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ORIGINAL ARTICLE

Vaginal repair of vesicovaginal fistula: comparison of national practice patterns by surgeon specialty

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Abstract

Introduction and hypothesis There are limited data comparing patient and operative characteristics for vaginal repair of vesicovaginal fistula (VVF) by surgeon specialty. Our objective was to compare national practice patterns by surgeon specialty for vaginal repair of VVF.

Methods Using the American College of Surgeons National Surgical Quality Improvement Program database, we conducted a retrospective cohort analysis of women who underwent vaginal repair of VVF from 2010 to 2019. Demographic and perioperative characteristics were compared by surgeon specialty.

Results A total of 252 women were analyzed. Urologists performed 57% of cases (n=144), gynecologists performed 38% (n=96), and general surgeons performed 5% (n=12). There were differences among surgeon specialties in patient characteristics including age (p=0.002), creatinine (p=0.002), hypertension (p=0.02), morbidity probability (p<0.001), hospital stay (p<0.001), inpatient status (p=0.03). Urologists were more likely than gynecologists to use grafts/flaps (p=0.002). There were trending differences among surgeon specialties in patient race (p=0.07) and ethnicity (p=0.06). Urologists and gynecologists were more likely to operate on younger, healthier patients with differences in racial populations. When directly comparing urologists with gynecologists, there were differences in race (p=0.05) and a trending difference in ethnicity (p=0.06), General surgeons were more likely to operate on older white women with worse health status, more concomitant procedures, and longer hospital stay.

Conclusions Urologists, gynecologists, and general surgeons perform vaginal repair of VVF. Among these specialties, there were differences in patient and perioperative characteristics. This information may help referring providers and patients to understand which types of surgical providers most commonly manage VVF.

Keywords NSQIP · Vesicovaginal fistula · Fistula · Urogynecology · Perioperative morbidity · Urogenital fistula

Introduction

The diagnosis of vesicovaginal fistula (VVF) is seen worldwide. Although the most common etiology in developing countries is obstructed labor, with an estimation of at least two million women with unrepaired obstetric fistulas; the most common etiology in developed countries is gynecological surgery [1–3]. In the United States, 80% of VVFs are due to benign gynecological surgery [4, 5].

Treatment options for VVF include prolonged bladder drainage with a catheter, ablative procedures (curetting, fulguration, and laser ablation), and surgical management [2, 4]. Approaches to the repair of a VVF include abdominal, laparoscopic, robotic, and vaginal [4], with the transvaginal approach being the most common [6]. Although urological or gynecological societies do not have recommendations for treatment approach, vaginal repair of VVF is preferred and has been found to be amenable to early repair and is less invasive, with success rates up to 90% [1, 2, 7]. Advantages of vaginal repair include fewer complications, decreased operative time, blood loss, pain, and length of hospital stay [4, 8]. Additionally, literature has demonstrated that vaginal

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repair is less technically challenging than laparoscopic and less invasive than the abdominal route [9].

There are several different surgical specialties that may manage VVF repair. With the combination of urology and gynecology specialties for urogynecology subspecialty training, trainees will be exposed to different practice patterns. Although the literature suggests that having an experienced surgeon might be an important factor for the successful repair of VVF [7, 10], there are limited data assessing differences in practice patterns in vaginal repair of VVF among surgeon specialties. This information would help referring surgeons and patients to understand which specialties most often perform this type of surgical repair. Therefore, our primary objective was to compare patient demographics and perioperative outcomes for vaginal repair of vesicovaginal fistula by surgeon specialty.

Materials and methods

This was a retrospective cohort analysis of women undergoing vaginal repair of VVF from 2010 to 2019 using the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database. The study was deemed exempt by the Institutional Review Board at the Office of Human Research Ethics at the University of North Carolina at Chapel Hill. The NSQIP database was designed to measure and improve surgical outcomes [11]. It captures over 200 variables from participating US institutions for patients undergoing outpatient and inpatient surgeries, including preoperative risk factors, intraoperative variables, and 30-day postoperative outcomes. Prior studies have validated the use of the ACS NSQIP database for improving surgical safety [12–14]. To prevent bias in the cases included in the database, cases are chosen using an 8-day cycle schedule with designated individuals at each site collecting data from medical records. ACS NSQIP exclusion criteria include patients under the age of 18. The database contains de-identified data. The ACS audits participating sites to ensure data reliability [11]. The methods for this study are reported according to Strengthening the Reporting of Observational Studies in Epidemiology guidelines [15].

Patients identified as female and undergoing vaginal repair of VVF in the ACS NSQIP database from 2010 to 2019 were identified by current procedural terminology (CPT) code 57320. Cases were excluded if the surgeon specialty was unknown.

Preoperative patient characteristics were collected including: age, weight, body mass index (BMI), race, ethnicity, American Society of Anesthesiologists (ASA) class, diabetes, smoking, dyspnea, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), hypertension, open wound/infection, steroid use, bleeding disorder, acute renal failure, dialysis, weight loss, preoperative transfusion, sepsis, infection present at time of surgery, preoperative laboratory values, functional health status (criteria determining level of patient independence [16]), and mortality and morbidity probabilities (NSQIP-provided logistic regression analysis using patient preoperative characteristics [17]). Intraoperative and postoperative characteristics included anesthesia type, operative time, surgical site infection, pneumonia, urinary tract infection, renal insufficiency, venous thrombosis requiring therapy, pulmonary embolism, stroke, myocardial infarction, wound disruption, deep incisional or organ/space surgical site infection (SSI), sepsis, septic shock, transfusion, reoperation, readmission, hospital stay, inpatient status, discharge destination, or unplanned reintubations. These variables were stratified by primary surgeon specialty. A secondary analysis was performed comparing gynecology and urology, as these were found to be the two major specialties that perform vaginal repair of VVF.

Patient characteristics and perioperative management were compared between surgeon specialties using Chi-squared or Fisher's exact test for categorical variables and Student's *t* test and ANOVA for continuous variables. A log linear model was used to analyze the number of CPT codes performed by surgical specialty. Multivariate linear regression was performed to investigate risk factors for hospital length of stay. A p value of ≤ 0.05 was considered statistically significant. SPSS® Statistics version 27 (IBM, Armonk, NY, USA) and SAS® 9.4 (Cary, NC, USA) were used for data analysis.

Results

A total of 253 patients was reported in the ACS NSQIP database for vaginal repair of VVF by the primary surgeon team between 2010 and 2019. One was excluded because the surgeon specialty was listed as "other," leaving 252 patients for analysis. Most women were white, non-Hispanic, postmenopausal (mean age was 52), and overweight (mean BMI was 30). There were no major changes in rates of vaginal repair of VVF over the study period (Fig. 1). Urologists performed 57.1% of the procedures, followed by gynecologists 38.1%, and general surgeons 4.8%. We first compared patient demographics by surgical specialty (Table 1). Most women were nondiabetic, nonsmokers, and had an independent functional health status. There were significant differences in mean patient age by surgeon specialty (p=0.002). Women who underwent vaginal repair of VVF with urology and gynecology were generally younger and healthier than women who underwent vaginal repair of VVF with general surgery. Additionally, racial and ethnic diversity trended toward significance (p=0.07 and p=0.06 respectively). General surgeons were more likely to operate on

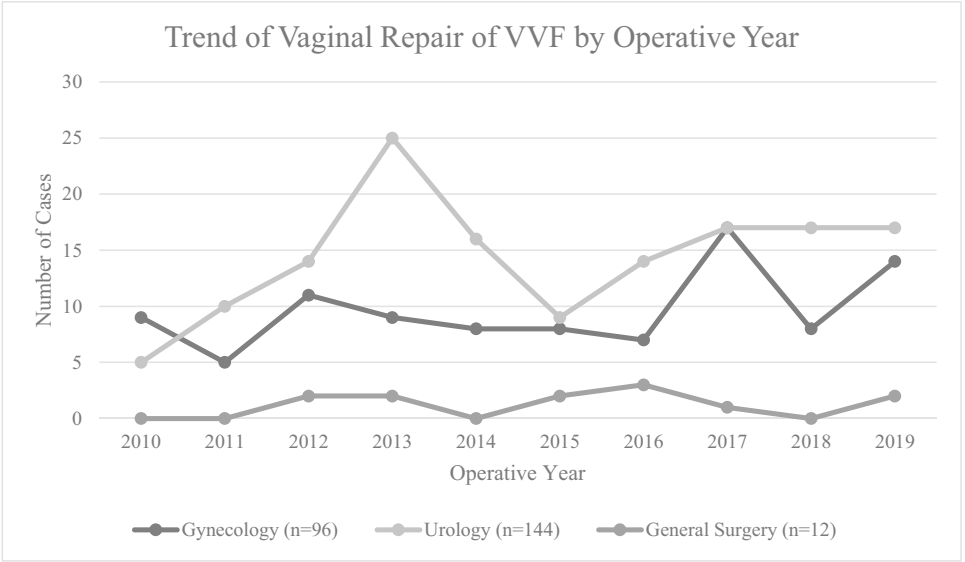

Fig. 1 Rate of vaginal repair of vesicovaginal fistula by operative year

older white women with worse health status. In terms of preoperative characteristics, preoperative labs were generally normal. There were no differences in preoperative labs among women based on surgeon specialties for white blood cell count, hematocrit, and platelets. There was a significant difference in preoperative creatinine, with women who underwent repair with general surgery having a higher preoperative creatinine than women who underwent repair with urology or gynecology (p=0.002). Women who underwent repair with general surgery also had a significantly higher rate of hypertension requiring medication and a higher morbidity probability than those who underwent repair with urology and gynecology (p=0.02). When assessing preoperative morbidity, there were no cases of congestive heart failure (CHF), acute renal failure or dialysis, preoperative transfusion within 72 h preoperatively, any type of SSI at the time of surgery (including superficial, deep, or organ space), pneumonia, sepsis, or septic shock.

In terms of peri- and postoperative characteristics, most women underwent general anesthesia, with a mean operating time of 160 min and mean length of hospital stay of 1–2 days. When comparing peri- and postoperative characteristics by surgeon specialty, there were no statistically significant differences in anesthesia type or operative time (Table 2). Women who underwent VVF repair with general surgery had a longer length of hospital stay than those who underwent VVF repair with urology and gynecology (p<0.001). They also had a longer time from operation to discharge (5.6 ± 4.0 days for general surgery vs 1.6 ± 2.2 days for urology vs 1.3 ± 2.1 days, p<0.001). Similarly, women who underwent VVF repair with general surgery were more likely to be inpatients than those undergoing VVF repair with urology and gynecology (p=0.03). Unplanned reoperation and readmission rates were low overall at 2.4% and 2.8% respectively. When assessing peri- and postoperative morbidity, there were no differences in superficial surgical site infection, pneumonia, urinary tract infection, transfusion, unplanned reoperation, unplanned readmission, and discharge destination. There were no cases of renal insufficiency, venous thrombosis requiring therapy, pulmonary embolism, stroke, myocardial infarction, wound disruption, deep incisional or organ/space SSI, sepsis, or septic shock. There were also no unplanned postoperative intubations. When controlling for age, preoperative creatinine and preoperative morbidity probability using multivariate logistic regression, hospital length of stay remained significantly different by surgical specialty (p<0.05). Preoperative morbidity probability also remained an independent predictor of length of stay (p<0.01, 95% CI 31.1, 56.2).

We also assessed the rate of concomitant procedures. Women who underwent vaginal repair of VVF with general surgery had more concomitant procedures than those undergoing vaginal repair of VVF with urology (mean 2.8 ± 1.4 vs 2.0 ± 1.0 procedures, p=0.02), whereas there was no difference when comparing either general surgery or urology with gynecology (mean of 2.2 ± 1.3 procedures). The most concomitant procedures based on CPT code were cystoscopy (25.4%), cystourethroscopy with stent (8.7%), suprapubic catheter (7.9%), cystotomy (6.8%), and cystourethroscopy with ureteral catheterization (6.4%). The most common concomitant procedures for urology were cystoscopy, cystotomy, cystoscopy with stent or ureteral catheterization, suprapubic catheter, or flap/graft. The most common concomitant procedures for gynecology were cystoscopy, suprapubic catheter, cystoscopy with stent, or ureteral catheterization. The most common concomitant procedures for general surgery were mobilization of splenic flexure in conjunction with partial colectomy, partial colectomy, total

Table 1 Demographics/preoperative characteristics

	Gynecology (*n*=96)	Urology (*n*=144)	General surgery (*n*=12)	*p* value
Age (years)	50.3 ± 13.0	51.9 ± 12.7	64.7 ± 13.9	0.002*
Weight [pounds (kilograms)])	170.7 ± 28.7 (77.4 ± 13.0)	172.6 ± 49.6 (78.3 ± 22.5)	186.5 ± 41.2 (84.6 ± 16.7)	0.53*
BMI (kg/m^2)	29.7 ± 6.9	30.1 ± 8.7	31.3 ± 6.8	0.79*
Race				0.07**
White	73 (81.1)	99 (87.6)	11 (91.7)	
Black or African American	13 (14.4)	11 (9.7)	0 (0)	
Asian	0 (0)	3 (2.7)	1 (8.3)	
American Indian/ Alaska Native	3 (3.3)	0 (0)	0 (0)	
Native Hawaiian or Pacific Islander	1 (1.1)	0 (0)	0 (0)	
Ethnicity				0.06***
Non-Hispanic	83 (92.2)	99 (83.2)	12 (100)	
Hispanic	7 (7.8)	20 (16.8)	0 (0)	
Preoperative creatinine (mg/dl)	0.8 ± 0.2	0.8 ± 0.3	1.0 ± 0.3	0.002*
Preoperative white blood cell count (k/mm^3)	7.9 ± 2.3	7.4 ± 2.6	8.3 ± 2.3	0.31*
Preoperative hematocrit (%)	38.5 ± 3.6	38.7 ± 4.2	38.8 ± 2.8	0.94*
Preoperative platelets (K/mm^3)	288.0 ± 89.3	266.2 ± 72.3	298.9 ± 61.2	0.13*
Mortality probability[a]	0.0006 ± 0.002	0.0013 ± 0.006	0.0025 ± 0.004	0.35*
Morbidity probability[a]	0.05 ± 0.03	0.05 ± 0.03	0.12 ± 0.07	< 0.001*
ASA class				0.31**
1	5 (5.2)	15 (10.4)	0 (0)	
2	68 (70.8)	84 (58.3)	7 (58.3)	
3	22 (22.9)	44 (30.6)	5 (41.7)	
4	1 (1)	1 (0.7)	0 (0)	
Diabetes				0.19**
No	88 (91.7)	134 (93.1)	9 (75)	
Non-insulin dependent	7 (7.3)	9 (6.3)	3 (25)	
Insulin dependent	1 (1)	1 (0.7)	0 (0)	
Smoker	22 (22.9)	29 (20.1)	4 (33.3)	0.58***
Dyspnea with moderate exertion	3 (3.1)	4 (2.8)	0 (0)	0.99**
Functional health				0.511**
Independent	94 (97.9)	135 (93.8)	12 (100)	
Totally dependent	0 (0)	3 (2.1)	0 (0)	
Partially dependent	0 (0)	4 (2.8)	0 (0)	
Unknown	2 (2.1)	2 (1.4)	0 (0)	
History of severe COPD	4 (4.2)	4 (2.8)	0 (0)	0.81**
Hypertension requiring medication	26 (27.1)	43 (29.9)	8 (66.7)	0.02***
Open wound/wound infection	2 (2.1)	8 (5.6)	0 (0)	0.43**
Active steroid use for chronic condition	5 (5.2)	5 (3.5)	0 (0)	0.71**
Bleeding disorder	1 (1)	2 (1.4)	0 (0)	0.99**
Active urinary tract infection				0.55**
No	81 (84.4)	125 (86.8)	12 (100)	
Yes	1 (1)	4 (2.8)	0 (0)	
Unknown	14 (14.6)	15 (10.4)	0 (0)	

Data represented as *n* (%) or *n* ± standard deviation

ASA American Society of Anesthesiologists, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *PATOS* present at the time of surgery, *SSI* surgical site infection

*ANOVA

**Fisher's exact test

***Chi-squared test

[a]According to NSQIP: developed for all cases based on a logistic regression analysis using the patient's preoperative characteristics as the independent or predictive variables [11]

Table 2 Intraoperative and postoperative characteristics

	Gynecology (*n*=96)	Urology (*n*=144)	General surgery (*n*=12)	*p* value
Anesthesia				0.22*
General	94 (97.9)	137 (95.1)	11 (91.7)	
MAC/IV sedation	2 (2.1)	3 (2.1)	0 (0)	
Spinal	0 (0)	4 (2.8)	1 (8.3)	
Operative time (min)	144.89 ± 100.54	165.30 ± 121.76	208.67 ± 162.70	0.14**
Superficial SSI	2 (2.1)	2 (1.4)	0 (0)	0.99*
Pneumonia	1 (1)	0 (0)	0 (0)	0.43*
Urinary tract infection	8 (8.3)	10 (6.9)	0 (0)	0.65***
Transfusion (intraoperative or postoperative)	1 (1)	1 (0.7)	0 (0)	0.99*
Unplanned reoperation	4 (4.2)	2 (1.4)	0 (0)	0.42*
Unplanned readmission				0.35*
No	1 (1)	1 (0.7)	0 (0)	
Yes	5 (5.2)	2 (1.4)	0 (0)	
Unknown	90 (93.8)	141 (97.9)	12 (100)	
Length of hospital stay (days)	1.3 ± 2.1	1.7 ± 2.3	5.8 ± 4.3	< 0.001**
Patient status				0.03***
Inpatient	41 (42.7)	67 (46.5)	10 (83.3)	
Outpatient	55 (57.3)	77 (53.5)	2 (16.7)	
Discharge destination				0.07*
Home	86 (89.6)	137 (95.1)	11 (91.7)	
Unknown	9 (9.4)	5 (3.5)	0 (0)	
Home facility	1 (1)	1 (0.7)	0 (0)	
Rehab	0 (0)	0 (0)	1 (8.3)	
Skilled care facility	0 (0)	1 (0.7)	0 (0)	

Data represented as *n* (%) or *n* ± standard deviation

IV intravenous, *MAC* monitored anesthesia care, *SSI* surgical site infection

*Fisher's exact test

**ANOVA

***Chi-squared test

colectomy, enterolysis, colostomy, ileostomy/jejunostomy, and proctectomy. Urologists performed more flaps/grafts than gynecologists or general surgery, with 94% of the flaps and grafts performed by urologists and 5% by gynecologists (p=0.002). Of the women who underwent vaginal repair of VVF with general surgery, 75% (9 out of 12) underwent concurrent bowel resection. In addition, 33% (4 out of 12) of cases by general surgery had another surgical team perform a separate procedure, which was cystoscopy with or without stent or catheterization. Although concurrent procedures performed by a separate surgical team were uncommon, general surgery had the highest mean of concurrent procedures (0.4), then gynecology (mean 0.2), then urology (0.03), with statistically significant differences between general surgery versus urology (p=0.002) and gynecology versus urology (p=0.007). This was analyzed using a log linear model. Of the patients analyzed, only four patients underwent concomitant hysterectomy, which was performed by gynecology.

A secondary analysis was performed comparing urology with gynecology, while excluding general surgery, as these two specialties had the highest rates of vaginal repair of VVF. Table 3 shows statistically significant differences by patient race when comparing urology and gynecology. There were differences in racial distribution (p=0.05), with ethnicity trending toward significance (p=0.06). Gynecologists operated on more Black/African American, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander patients than urologists, whereas urologists operated on more Hispanic patients than gynecologists. There were no differences in mean age, weight, BMI, preoperative creatinine, preoperative white blood cell count, preoperative hematocrit, preoperative platelets, mortality or morbidity probability, diabetes, smoker status, dyspnea, COPD, hypertension on medication, cancer, wound infection, steroid use, weight loss, bleeding disorder, sepsis, ASA class, and urinary tract infection (UTI). There were no statistically

Table 3 Demographics/ preoperative characteristics

	Gynecology (n=96)	Urology (n=144)	p value
Race			0.05*
White	73 (81.1)	99 (87.6)	
Black or African American	13 (14.4)	11 (9.7)	
American Indian/Alaska Native	3 (3.3)	0 (0)	
Asian	0 (0)	3 (2.7)	
Native Hawaiian or Pacific Islander	1 (1.1)	0 (0)	
Ethnicity			0.06**
Non-Hispanic	83 (92.2)	99 (83.2)	
Hispanic	7 (7.8)	20 (16.8)	
Age (years)	50.3 ± 13.0	51.9 ± 12.7	0.37***
Weight [pounds (kilograms)]	170.7 ± 28.7 (77.4 ± 13.0)	172.6 ± 49.6 (78.3 ± 22.5)	0.76***
BMI (kg/m^2)	29.7 ± 6.9	30.1 ± 8.7	0.71***
Preoperative creatinine (mg/dl)	0.8 ± 0.2	0.77 ± 0.3	0.84***
Preoperative white blood cell count (k/mm^3)	7.9 ± 2.3	7.40 ± 2.6	0.18***
Preoperative hematocrit (%)	38.5 ± 3.6	38.7 ± 4.2	0.73***
Preoperative platelets (K/cumm)	288.0 ± 89.3	266.2 ± 72.3	0.07***
Mortality probability	0.0006 ± 0.002	0.001 ± 0.006	0.29***
Morbidity probability	0.05 ± 0.03	0.051 ± 0.03	0.96***
Diabetes			0.90**
No	88 (91.7)	134 (93.1)	
Non-insulin dependent	7 (7.3)	9 (6.3)	
Insulin dependent	1 (1)	1 (0.7)	
Smoker status			0.63**
No	74 (77.1)	115 (79.9)	
Yes	22 (22.9)	29 (20.1)	
Dyspnea			0.99**
No	93 (96.9)	140 (97.2)	
Moderate exertion	3 (3.1)	4 (2.8)	
Functional health			0.11*
Independent	94 (100)	135 (95.1)	
Partially dependent	0 (0)	4 (2.8)	
Totally dependent	0 (0)	3 (2.1)	
History of severe COPD	4 (4.2)	4 (2.8)	0.72*
Hypertension requiring medication	26 (27.1)	43 (29.9)	0.67**
Disseminated cancer	1 (1)	2 (1.4)	0.99*
Open wound/ wound infection	2 (2.1)	8 (5.6)	0.32**
Steroid use for chronic condition	5 (5.2)	5 (3.5)	0.74**
>10% loss body weight in the last 6 months	1 (1)	0 (0)	0.40*
Bleeding disorder	1 (1)	2 (1.4)	0.99*
Systemic sepsis			0.99*
None	95 (99)	142 (98.6)	
Sepsis	0 (0)	1 (0.7)	
Systemic inflammatory response syndrome	1 (1)	1 (0.7)	
ASA class			0.16*
1	5 (5.2)	15 (10.4)	
2	68 (70.8)	84 (58.3)	
3	22 (22.9)	44 (30.6)	
4	1 (1)	1 (0.7)	

Table 3 (Continued)

	Gynecology (*n*=96)	Urology (*n*=144)	*p* value
Urinary tract infection PATOS			0.65*
No	81 (98.8)	125 (96.9)	
Yes	1 (1.2)	4 (3.1)	

Data represented as *n* (%) or *n* ± standard deviation
ASA American Society of Anesthesiologists, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *PATOS* present at the time of surgery, *SSI* surgical site infection

*Fisher's exact test

**Chi-squared test

***Student's *t* test

significant differences in perioperative variables including anesthesia type, mean operative time, superficial surgical site infection, pneumonia, UTI, cardiac arrest requiring cardiopulmonary resuscitation, transfusion, unplanned reoperation, unplanned readmission, mean length of hospital stay, mean days from operation to discharge, inpatient status, and discharge destination.

Discussion

Our findings suggest that among women who undergo vaginal repair of VVF with urologists, gynecologists, and general surgeons, there were some differences noted in patient demographics, patient health status, and perioperative management. Urologists and gynecologists were more likely to operate on younger, healthier patients with differences in racial populations. General surgeons were more likely to operate on older white women with worse health status, with more concomitant procedures, and a longer hospital stay. There were no major changes in rates of vaginal repair of VVF over the study period.

It is possible that more women underwent vaginal repair of VVF with urologists than with gynecologists owing to a suspected larger number of urologists than gynecologists who perform this type of surgery. The higher proportion of vaginal repair of VVF surgeries performed by urologists here reflects this specific surgery rather than all types of urogynecological vaginal surgery. One study found that two-thirds (62%) of surgical repairs of urogenital fistulas or ileal conduit constructed for urogenital fistulas were performed by urologists, with 26% performed by gynecologists; however, this did not address the approach of fistula repair or perioperative morbidities [10]. This database is unable to distinguish gynecologists or urologists who practice generally versus those subspecialized in urogynecology. Additionally, there are to our knowledge no published data investigating this question. Notably, both urology and gynecology residents can undergo subspecialty training in urogynecology. Owing to the combination of subspecialty training for urology and gynecology and the grandfathering of nonsubspecialty-trained surgeons in both fields, there is a wide variety of training and degree of experience with vaginal repair of VVF. In the future, this could likely funnel down to the subspecialty trained surgeons in both fields, as older more experienced generalists retire. Therefore, it is difficult to currently use subspecialty training as a proxy for more experience or better outcomes. A future direction would be to prospectively assess the effect of subspecialty training of surgeons on vaginal repair of VVF outcomes.

We also assessed racial and ethnic diversity. It is unclear why women who underwent VVF repair with urologists tended to be more ethnically diverse, whereas women who underwent VVF repair with gynecologists were more racially diverse. This finding could be related to differing referral patterns [18] or practice locations. For example, urban communities have been shown to be more diverse than rural locations [19, 20]. Prior studies have shown the respective densities of urology and OB/GYN practices to decline from metropolitan to rural areas. Half of US counties lack an OB/GYN, and 63% of counties lack a urologist [21, 22]. We are unable to determine exact breakdown differences between the two types of specialties and therefore can only hypothesize that this might be a potential contributor to differences. The association of different patient racial and ethnicity patterns between surgeon specialty does not imply causation.

We also found that women who underwent VVF repair with general surgeons were older, had a higher rate of morbidity, and were more likely to undergo a higher number of concomitant procedures, especially bowel resection. Although the majority of VVFs occur after obstetric delivery and gynecological surgery, one could infer from our data that women who undergo vaginal repair of VVF with general surgeons may have additional inflammatory disease processes, such as bowel disease. This could contribute to the significant age difference present as well. The greater morbidity of women who underwent VVF repair with general surgery may be due to concomitant GI disorder, as the database did show that the majority of women undergoing VVF repairs performed by general surgeons also underwent bowel surgery. These additional procedures could also be why general surgery patients were more likely to be inpatients and have a longer hospital stay. Another hypothesis for

general surgeons performing vaginal repair of VVF could be limited access to specialty surgeons. This can occur with other subspecialty surgeries, such as cesarean sections [23, 24]. However, there were some cases in general surgery in which a second surgical team was present (4 out of 12, 33%) and performed cystoscopies and stents, therefore, indicating genitourinary specialists were available.

There were no differences in postoperative complications or readmission rates. This could be attributed to the fact that urologists, gynecologists, and general surgeons performing vaginal repair of VVF were trained or experienced in this procedure. However, owing to the rare nature of these occurrences, the study was likely underpowered to fully assess these rare outcomes.

This study noted a difference in the use of flaps/grafts between urologists and gynecologists, with urologists using flaps/grafts more frequently, in 12.5% of their cases. To our knowledge, there is no published literature examining the frequency differences of these procedures by specialty. Use of a flap/graft could suggest that those procedures had larger or more complicated defects. However, evidence is mixed regarding the benefit of a flap ranging from improved success rate to no benefit in obstetric fistula repair [25, 26].

From a training perspective, none of the involved surgical specialties (urology, gynecology, or general surgery) have a residency minimum training requirement for fistula repair [27–29]. However, urogynecology has a new requirement for a minimum of three urinary fistula repairs [30] as well as assessment of milestones related to urinary fistula diagnosis and management [31]. Owing to the formalized curriculum for urogynecology, it may be considered to refer women with VVF to a urogynecologist if available. Voices for PFD, a patient-friendly source with information for those with pelvic floor disorders, has a reference tool to search for urogynecologists by location [32].

There are no other studies regarding vaginal repair of VVF for comparison; however, the ACS NSQIP database has been utilized to analyze practice patterns of urologists versus gynecologists for midurethral mesh sling procedures for the treatment of stress urinary incontinence [18]. The authors found that gynecologists perform the majority of slings and that there were significant differences in patient characteristics, with urology patients having more preoperative comorbidities [18]. Interestingly, our study did not show parallel findings for vaginal repair of VVF.

There are limitations to this study that are inherent in the retrospective design, including the risk of selection bias and misclassification. These risks were minimized by using the ACS NSQIP database, which includes objective data abstracted from medical records. Variables not included in the database include surgeon volume, surgeon expertise, subspecialty training (such as urogynecology), and case complexity. These factors could play a role in perioperative and postoperative outcomes. Operative times include other surgeries that the primary team performed. Therefore, this datapoint may not accurately represent duration of vaginal repair of VVF. Variables listed as unknown could additionally affect the outcomes presented. An additional limitation is the inability to evaluate surgical specialty for surgical teams that were not the primary team, although concomitant surgical teams were uncommon.

Strengths of this study include the large, validated database that was used to identify cases of vaginal repair of VVF from institutions throughout the United States that participate in NSQIP. The data included all types of surgeons who perform vaginal repair of VVF, which also increases generalizability.

In conclusion, women who undergo vaginal repair of VVF are typically treated by urologists and gynecologists, and less commonly by general surgeons, with low rates of perioperative and postoperative complications. Urologists and gynecologists were more likely to operate on younger, healthier patients with differences in racial populations, whereas general surgeons were more likely to operate on older white women with a worse health status, with the majority undergoing a concomitant bowel resection, with a longer hospital stay. Although there are differences in patient and perioperative characteristics when comparing vaginal repair of VVF by surgeon specialty, overall reoperation and readmission rates are low, further supporting repair of VVF via the vaginal route. This information may help referring providers and patients to understand which types of surgical providers most commonly manage VVF.

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Author contributions Geller and Margulies significantly contributed to the project development, data collection, data analysis, manuscript writing and editing.

Declarations

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