by an assistant. The first step of dissection consisted of posterior peritoneal opening, with access to the pouch of Douglas within the uterosacral ligament via an inverted U-shaped incision separating the rectum and vagina; dissection was continued up to the levator ani muscle on either side and down to the lower rectum. Glue was applied using a dedicated applicator (Fig. 1). A single 1.5-mL vial was enough for each procedure; a single droplet of about 0.2 mL was required at each anchorage. The posterior mesh was anchored as laterally as possible to the levator ani muscles to avoid tying the lower rectum and then laid without tension over the vaginal wall. The bladder and vagina were then separated within the vesicovaginal pillars until the collagen fiber was exposed at the vesical trigone. The anterior mesh was glued over the whole surface of the vagina and then fixed to the uterine isthmus with a single nonresorbable suture (Mersuture; Ethicon, Cincinnati, OH) and brought into the subperitoneal space via the parametrium. Only the anterior mesh was fixed to the anterior vertebral ligament of the promontory by a nonabsorbable suture (Mersuture, Ethicon). The 2 meshes were held entirely subperitoneally by a continuous absorbable suture (Vicryl 00; Johnson and Johnson, Cincinnati, OH) between the prerectal and retroisthmic peritoneum posteriorly and the vesical and preisthmic peritoneum anteriorly. Vaginal palpation was performed systematically at the end of surgery. Operative time was measured from incision to closure in a sample of 32 patients.

Physical and Chemical Properties of the Tissue Glue

IFABond synthetic solution is a liquid, translucent, nontoxic cyanoacrylate (patent: Fimed SAS; CE label, class

III). IFABond glue is approved for internal use. This sterile tissue adhesive has low viscosity (around 12 cP) and is composed of a cyanoacrylate monomer (alkyl group: n-hexyl) and traces of radicular and anionic stabilizers; it is sterilized by beta radiation. On application on living tissue, it quickly polymerizes into flexible adhesive poly n-hexyl-cyanoacrylate. During polymerization, the cyano group forms hydrogen bonds with proteins. Polymer degradation is enzymatic by hydrolysis with formation of formaldehyde, hexanol, and cyanoacetic acid at a speed inversely proportional to the length of the chain. Mesh attachment is based on very fine, drop-by-drop application of the glue (Fig. 1). In an animal model, wall reinforcement integrated tissue faster when glued than when sutured [11]. Tissue formation by cell colonization, enabling the reinforcement to be integrated, takes places around the glue fixation points [12]. Bellón et al [12], in a rabbit model, found a significantly increased macrophage count between 14 and 90 days after polytetrafluoroethylene reinforcement fixation using IFABond glue. Likewise, the inflammatory cell response (lymphocytes and plasma cells) at 2 weeks was significantly greater with IFABond than staples in a sheep model [13]. Also, the apoptotic cell count at 90 days was significantly higher with IFABond than with an octyl cyanoacrylate. All this contributed to significantly stronger fixation at 14 and 90 days with IFABond [12]. The inflammatory reaction induced by the fixation method plus the wall reinforcement contribute to good mesh anchorage without vaginal ulceration [14].

Statistical Analysis

Statistical analysis was performed using SAS statistical software (SAS 9.3; SAS Institute Inc, Cary, NC). Continuous quantitative data were described by mean and standard deviation and qualitative data by number and percentage. Comparison between preoperative and follow-up values was performed using the McNemar test, and the Student *t* test was used for matched variables. A p value $<.05$ indicated statistical significance.

Results

Seventy patients were eligible for the study, 66 of whom were included for analysis. The 4 exclusions concerned 1 case of surgical conversion for a small intestinal wound during positioning of the umbilical trocar, 2 withdrawals of consent, and 1 patient who did not undergo the operation. Sixty-six patients were reviewed at 1 month and 64 at 12 months. All patients presented with primary POP-Q stage $\geq$3 genital prolapse (75.8% stage 3 and 24.2% stage 4). Concomitant subtotal hysterectomy was performed in 19.7% of cases (13 patients), bilateral adnexectomy in 29 patients (43.9%), and bilateral salpingectomy in 37 patients (56.1%) (Table 1); 30.3% of patients (n = 20) showed preoperative urinary stress incontinence including 5 grade 3.

Table 1

Baseline characteristics of patients and perioperative outcomes (n = 66)

Age	56.7 ± 1.2
Parity	2.6 ± 0.2
Number of vaginal deliveries	2.6 ± 0.2
Body mass index	25.4 ± 0.5
Menopause	47 (71.2%)
History of hysterectomy	0
Urinary incontinence surgery	6 (9.1%)
Urinary stress incontinence	20 (30.3%)
Grade I	8
Grade II	7
Grade III	5
Urinary incontinence by instability	9 (13.6%)
Dysuria	24 (36.4%)
Preoperative UDA	55 (83.3%)
Mean closure pressure (cm H_2O)	73.2 ± 5.1
Maximum flow (mL/s)	22.2 ± 1.3
Dyschezia	7 (10.6%)
Prolapse stage*	
Stage III	50 (75.8%)
Stage IV	16 (24.2%)
Straightforward gluing	65 (98.5%)
Operative time (min)	145 ± 5
Subtotal hysterectomy	13 (19.7%)
Bilateral salpingectomy	37 (56.1%)
Transobturator tape	10 (15.1%)
Organ lesion	0
Fever ($\geq$38°C)	1 (1.5%)
Hemorrhage	0
Urinary infection	2 (3.0%)
Pelvic infection	0
D-1 visual analog scale pain scale	1.8 ± 0.2
Hospital stay (days)	3.4 ± 0.2

UDA = urodynamic assessment.

Data are mean (±standard deviation) or n (%).

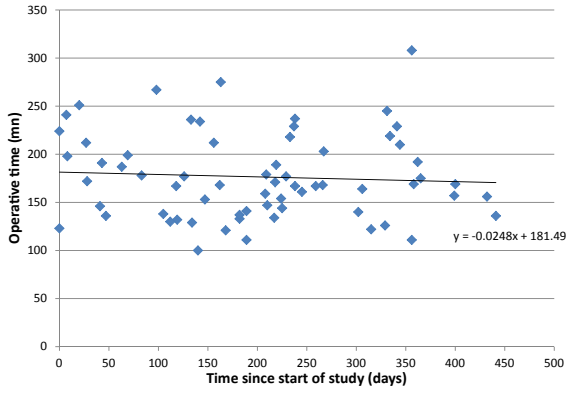
* Prolapse classification was determined using Pelvic Organ Prolapse Quantification.

Most (83.3%) had had preoperative urodynamic workup; none showed sphincter failure. A transobturator tape was associated in 10 cases (15.1%) (Table 1).

Gluing was straightforward in 65 cases (98.5%) and difficult in 1 because of problems of levator ani access. The mean surgery time was 145 ± 5 minutes, including all associated procedures (subtotal hysterectomy, bilateral adnexectomy, and salpingectomy). The mean glue application time was less than 2 minutes for both the anterior and posterior meshes (ranges, 1 minute 20 seconds–2 minutes 30 seconds and 1 minute 40 seconds–2 minutes 50 seconds, respectively). The leading coefficient of the trend line ($\alpha = -0.0248$) indicated that operators decreased 10 minutes of operative time with 12 months of practice (Fig. 2). The urinary probe time was 24 hours. The mean hospital stay was 3.4 ± 0.2 days (Table 1). One-month

Fig. 2

Operative time according to surgeon's experience using glue.



and 1-year anatomic success rates were 90.9% and 87.5%, respectively. Points Ba and C improved significantly over baseline at 1 month and 1 year (Ba at −2.3 and C at −6.1, $p < .0001$) (Table 2). Eight patients showed recurrence of cystocele, including 3 who underwent secondary surgery using a vaginal approach for mesh reinforcement during the year of follow-up.

There were no intraoperative complications or vaginal, vesical, or rectal wounds. There were no cases of glue extrusion into the vagina at 1 month or 1 year, and the vagina conserved flexibility. There were no cases of mesh exposure during follow-up (Table 3). There were no cases of mesh shrinkage at 1 month, but there were 5 at 1 year (7.8%). There were no cases of bleeding. One patient (1.5%) showed postoperative fever related to urinary infection, which was successfully treated by urinary antiseptics. The mean day 1 visual analog scale pain score was 1.8 ± 0.2. The postoperative urinary incontinence rate at 1 year was 29.7% (19 patients), with 17 cases of de novo urinary stress incontinence (25.7%) during the first year, including 5 patients (29.4%) who underwent secondary intervention with a transobturator tape for grade 3 urinary stress incontinence. Reductions in bladder instability at 1 year and improvements in dyschezia at 1 month and 1 year were nonsignificant (7.8% vs 13.6%, $p = .75$; 6.2% vs 10.6%, $p = .75$, respectively). All quality of life scores improved significantly by 1 year as follows: PFIQ-7 ($p < .0001$), including the UIQ-7 (Urinary Impact Questionnaire -7) score ($p < .0001$), and PFDI-20 ($p < .0001$), including POPDI-6 (Pelvic Organ Prolapse Distress Inventory-6) ($p < .0001$); the PISQ-12 score showed weaker but still significant improvement at 1 year ($p = .02$) (Table 4).

Table 2

Anatomic results according to POP-Q classification and stage

	Preoperative	1 month	p value*	12 months	p value*
Aa (cm)	2.7 ± 0.2	−2.6 ± 0.1	<.0001	−2.3 ± 0.2	<.0001
Ba (cm)	2.9 ± 0.2	−2.6 ± 0.1	<.0001	−2.3 ± 0.2	<.0001
C (cm)	2.1 ± 0.3	−6.7 ± 0.2	<.0001	−6.1 ± 0.3	<.0001
Ap (cm)	−1.0 ± 0.2	−2.9 ± 0.1	<.0001	−2.6 ± 0.1	<.0001
Bp (cm)	−1.0 ± 0.2	−2.9 ± 0.1	<.0001	−2.6 ± 0.1	<.0001
D (cm)	−2.0 ± 0.3	−8.4 ± 0.1	<.0001	−8.1 ± 0.2	<.0001
tvl (cm)	8.6 ± 0.1	8.8 ± 0.1	.35	8.8 ± 0.1	.41
Cystocele success		60 (90.9%)		56 (87.5%)	
Cystocele		13 (19.7%)		20 (31.2%)	
Stage I		7		12	
Stage II		6		5	
Stage III		0		3	
Hysterocele success		65 (98.5%)		61 (95.3%)	
Hysterocele		4 (6.1%)		10 (15.6%)	
Stage I		3		7	
Stage II		1		3	
Stage III		0		0	
Rectocele success		65 (98.5%)		59 (92.2%)	
Rectocele		7 (10.6%)		12 (18.7%)	
Stage I		6		7	
Stage II		1		4	
Stage III		0		1	

POP-Q = Pelvic Organ Prolapse Quantification.

Data are mean (±standard deviation) or n (%).

* Versus preoperative.

Table 3

Complications

	Preoperative, n (%)	1 month, n (%)	p value*	12 months, n (%)	p value*
Urinary stress incontinence	20 (30.3)	19 (28.8)	1.00	19 (29.7)	1.00
Urinary incontinence by instability	9 (13.6)	3 (4.5)	.07	5 (7.8)	.75
Dysuria	24 (36.4)	0		2 (3.1)	<.0001
Pressing need	25 (37.9)	9 (13.6)	.001	10 (15.6)	.01
Dyschezia	7 (10.6)	2 (3.0)	.18	4 (6.2)	.75
Mesh exposure		0		0	
Mesh retraction		0		5 (7.8)	
Vaginal irritation		3 (4.5)		3 (4.7)	
Urinary		3 (4.5)		4 (6.2)	
Vaginal infection		2 (3.0)		0	

Data are n (%).
* Versus preoperative.

Discussion

Laparoscopic sacrocolpopexy is the reference treatment for medial compartment prolapse [4,5,15]. The principles of sacrocolpopexy on an abdominal approach consist of shifting the uterus and vaginal column toward L5-S1. Laparoscopic sacrocolpopexy has been shown to be feasible in many reports, but there is no consensus on the means of mesh attachment [16]. Dissection techniques are now standardized, and simplification in conventional laparoscopic surgery depends on developing anchorage and adhesion methods that are simpler than suturing [17].

The learning curve comprises 15 to 30 procedures (ie, the technique is difficult even for surgeons experienced in laparoscopic surgery) [6–8]. A survey of 148 surgeons experienced in laparoscopic sacrocolpopexy found that 57% performed vaginal fixation using a single-thread nonabsorbable suture with 3 or 4 sutures on the anterior and posterior vaginal wall; only 12.4% used fixation to the levator ani muscles [18].

The procedure is complex, requiring mastery of dissection and laparoscopic suture, and operative time is a factor hindering more widespread use [8]. The present series showed a trend toward reduced operative time over the learning curve, with 10 minutes saved for 12 months of practice (Fig. 2). Mustafa et al [8] reported a significant decrease in operative time, from 196 minutes to 162 minutes, between their first 15 and last 30 procedures. In the present study, the mean operative time was 145 minutes, including associated procedures (hysterectomy, adnexectomy, and salpingectomy). Willecocq et al [19], reporting the use of tissue glue versus suture, found no significant reduction in the overall operative time (173 minutes) because of the small sample size and the fact that surgeons were beginning their experience of mesh gluing. The retrospective study by Bui et al [20] in 86 patients found a significantly shorter

Table 4

Quality of life scores

	Preoperative	1 month	p value*	12 months	p value*
PFIQ-7	69.3 ± 7.7	37.4 ± 7.5	.002	20.3 ± 4.6	<.0001
UIQ-7	27.1 ± 3.2	14.6 ± 2.8	.003	9.6 ± 2.2	<.0001
CRAIQ-7	10.5 ± 2.4	9.4 ± 2.7	.76	4.1 ± 1.6	.02
POPIQ-7	33.3 ± 3.6	13.6 ± 2.9	<.0001	6.0 ± 2.1	<.0001
PFDI-20	98.4 ± 6.1	46.7 ± 6.2	<.0001	40.8 ± 5.1	<.0001
POPDI-6	45.2 ± 2.7	15.6 ± 2.5	<.0001	11.0 ± 1.7	<.0001
CRADI-8	17.6 ± 2.3	13.2 ± 2.3	.06	14.9 ± 2.2	.25
UDI-6	35.6 ± 3.3	18.0 ± 2.8	<.0001	14.4 ± 2.4	<.0001
Sexual relations	38 (58.5%)	21 (33.9%)	<.001	41 (68.3%)	.34
PISQ12	34.2 ± 1.0	38.6 ± 1.1	.03	38.0 ± 0.9	.02

CRADI = Colorectal-Anal Distress Inventory; CRAIQ = Colo-Rectal-Anal Impact Questionnaire; PFDI = Pelvic Floor Distress Inventory; PFIQ = Pelvic Floor Impact Questionnaire; PISQ = Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire; POPDI = Pelvic Organ Prolapse Distress Inventory; POPIQ = Pelvic Organ Prolapse Impact Questionnaire; UDI = Urogenital Distress Inventory; UIQ = Urinary Impact Questionnaire.

Data are mean (±standard deviation) or n (%).
* Versus preoperative.

operative time for posterior fixation using staples (185 minutes) compared with suture (213 minutes). Although operative times are not strictly comparable, because of associated procedures, it is interesting to compare the suture or fixation time for each implant. Claerhout et al [21] detailed the operative time for each step comparing a group of students and a group of senior surgeons; there were learning curves for each step, notably for suturing, which took 38 minutes for the senior surgeons and 58 minutes for the students.

Several technical variants exist according to the type of prosthetic material and type of fixation to the anterior and posterior vaginal wall. Knotted suturing requires in vitro training to be reliable; biomechanical tests have shown that failure to tighten the knot affects its strength and that fraying accounts for 48% of suture failures [22]. Intraperitoneal suturing is tricky, requiring constant practice. Moreover, sutures passing through the bladder require cystoscopy and suture ablation [23].

Staple fixation onto the vaginal wall was described to reduce the number of intracorporeal sutures. Stapling techniques are of only moderate quality; fixation may be weaker, with risk of infection, vaginal erosion, and mesh exposure leading to dyspareunia, which is why staples are less widely used [20,24]. Automatic stapling (Takers, ProTack; Covidien, Mansfield, MA) onto the promontory was reported as an alternative to suture to reduce the risk of bladder lesion but with an increased risk of spondylodiscitis [20,24]; this cannot be recommended for routine use because of the lack of evidence.

The present study showed synthetic glue to be harmless. In digestive surgery, it has been proven to be effective and safe in stabilizing implant reinforcement [25,26]. A meta-analysis comparing glue versus suture fixation in inguinal hernia found a significantly shorter operative time and less postoperative pain with glue [9]. In laparoscopic repair of inguinal hernia, there was no significant difference in recurrence rates between glue and staple fixation, but there was significantly less chronic inguinal pain using glue [27]. None of the present patients showed toxic effects related to formaldehyde release during degradation. Visible polymerization within a few seconds is a sure sign of good fixation. On the other hand, excess glue produces an amalgam that hinders good mesh contact with the vagina. A histologic study showed that the n-hexyl cyanoacrylate polymer persisted 3 months after application, with absorption partially completed by 6 months. In the present study, a single 1.5-mL vial of glue was enough for each procedure; a single droplet of about 0.2 mL was needed for each anchorage. A physiological fibrotic reaction occurs on tissue contact, reinforcing efficacy. To date, there have been no studies of other types of tissue glue.

One-year anatomic and functional results were comparable with literature reports. The retrospective study by Rozet et al [28] of 363 patients at a median 14.5-month follow-up found an anatomic success rate (POP-Q stage ≤ 1) of 86%, and the retrospective study by Sergent et al [29] of 116 patients at a median 34.2-month follow-up reported 89%. The prospective study by Claerhout et al [7] in 132 patients at a median 12.5-month follow-up reported 98%, with 3% and 2% recurrence in the anterior and medial compartments, respectively, but 18% in the posterior compartment despite the use of a posterior prosthesis. Higgs et al [30] reported a 92% success rate in 140 patients. A study of n-hexyl cyanoacrylate to fix polypropylene parietal reinforcements in inguinal hernia in 87 patients found that, whatever the approach (Lichtenstein, Trans Abdominal Pre Peritoneal, or plug), fixation was considered successful by 94% of surgeons with reduced postoperative pain [9]. The present study found significant improvement in all quality of life scores at 1 year; quality of sexual life was also improved (Table 4), which is in agreement with Wagner et al [17].

A further advantage of tissue glue is to enable the mesh to be stretched as laterally as possible onto the levator ani muscles without tension to avoid tying the lower rectum and inducing dyschezia [30]. Glue fixation to the levator ani is more straightforward and avoids having to perform technically difficult suture fixation.

Regarding complications, a literature review by Ganatra et al [16] found mean rates of 2.7% for mesh exposure and 3.4% for erosion. Glue, by avoiding transfixation of the vaginal wall, probably explains the absence of mesh exposure and erosion in the present series. Sergent et al [29], using nonabsorbable extracorporeal suture fixation, reported rates of 4% for erosion and 0.8% for implant infection. Risk of erosion is increased to 16% in case of concomitant total hysterectomy [31]. Willecocq et al [19] reported no cases of mesh-related infection in their "glue" group. In the present series, there was only 1 case of $\geq 38^{\circ}$C fever related to a successfully treated urinary infection and no cases of mesh infection. It seems to us to be important to maintain the mesh intraperitoneally using absorbable sutures rather than glue to avoid any glue coming in contact with the intestinal loop with risk of reflex ileus or digestive occlusion.

Wagner et al [17] reported 18.2% of patients developed postoperative urinary incontinence. In the present series, de novo urinary stress incontinence occurred during the first year in 17 patients (25.7%) including 5 (29.4%) who underwent secondary intervention with a transobturator tape for grade 3 urinary stress incontinence.

The weakness of our study is its descriptive design without a control group, and the efficacy of the procedure is to be interpreted with caution. Moreover, this glue may not be available yet or approved for use in other countries.

The main strong point of the present study is that it was the first prospective study to assess 1-year anatomic and functional results after mesh attachment using tissue glue in laparoscopic sacrocolpopexy with complete assessment of all POP-Q scores and quality of life criteria recommended by the International Urogynecological Association/International Continence Society [10]. Moreover, all procedures were standardized and performed by surgeons experienced in laparoscopic sacrocolpopexy.

Conclusions

Synthetic tissue glue fixation in laparoscopic sacrocolpopexy proved simple, safe, and effective at 1 year. This new technique facilitates laparoscopic sacrocolpopexy, reducing operative time and ensuring good anatomic and functional results at 1 year. This is a pilot study, and well-controlled clinical trials should be performed before generalized use of this technique. Only a large-scale prospective randomized study comparing glue versus suture could confirm the long-term benefit of using synthetic tissue glue in sacrocolpopexy.

Acknowledgments

The authors thank Dr. Stephanie Moret (biostatistician at Lyon University, Lyon, France) for statistical analysis.

References

1. Luber KM, Boero S, Choe JY. The demographics of pelvic floor disorders: current observations and future projections. *Am J Obstet Gynecol*. 2001;184:1496–1501. discussion 1501–1503.
2. Samuelsson EC, Victor FT, Tibblin G, Svärdsudd KF. Signs of genital prolapse in a Swedish population of women 20 to 59 years of age and possible related factors. *Am J Obstet Gynecol*. 1999;180:299–305.
3. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. *Obstet Gynecol*. 1997;89:501–506.
4. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. *Cochrane Database Syst Rev*. 2013;CD004014.
5. Maher CF, Feiner B, DeCuyper EM, Nichlos CJ, Hickey KV, O'Rourke P. Laparoscopic sacral colpopexy versus total vaginal mesh for vaginal vault prolapse: a randomized trial. *Am J Obstet Gynecol*. 2011;204:360.e1–360.e7.
6. Akladios CY, Dautun D, Saussine C, Baldauf JJ, Mathelin C, Wattiez A. Laparoscopic sacrocolpopexy for female genital organ prolapse: establishment of a learning curve. *Eur J Obstet Gynecol Reprod Biol*. 2010;149:218–221.
7. Claerhout F, De Ridder D, Roovers JP, et al. Medium-term anatomic and functional results of laparoscopic sacrocolpopexy beyond the learning curve. *Eur Urol*. 2009;55:1459–1467.
8. Mustafa S, Amit A, Filmar S, et al. Implementation of laparoscopic sacrocolpopexy: establishment of a learning curve and short-term outcomes. *Arch Gynecol Obstet*. 2012;286:983–988.
9. de Goede B, Klitsie PJ, van Kempen BJ, et al. Meta-analysis of glue versus sutured mesh fixation for Lichtenstein inguinal hernia repair. *Br J Surg*. 2013;100:735–742.
10. Haylen BT, Freeman RM, Lee J, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint terminology and classification of the complications related to native tissue female pelvic floor surgery. *Int Urogynecol J*. 2012;23:515–526.
11. Kukleta JF. TAPP - the logic of hernia repair. *Le Jour de Coelio-chir*. 2010;76:14–20.
12. Bellón JM, Fernández-Gutiérrez M, Rodríguez M, et al. Bioassay of cyanoacrylate tissue adhesives used for intraperitoneal mesh fixation. *J Biomed Mater Res B Appl Biomater*. 2015 Oct 27. [Epub ahead of print].
13. Reynvoet E, Van Cleven S, Van Overbeke I, et al. The use of cyanoacrylate sealant as simple mesh fixation in laparoscopic ventral hernia repair: a large animal evaluation. *Hernia*. 2015;19:661–670.
14. Barbosa S, Nieves T, García F, et al. Fixation of light weight polypropylene mesh with n-butyl-2-cyanocrylate in pelvic floor surgery: experimental design approach in sheep for effectiveness evaluation. *Biomed Res Int*. 2015;2015:737683.
15. Lee RK, Mottrie A, Payne CK, Waltregny D. A review of the current status of laparoscopic and robot-assisted sacrocolpopexy for pelvic organ prolapse. *Eur Urol*. 2014;65:1128–1137.
16. Ganatra AM, Rozet F, Sanchez-Salas R, et al. The current status of laparoscopic sacrocolpopexy: a review. *Eur Urol*. 2009;55:1089–1103.
17. Wagner L, Boileau L, Delmas V, Haab F, Costa P. Surgical treatment of prolapse using coelioscopic promontofixation: techniques and results. *Prog Urol*. 2009;19:994–1005.
18. O'Sullivan OE, Matthews CA, O'Reilly BA. Sacrocolpopexy: is there a consistent surgical technique? *Int Urogynecol J*. 2016;27:747–750.
19. Willecocq C, Pizzoferrato AC, Fauconnier A, Bader G. Use of glue in laparoscopic sacrocolpopexy. A comparative study about 32 cases. *Gynecol Obstet Fertil*. 2014;42:822–826.
20. Bui C, Ballester M, Chéreau E, Guillo E, Daraï E. Comparison of suture or stapling of the posterior mesh during promontofixation. *Gynecol Obstet Fertil*. 2010;38:723–728.
21. Claerhout F, Verguts J, Werbrouck E, Veldman J, Lewi P, Deprest J. Analysis of the learning process for laparoscopic sacrocolpopexy: identification of challenging steps. *Int Urogynecol J*. 2014;25:1185–1191.
22. Ritter EM, McClusky DA, Gallagher AG, Smith CD. Real-time objective assessment of knot quality with a portable tensiometer is superior to execution time for assessment of laparoscopic knot-tying performance. *Surg Innov*. 2005;12:233–237.
23. Patsner B. Mesh erosion into the bladder after abdominal sacral colpopexy. *Obstet Gynecol*. 2000;95:1029.
24. Cosson M, Vinatier D, Rajabally R, Querleu D, Crepin G. Rejection of stapled prosthetic mesh after laparoscopic sacropexy. *Int Urogynecol J Pelvic Floor Dysfunct*. 1999;10:349–350.
25. Kaul A, Hutfless S, Le H, et al. Staple versus fibrin glue fixation in laparoscopic total extraperitoneal repair of inguinal hernia: a systematic review and meta-analysis. *Surg Endosc*. 2012;26:1269–1278.
26. Tolver MA, Rosenberg J, Juul P, Bisgaard T. Randomized clinical trial of fibrin glue versus tacked fixation in laparoscopic groin hernia repair. *Surg Endosc*. 2013;27:2727–2733.
27. Sajid MS, Ladwa N, Kalra L, McFall M, Baig MK, Sains P. A meta-analysis examining the use of tacker mesh fixation versus glue mesh fixation in laparoscopic inguinal hernia repair. *Am J Surg*. 2013;206:103–111.
28. Rozet F, Mandron E, Arroyo C, et al. Laparoscopic sacral colpopexy approach for genito-urinary prolapse: experience with 363 cases. *Eur Urol*. 2005;47:230–236.
29. Sergent F, Resch B, Loisel C, Bisson V, Schaal JP, Marpeau L. Mid-term outcome of laparoscopic sacrocolpopexy with anterior and posterior polyester mesh for treatment of genito-urinary prolapse. *Eur J Obstet Gynecol Reprod Biol*. 2011;156:217–222.
30. Higgs PJ, Chua HL, Smith AR. Long term review of laparoscopic sacrocolpopexy. *BJOG*. 2005;112:1134–1138.
31. Cundiff GW, Varner E, Visco AG, et al. Pelvic Floor Disorders Network. Risk factors for mesh/suture erosion following sacral colpopexy. *Am J Obstet Gynecol*. 2008;199:688.e1–688.e5.