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REVIEW

Vesico-Vaginal Fistula in Females in 2010–2020: a Systemic Review and Meta-analysis

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Abstract

Introduction In the Western world today, urogenital fistula, including vesicovaginal fistula (VVF), is rare. However, while it remains significant in developing parts of the world due to prolonged and obstructed labor, in this study, we systematically reviewed the existing literature, discussing VVF occurrence, its etiology, and outcomes.

Material and Methods We used electronic databases to search relevant articles from 2010–2020. The screening was performed with the help of Covidence. Relevant data from included studies were extracted in excel sheets, and final analysis was done using CMA-3 using proportion with 95% confidence interval (CI).

Results Fifteen studies reported the VVF among the fistula series. The pooled result showed 76.57% cases of VVF (CI, 65.42–84.96), out of which 27.54% were trigonal, 55.70% supra-trigonal, and the rest with a varied description like circumferential, juxta-cervical, juxta-urethral. Obstetric etiology was commonly reported with 19.29% (*CI*, 13.26–27.21) with cesarean section and 31.14% (*CI*, 18.23–47.86) with obstructed labor. Hysterectomy was the commonly reported etiology among gynecological etiology (46.52%, *CI*; 36.17–57.19). Among different surgical treatments employed for fistula closure, 49.50% were by abdominal approach (*CI*, 37.23–61.82), and 42.31% by vaginal approach (*CI*, 31.82–53.54). Successful closure of fistula was reported in 87.09% of the surgeries (*CI*, 84.39–89.38).

Conclusion The vesicovaginal fistula is the most common type of genitourinary fistula. Major causes of fistula are gynecological surgery, obstructed labor, and cesarean section. The vaginal approach and abdominal are common modalities of repair of fistula with favorable outcomes in the majority of the patients.

Keywords Cesarean section · Hysterectomy · Vesicovaginal fistula

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Introduction

Vesicovaginal fistula (VVF) is an abnormal connection between the urinary bladder and the vagina, which causes leakage of urine in the vagina. Although a rare entity, urogenital fistula is caused mainly by surgery, radiation therapy, or malignancy in the Western world [1]. It occurs due to obstetric complications such as prolonged and obstructed labor in developing parts of the world. It remains an important but neglected topic that the World Health Organization has referred to as a forgotten disease [2–4]. The incidence of VVF ranges from 0.3 to 2% [5]. At least 3 million women worldwide are believed to have an untreated vesicovaginal fistula, with the majority of them from Africa and Southern Asia. In Africa, 30,000 to 130,000 women develop vesicovaginal fistula annually [1]. Women having VVF are continuously damp from urine leakage and sometimes suffer genital ulceration, infections, and an unpleasant smell. Approximately 20% of women with fistula often develop unilateral or bilateral foot drop that restricts their daily activities [6].

In women with this disorder, it causes physical, social, and psychological effects. VVF prevention and management can be supported by knowledge of the disease, professional birth attendance, surgical care, along with therapeutic support. Addressing the rising public health concerns of VVF, various charitable and non-governmental organizations are developing management programs and establishing particular centers for the care of patients with VVF [3, 7].

The majority of reports for VVF consisted of case series and experiences of health professionals. Whereas the existing studies were not specific, with studies mostly focused on obstetric fistulas as mainstream. In this study, we systematically reviewed the existing literature of the last decade, discussing the occurrence of vesicovaginal fistula, its etiology, surgical approach, and outcomes after developing VVF.

Material and Methods

Protocol

Our systematic review and meta-analysis were conducted according to the MOOSE guidelines after registration in PROSPERO (CRD42020215772) [8].

Eligibility Criteria

We included cross-sectional studies, case-control studies, cohort studies, and case series (more than 20 patients) with women diagnosed with vesicovaginal fistula during 2010–2020 and excluded studies with women diagnosed as other causes of urinary incontinence and pregnant women. We also excluded the study with inadequate data and results. In addition, letters to the editor, viewpoints, and experiences were also excluded in the study.

Search Strategy

We used electronic databases like PubMed, PubMed Central, Scopus, and Embase to search relevant articles from 2010 to 2020 using terms like "vesicovaginal fistula", "VVF" and "gynecological fistula" with appropriate Boolean operators. The detailed search strategy is included in the supplementary file.

Study Selection

Two reviewers (PJ and PK) independently screened the title and abstract of imported studies, and any arising conflict was solved by the third reviewer (GM). A full-text review was done independently by GM and PK. Data were extracted for both quantitative and qualitative synthesis. The conflicts were resolved by taking the opinion of the third reviewer (PJ). The screening was performed with the help of Covidence [9].

Data Extraction

Relevant data, including study characteristics, quality, and endpoints, were extracted onto a standardized form designed in Excel. Our outcomes were the prevalence of overall genitourinary fistulas, vesicovaginal fistulas among different genitourinary fistula, anatomical types of vesicovaginal fistula, and gynecological etiology of vesicovaginal fistula, the surgical approach for closure, and success of closure of the vesicovaginal fistula. We extracted the data from included studies based on our outcomes of interest.

Methodologic Quality

The quality of individual articles was evaluated using the Joanna Briggs Institute (JBI) critical appraisal. In addition, the risk of bias was assessed. Two of the authors had independently assessed the design of each study, the number of patient included outcomes of VVF, included risk factors, and if the outcome as mentioned earlier were measured. Disagreements were resolved by discussion with a third person.

Data Analysis

Data were analyzed using CMA-3 [41]. The proportion was used as a measure of effects, and the I^2 test measured heterogeneity. The random/fixed-effect model was used based on heterogeneity.

Sensitivity Analysis

Sensitivity analysis was done by excluding individual studies to observe the impact of individual studies.

Subgroup Analysis

Subgroup analysis was performed while evaluating the outcome of interest as appropriate. In addition, less commonly reported results were tabulated in supplementary files.

Publication Bias

Publication bias across the study was assessed using Egger's funnel plot using the MD and 1/SE values for appropriate outcomes.

Results

We identified a total of 8288 studies after thorough database searching and a total of 1875 duplicates were removed. We screened 6413 studies and excluded 6014 studies. After assessing 399 studies for full-text eligibility, 368 were excluded for definite reasons (Fig. 1). The remaining 31 studies were included in the qualitative summary and quantitative analysis (Table 2 and Supplementary file 2).

Quantitative Analysis

Total of 31 studies were included in the analysis. There was no study from an apparently normal population investigating genitourinary fistula, but two studies evaluated the prevalence of genitourinary fistula (GUF) among risk groups and showed 12.3% (*CI*: 1.5–56%) (Supplement file 3, Fig. 1).

Rate of VVF Among GUF

Fifteen studies reported the VVF among the GUF series they have studied. Pooling the data using the random effect model showed 76.57% of cases were VVF among GUF (proportion, 0.7657; *CI*, 0.6542–0.8496) (Fig. 2**).** Sensitivity analysis to gauge the impact of individual studies in the overall result was conducted by excluding individual studies and showed no significant change after excluding particular studies (Supplement file 3, Fig. 2**).**

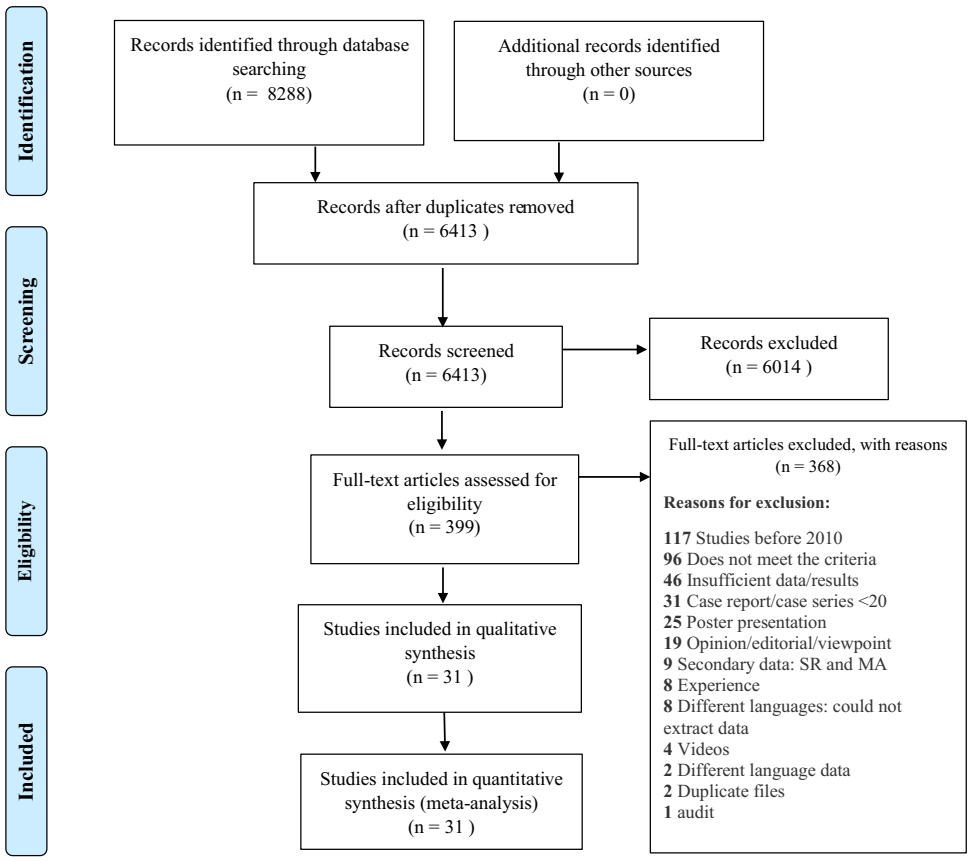

Fig. 1 PRISMA flow diagram

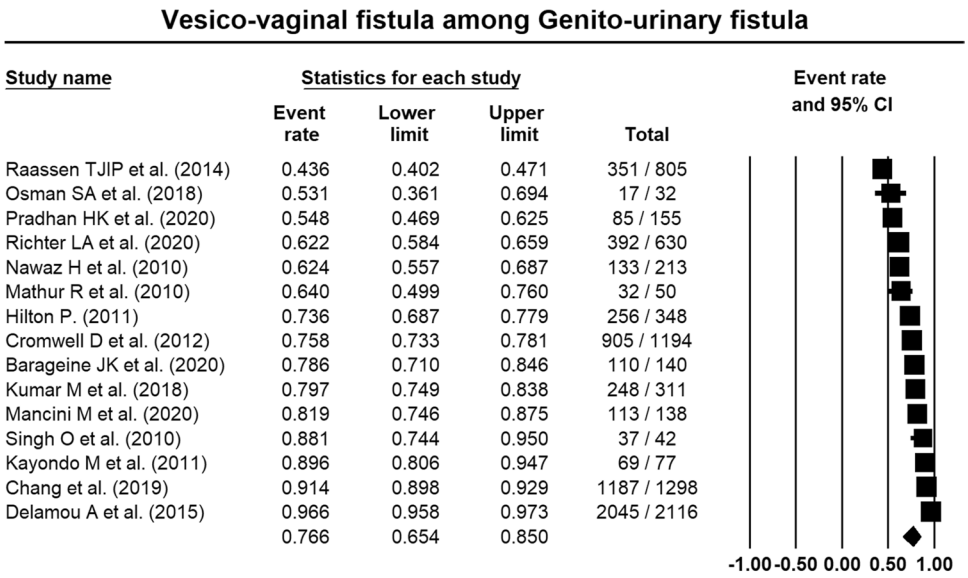

Fig. 2 Rate of vesico-vaginal fistula (VVF) among genitourinary fistula (GUF) studied in different studies

Common Anatomical Types of Fistula Reported

In most studies, there were no clear specifications of different anatomical types of VVF rather classified overall GUF, so while pooling anatomical types of all GUF pooled. Pooling of data from six studies reporting a common anatomical type of fistula using a random-effect model showed supra-trigonal in 55.70% (Proportion, 0.5570; *CI*, 0.3439–0.7510; I^2, 93.87), trigonal in 27.54% (Proportion, 0.2754; *CI*, 0.1811–0.3952; I^2, 83.86) (Fig. 3). Rest, less commonly reported fistula were circumferential, juxta-cervical, juxta-urethral, etc. (Supplement file 3, Table 1)**.**

Obstetric Fistula

Obstetric etiology was commonly reported etiology in most of the studied fistula population.

Cesarean Section

Pooling of data from 19 studies reporting a cesarean section using a random-effect model showed 19.29% (proportion, 0.1929; *CI*, 0.1326–0.2721; I^2, 97.78) (Fig. 4). Sensitivity analysis to gauge the impact of the individual study on the cesarean section as etiology was carried out by excluding individual studies and showed no significant change after excluding particular studies (Supplement file 3, Fig. 3)**.**

Obstructed Labor

Pooling of data from 13 studies reporting an obstructed labor using a random-effect model showed 31.14% (proportion, 0.3114; *CI*, 0.1823–0.4786; I^2, 96.80) (Fig. 5). Sensitivity analysis to gauge the impact of the individual study on obstructed labor as etiology was carried out by excluding individual studies and showed no significant change after excluding a particular study (Supplement file 3, Fig. 4)**.** Other less commonly reported obstetric etiology of fistula were vaginal delivery, cesarean hysterectomy, instrumental delivery, etc. (Supplement file 3, Table 2)**.** Most obstetric fistulae were iatrogenic in origin, and the commonly reported were cesarean section, cesarean hysterectomy, instrumental deliveries, etc. (Supplement file 3, Table 3)**.**

Gynecological Etiology of Fistula

Among gynecological etiology, hysterectomy (vaginal, abdominal) was the commonly reported etiology. Less widely reported gynecological etiologies include radiation therapy for cancer, different gynecological procedures, and cancer (Supplement file 3, Table 4).

Among 16 studies reporting hysterectomy, pooling of data using a random-effect model showed 46.52% of fistula associated with hysterectomy (proportion, 0.4652; *CI*, 0.3617–0.5719, I^2, 95.72) (Fig. 6). Sensitivity analysis to gauge the impact of the individual study on hysterectomy as etiology was carried out by excluding individual studies and

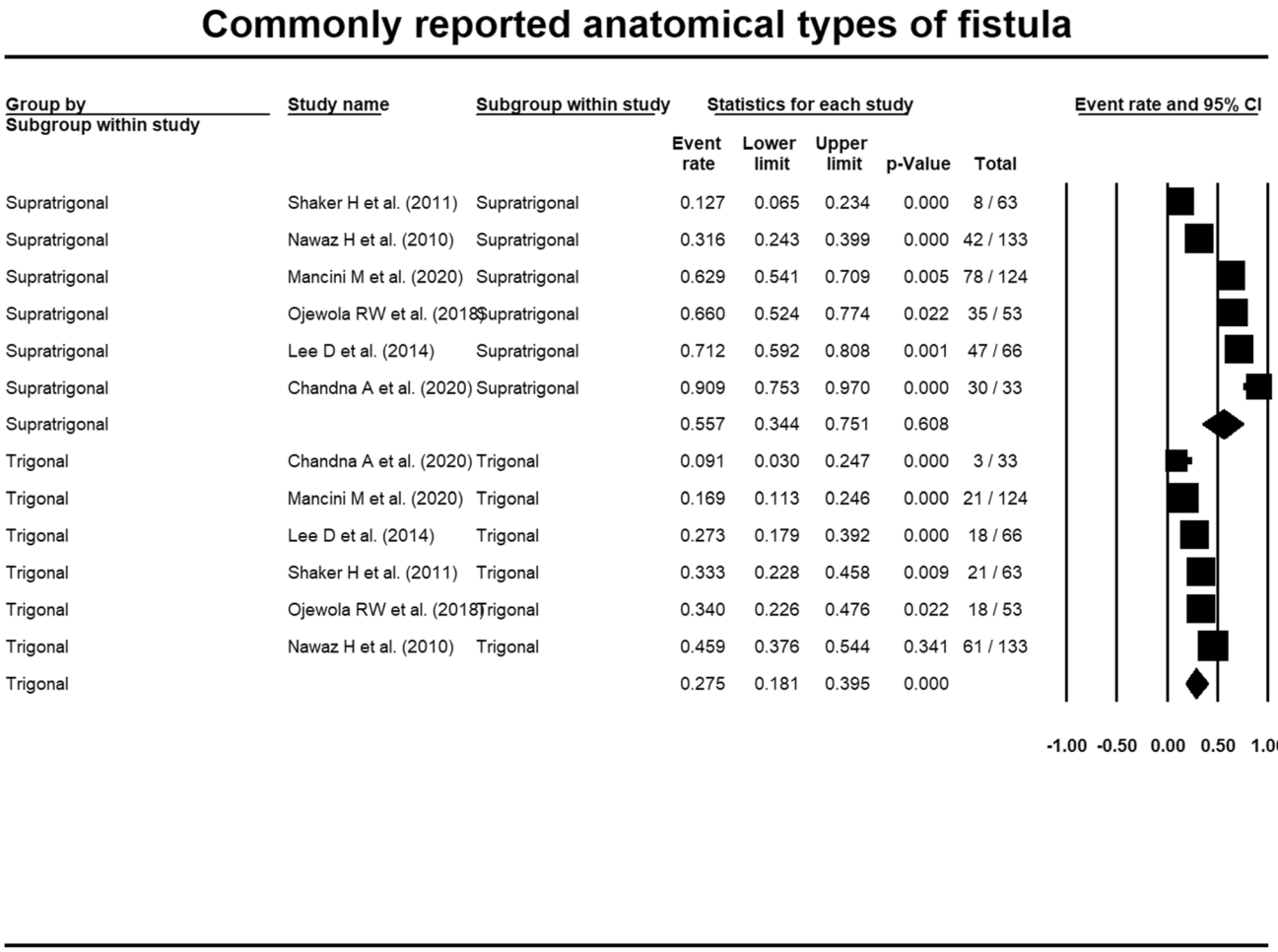

Fig. 3 Commonly reported anatomical types of fistula

showed no significant change after excluding a particular study (Supplement file 3, Fig. 5).

Surgery for Fistula Closure

Different types of surgical treatment were employed as a definitive treatment of fistula closure. Due to the unavailability of data on surgical treatment of VVF, the management of GUF was only reported in most studies, so pooling was done for the management of GUF. Surgical approach for closure includes the vaginal approach, abdominal approach, combined abdominal and vaginal, laparoscopic approach, and less commonly employed procedures were diversion techniques, etc. (Supplement file 3, Table 5)**.**

The abdominal approach was reported in 17 studies. Pooling of data showed that 49.50% of the surgical closure was done by the abdominal approach (proportion, 0.4950; *CI*, 0.3723–0.6182; I^2, 93.55) (Fig. 7). Sensitivity analysis to gauge the impact of the individual study on the abdominal approach for fistula closure was carried out by excluding individual studies and showed no significant change after excluding particular studies (Supplement file 3, Fig. 6)**.**

A vaginal approach for fistula closure was reported in 14 studies. Pooling of data showed 42.31% of procedures carried out by a vaginal approach (proportion, 0.4231; *CI*, 0.3182–0.5354) (Fig. 8). Sensitivity analysis to gauge the impact of the individual study on the vaginal approach for fistula closure was carried out by excluding individual studies (Supplement file 3, Fig. 7).

Successful Closure of the Fistula

Twenty-three studies reported successful closure of fistula in their outcome. In 87.09% of the surgeries (proportion, 0.8709; *CI*, 0.8439–0.8938), a successful closure of fistula was reported (Fig. 9). Sensitivity analysis on successful fistula closure by excluding individual studies showed no differences (Supplement file 3, Fig. 8). Among operated cases, 82.69% were successful and continent surgeries (Proportion, 0.8269; *CI*, 0.7393–0.8895; I^2, 83.39)

Table 1 JBI assessment of included studies

Study name	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	RESULT (Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐)
Akpak et al. [10] (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Barageine et al. [11] (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Chandna et al. [12] (2020)	Yes	Unclear	Yes	Yes	No	Yes	No	No	Yes	Include
Chang et al. [13] (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Cromwell et al. [14] (2012)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Delamou et al. [15] (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Farahat et al. [16] (2012)	Yes	Unclear	No	No	No	Yes	Yes	Unclear	Yes	Include
Gupta et al. [17] (2010)	Yes	Unclear	No	No	No	Yes	Yes	Unclear	Unclear	Include
Hilton [18] (2011)	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Kayondo et al. [19] (2011)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Include
Kumar et al. [20] (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Kurniawati et al. [21] (2020)	Yes	Not Clear	Yes	Yes	No	No	No	No	Yes	Include
Lee et al. [22] (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Mancini et al. [23] (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Mathur et al. [24] (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Include
McCurdie et al. [25] (2018)	Yes	Yes	Yes	No	No	Yes	Yes	No	No	Include
Nawaz et al. [26] (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Include

Table 1 (continued)

Study name	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?	RESULT (Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐)
Ojewola et al. [27] (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Include
Osman et al. [28] (2018)	No	Unclear	No	Yes	Yes	Yes	Yes	Yes	Yes	Include
Pradhan et al. [29] (2020)	Yes	Unclear	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Include
Raassen et al. [30] (2014)	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Reddy et al. [31] (2019)	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Include
Richter et al. [32] (2020)	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear	Yes	Yes	Include
Rupley et al. [33] (2020)	Yes	Unclear	Yes	Yes	Yes	Unclear	Yes	Unclear	Unclear	Include
Shaker et al. [34] (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Include
Singh et al. [35] (2010)	No	Unclear	No	Yes	Yes	Yes	Yes	Yes	Yes	Include
Singh et al. [36] (2011)	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Include
Sunday-Adeoye et al. [37] (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include
Tatar et al. [38] (2017)	No	Unclear	No	Yes	Yes	Yes	Yes	Yes	Yes	Include
Wahab et al. [39] (2016)	No	Unclear	No	No	No	Yes	Yes	Unclear	Unclear	Include
Zhou et al. [40] (2016)	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Include

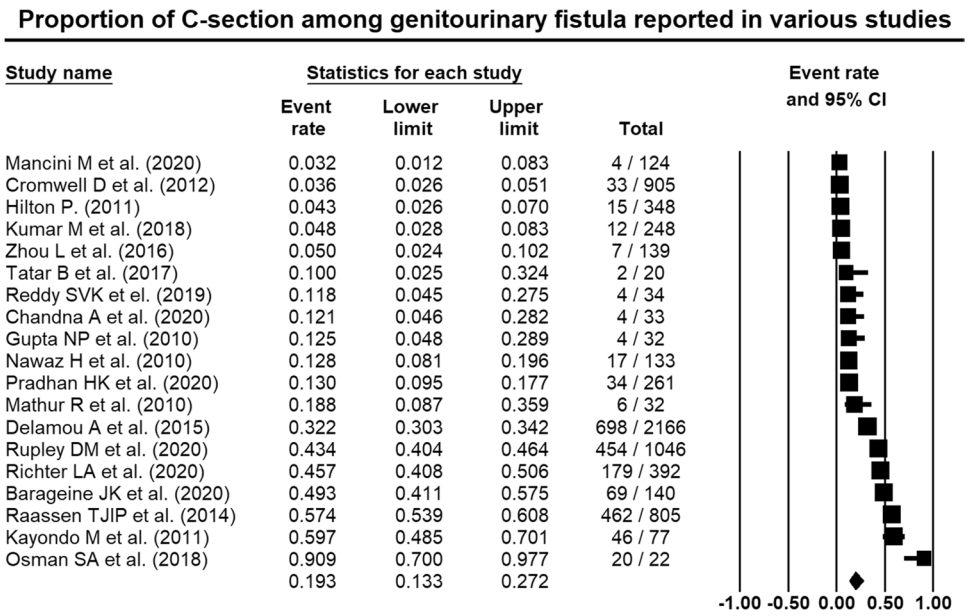

Fig. 4 Cesarean section as culprit etiology for fistula among GUF cases reported in various studies

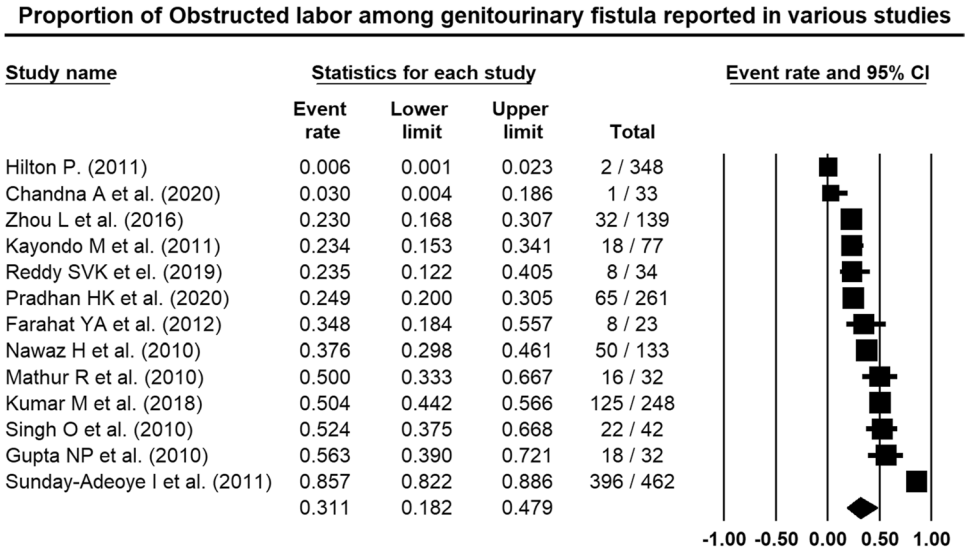

Fig. 5 Obstructed labor as culprit etiology for fistula among GUF cases reported in various studies

(Supplement file 2, Fig. 9.). Sensitivity analysis on successful and continent surgeries by excluding individual studies showed no significant differences (Supplement file 3, Fig. 10).

Publication Bias

Included studies showed some publication bias for the respective outcome. Supplementary file 3, Fig. 11 showed publication bias of reporting VVF among fistula using Egger's funnel plot.

Table 2 Qualitative summary

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Akpak et al. [10] (2020)	Retrospective case series	**Total population**: **56** **VVF patient**: **51** **Age: >18**	Abdominal: 17/51 Vaginal: 31/51 Laproscopic: 2/51	**Successful surgery: 43/51** **Unsuccessful surgery: 8/51**	**FGM/C: 47/51** **H/o prior repair: 12/51**	
Barageine et al. [11] (2014)	Case control study	**Population**: 140 **VVF:** 110/140**, VVF and RVF:** 5/140	**Not specific**	**Not specific**	**Mode of delivery:** Vaginal delivery: 71/140 CS: 69/140	Primipara: 46/140 Para 2–4: 47/140 Grand multipara: 47/140
Chandna et al. [12] (2020)	Prospective observational study	**Robot assisted surgery**: **73** **VVF population**: **33** **Age: 35.5 years -49.9 years** **Location of VVF**: Supratrigonal: 30/33 Trigonal: 3/33		Successful: 31/33 Unsuccessful: 2/33	Hysterectomy: 27 CS: 4 Obstructed Labor: 1 Radiation: 1 Recurrent: 20/33	
Chang et al. [13] (2019)	Retrospective case-control	**Total population**: 1298 **VVF population:** 1187		**Patients with post-repair urinary retention**: **40**		
Cromwell et al. [14] (2012)	Retrospective cohort study	**Urogenital cases**: **1194** **VVF and urethro-vaginal fistula**: 905/1194 **Age**: 52.4(15.6)		**Successful surgery**: 797/905 **1st repair failed**: 108/905	Hysterectomy: 426/905 CS: 33/905	
Delamou et al. [15] (2015)	Retrospective cohort study	**Total surgery**: 2116 **VVF population**: **2045/2116** **VVF and RVF: 48/2116** **Age**: **< 17** = 63/2116, **17–24** = 402/2116,**25–49** = 1293/2116, **≥ 50** = 326/2116, **unknown**: 32/2116	**For VVF** Fistula Closed: 1744/2045 Dry: 1630/2045 Residual Incontinence: 114/1744 Fistula not closed: 297/2045 **For VVF and RVF** Fistula closed: 28/48 Dry: 27/28 Residual Incontinence: 1/28 Fistula not closed: 20/48		**Mode of delivery**: Vaginal: 1377/2116 CS: 698/2116 Unknown: 41/2116	1 birth: 625/2116 2–5 births: 950/2116 ≥ 6 birth: 510/2116 Unknown: 31/2116
Farahat et al. [16] (2012)	Pilot study	**VVF population**: **23** **Location**: Trigonal: 7/23 Trigonal +ureteral orifice encroachment: 2/23 Posterior bladder wall: 14/23	**Types of surgery done** Abdominal: 16/23 Vaginal: 7/23	**Successful Surgery:** Dry: 21/23 **Unsuccessful surgery:** Wet on 1st follow-up: 2/23	Obstructed labor: 8/23 Cystocele repair: 3/23 AH: 9/23 VH: 3/23	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Gupta et al. [17] (2010)	Retrospective study	**VVF population: 32** **Previous delivery (in obst VVF): $N = 22$** Hospital: 5/22 Home with TBA: 6/22 Home with untrained BA: 11/22		**Successful Surgery:** 30 **Unsuccessful surgery:** 2	**Obstructed labor: 18/32** Post hysterectomy: 10/32 CS: 4/32	Primi-para:21/32 Multi-para:11/32
Hilton P [18] (2011)	Retrospective study	**Total ample: 348** VVF: 256/348 Combined VVF + UVF: 13/348 **Age: 44 (7–89)** **Fistula site** Vault:180/256 Midvaginal: 32/256 Bladder neck: 17/256 Large: 13/256 Juxtacervical: 11/256 Subsymphyseal: 3/256	**Types of surgery done** Abdominal: 90/291 Vaginal: 201/291 **Outcome:** Healed spontanously: 24/348 No surgery: 33/348 Primary diversion: 8/348 Primary repair Procedure: 283/348 Closed at First operation: 267/283		AH: 132/348 Radical hysterectomy: 19/348 VH: 8/348 **Obstetric cause:** CS: 15/348 Ruptured uterus: 8/348 Obstructed labor: 2/348	
Kayondo et al. [19] (2011)	Prospective observational study	**VVF population:** 69/77 **Age:** < 18 years: 2/77 18–34: 50/77 > 35 year: 25/77 **Types of VVF:** Juxta urethral: 16/77 Circumferential: 12/77 **Recurrent VVF**: 32/77 **Vaginal scarring**: 17/77	**Hospital stay days:** 14–21 **Successful surgery:** 55/69 **Continent: 42/69** **Incontinent: 13/69**		Instrumental delivery: 8/77 Obstructed labor: 18/77 CS: 46/77	
Kumar et al. [20] (2018)	Retrospective study	**Sample size**: 311 **VVF population**: 248/311 **Mean age in years ± SD** (34.4 ± 7.6 (20–61) **Mean interval since presentation in months ± SD**: 26.2 ± 49.9 (1–360) **Mean size of fistula (mm)**: 36 (5–60) **Mean Hospital stay days**: 14.9 ± 5.3 (5–36)	**Types of surgery done** Abdominal: 111/248 Abdominal repair + ureteroneocystostomy: 14/248 Vaginal: 103/248 Laparoscopic repair: 19/248 Continent cutaneous diversion: 2/248 Augmentation with ileum: 2/248	**Successful surgery:** Abdominal: 106//111 Vaginal: 95//103 Laparoscopic repair: 17/19	Obstructed Labor: (vaginally): 85/248, (LSCS): 40/248 LSCS for other indications: 12/248 Cesarean hysterectomy: 9/248 AH: 88/248 VH: 2/248 Uterus rupture: 3/248 Carcinoma cervix: 2/248 Dilatation and curettage: 6/248 Myomectomy: 1/248	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Kurniawati et al. [21] (2020)	Observational study	**VVF population**: 35	**Treatment** Conservative management: 19/35 Surgical Management**:** 16/35 **Types of surgery done** Abdominal: 1/16 Vaginal: 15/16	**Successful surgery:** 11/16 **Unsuccessful surgery:** 5/16		
Lee et al. [22] (2014)	Retrospective study	**Sample size**: **66** **VVF population**: **66** **Age mean ± SD**: 45 ± 10.4 **Previous surgery-definitive VVF repair**: 66/66 **Location of VVF** Trigonal 18/66 Supratrigonal: 47/66 Ureteral: 1/66	**Types of surgery done** Abdominal: 16/66 Vaginal: 50/66	**Successful surgery: 64/66**	Hysterectomy (total): 58/66 Hysterectomy (unknown route): 48/58 AH: 7/58 VH: 2/58 LH: 1/58 Obstetric: 3/66 Other: 5/66	
Mancini et al. [23] (2020)	Retrospective study	**Sample size**: 138 **VVF population**: 113/138 VVF + RVF: 6/138 VVF + ureterovaginal: 3/138 Neobladder + VVF: 2/138 **Mean age (SD)**: 48 (10.9) **Location in the bladder**: Trigonal: 21/124 Subtrigonal: 3/124 Supratrigonal: 78/124 Bladder neck: 5/124 Lateral wall: 2/124 Posterior wall: 11/124 Not reported: 4/124	**Types of surgery done** **Vaginal:** 14/138 **Abdominal:** 124/138 Noncontinent urinary diversions: 6/124 Considered for outcome measures: 118/124	**Successful surgery**: 111/118 **Failed repair:** 7/118 Follow up possible in 95/138 patients only **Symptom free on follow-up (30 months):** 91/95 **Persistence of urinary leakage per vaginum:** 2/95 **Urge urinary incontinence:** 2/95	Hysterectomy: 91/124 Radiotherapy: 10/124 Vaginal delivery: 9/124 CS:4/124 Bladder biopsy: 1/124 Bladder diverticulectomy: 1/124 Resection of urethral lesion: 3/124 Vaginoplasty: 2/124 Sacral colpopexy: 1/124 Radical cystectomy and neobladder: 2/124 Trauma: 1/124 Not reported: 1/124 **Previous closure attempts:** 36/138	
Mathur et al. [24] (2010)	Prospective study.	**Sample size**: **50** **VVF population**: **32/50** **Age**: < 20 years: 2/50 20–39 year: 28/50 > 40 year: 20/50	**Surgery done: 44/50** Abdominal: 22/50 Vaginal: 14/50 Both: 8/50 Conservative treatment: 6/50	**Successful surgery:** 30/32	Obstructed Labor: 16/32 Post LSCS: 6/32 Post TAH: 10/32	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
McCurdie et al. [25] (2018)	Retrospective case review	**Sample size**: 93 **VVF population**: 93 **Age**: < 20 years: 11/93 20–39 year: 68/93 > 40 year: 14/93	**Successful surgery: 87/93** **Symptom free on follow-up: 24//26**			**Recurrent VVF:** 15/93
Nawaz et al. [26] (2010)	Retrospective study.	**Sample size**: **213** **VVF population**: **133/213** **Location of vesicovaginal fistula** Trigonal: 61/133 Supratrigonal: 42/133 Mixed: 30/133 **Mean hospital stay (days)**: 15 ± 3.5	**Types of surgery done** Vaginal: 51/133 Transvesicle: 29/133 Abdom. + vaginal: 28/133 Abdominal: 13/133 Endoscopic fulguration: 02/133 Ileal conduit: 02/133 Uretero- singmoidostomy: 04/133 Mitraffinof: 04/133 **Successful surgery:** 117/133 **Failed repair:** 16/133		AH: 19/133 VH: 6/133 CS: 17/133 Forceps delivery: 15/133 Pressure Necrosis:50/133 CS hysterectomy: 19/133 Colporrhaphy: 1/133 Others: 6/133	
Ojewola et al. [27] (2018)	Retrospective study	**Sample size**: **53** **VVF population**: **53** **Age Mean ± SD**: 29.8 ± 15.4 years **Location in the bladder** Trigonal: 18/53 Supratrigonal: 35/53	**Types of surgery done** Abdominal: 53/53 Trans peritoneal transvesical: 44/53 Extra peritoneal transvesical: 9/53	**Successful surgery:** 47/53 **Failed repair: 6/53**	Obstetric: 41/51 AH: 3/51 VH: 6/51	**History of previous repairs:** 43/51
Osman et al [28] (2018)	Retrospective cohort study	**VVF population**: 17/32 **Age (years) (range) mean**: (17–62) 43.0 **Mean post-treatment follow-up duration**: 13 months (range: 2 months to 3 years)	**Procedure (Total number of procedures = 40)** **Types of surgery done (for VVF):** Abdominal: 9/24 Vaginal: 10/24 Robotic: 3/24 Fulguration: 2/24	**Need for repeat procedure**: 6/17 **Cured based on symptoms and the findings of physical and radiologic investigations**: 30/32	Iatrogenic obstetric: 22/32 Cesarean delivery: 20/22 Cervical cerclage: 2/22 Gynecologic: 9/32 Motor vehicle accident: 1/32	
Pradhan et al. [29] (2020)	Retrospective study	**Total cases of fistula**: 261 Total obstetric fistula = 155/261 VVF: 85/155 RVF: 42/155 Circumferential fistula: 10/155 Juxtacervical fistula: 7/155	**Successful surgery**:130/155 **Successful surgery with continence**: 121/155 **Successful surgery with urinary incontinence**: 9/155 **Unsuccessful surgery**: 23/155		**Obstetrical cause (n = 155)** After prolonged VD: 65 Instrumental delivery: 43 CS: 34 After cesarean hysterectomy: 7 Ruptured uterus: 6	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Raassen et al. [30] (2014)	Retrospective record review	*Waaldijk classification* **VVF population (I + II + III)**: (351/805 + 181/805 + 273/805) **Previous laparotomy among women with iatrogenic fistula**: 201/805	**Not mentioned**		**Obstetric procedures** C-section(I + II + III): (324/462 + 0/462 + 138/462) Repair of ruptured uterus(I + II + III): (9/25 + 0/25 + 16/25) Hysterectomy for ruptured uterus(I + II + III) : (16/159 + 86/159 + 57/159) **Gynecological procedures** Gynecological hysterectomy(I + II + III): (1/158 + 95/158 + 62/158) Other(I +I I + III): (1/1 + 0/1 + 0/1)	
Reddy et al. [31] (2019)	Retrospective case series study	**Sample size**: **34** **VVF population**: **34** **Age Mean ± SD**: 36.62 ± 9.02 **Types of vesicovaginal Fistula** Juxta urethral: 3/34 Circumferential: 8/34 Mid-vaginal: 20/34 Juxta cervical: 3/34 **Recurrent VVF**: 6/34	**Types of surgery done** Abdominal: 21/34 Vaginal: 8/34 Laparoscopic: 5/34 **Hospital stay days:** 10–21 **Successful surgery:** 28/34 **Failed to repair:** 6/34 **Symptom free on follow-up (33 months):** 33/33 1 patient lost to follow-up		Instrumental delivery: 8/34 Delay in seeking medical help during labor: 8/34 Hysterectomy: 11/34 History of CS: 4/34	
Richter et al. [32] (2020)	Cross-sectional study	**Sample**: 2091 women screened Total Genitourinary fistulas: 630/2091 **VVF**: 392/630 **VUF**: **185/630** **Ureterovaginal F**: **56/630**	Surgical Fistula Repairs (*N*) = 259 Vaginal Repair: 127/259 Required Hysterectomy: 1/127 Abdominal Repair: 132/259 Required Hysterectomy: 103/132		History of Surgery: 268/392 CS: 179/392 No History of Surgery: 114/392 Unknown Surgical Hx: 10/392	
Rupley et al. [33] (2020)	Case-control study	**Women with VVF at time of delivery (cases)**: 1046 **Length of labor** < = 12 hours: 309/1046 > 12 hours: 734/1046 Missing: 3/1046	Not mentioned		**Type of delivery** Vaginal: 589/1046 Cesarean section: 454/1046 Missing: 105/1046	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Shaker et al. [34] (2011)	Randomized prospective study	**VVF population**: 63 **Non-trimming (NT)**: 32/63 **Trimming (T)**: 31/63 **Age mean 29 ± 7** **Location of fistula**: Urethra: (*T* = 4/31, *NT* = 6/32) Urethro-vesical: 24 (*T* = 13/31, *NT* = 11/32) Trigone:21 (*T* = 10/31, *NT* = 11/32) Supratrigonal: 8 (*T* = 4/31, *NT* = 4/32)	**Successful:** *T* = 21/31, *NT* = 24/32 **Failed repair:** *T* = 10/31, *NT* = 8/32			
Singh et al. [35] (2010)	Case series/Experience	**Urogenital fistulas (UGFs)-42** **VVF cases- 37/42** **Vesicovaginal and uret-erovaginal fistulas** Transabdominal hysterec-tomy: 1/42 Radical hysterectomy for malignancy: 1/42	**Conservative management with catheterization(successful)**: 3/37 **Surgical Management of all Urogenital fistulas**: 39 **Total transabdominal approach**- 28/39 **Transvaginal approach (VVF)-** 11/39		**Vesicovaginal fistula** Obstructed labor: 22/42 TAH: 7/42 VH: 4/42 LH: 1/42 Radical hysterectomy for malignancy: 1/42	
Singh et al. [36] (2011)	Retrospective case review	**Sample size**: 48 **VVF population**: 48 **Age (range)**: **24 (18–48)** **Mean size of fistula in cm (range)**: 4.8 (2.5–7)	**Type of surgery:** Abdominal: 48	**Successful surgery at 1st attempt:** 42 /48 **Successful surgery at 2nd attempt:** 2/6 **Failed repair including both attempts:** 4/48	Obstetric: 30/48 Gynecological: 18/48	
Sunday-Adeoye et al. [37] (2011)	Prospective descriptive study	**VVF population:** 462 among 10,641 deliver-ies during the study period **Age**: < 20 years: 39/462 20–39 year: 232/462 ≥ 40 year: 191/462	**Not specified**	**Mode of delivery**: Instrumental delivery: 88/462 Spontaneous Vaginal delivery: 169/462 Cesarean section: 197/462	Obstructed labor: 396/462 Iatrogenic: 60/462 Circumcision: 3/462 Trauma: 3/462	Multiparity:172/462 Grand multipara: 146/462 Primigravida: 138/462 Nullipara: 6/462
Tatar et al. [38] (2017)	Retrospective study	Total cases of VVF (*T*) = 20	**Abdominal repair**: 13/20 **Vaginal repair**: 5/20 **Laparoscopic repair**:2/20	**Recurrence** Yes: 1/20 No: 19/20 **Follow-up months, (range) mean**: (2–18), 9.1	**All Iatrogenic cases** **Surgical: 16/20** **C-section: 2/20** **Cancer related: 2/20**	

Table 2 (continued)

Study ID	Study design	Population	Types of surgery	Other outcomes	Etiology/risk	Parity
Wahab et al. [39] (2016)	Descriptive study	**Sample**: 30 **Total VVF**: 28/30		**Successful surgery**-28/28		
Zhou et al. [40] (2016)	Hospital-based retrospective study	**Total patients (*T*)** = 139 **Age, years *T*** = 46.6 **Fistula number** Single = 123/139 Multiple = 16/139	**Approach** Vaginal = 114 Abdominal = 25	Success = 119 Failure = 20	Hysterectomy for malignant condition = 28/139 Hysterectomy for benign condition = 68/139 Obstructed labor = 32/139 Cesarean = 7/139 Others = 4/139202	

AH, abdominal hysterectomy; *CS*, cesarean section; *LH*, laparoscopic hysterectomy; *LSCS*, a lower segment cesarean section; *RVF*, recto vaginal fistula; *T*, total patients; *TAH*, total abdominal hysterectomy; *UGF*, urogenital fistula; *VH*, vaginal hysterectomy; *VVF*, vesico-vaginal fistula

Discussion

Vesicovaginal fistulas have a significant impact on the patient's physical, social, and mental well-being. They have remained a concealed condition as it affects most of the overlooked population of women in the rural parts of the world. It can stigmatize a woman in society and lower her self-confidence and outlook towards life. A paper labels obstetric fistula to be the neglected condition of poverty [42]. There is a need for effective measures to prevent this condition by properly identifying the etiology, its occurrence, and risk factors in the community. Furthermore, there is a need for proper universal education, empowerment of women with accessible and improved medical services.

We found that the vesicovaginal fistula is the most common type of genitourinary fistula, and it accounted for 76.57% of various types of genitourinary fistula. This is concordant with Hillary's systematic review, which mentions vesicovaginal fistula as the most common type of fistula [3]. We found that the prevalence of genitourinary fistula (GUF) among the risk group is 12.3% (*CI*: 1.5–56%). However, this estimate was based on just two studies, and the lack of inclusion of normal women of reproductive age group makes our finding hard to generalize. Among the different types of vesicovaginal fistula, the common types were supra-trigonal in 55.70%, followed by trigonal in 27.54%, and other types including circumferential, juxta-cervical, and juxtaurethral. VVF can be classified on various bases like the fistula site, etiology, involvement of continent mechanism, size of fistula, and clinical examination. Classification of fistula into types aids in the decision-making about the management of the patients, adjunct treatments, and follow-up guidance.

The pooling of data from our study showed that the primary etiology of the fistula was obstructed labor and C-section among obstetric etiology, and history of gynecological surgery among gynecological etiology. This aligns with a review that points out the common cause of VVF in developed countries to be pelvic surgery [3]. In cases of underdeveloped countries, prolonged obstructive labor is noted to be the most common etiology (95.2%), followed by cesarean section (9%) and instrumental delivery (2%) [3]. There is a significant discrepancy in VVF's reported incidence and causes between the developed (0.3%) and developing nations (2%) [43]. These figures suggest the need for more intensive studies in this area, especially in developing countries, due to its relatively high incidence and preventable etiology. There is a lack of adequate studies done in these nations reporting on vesicovaginal fistula.

The timing of repair of the vesicovaginal fistula is widely debated, dependent on the status of surrounding

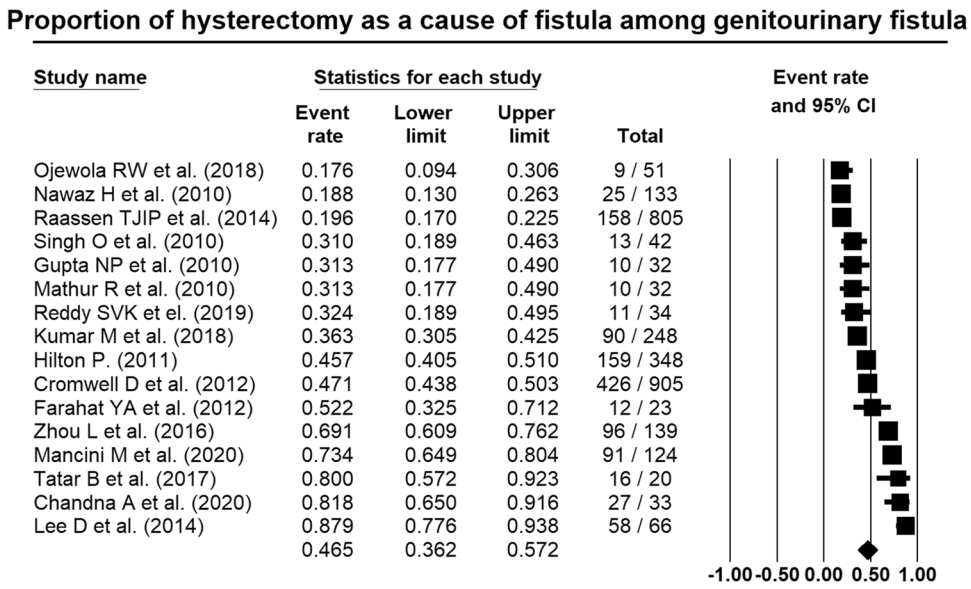

Fig. 6 Hysterectomy as culprit etiology for fistula among GUF cases reported in various studies

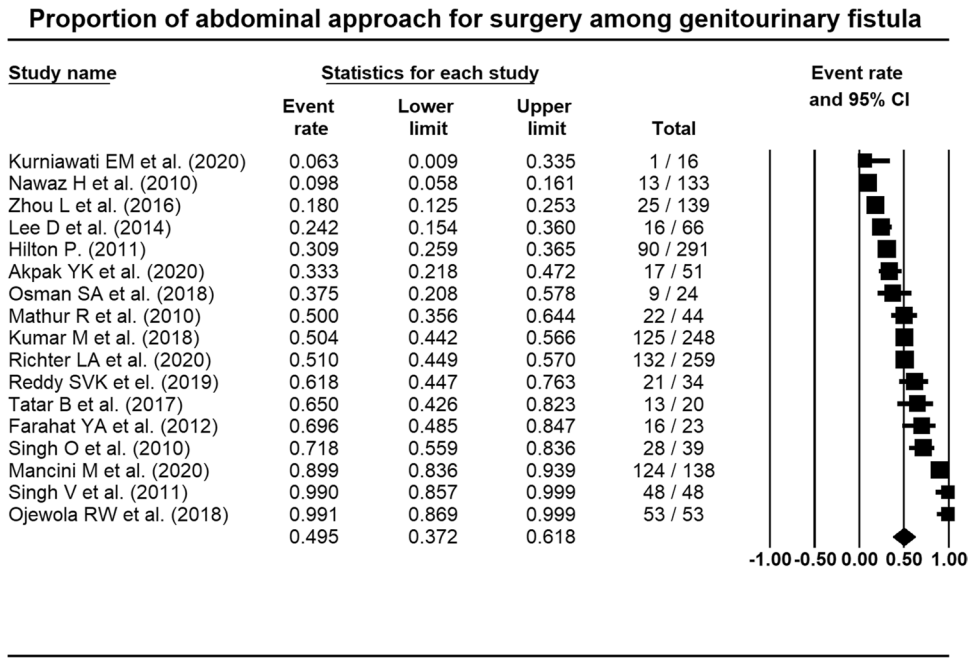

Fig. 7 Abdominal approach for surgery among GUF

tissues. Early repair is preferred in the case of instrumental delivery or cesarean section when the tissue is healthy. However, in cases of gynecological surgery, a 6–12-week delay allows dissipation of most granulation tissue, increasing the possibility of a successful repair. This review shows that most of the research displayed that the surgery successfully treated the fistula, with 87.09% having urinary continence post-surgery. Rajamaheswari et al. [44] demonstrated the successful vaginal and abdominal repair outcome as 86.7% and 100%, respectively. The study also concluded that most supratrigonal VVF showed comparable results when approached vaginally or abdominally [44]. Another study by El-Azab [45] noted that the success rate for a vaginal approach was 91%, whereas an abdominal repair was 84%. The preferred approach for surgical repair relies on the surgeon's familiarity, location of the fistula, space in the vaginal cavity, need for procedures like ureteric reimplantation, and feasibility

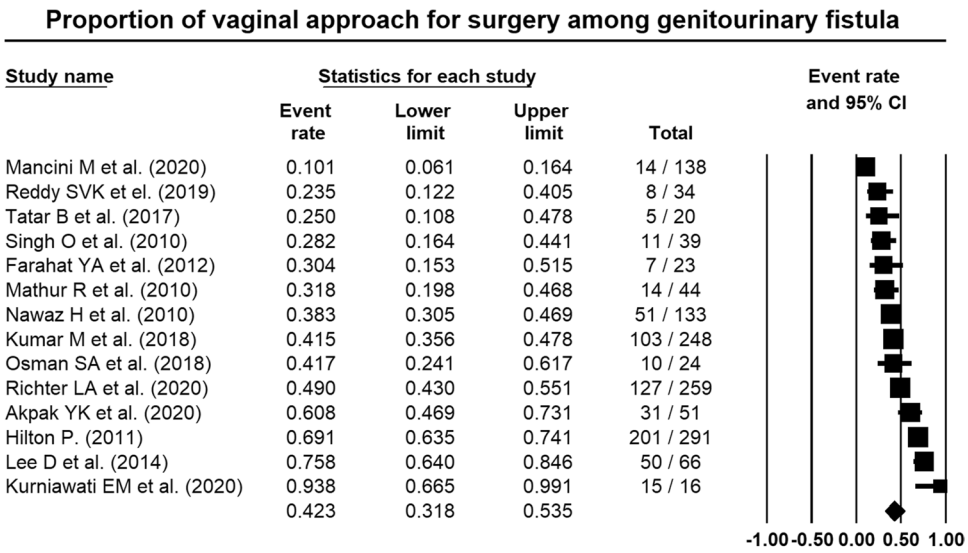

Fig. 8 Vaginal approach for surgery among GUF

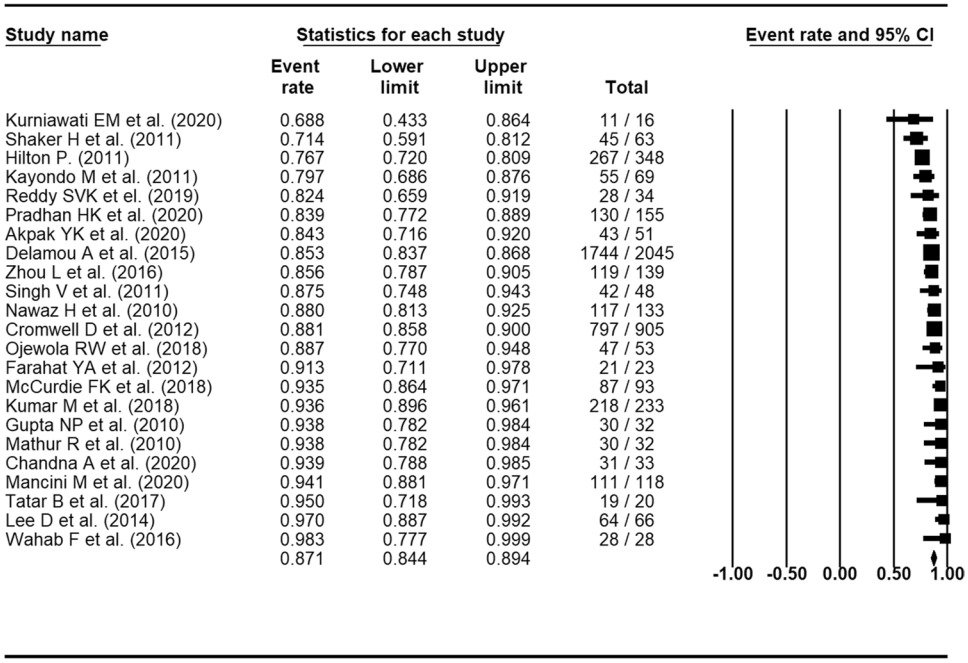

Fig. 9 Successful surgery among GUF

of getting necessary interposition flaps. Both routes have their advantages and drawbacks. Our study found a higher rate of abdominal approach for the correction of the fistula than the vaginal approach. Usually, the abdominal route is chosen when the vaginal repair is contraindicated. The vaginal approach was used in 42.31% of patients with vesicovaginal fistula based on our study, which is far lower than Hillary's review in which 71% and 81% of repair of lower urinary tract fistula were done transvaginally [3]. There are multiple advantages with a vaginal repair, such as shorter operative time, decreased hospital stay, reduced blood loss, and avoidance of abdominal and bladder incisions. However, both studies pointed out a lack of randomized trials to effectively compare the benefits of transabdominal and transvaginal approaches, which could provide an important area of study for future research [44, 45].

It is important to implement guidelines on safe obstetric practice and good surgical practice in gynecological surgeries that would help reduce the genitourinary fistula. However, one of the limitations of our review could be the inability to correctly portray the incidence and prevalence rates because many cases occur in developing nations where there is a lack of proper diagnosis, documentation, and treatment modalities available. Additionally, most studies did not clearly report the outcome of VVF separately, instead, they reported the outcome of overall GUF so we could not fully dissect the details of VVF alone. Also, our review was limited to English-language articles alone. Thus, we recommend formulating national policies that disseminate the information about the condition among middle-aged women, proper identification and documentation of the cases seen, proper maternal prenatal, natal, and postnatal care, and the provision of proper technologies and resources for its treatment.

Selecting the abdominal or vaginal approach of vesicovaginal fistula repair may be biased by the surgeon's basic specialization, whether gynecologist or urologist. Thus, another variable of study would be a basic specialization or specialty unit carrying out the repair.

Conclusion

Vesicovaginal fistula is the most common type of genitourinary fistula. Still, there is a significant discrepancy in the incidence and causes of VVF between developed and developing nations, and obstructed labor leads to the most common cause in developing countries. Though we have noticed that both vaginal and abdominal approaches are almost equally used to repair a fistula, both show favorable outcomes. This could be the result of bias of operating surgeons' preference based on their initial training. More robust studies and improved reporting of cases should be encouraged to improve the data in the future.

Abbreviations AH: Abdominal hysterectomy; CS: Cesarean section; LH: Laparoscopic hysterectomy; LSCS: Lower segment cesarean section; RVF: Recto vaginal fistula; TAH: Total abdominal hysterectomy; UGF: Urogenital fistula; VH: Vaginal hysterectomy; VVF: Vesicovaginal fistula

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Author Contribution DBS, PB, and GD contributed to the concept and design, analysis, and interpretation of data. DBS, PB, PK, PJ, GM, MS, and PG contributed to the literature search, data extraction, review, and initial manuscript drafting. GD and GB interpretation of data, revising the manuscript for important intellectual content, and approval of the final manuscript.

All authors were involved in drafting and revising the manuscript and approved the final version.

Declarations

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

Competing Interests The authors declare no competing interests.

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