EUROPEAN UROLOGY 70 (2016) 478–492

available at www.sciencedirect.com
journal homepage: www.europeanurology.com

European Association of Urology

Review – Reconstructive Urology

The Aetiology, Treatment, and Outcome of Urogenital Fistulae Managed in Well- and Low-resourced Countries: A Systematic Review

Christopher J. Hillary [a], *Nadir I. Osman* [a], *Paul Hilton* [b], *Christopher R. Chapple* [a,*]

[a] *Academic Urology Unit, Royal Hallamshire Hospital, Sheffield, UK;* [b] *Department of Urogynaecology, Newcastle University, Newcastle, UK*

Article info

Article history:
Accepted February 3, 2016

Associate Editor:
Jean-Nicolas Cornu

Keywords:
Fistula
Interposition graft
Obstetric fistula
Obstructed labour
Radiation fistula
Vesico-vaginal fistula

EU ACME
www.eu-acme.org/europeanurology

Please visit www.eu-acme.org/europeanurology to read and answer questions on-line. The EU-ACME credits will then be attributed automatically.

Abstract

Context: Urogenital fistula is a global healthcare problem, predominantly associated with obstetric complications in low-resourced countries and iatrogenic injury in well-resourced countries. Currently, the published evidence is of relatively low quality, mainly consisting retrospective case series.
Objective: We evaluated the available evidence for aetiology, intervention, and outcomes of urogenital fistulae worldwide.
Evidence acquisition: We performed a systematic review of the PubMed and Scopus databases, classifying the evidence for fistula aetiology, repair techniques, and outcomes of surgery. Comparisons were made between fistulae treated in well-resourced countries and those in low-resourced countries.
Evidence synthesis: Over a 35-yr period, 49 articles were identified using our search criteria, which were included in the qualitative analysis. In well-resourced countries, 1710/2055 (83.2%) of fistulae occurred following surgery, whereas in low-resourced countries, 9902/10 398 (95.2%) were associated with childbirth. Spontaneous closure can occur in up to 15% of cases using catheter drainage and conservative approaches are more likely to be successful for nonradiotherapy fistulae. Of patients undergoing repairs in well-resourced countries, the median overall closure rate was 94.6%, while in low-resourced countries, this was 87.0%. Closure was significantly more likely to be achieved using a transvaginal approach then a transabdominal technique (90.8% success vs 83.9%, Fisher's exact test; $p = 0.0176$).
Conclusions: It is difficult to conclude whether any specific route of surgery has advantage over any other, given the selection of patients to a particular procedure is based upon individual fistula characteristics. However, surgical repair should be carried out by experienced fistula surgeons, well versed in all techniques as the primary attempt at repair is likely to be the most successful.
Patient summary: Urogenital fistulae are a common problem worldwide; however, the available evidence on fistula management is poor in quality. We searched the current literature and identified that 95% of fistulae occur following childbirth in low-resourced countries, whereas 80% of fistulae are associated with surgery in well-resourced countries, where successful repair is also more likely to be achieved. The first attempt at repair is often the most successful and therefore fistula surgery should be centralised to hospitals with the most experience.

* Corresponding author. Room H26, H-Floor, Royal Hallamshire Hospital, Glossop Road, Sheffield S10 2JF, UK. Tel. +44 (0)114 271 3048; Fax: +44 (0)114 279 7841.
E-mail address: c.r.chapple@sheffield.ac.uk (C.R. Chapple).

http://dx.doi.org/10.1016/j.eururo.2016.02.015

1. Introduction

Urogenital fistula represents a major global health problem, responsible for significant physical, social, and psychological morbidity. In low-resourced countries (LRC), it is estimated that at least 3 million women worldwide have an untreated fistula, while between 30 000 and 130 000 new fistulae develop annually in Africa alone [1]. Vesico-vaginal fistula is the most common type and in LRC most often results from neglected prolonged obstructed labour, which is associated with tissue ischaemia resulting from compression of the bladder and vagina by the foetal presenting part against the bony pelvis. In contrast, urogenital fistulae are relatively uncommon in well-resourced countries (WRC) and in the UK it is estimated that approximately 120 repairs are carried out on an annual basis [2]. Hence, the literature on fistula repairs in WRC relates to case series or retrospective cohorts from relatively few centres. In comparison to fistulae in LRC, which are largely of obstetric aetiology, those that occur in WRC are associated with iatrogenic factors (surgery or radiotherapy) in almost three quarters of cases [2].

In response to the growing public health issues surrounding obstetric vesico-vaginal fistulae, various charitable and nongovernmental bodies are involved in the development of management programmes and in establishing specific treatment centres [3]. As a result, most fistula repairs are performed by relatively few fistula surgeons in areas of high fistula prevalence, each with their own favoured methods for repair. Therefore, much of our knowledge results from the opinions of comparatively few, borne out of large case series rather than a trial setting. Consequently, there is wide variation in the definitions of fistula location and complexity with little standardisation of treatment protocols and outcome measures.

We aimed to systematically review the current literature on urogenital fistulae in economically less-resourced and WRC, with emphasis on the aetiology, approach to treatment, and the outcomes of fistula management, in order to allow conclusions to be made about the most appropriate management of fistulae worldwide.

2. Evidence acquisition

In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement, a prospective search protocol was developed and registered with the PROSPERO database (ID number: CRD42015019021). Published evidence was identified through a search of the PubMed and Scopus databases using the following search terms: "obstetric fistula", "vaginal fistula", "bladder fistula", "urethral fistula", "urinary fistula", "vesicovaginal fistula", "genital fistula", and "fistula", which yielded 12 626 articles. The search was limited to women and the English language and further refined by excluding the following MeSH headings "infant", "child", "neonate", "male", "penile", "Crohn's disease", "hypospadias", "anal", "rectal", "arterial", and "venous". The search was limited to the period between January 1980 and March 2015 and further excluded case reports, which yielded 680 articles (Fig. 1). Forty-seven additional records were identified through searching the references of included articles and other review texts. Abstract screening followed by full text screening was performed.

The primary outcome was to report fistula aetiology; secondary outcomes included surgical technique and surgical outcomes. Each article was rated following the Oxford Centre for Evidence-Based Medicine levels of evidence scale (Fig. 2) [4].

3. Evidence synthesis

After screening these abstracts and excluding articles with fewer than 20 patients (for quality purposes), 98 full texts were identified, which includes four articles found through reviewing the references of other included articles. Of these, 49 were excluded for not reporting fistula aetiology, not clearly reporting outcomes, or excluding those that describe a significant proportion of recto-vaginal fistulae or ureterovaginal fistulae. Table 1 demonstrates that from 49 studies, 15 studies reported on fistula repair in WRC [2,5–18], while 34 studies reported on fistula management in LRC [19–52]. In all, two studies were randomised controlled trials (RCTs) and two were feasibility cohort studies that compared new treatments. RCTs compared outcomes for patients randomised to use fibrin glue compared with Martius flap interpositioning [42] and to trimming versus no trimming of the fistula tract [43]. The two cohort studies included in this review investigated the use of Floseal haemostatic matrix (Baxter Healthcare Corp., IL, USA) [19] and porcine small intestinal submucosa (Surgisis Biodesign, Cook Medical, Bloomington, IN, USA) [25] as interposition materials. Eleven studies included prospective data, while 34 were retrospective series.

3.1. *Fistula aetiology*

3.1.1. *Surgery/radiotherapy*

The 15 included articles reporting data from WRC included 2055 fistulae, of which 1710 (83.2%) were of a surgical aetiology; in contrast, the 34 included articles reporting data from LRC included 10 398 fistulae, of which only 459 (4.4%) were of a surgical aetiology (Table 2). Of the 2055 fistulae in WRC, 46.2% were associated with simple abdominal hysterectomy and hysterectomy by any route was an aetiological factor in 62.7% of all fistulae and 75.4% of the 1710 cases of fistulae resulting from surgery. Some cases were associated with other types of pelvic surgery (12.7%), including benign and malignant colorectal, urological, and gynaecological procedures that were otherwise unspecified in the included articles.

Of the 2055 fistulae reported from WRCs, 268 (13.0%) followed radiotherapy (with or without previous radical surgery); in comparison, only 17/10 015 (0.2%) of fistulae seen in LRCs followed radiotherapy.

3.1.2. *Childbirth*

Of fistulae reported from LRCs, 9902/10 398 (95.2%) cases were of an obstetric aetiology. Prolonged neglected

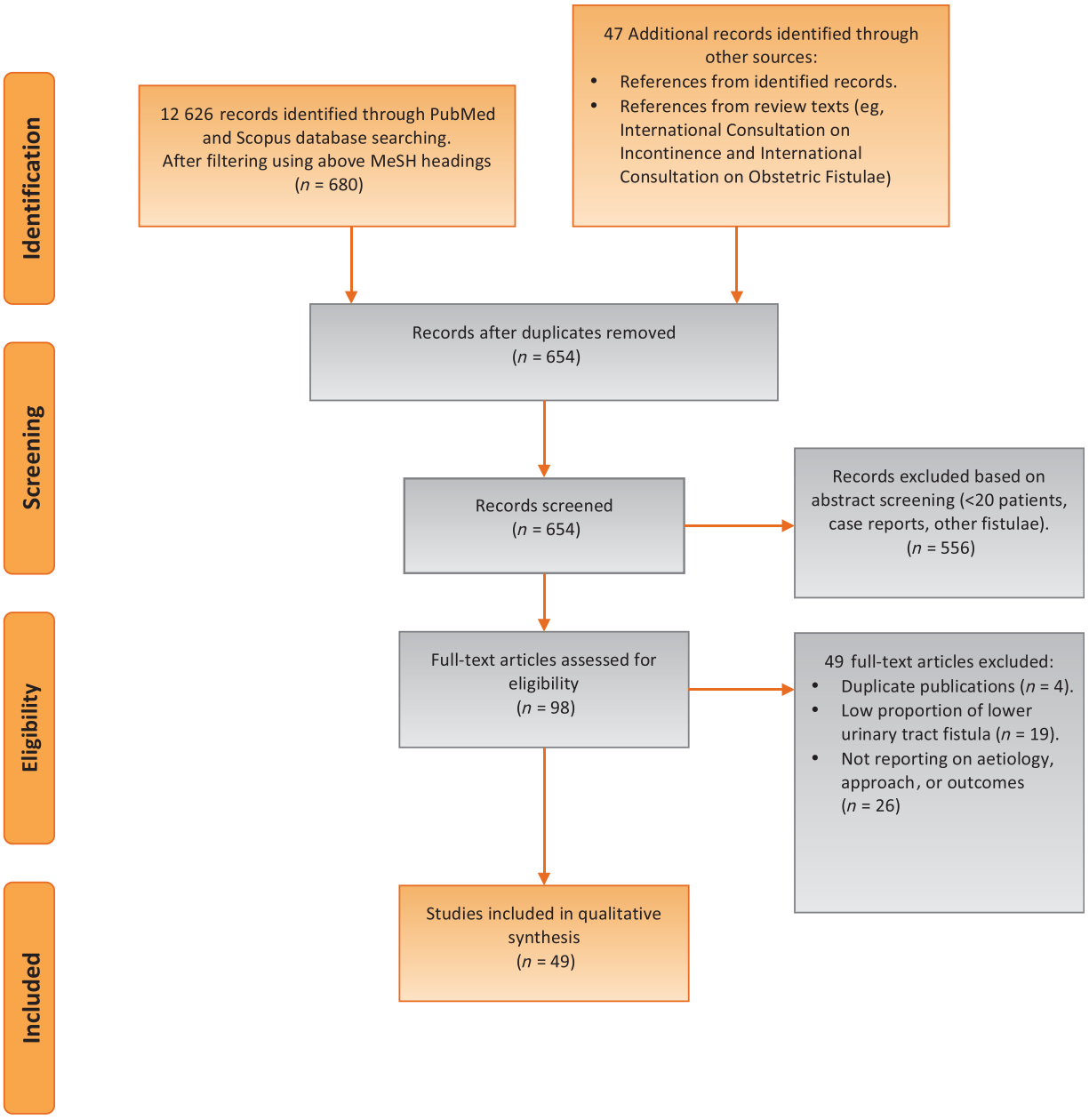

Fig. 1 – Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow-diagram to demonstrate progress of articles through the review.

Level	Type of evidence
1a	Systematic review with homogeneity of randomised control trials
1b	Individual randomised control trial with a narrow confidence interval
1c	All or none related outcome
2a	Systematic review with homogeneity of cohort studies
2b	Individual cohort study (including low-quality randomised control trials, eg, <80% follow-up)
2c	"Outcomes" research; Ecological studies
3a	Systematic review with homogeneity of case–control studies
3b	Individual case–control study
4	Case-series (and poor-quality cohort and case–control studies)
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research, or "first principles"

Fig. 2 – Evidence-based medicine levels of evidence scale [4].

Table 1 – Available articles included in the review

Well-resourced countries										
Study	Design	Population	Sample size	Aetiology	Outcome definition	Exposure of interest	Approach	Outcomes	Follow up or study duration	CEBM levels of evidence
Blaivas et al., 1995 [5]	Retrospective	All VVF	24	12 TAH 3 TVH 2 anterior colporrhaphy 2 urethral diverticulectomy 1 Colposuspension 1 bladder rupture 3 no details provided	Not given	Transvaginal repair vs transabdominal repair	Transvaginal in 15, transabdominal in 8, conservative in 1	23/24 success (96%) 1 SUI	6 mo to 4 yr	4
Brandt et al., 1998 [6]	Prospective	All benign VVF	80	68 TAH 5 TVH 7 anterior colporrhaphy	Not given	Use of bladder mucosa autograft via vaginal approach	All vaginal	77/80 overall success (96%) 1 SUI	1 yr	2b
Cromwell and Hilton 2012 [2]	Retrospective	All VVF and genitourinary tract fistula	1194	177 malignant gynaecological conditions 328 benign gynaecological conditions 171 bladder/colon malignancies 518 others (426 hysterectomy, 33 caesarean sections)	Need for repeat repair		Not specified 294 ileal conduit	797/905 overall success (88.1%)	10 yr retrospective analysis Re-op rates for trusts performing >3 procedures/yr 7.4% vs 13.2% for less	2c
Eilber et al., 2003 [7]	Retrospective	All VVF repaired transvaginally	207	172 TAH 17 TVH 8 DXT 10 obstetric causes/ colporraphy Total of 159 recurrent fistulae	Need for repeat procedure	Transvaginal repair using interposition ing 120 - peritoneum/ Martius/full-thickness labia flap	Transvaginal In 120 patients with complex/recurrent fistulae, peritoneum flap in high fistulae, Martius in low, labia used if sufficient vaginal epithelium not available.	201/207 overall success (97%) 99% success for those not requiring interposition 96%, 97%, 33% for peritoneum, Martius, and labial flaps respectively	10 yr retrospective analysis	2b
Evans et al., 2001 [8]	Retrospective	All VVF repaired transabdominally	37	20 TAH 1 D&C 1 obstetric 2 caesarean section 1 tubo-ovarian abscess 4 trauma 4 gynaecological DXT 3 radical gynaecological surgery and DXT 1 radical gynaecological surgery Total of 12 redo procedures	Completely dry by patient report	Transabdominal - interposition (omentum) vs no flap	Transabdominal	28/37 overall success (75.8%) 100% success when interposition flap used 63% success no flap (benign) 67% no flap (malignant)	>6mo	4
Hadzi-Djokic et al., 2008 [9]	Retrospective	All primary or recurrent VVF	220	138 benign hysterectomy 67 radical hysterectomy 13 caesarean section 2 obstetric injuries	Need for repeat repair		129 transvesical, 59 transvaginal, 32 transperitoneal with omentum/ peritoneum interposition flap	208/220 overall success (94.6%)		4

Table 1 (*Continued*)

Well-resourced countries										
Study	Design	Population	Sample size	Aetiology	Outcome definition	Exposure of interest	Approach	Outcomes	Follow up or study duration	CEBM levels of evidence
Hilton 2012 [10]	Prospective	All genitourinary tract fistula	283	132 TAH 19 radical hysterectomy 15 urethral diverticulectomy 7 midurethral tape 9 TVH 12 colporrhaphy 45 other pelvic procedure 15 caesarean section 8 uterine rupture 5 instrumental delivery 4 caesarean hysterectomy 2 prolonged labour 4 other obstetric 28 DXT 11 pessary 6 congenital 25 others	Absence of urinary leakage at 2–3 mo follow-up		82 transabdominal procedures, including 66 transperitoneal (15 with ureteric reimplantation), 16 transvesical, 201 transvaginal	267/283 overall success (95.4%) (83.3% success for transabdominal, 96.1% for transvaginal) 93.5% continence rate		4
Kochakarnand Pummangura 2007 [11]	Retrospective	All VVF	45	28 laparoscopic hysterectomy 10 TAH 4 TVH 3 RH	Subjective dry		19 transvaginal, 26 transabdominal	42/45 overall success (93.3%) (89% of transvaginal dry, 96% of transabdominal dry)	8 yr retrospective	4
Langkilde et al., 1999 [12]	Retrospective	All VVF	37	30 pelvic surgery 7 DXT	Subjective dry		25 transabdominal, 12 transvaginal	28/37 overall success (76%) 90% success for benign fistulae, 14% for fistulae following DXT		4
Lee et al., 2014 [13]	Retrospective	All nonradiated VVF	66	28 hysterectomy unknown route 5 TAH 1 TVH 1 laparoscopic hysterectomy 2 obstetric 5 other	Absence of leakage on postoperative UDS	Primary vs recurrent	50 transvaginal, 16 transabdominal	64/66 overall success (97%) (failures all transvaginal and underwent successful transabdominal repair. No significant difference between primary and multiple surgical repairs 8 SUI	Mean follow-up 55 mo (6–198 mo)	4
Milicevic et al., 2013 [14]	Retrospective	All VVF	24	4 DXT 19 TAH 1 caesarean section	Need for further repair		All routes	23/24 overall success (96%). 75% following primary repair (100% with transvaginal and transperitoneal each, 68% with transvesical)		4
Mondet et al., 2001 [15]	Retrospective	All VVF treated by trans peritoneal transvesical repair	28	19 hysterectomy nos 1 obstetric 4 caesarean-section 2 DXT 2 pelvic surgery nos	Complete repair of communication and absence of symptoms		Transperitoneal, transvesical	24/28 overall success (85%) 0/2 success for patients with history of DXT	Mean follow-up 30 mo (23 d to 14.6 yr)	4

Ockrim et al., 2009 [16]	Retrospective	All VVF and UVF	37	16 TAH 3 caesarean section 2 caesarean hysterectomy 2 cystoplasty 1 bladder neck closure 1 colposuspension 2 DXT 1 obstructed labour 2 urethral diverticulectomy 3 autologous fascial sling 2 MUT 2 urethropexy	Subjective and objective (UDS) cure		Transabdominal and transvaginal	34/37 overall success (92%) 73% success after initial procedure	6 mo	4
Pushkar et al., 2009 [17]	Retrospective	All VVF following DXT	210	Radical hysterectomy and DXT	Absence of urinary leakage		Transvaginal	169/210 overall success (80.4%) 48.1% success after initial repair	40 yr retrospective	4
Pushkar et al., 2006 [18]	Retrospective	All urethrovaginal fistulae	71	19 obstetric 16 periurethral cyst 12 anterior colporrhaphy 9 autologous fascial sling 8 periurethral bulking agents 4 midurethral tape 3 other	Absence of fistulae recurrence		Transvaginal (9 with Martius flap interpositioning)	70/71 overall success (98.59%) 90.14% success after initial repair SUI 37/71 (52%)	21 patients with mean follow-up of 99.6 mo (84–103 mo)	4

Low-resourced countries

Study	Design	Population	Sample size	Aetiology	Outcome definition	Exposure of interest	Approach	Outcomes	Follow-up or study duration	CEBM levels of evidence
Abou-Elela et al [19]	Cohort study	Supratrigonal and complex VVF	20	Obstetric trauma	Not given	Use of Floseal matrix and parasagittal abdominal approach with bladder flap		20/20 overall success (100%) after initial repair	Not given	4
Ahmad et al., 2005 [20]	Retrospective	All obstetric genitourinary fistulae	1086	790 obstructed labour 83 caesarean hysterectomy 79 caesarean section 48 forceps delivery 46 foetal destructive procedures 40 uterine/bladder rupture	Not given		1002 transvaginal 84 transabdominal	918/1086 overall success (84.5%) 5% SUI	25 yr retrospective	4
Amr 1998 [21]	Retrospective	All VVF	132	30 obstructed labour 16 caesarean-section 18 uterine rupture 14 forceps delivery 25 TAH 8 TVH 3 anterior colporrhaphy 11 others	Absence of urinary leakage following catheter removal		123 transvaginal 9 transabdominal	108/132 overall success (82%) 45% success after initial repair	24 yr retrospective	4
Dalela et al., 2006 [22]	Prospective	Supratrigonal VVF	26	22 obstructed labour 2 TVH 2 TAH	Absence of urinary leakage following catheter removal	Modified O'Connor's transperitoneal repair	Transperitoneal (24 omentum interpositioning 2 paravesical peritoneum)	26/26 overall success (100%) 1 SUI	21 followed up 1–5 yr	4
El-Lamie 2008 [23]	Retrospective	All genitourinary fistulae (VVF 22, VUF 4)	26	(VVF) 10 obstructed labour 6 TAH 3 radical hysterectomy + DXT 1 vaginoplasty, 2 cystolitholapaxy (VUF) 4 elective caesarean section	Subjective absence of urinary leakage		16/22 of VVF underwent transvaginal approach (Martius flap following DXT) 6 transabdominal	26/26 overall success (100%) 100% success after initial surgery for VUF 91% success after initial surgery for VVF	10 yr retrospective	4

Table 1 (*Continued*)

Low-resourced countries										
Study	Design	Population	Sample size	Aetiology	Outcome definition	Exposure of interest	Approach	Outcomes	Follow-up or study duration	CEBM levels of evidence
Ezzat et al., 2008 [24]	Retrospective	Large VVF using combined abdominal and vaginal approach	35	25 obstructed labour 5 iatrogenic pelvic surgery 3 sling erosion 2 DXT (12 recurrent fistulae)	Combined symptomatic and anatomical absence of leakage	Combined abdominal (O'Connor) and vaginal approach	Interposition type: 5 omentum 2 peritoneum 3 Martius 13 gracillis 12 no flap	35/35 overall success (100%) 88% success after initial surgery, all successfully repaired with vaginal approach 10/12 recurrent fistulae repaired at 1st attempt, 2 at second	27 yr retrospective	4
Farahat et al., 2012 [25]	Cohort study	Complicated VVF: recurrent, large, or with excessive scarring	23	8 obstructed labour 3 anterior colporrhaphy 9 TAH 3 TVH (10 fistula > 1.5 cm)	Symptomatic absence of leakage	Porcine small intestinal submucosa graft	7 transvaginal (low fistulae) 16 transabdominal	21/23 overall success (91.3%) (all transvaginal approaches and 14/16 transabdominal approaches successful)	6 mo	2b
Hilton and Ward 1998 [26]	Retrospective	All urogenital fistulae	2484	(Case notes only available for 2389 patients) 1918 obstructed labour 165 caesarean section 119 uterine rupture 105 gynaecological surgery 42 malignancy 40 miscellaneous 0 DXT	Subjectively dry at last assessment		83% transvaginal 17% transabdominal	Only 2360 patients operated on 2306/2360 overall success (97.7%) 1954/2360 success after initial repair (82.8%)	25 yr retrospective	4
Holme et al., 2007 [27]	Retrospective	All obstetric fistulae	255	All obstetric	Not given	Socio economic status	Not given	186/255 overall success (72.9%) SUI 44/255 = 17.3%	18 mo retrospective	4
Jatoi et al., 2005 [28]	Prospective	All VVF	32	8 vaginal delivery 2 instrumental delivery 10 Caesarean hysterectomy 1 D&C 2 TAH 1 vaginoplasty 1 DXT 2 congenital 1 cystolitholapaxy	Subjective dry following catheter removal at 2 wk		29 operations: 27 transvaginal 2 transabdominal	27/29 overall success (93%)	3 mo	4
Jokhio and Kelly 2006 [29]	Retrospective	All obstetric fistulae	116	98 obstructed labour, 15 pelvic surgery 3 congenital (23 recurrent fistulae)	Absence of urinary leakage		Not specified	93/116 overall success (80%) 6% recurrent fistulae 14% SUI		4
Kayondo et al., 2011 [30]	Prospective	All obstetric fistulae. VVF only included	68	All obstructed labour	Closed on dye test but dry, closed on dye test but incontinent, failed repair	Patient demographics	Not specified	55/68 overall success (79.7%) 13 (23.6%) incontinent		4
Khan et al., 2005 [31]	Retrospective	All VVF	30	19 vaginal delivery 4 caesarean-section 4 hysterectomy 1 forceps delivery 1 bladder calculus 1 DXT (3 recurrent fistulae)	Absence of any urinary leakage		All transabdominal transvesical	24/30 overall success (80%): fistula closure 3/30 failed repair (10%) 3/30 had SUI (10% SUI)	6 yr	4

Kirschner et al., 2010 [32]	Retrospective	All VVF	926	Obstructed labour: 369 caesarean section 303 vaginal delivery 84 forceps delivery 9 foetal destruction 161 unknown	Subjective dry vs wet		90% transvaginal 10% transabdominal	779/926 overall success (84.1%): fistula closure 70% continence	6 yr retrospective	4
Lewis et al., 2009 [33]	Retrospective	All obstetric fistula	505	Obstetric no other details	Subjective dry at discharge		Not given	294/505 overall success (58%) 10% SUI		4
Mathur et al., 2010 [34]	Prospective	All VVF	32	18 obstructed labour 8 caesarean section 14 TAH 4 TVH 2 DXT 4 miscellaneous	No definition given		9 transvaginal 14 transabdominal 5 transabdominal after initial transvaginal 4 conservative	24/32 overall success (76%)	4 yr	4
Nafiou et al., 2007 [35]	Prospective	All obstetric VVF	104	Obstetric no other details	Subjective and objective dry		91% transvaginal 7% transabdominal2% combined	76/104 closed and dry (73%) 14/104 closed and wet (13.5%) 5 unsuccessful (5%) 7 lost to follow up, 2 died	3 mo	4
Nawaz et al., 2010 [36]	Retrospective	All fistulae (VVF only presented)	133	50 obstructed labour 19 caesarean hysterectomy 17 caesarean section 15 instrumental delivery 19 TAH 6 TVH 1 colporrhaphy 3 DXT 2 neglected pessary 1 inflammatory	Anatomical closure of fistula		Not given	117/133 overall success (88%)	3 mo	4
Obi et al., 2008 [37]	Retrospective	All VVF	476	412 obstructed labour: (330 vaginal delivery 35 caesarean section 26 caesarean hysterectomy 21 instrumental delivery) 33 TAH 13 TVH 12 malignancy 6 DXT	Anatomical closure and complete functional continence		Not given	4/18 successful conservative treatment 380/458 overall success (83%)	25 yr retrospective	4
Raashid et al., 2010 [38]	Retrospective	All VVF	61	27 hysterectomy 5 elective caesarean sections 1 forceps delivery 28 obstructed labour (17 spontaneous delivery, 11 caesarean section)	Absence of leakage at 6 wk follow-up		87% transvaginal, 13% transabdominal	53/61 overall success (87%) 46/53 transvaginal success (87%) 7/8 transabdominal success (88%)	2 yr retrospective	4
Raassen et al., 2008 [39]	Prospective	All primary lower genitourinary fistulae	639	581 obstetric nos 45 hysterectomy 9 miscellaneous 4 unknown	Negative dye test	Obstetric VVF only 565	87.6% transvaginal, 12.4% transabdominal	5532/565 overall success (94.1%): closure	<3 mo	4
Rafique 2003 [40]	Retrospective	All obstetric genitourinary fistulae	42	16 obstructed labour 16 obstructed labour, and caesarean section, 2 elective caesarean sections 2 caesarean hysterectomy 5 dilatation and curettage 1 forceps delivery	Subjective dry and gynaecological exam		29 transvesical 10 transvaginal 3 transabdominal for ureterovaginal fistula	36/41 overall success (87%)	<3 mo	4

Table 1 (*Continued*)

Low-resourced countries										
Study	Design	Population	Sample size	Aetiology	Outcome definition	Exposure of interest	Approach	Outcomes	Follow-up or study duration	CEBM levels of evidence
Sachdev et al., 2009 [41]	Retrospective	All obstetric VVF	276	117 obstructed labour 29 caesarean hysterectomy 24 hysterectomy 2 D&C 2 malignancy 1 trauma 2 cystolitholapaxy 1 congenital	Subjective dry		8 conservative 261 transvaginal 7 transabdominal	265/276 overall success (96%)	Retrospective 10 yr	4
Safan et al., 2009 [42]	RCT	All VVF in patients aged 16–50 yr, fistula size < 5 cm, < 3m from occurrence	38	Obstetric nos	Dry at clinic 3/12	Use of fibrin glue vs Martius flap interpositioning	19 transvaginal with fibrin glue 19 transvaginal with Martius flap	13/19 overall success using fibrin (68%) 11/19 overall success using Martius flap interpositioning (58%)	3 mo	2b
Shaker et al., 2011 [43]	RCT	All obstetric VVF aged 16–50 y, any fistula size, <3 mo from occurrence	63	Obstetric nos	Objective during examination at 3 mo follow-up	Trimming or no trimming of fistula edges	31 transvaginal with fistula trimming 32 transvaginal without fistula trimming	23/31 of trimming group overall success (75%) 22/32 of no trimming group overall success (67.6%) 6 SUI (4 trimming, 2 nontrimming)	3 mo	2b
Shoukry et al., 2010 [44]	Retrospective	All obstetric VVF	20	Obstructed labour: (15 vaginal delivery, 5 forceps delivery)	Subjective and objective dry	Use of rectangular vaginal flap using transvaginal approach	Transvaginal vaginal flap technique	20/20 overall success (100%)	Follow-up mean 16 mo (8–28 mo)	4
Singh et al., 2010 [45]	Retrospective	All genitourinary fistulae (37 VVF)	42	22 obstructed labour nos 8 TAH 4 TVH 1 laparoscopic hysterectomy 3 radical hysterectomy 4 miscellaneous	Not described		3 successful conservative management. 28 trans abdominal + peritoneum interpositioning11 transvaginal + Martius flap	34/39 overall success (80.1%) after initial attempt	4–42 mo	4
Singh et al., 2012 [46]	Prospective	All VVF	48	30 obstetric nos 18 gynaecological surgery	Negative postoperative cystogram	Transabdominal approach	Transabdominal	44/48 overall success (91.6%) 87.5% success after initial repair	4 wk	4
Singh et al., 2011 [47]	Retrospective	All VVF	102	78 obstructed labour (64 spontaneous delivery, 14 instrumental delivery) 20 gynaecological procedure nos 4 DXT	Negative postoperative cystogram	Transvaginal approach	Transvaginal Martius (3), gracillis flap (1)	88/102 overall success (86.3%) 10 SUI	Median 48 mo	4
Sjoveian et al., 2011 [48]	Retrospective	All obstetric fistulae	595	470 obstructed labour 69 caesarean section or emergency peripartum hysterectomy 28 gynaecological surgery	Negative dye test at 14 d		Not specified	518/595 overall success (87.1%), of which 15.6% remained incontinent despite closure	2 yr retrospective	4

Tayler-Smith et al., 2013 [49]	Retrospective	All obstetric fistulae	458	Obstetric	Negative dye test at 14 d		Not specified	4/35 had successful conservative management (11%) 394/454 overall success (87%) 76% continent	1 yr retrospective data	4
Vanderputte et al., 1985 [50]	Retrospective	All obstetric fistulae	87	74 obstructed labour, spontaneous delivery 2 caesarean section 7 laparotomy for uterine rupture 2 foetal destructive procedures 2 instrumental delivery	Clinical examination at 2 mo		84 transvaginal 3 transabdominal	77/87 overall success (88.5%), including 4 patients with UUI/SUI > 6mo, 1 patient with total incontinence, 3 patients with failed second repair, and 2 deaths		4
Vyas et al., 2005 [51]	Prospective	All VVF	22	15 Obstetric nos 5 TAH 2 TVH (5 recurrent fistulae)	Leakage following catheter removal	Bladder mucosa autografts	19 transabdominal 3 combined transabdominal and transvaginal	20/22 overall success (91%)		4
Waaldijk 2004 [52]	Prospective	All obstetric VVF <3 mo from occurrence	1716	Obstetric nos	Successful fistula closure		265 conservative 1451 surgical	1690/1716 overall success (98.5%) 94.3% successful closure after initial surgical attempt 93.2% continent	90% of patients were followed-up between 3–6 mo	4

CEBM = Centre for Evidence-Based Medicine; DXT = radiotherapy; D&C = dilatation of the cervix and curettage of the endometrium; MUT = midurethral tape; NOS = not otherwise specified; RH = radical hysterectomy; SUI = stress urinary incontinence; TAH = total abdominal hysterectomy; TVH = total vaginal hysterectomy; UDS = urodynamics; VUF = vesico-uterine fistula; VVF = vesico-vaginal fistula.

Table 2 – Fistula by aetiology

Cause	Well-resourced countries *N* (%)		Low-resourced countries *N* (%)	
Surgical causes				
Abdominal hysterectomy	949	(46.2)	123	(1.2)
Radical hysterectomy	87	(4.2)	3	(0.0)
Vaginal hysterectomy	39	(1.9)	42	(0.4)
Urethral diverticulectomy	19	(0.9)	0	(0.0)
Anterior colporrhaphy	33	(1.6)	7	(0.1)
Laparoscopic hysterectomy	29	(1.4)	1	(0.0)
Midurethral tape	15	(0.7)	3	(0.0)
Colposuspension	2	(0.1)	0	(0.0)
Autologous fascia sling	12	(0.6)	0	(0.0)
Urethropexy	2	(0.1)	0	(0.0)
Vaginoplasty	0	(0.0)	2	(0.0)
Periurethral bulking agent	8	(0.4)	0	(0.0)
Periurethral cyst excision	16	(0.8)	0	(0.0)
Hysterectomy NOS	185	(9.0)	100	(1.0)
Pelvic surgery NOS	262	(12.7)	162	(1.6)
D&C	1	(0.0)	8	(0.1)
Cystoplasty	2	(0.1)	0	(0.0)
Pessary	11	(0.5)	2	(0.0)
Cystolitholapaxy	0	(0.0)	6	(0.1)
Caesarean section (WRC only)	38	(1.8)	–	–
Subtotal	1710	(83.2)	459	(4.4)
Obstetric causes				
Caesarean section (LRC only)	–	–	940	(9.0)
Uterine/bladder rupture	9	(0.4)	184	(1.8)
Instrumental delivery	5	(0.2)	208	(2.0)
Caesarean hysterectomy	4	(0.2)	193	(1.9)
Prolonged obstructed labour	3	(0.1)	4665	(44.9)
Foetal destructive procedures	0	(0.0)	57	(0.5)
Obstetric NOS	50	(2.4)	3655	(35.2)
Subtotal	71	(3.5)	9902	(95.2)
Radiotherapy	268	(13.0)	17	(0.2)
Malignancy	0	(0.0)	14	(0.1)
Congenital	6	(0.3)	6	(0.1)
Total	2055		10 398	

D&C = dilatation of cervix and curettage of endometrium; LRC = low-resourced country; NOS = not otherwise specified; WRC = well-resourced country.

obstructed labour was a causative mechanism in the majority of these, and where specified, caesarean section and instrumental delivery were associated in 9% and 2% respectively. A further 35.2% of fistulae resulted from delivery without any further specific details. Emergency peripartum injury (bladder/uterine rupture, caesarean hysterectomy for bleeding, or foetal destructive procedures) were associated with fistula formation in 1.8%, 1.9%, and 0.5% of cases respectively.

Of so-called ‘obstetric fistulae’ in LRCs, 940/9902 (9.5%) were associated with caesarean section and 1341/9902 (13.5%) were associated with some surgical intervention. Seventy one out of 2055 (3.5%) fistulae in WRCs were classified as obstetric in origin; however, those fistulae that occur following caesarean section in WRCs were classified as “surgical fistulae.”

Miscellaneous causes, such as trauma, foreign bodies, and infection are not included in these data, as they represented only a very small proportion of fistula cases; one of the largest studies [2] could not be included as the exact aetiology of

fistula formation was not apparent and one study included solely radiotherapy induced fistulae [17].

3.2. Fistula management

Six studies directly commented on the conservative treatment of fistulae (two in LRCs and four in WRCs) [5,10,37,45,49,52]. In WRCs, the usual current practice is to perform a delayed repair of the fistula following a period of catheter drainage to allow necrotic tissue to slough and local inflammatory responses to subside. Successful closure rates from this conservative management approach, however, are likely to be underestimated given that successful outcomes in this context are not referred for surgical intervention, and therefore often unreported. A similar "delayed" approach has usually been undertaken in LRCs, although both Waaldijk [52] and Tayler-Smith et al [49] selected patients for conservative management if the time-to-fistula development was short, the fistula itself was small (<3 cm), and the prospects for spontaneous healing were good. In the Waaldijk series [52], catheter drainage was continued in 265/1716 (15.4%) of patients, achieving fistula closure in 264 patients, while Tayler-Smith et al [49] demonstrated spontaneous closure rates in four out of 35 (11%) patients. Patients with a longer history or those in whom the fistula edges were clean were selected for immediate surgery, while those with no evidence of healing following catheterisation underwent repair. In total, 1451/1716 cases in the Waaldijk [52] series were treated with surgery, with anatomical closure in 1369/1451 (94.3%).

Given the heterogeneity in fistula characteristics and locations, it is difficult to comment on the surgical approach. Of studies which specify a particular approach in WRCs, 924/1307 (70.7%) of procedures were performed transvaginally. In comparison, 5376/6369 (84.4%) of patients reported from LRCs, where a specific approach was documented, underwent a transvaginal approach; with 14.6% undergoing a transabdominal procedure and 1% having a combined abdominal/vaginal approach.

A variety of interposition grafts have been used. These include omentum or perivesical peritoneum during abdominal repairs, and the Martius bulbocavernosus muscle/fat graft, or labial skin flap at transvaginal repairs. Peritoneum can be used for high fistulae and gracillis myocutaneous flaps were used in two studies in large or postradiotherapy fistulae [24,47]. No high quality evidence exists to support the use of graft interposition in any context, and anecdotally the use of grafting by obstetric fistula surgeons has declined in LRCs.

The largest series of radiotherapy-induced fistulae, from Pushkar et al [17], describes the transvaginal approach in all patients using either a Martius flap or a Latzko colpocleisis in patients with small, defined fistulae. Many patients with radiation-induced fistula will ultimately undergo urinary diversion either due to the complexity of the fistula itself, poor tissue viability, anaesthetic issues, or surgeon preference [2]. Reporting of patients undergoing diversion are not included in this review; however, urinary diversion is seen as a treatment of choice in many patients with radiotherapy-induced fistulae, owing to the wide field abnormality in this context. Others argue that in carefully selected patients with malignant- or radiotherapy-induced fistulae, repair should be attempted. In Hilton's series [10] reported in 2012, of the 19/36 (53%) patients with malignant- or radiotherapy-induced fistulae who underwent a primary repair operation, 95% were successfully closed after the first surgery.

Two feasibility cohort studies [19,25] investigated the benefit of Floseal haemostatic matrix (Baxter Healthcare Corp.) and porcine small intestinal submucosa (Surgisis Biodesign, Cook Medical) grafts respectively. One RCT investigated the use of autologous fibrin glue versus standard Martius flap interposition grafting [42], while the other assessed the outcomes of patients undergoing trimming versus no trimming of the bladder edge of the fistula [43].

3.3. Definition of success

The definition of surgical success varies between studies. In general, these range from "anatomical closure of fistula", "anatomical closure of fistula but residual leakage", or "failed repair", while others use the "need for a repeat procedure" as the definition of failure. A common practice in studies in WRCs is to perform a cystogram prior to catheter removal following surgery, while those in LRCs opt to perform catheter removal 14 d postoperatively, with catheter reinsertion in the presence of continued urinary leakage. There may therefore be some discrepancy in the reporting of urinary leakage that is due to the closure of the fistula from that caused by stress or urgency urinary incontinence.

The timing of the outcome definition is clearly important. While the majority of studies involving patients in LRCs will define the success of a procedure at the time of catheter removal, those in WRCs will reserve the definition of success until discharge or at clinic follow-up.

3.4. Management outcomes

Of patients managed conservatively, Hilton [10] demonstrated 24 patients in his UK series (6.9% of total) showing spontaneous successful closure following 6–8 wk of catheter drainage; spontaneous closure was not seen in any of the radiotherapy-induced fistulae in this series. While in LRCs, successful conservative management was achieved in 264/1716 patients, constituting 15.6% of patients and 16.2% of fistula closures in the Waaldijk series [52], and in four out of 35 (11%) patients with small necrotic fistulae reported by Tayler-Smith et al [49].

Of patients undergoing surgical closure in WRCs, the median overall closure rate was 94.6% (range, 75.8–98.6%). Studies included with the lowest overall success had a high proportion of radiation-induced fistulae [8,12,17]. In this context a higher success rate was claimed in one small series when interposition grafts were used [two out of two (100%) success rate vs four out of six (67%) when no grafts were used], although these differences are not statistically significantly different [8]. The highest anatomical closure rate of included studies was reported by Pushkar et al [18]

for patients undergoing a transvaginal repair of urethrovaginal fistulae. Of studies that reported postfistula repair stress urinary incontinence (SUI) in WRCs [5,6,10,13,18], the median rate was 6.5% (range, 1.1–51.9%), with the highest rates seen following a transvaginal repair of urethrovaginal fistulae.

Of patients undergoing surgical repair in LRCs, the median overall closure rate was 87.0% (range, 58.0–100%). The median SUI rate for patients with a closed fistula was 10.0% (range, 3.8–30.0%), across all surgical approaches and fistula characteristics.

Abou-Elela et al [19] used Floseal matrix to promote healing and haemostasis and demonstrated 100% success rates following initial attempts at repair in a series of 20 cases. Farahat et al [25] used porcine small intestinal submucosa interposition grafting by either transvaginal or transabdominal approaches in patients with large, complicated vesico-vaginal fistulae. The group demonstrated a 91.3% overall success, with seven out of seven transvaginal procedures and 14/16 transabdominal procedures achieving closure over a follow-up period of 6 mo, with no reported SUI.

In one randomised trial by Safan et al [42], 13/19 (68%) of patients were dry at the 3-mo postoperative follow-up visit following a transvaginal repair using fibrin glue versus 11/19 (58%) of patients (not statistically significant) undergoing a transvaginal repair using a Martius flap. Shaker et al [43] demonstrated that 24/32 (75%) of patients had a closed fistula at the 3-mo postoperative follow-up visit following trimming of the bladder edge of the fistula by 5 mm using a transvaginal approach compared with 21/31 (67.6%) of patients when trimming is not performed. Again, these findings did not reach statistical significance.

There are no randomised studies available that directly compare the outcomes of transabdominal versus transvaginal approaches, given that each surgeon has a particular preference for a certain indication and clearly there would be ethical issues with the conduct of such a study. Of the included studies, three [9,10,16] reported the outcomes of transvaginal versus transabdominal approaches for fistula repair. Amongst these, the overall success rates were 90.8% of 286 vaginal repairs and 83.9% of 250 abdominal repairs (Fisher's exact test; $p = 0.0176$). It must be emphasised that these reports were reviewing nonrandomised cohorts; it is likely that the particular approach used in individual cases was selected based on the preoperative evaluation and dependant on individual surgical bias and it is not therefore valid to carry out a direct comparison of outcomes.

3.5. Discussion

To the best of our knowledge, this is the first review article of its type to compare the aetiologies and management of lower urinary tract fistula in WRCs and LRCs. Most studies included were retrospective case series, while 11 included prospective data, two were nonrandomised cohort studies, and two were RCTs.

We demonstrate that while 83.2% of fistulae in WRCs result from surgical intervention, 95.2% of fistulae in LRCs result from obstetric causes. The large majority of obstetric fistulae seen in LRCs occur as a consequence of prolonged neglected obstructed labour, where sustained pressure necrosis arises due to compression of the bladder base and anterior vaginal wall between the foetal head and symphysis pubis. Furthermore, iatrogenic injury, especially of these devitalised areas during a caesarean delivery may lead to fistula formation subsequently. As the necrotic tissue sloughs off postoperatively, the fistula may become manifest. It is important to note that the fistulae that occur following caesarean section in WRCs are more akin to surgical fistulae, as prolonged obstructed labour is unlikely to be involved in this context.

It must be emphasised that the fistulae that occur after pelvic surgery, are not necessarily a consequence of inadvertent organ injury or surgical misadventure. Tissues may become devitalised as a consequence of extensive dissection or haematoma formation with fistulae forming weeks later. Fistulae that result following ionising radiation may present many months to years later and are thought to occur due to chronic small vessel inflammatory changes leading to tissue ischaemia.

It is apparent that any surgical procedure in the pelvis can lead to fistulae formation. In the current study, 75.4% of postsurgical fistulae resulted following a hysterectomy. Hilton and Cromwell [53] examined Hospital Episode Statistics for English National Health Service hospitals and found that the overall rate of fistula formation following a hysterectomy was one in 788. Furthermore, the study demonstrated a 46% rise in the rate of fistula formation following a hysterectomy from 2000 to 2008, which the authors concluded could reflect the reduced exposure of trainees to these cases associated with a fall in the number of hysterectomies performed.

Spontaneous closure of fistulae is feasible and the rate with which this occurs is likely to be underestimated due to the fact these cases are seldom referred for further treatment. A 6–8-wk period of continuous catheter drainage allows the diversion of urine away from the visceral communication, which can allow spontaneous closure before epithelialisation of the fistula track can occur and this is certainly worth attempting in patients with vesico-vaginal or urethrovaginal fistulae [54]. In patients with a significant degree of necrotic material and slough, catheterisation can allow maturation of the fistulous tract to a sufficient degree that closure can be performed. Rates of spontaneous closure, even for obstetric fistulae, are reported in up to 28% of patients when early catheter drainage is instituted [55]. Radiotherapy-induced fistulae, however, are seldom if ever associated with spontaneous closure and operative management should be performed as appropriate.

There is debate surrounding the optimum timing of repair; immediate or delayed. While the exact definition of what constitutes an "immediate" repair varies between studies, most would consider less than 6 wk. Intuitively, repair should be performed following a period of catheterisation to allow inflammation to settle and necrotic material to slough off whilst providing the opportunity for spontaneous closure and allowing the patient to recover from the initial surgery. Waaldijk [52] using a definition of

"immediate" as within 3 mo of creation, reported 95.2% successful initial closure rates. The rationale behind immediate surgical treatment is to prevent distress to the patient, contain skin irritation, and in LRCs, to minimise stigmatisation.

There is currently an absence of adequate trial data, however, to support immediate repair over a delayed approach. In the experience of the authors, it is certainly more challenging to perform a repair between the 3rd wk and the 3rd mo following fistula formation.

A further area of contention in contemporary fistula surgery surrounds the route of surgery. Clearly, where there is synchronous ureteric involvement, vesico-uterine fistulae, or when access to the vagina is limited, then a transabdominal approach is more likely to be indicated. In the current review, 71% of lower urinary tract fistulae were repaired transvaginally in WRCs compared with 84% in LRCs. The success rates for transvaginal versus transabdominal repairs were 90.8% and 83.9% respectively. While this is a significant finding, clearly these results should be interpreted with caution, given that these approaches are not chosen at random, but based upon specific patient characteristics.

Both laparoscopic- and robot-assisted repair of vesico-vaginal fistula repairs have been performed. Nezhat et al [56] performed the first laparoscopic vesico-vaginal fistula repair in 1994, while Melamud et al [57] reported on the first robot-assisted repair of a vesico-vaginal fistula in 2005. The recent systematic review of the literature performed by Miklos et al [58] including 44 studies and a total of 256 patients, demonstrated that there is an absence of appropriate high level evidence in the contemporary literature and it can therefore be surmised that a significant selection bias exists in these articles. Furthermore, only two of the articles included in this review contained a sample size of >15 cases. With minimally invasive approaches, the same surgical principles as used with open surgery apply: namely separation of the vagina from the bladder and the interposition of well-vascularised tissue between both organs.

Vascularised tissue flaps are used to reinforce a repair, fill dead space, and to improve vasculogenesis following a repair. While this can be useful in complex, radiotherapy-induced, recurrent, or obstetric fistulae, there is no high level evidence to confirm benefit of tissue interposition, particularly as the decision to use tissue transfer techniques is based on specific fistula characteristics. Despite this, a Martius interposition flap is readily available during a transvaginal approach and is therefore commonly performed in this context. During an abdominal procedure, the greater omentum is commonly used as an interposition flap, while a variety of other tissues and materials have been used, including peritoneum [9,22,24,45], gracillis muscle [24,47], porcine small intestinal submucosa [25], Floseal haemostatic matrix [19], and bladder mucosa advancement flaps [6].

4. Conclusions

We have reviewed the English language literature since 1980 relating to lower urinary tract fistula, with a view to highlighting differences in aetiology and management between LRCs and WRCs. Only 49 relevant studies were identified, and most were of low quality.

Over 80% of all fistulae reported in the included studies were of obstetric aetiology, and of those reported from LRCs, childbirth was the causative factor in over 95%. In contrast, of the fistulae reported in the included studies from WRCS, over 80% occurred following pelvic surgery, with hysterectomy being the antecedent operation in over three quarters of these cases.

Closure of a fistula can be achieved in up to one third of cases by conservative management. Whilst the heterogeneity of cases and management pathways makes comparison of reported series difficult, spontaneous closure seems most likely to occur where there has been minimal tissue damage, and is seen more often with obstetric and surgical fistulae than postradiation fistulae.

For similar reasons, comparison between different surgical approaches is also difficult, and is more often based on individual surgeon preference than on evidence-based criteria. There is no proven benefit to delayed repair and surgery can be undertaken once it is clear that conservative measures are not going to be successful, and as soon as any oedema, inflammation, tissue necrosis, and infection are resolved.

There is no high level evidence that any specific route of surgery has an advantage over any other; similar success rates are reported for vaginal and abdominal, and for transvesical and transperitoneal approaches, and for repairs with and without interposition grafting. It has, however, to be borne in mind that series tend to be reported from high-volume centres and as a consequence clinical judgment has been exercised, rendering cohorts highly selected. Clearly an abdominal approach may be appropriate in the context of a complex procedure where the fistula is high in the bladder, close to the ureter(s), associated with radiotherapy, and involving the uterus. There is limited experience with laparoscopic approaches and inevitably this will require the appropriate technical knowledge and definitive statements can only be made when larger series are reported in the literature.

Intuitively, optimum results are more likely if fistula surgery is carried out by surgeons well versed in all available techniques. Limited surgical experience would seem to make failure of a repair more likely and an association between workload and outcome has been shown [2]. Outcomes from first repairs are consistently shown to be better than from repeat procedures. These factors all argue in favour of centralisation of management in areas of high prevalence/workload by an experienced multidisciplinary team. This pragmatic approach to management would seem to be equally applicable to both well and low-resourced settings.

Author contributions: Christopher R. Chapple had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Chapple, Hilton.
Acquisition of data: Hillary, Osman.
Analysis and interpretation of data: Hillary, Osman.

Drafting of the manuscript: Hillary, Osman.
Critical revision of the manuscript for important intellectual content: Hillary, Osman, Hilton, Chapple.
Statistical analysis: Hillary.
Obtaining funding: None.
Administrative, technical, or material support: None.
Supervision: Hilton, Chapple.
Other: None.

Financial disclosures: Christopher R. Chapple certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: Hilton was a member of faculty on the 1st International Consultation on Vesicovaginal Fistula (2010–2012), and on each of the first five International Consultations on Incontinence, in particular on the "Fistula committee" of the 5th consultation (2011–2013). Chapple is a speaker for Ranbaxy; a consultant for AMS, Lilly, and ONO; and a consultant, researcher, speaker, and trial participant for Allergan, Pfizer, and Recordati. He is a member of faculty on the International Consultations on Incontinence.

Funding/Support and role of the sponsor: None.

References

[1] Wall LL. Obstetric vesicovaginal fistula as an international public-health problem. Lancet 2006;368:1201–9.
[2] Cromwell D, Hilton P. Retrospective cohort study on patterns of care and outcomes of surgical treatment for lower urinary-genital tract fistula among English National Health Service hospitals between 2000 and 2009. BJU Int 2013;111:E257–62.
[3] de Bernis L. Obstetric fistula: guiding principles for clinical management and programme development, a new WHO guideline. Int J Gynaecol Obstet 2007;99(Suppl 1):S117–21.
[4] Oxford Centre for Evidence-based Medicine–Levels of Evidence (March 2009). Centre for Evidence-based Medine 2009, http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/.
[5] Blaivas JG, Heritz DM, Romanzi LJ. Early versus late repair of vesicovaginal fistulas: vaginal and abdominal approaches. J Urol 1995;153:1110–2.
[6] Brandt FT, Lorenzato FR, Albuquerque CD. Treatment of vesicovaginal fistula by bladder mucosa autograft technique. J Am Coll Surg 1998;186:645–8.
[7] Eilber KS, Kavaler E, Rodriguez LV, Rosenblum N, Raz S. Ten-year experience with transvaginal vesicovaginal fistula repair using tissue interposition. J Urol 2003;169:1033–6.
[8] Evans DH, Madjar S, Politano VA, Bejany DE, Lynne CM, Gousse AE. Interposition flaps in transabdominal vesicovaginal fistula repairs: are they really necessary? Urology 2001;57:670–4.
[9] Hadzi-Djokic J, Pejcic TP, Acimovic M. Vesico-vaginal fistula: report of 220 cases. Int Urol Nephrol 2009;41:299–302.
[10] Hilton P. Urogenital fistula in the UK: a personal case series managed over 25 years. BJU Int 2012;110:102–10.
[11] Kochakarn W, Pummangura W. A new dimension in vesicovaginal fistula management: an 8-year experience at Ramathibodi hospital. Asian J Surg 2007;30:267–71.
[12] Langkilde NC, Pless TK, Lundbeck F, Nerstrom B. Surgical repair of vesicovaginal fistulae–a ten-year retrospective study. Scand J Urol Nephrol 1999;33:100–3.
[13] Lee D, Dillon BE, Lemack GE, Zimmern PE. Long-term functional outcomes following nonradiated vesicovaginal repair. J Urol 2014;191:120–4.
[14] Milicevic S, Krivokuca V, Ecim-Zlojutro V, Jakovljevic B. Treatment of vesicovaginal fistulas: an experience of 30 cases. Med Arch 2013;67:266–9.
[15] Mondet F, Chartier-Kastler EJ, Conort P, Bitker MO, Chatelain C, Richard F. Anatomic and functional results of transperitoneal-transvesical vesicovaginal fistula repair. Urology 2001;58:882–6.
[16] Ockrim JL, Greenwell TJ, Foley CL, Wood DN, Shah PJ. A tertiary experience of vesico-vaginal and urethro-vaginal fistula repair: factors predicting success. BJU Int 2009;103:1122–6.
[17] Pushkar DY, Dyakov VV, Kasyan GR. Management of radiation-induced vesicovaginal fistula. Eur Urol 2009;55:131–8.
[18] Pushkar DY, Dyakov VV, Kosko JW, Kasyan GR. Management of urethrovaginal fistulas. Eur Urol 2006;50:1000–5.
[19] Abou-Elela A, Alfaiomy H, Torky H, Reyad E, Azazy S. The use of rotational bladder flap and hemostatic matrix sealant (FloSeal): a modified transabdominal approach to repair supratrigonal and complex vesicovaginal fistula. Surg Technol Int 2012;22:44–8.
[20] Ahmad S, Nishtar A, Hafeez GA, Khan Z. Management of vesico-vaginal fistulas in women. Int J Gynaecol Obstet 2005;88:71–5.
[21] Amr MF. Vesico-vaginal fistula in Jordan. Eur J Obstet Gynecol Reprod Biol 1998;80:201–3.
[22] Dalela D, Ranjan P, Sankhwar PL, Sankhwar SN, Naja V, Goel A. Supratrigonal vesico-vaginal fistula repair by modified O'Connor's technique: an experience of 26 cases. Eur Urol 2006;49:551–6.
[23] El-Lamie IK. Urogenital fistulae: changing trends and personal experience of 46 cases. Int Urogynecol J Pelvic Floor Dysfunct 2008;19:267–72.
[24] Ezzat M, Ezzat MM, Tran VQ, Aboseif SR. Repair of giant vesicovaginal fistulas. J Urol 2009;181:1184–8.
[25] Farahat YA, Elbendary MA, Elgamal OM, et al. Application of small intestinal submucosa graft for repair of complicated vesicovaginal fistula: a pilot study. J Urol 2012;188:861–4.
[26] Hilton P, Ward A. Epidemiological and surgical aspects of urogenital fistulae: a review of 25 years' experience in southeast Nigeria. Int Urogynecol J Pelvic Floor Dysfunct 1998;9:189–94.
[27] Holme A, Breen M, MacArthur C. Obstetric fistulae: a study of women managed at the Monze Mission Hospital, Zambia. BJOG 2007;114:1010–7.
[28] Jatoi N, Jatoi NM, Shaikh F, Sirichand P. Key to successful vesico-vaginal fistula repair–an experience of urogenital fistula surgeries and outcome at gynaecological surgical camp-2005. J Ayub Med Coll Abbottabad 2008;20:125–7.
[29] Jokhio AH, Kelly J. Obstetric fistulas in rural Pakistan. Int J Gynaecol Obstet 2006;95:288–9.
[30] Kayondo M, Wasswa S, Kabakyenga J, et al. Predictors and outcome of surgical repair of obstetric fistula at a regional referral hospital, Mbarara, western Uganda. BMC Urol 2011;11:23.
[31] Khan RM, Raza N, Jehanzaib M, Sultana R. Vesicovaginal fistula: an experience of 30 cases at Ayub Teaching Hospital Abbottabad. J Ayub Med Coll Abbottabad 2005;17:48–50.
[32] Kirschner CV, Yost KJ, Du H, Karshima JA, Arrowsmith SD, Wall LL. Obstetric fistula: the ECWA Evangel vesico-vaginal fistula Center surgical experience from Jos, Nigeria. Int Urogynecol J 2010;21:1525–33.
[33] Lewis A, Kaufman MR, Wolter CE, et al. Genitourinary fistula experience in Sierra Leone: review of 505 cases. J Urol 2009;181:1725–31.
[34] Mathur R, Joshi N, Aggarwal G, et al. Urogenital fistulae: A prospective study of 50 cases at a tertiary care hospital. Urol Ann 2010;2:67–70.
[35] Nafiou I, Idrissa A, Ghaichatou AK, Roenneburg ML, Wheeless CR, Genadry RR. Obstetric vesico-vaginal fistulas at the National Hospital of Niamey, Niger. Int J Gynaecol Obstet 2007;99(Suppl 1):S71–4.

[36] Nawaz H, Khan M, Tareen FM, Khan S. Retrospective study of 213 cases of female urogenital fistulae at the Department of Urology & Transplantation Civil Hospital Quetta, Pakistan. J Pak Med Assoc 2010;60:28–32.
[37] Obi SN, Ozumba BC, Onyebuchi AK. Decreasing incidence and changing aetiological factors of vesico-vaginal fistula in south-east Nigeria. J Obstet Gynaecol 2008;28:629–31.
[38] Raashid Y, Tmajeed T, Majeed N, Shahzad N. Iatrogenic vesicovaginal fistula. J Coll Physicians Surg Pak 2010;20:436–8.
[39] Raassen TJ, Verdaasdonk EG, Vierhout ME. Prospective results after first-time surgery for obstetric fistulas in East African women. Int Urogynecol J Pelvic Floor Dysfunct 2008;19:73–9.
[40] Rafique M. Genitourinary fistulas of obstetric origin. Int Urol Nephrol 2002;34:489–93.
[41] Sachdev PS, Hassan N, Abbasi RM, Das CM. Genito-urinary fistula: a major morbidity in developing countries. J Ayub Med Coll Abbottabad 2009;21:8–11.
[42] Safan A, Shaker H, Abdelaal A, Mourad MS, Albaz M. Fibrin glue versus martius flap interpositioning in the repair of complicated obstetric vesicovaginal fistula. A prospective multi-institution randomised trial. Neurourol Urodyn 2009;28:438–41.
[43] Shaker H, Saafan A, Yassin M, Idrissa A, Mourad MS. Obstetric vesico-vaginal fistula repair: should we trim the fistula edges? A randomised prospective study. Neurourol Urodyn 2011;30:302–5.
[44] Shoukry MS, Hassouna ME, El-Salmy S, Abdel-Karim AM. Vaginal flap re-enforcement of vesico-vaginal fistula repair. Int Urogynecol J 2010;21:829–33.
[45] Singh O, Gupta SS, Mathur RK. Urogenital fistulas in women: 5-year experience at a single center. Urol J 2010;7:35–9.
[46] Singh V, Sinha RJ, Mehrotra S, Sankhwar SN, Bhatt S. Repair of vesicovaginal fistula by the transabdominal route: outcome at a north Indian tertiary hospital. Int Urogynecol J 2012;23:411–6.
[47] Singh V, Sinha RJ, Sankhwar SN, Sinha SM, Vatsal P, Jain V. Transvaginal repair of complex and complicated vesicovaginal fistulae. Int J Gynaecol Obstet 2011;114:51–5.
[48] Sjoveian S, Vangen S, Mukwege D, Onsrud M. Surgical outcome of obstetric fistula: a retrospective analysis of 595 patients. Acta Obstet Gynecol Scand 2011;90:753–60.
[49] Tayler-Smith K, Zachariah R, Manzi M, et al. Obstetric fistula in Burundi: a comprehensive approach to managing women with this neglected disease. BMC Pregnancy Childbirth 2013;13:164.
[50] Vanderputte SR. Obstetric vesicovaginal fistulae. Experience with 89 cases. Ann Soc Belge Med Trop 1985;65:303–9.
[51] Vyas N, Nandi PR, Mahmood M, Tandon V, Dwivedi US, Singh PB. Bladder mucosal autografts for repair of vesicovaginal fistula. BJOG 2005;112:112–4.
[52] Waaldijk K. The immediate management of fresh obstetric fistulas. Am J Obstet Gynecol 2004;191:795–9.
[53] Hilton P, Cromwell DA. The risk of vesicovaginal and urethrovaginal fistula after hysterectomy performed in the English National Health Service–a retrospective cohort study examining patterns of care between 2000 and 2008. BJOG 2012;119:1447–54.
[54] Davits RJ, Miranda SI. Conservative treatment of vesicovaginal fistulas by bladder drainage alone. Br J Urol 1991;68:155–6.
[55] Waaldijk K. Immediate indwelling bladder catheterisation at postpartum urine leakage–personal experience of 1200 patients. Trop Doct 1997;27:227–8.
[56] Nezhat CH, Nezhat F, Nezhat C, Rottenberg H. Laparoscopic repair of a vesicovaginal fistula: a case report. Obstet Gynecol 1994;83:899–901.
[57] Melamud O, Eichel L, Turbow B, Shanberg A. Laparoscopic vesicovaginal fistula repair with robotic reconstruction. Urology 2005;65:163–6.
[58] Miklos JR, Moore RD, Chinthakanan O. Laparoscopic and robotic-assisted vesicovaginal fistula repair: A systematic review of the literature. J Minim Invasive Gynecol 2015;22:727–36.