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Outcome of urethral reconstruction among vesico-vaginal fistula patients: a cross-sectional study

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Abstract

Background: Obstetric fistula (OF) complicated by urethral loss (UL) poses a challenge to both the fistula surgeon and obstetric fistula patient. The involvement of the urethra and urethral closure mechanism in OF is an important determinant of successful closure of fistula and restoration of urinary continence. OF with UL is often associated with unsuccessful repair outcome. We describe urethral reconstruction in genital tract fistula patients with UL and the outcomes of the repair.

Methods: *Aim* To review the clinical characteristics and outcome of vesico-vaginal fistula associated urethral loss following urethral reconstruction.

This was a descriptive cross-sectional study conducted at the University College Hospital, Ibadan, Nigeria. A 5-year prospective data of all vesico-vaginal fistula patients with urethral loss (2011–2016) were reviewed and analysed. Data collected include socio-demographic and obstetric characteristics; cause of the fistula; and fistula characteristics—type of fistula, number of previous repairs, urethral loss, outcome of repair and follow-up. Data were entered and analysed using IBM SPSS version 20.

Results: Urethral loss occurred in 23 (15.3%) out of 150 women with OF; these women had urethral reconstruction surgery. The commonest type of urethral loss encountered in this cohort was proximal urethral loss which was seen in 12 (52.2%) patients. The most common types of fistula seen with urethral loss were large vesico-vaginal fistula (34.8%) and mid-vaginal fistula (26.1%). More than half of the women (56.6%) had previous unsuccessful repair at other facilities before presentation. The fistula closure rate was high (82.6%) regardless of type of urethral loss. Among the women with successful closure of OF with UL, about 36.8% had urinary stress incontinence post-fistula repair.

Conclusion: Urethral loss appears to be a rare complication of obstetric fistula. Successful closure with stress incontinence was seen in a sizeable number of women with OF with UL. Preoperative assessment for determinant of post-repair incontinence and surgical repair by experienced surgeons will improve successful outcome of repair in women with obstetric fistula with UL.

Keywords: Urethral reconstruction, Female urethral reconstruction, Urethral loss, Urethral loss obstetric fistula, Difficult obstetric fistula

1 Background

Genital tract fistula is a tragedy which occurs usually as childbirth trauma. It is a public health challenge in the underdeveloped and developing countries; and it continues to affect the lives of its victims adversely. Genital tract

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fistula is commonly due to prolonged obstructed labour resulting in pelvic tissue ischaemia and necrosis which leads to obstetric fistula in the developing world [1, 2]. Trauma to the genital tract leads to leakage of urine or faeces or a combination of both with associated extensive tissue damage which may result in urethral involvement, complete urethral loss (UL) and acquired gynaetresia with severe vaginal fibrosis or complete occlusion of the vagina popularly known as 'Ba Anya' meaning 'no road'.

The true incidence of obstetric fistula (OF) is unknown [3]. The estimates suggest that there are about 2 million women in sub-Saharan Africa, Asia, Latin America and Caribbean living with genital tract fistula, with an annual incidence of about 50,000–100,000 new cases [4, 5]. Nigeria accounts for nearly 40% of the global burden of fistula, with about 12,000 new cases occurring every year [6]. Genital tract fistula may be complicated by urethral injury leading to UL. Urethral loss complicates about 5% of obstetric fistulae [7, 8]. Stress incontinence complicates about 10% of obstetric fistulae, and it is mostly associated with injury involving urethral tissue loss or involvement of the sphincter mechanism [9].

Vesico-vaginal fistula (VVF) with UL is often associated with unsuccessful repair and increased risk of repeated failed attempts at repair of the fistula. Urethral fistula develops through the same mechanism as VVF; that is bladder tissue ischaemia involving the urethra, followed by necrosis and sloughing off. The involvement of the urethra in genital tract fistula is an important parameter and determinant in the diagnosis, classification, prognosis, surgical technique of repair, and outcome of the surgery for the fistula client. The description of complexity in the classification of obstetric fistula involves injury to the urethra including the bladder closure mechanism [10, 11]. Also, the injury could be in the distal edge of the fistula < 1.5–< 2.5 from the external urinary meatus or associated with a residual incontinence [12].

Vesicourethrovaginal fistula was once described as inoperable because of poor closure rate of the urethral component [13, 14]. Mahfouz described fistulae in which the whole urethra has sloughed off as the most troublesome type of all fistula types [15]. Moir also defined a major variety of obstetric injury which may cause the urethra to slough off leaving little or no urethral tissue [16].

Urethral reconstruction is a corrective surgery performed for the restoration of the urethra in partial or complete urethral loss. There are three standard approaches to urethral reconstruction; these include the use of anterior bladder flaps, posterior bladder flaps and vaginal wall flaps. The vaginal wall flap approach is considered the best approach, easier and faster technique and quiet amenable to anti-incontinence surgical

procedures [17]. The vaginal flaps technique could be by primary closure, use of bilateral labial pedicle flaps, peninsular flaps and labial island flaps [17].

The success of a urinary fistula repair is defined based on successful closure and restoration of urinary continence. A fistula may be successfully closed but associated with persistent urinary incontinence following surgery, and this is particularly common with urinary fistula associated with urethral involvement [18]. Following successful closure by urethral reconstruction, the repair may be complicated by stress incontinence, persistent uncontrollable leakage of urine, urinary retention, urethral stenosis and vaginal stenosis [3, 19].

Several factors associated with persistent urinary incontinence despite successful closure have been documented by previous studies; these factors include urethral damage, degree of vaginal mucosal scarring/fibrosis, fistula located at the bladder neck, large fistula, circumferential fistula and bladder capacity [18, 20]. Urethral fistula (type IIA and IIB) and circumferential defect are 10 times more likely associated with residual incontinence [18].

Urethral reconstruction is technically demanding and requires considerable degree of surgical skills and experience. The aim of this study is to evaluate the proportion of patients with urethral loss among VVF, clinical and fistula characteristics, and outcome of VVF associated with urethral loss/damage/injury managed by the female pelvic medicine and reconstructive surgery unit. We describe the experience with and outcome of urethral reconstruction in women living with obstetric fistula during the study period.

2 Methods

This was a prospective cross-sectional study conducted in Ibadan, South-west Nigeria, between 2013 and 2017. It was conducted among women diagnosed with obstetric fistula—vesico-vaginal fistula with associated urethral loss from prolonged obstructed labour.

Following counselling and informed consent, eligible women living with obstetric fistula were enrolled into the study. A total of 23 women with vesico-vaginal fistula associated with urethral loss were identified. The baseline data on socio-demographic characteristics, parity, obstetric characteristics, duration of labour, mode of delivery, outcome of delivery and previous repair were collected. Information on fistula characteristics such as the size, site and type of fistula, the type of urethral loss and extent of vaginal fibrosis was obtained. The outcome of surgery was determined at discharge and reviewed at the follow-up visits at 1, 3 and 6 months post-operative period. The complexity of fistula was defined based on the size of fistula, extent of urethral damage and vaginal scarring.

The data collected were entered and analysed using IBM SPSS Statistics Software version 20. Descriptive analysis was performed using mean (standard deviation), median for continuous variables, frequencies and proportions for categorical variables. Chi-square test was used to assess the association between categorical variables. The level of statistical significance was set at $p < 0.05$.

Ethical approval was obtained from the Oyo State, Research Ethical Review Committee, Oyo State Ministry of Health, Secretariat, Oyo State, Nigeria.

3 Results

This study evaluated the clinical characteristics, outcome of surgery and the determinants of successful surgical repair of obstetric urinary fistula associated with urethral

loss. Of the 150 women repaired during the study period, 23 (15.3%) had urethral loss of varying degrees (Fig. 1). Of the 23 women, nine women (39.1%) had total urethral loss, while twelve women (52.2%) and two women (8.7%) had proximal and distal urethral loss, respectively.

The mean age of the participants was 32.14 (± 7.2) years and ranged between 21 and 50 years (Table 1). The participants were predominantly of the Yoruba ethnic extraction (87.0%); majority were married (43.5%) and had mainly primary (47.8%) level of education. They were mostly Christians (43.5%), and Muslims were 26.1%. The average duration of labour was approximately 3 days. More than half of the patients were not booked for antenatal care in the antecedent pregnancy (56.5%) and had at least two or more pregnancies (56.6%). Mode of delivery was predominantly via vaginal delivery (60.9%) followed by CS deliveries (30.4%), while one patient had a forceps delivery (4.3%). Majority of the patients had a stillbirth (82.6%) (Table 1).

Figure 2 shows VVF with complete urethral loss (green arrow) and rectovaginal fistula (blue arrow) (Fig. 2). In Table 2, majority of the patients presented with only leakage of urine (87.0%). Three patients presented with both leakage of urine and faeces (13.0%). The median duration of leakage was 48 months; mean duration of leakage was 88.2 ± 80.8 months with a range of 2 to 216 months (18 years). The predominant cause of leakage of urine or urine and faeces for 18 (78.3%) of the 23 patients was obstructed labour, followed by two patients who had

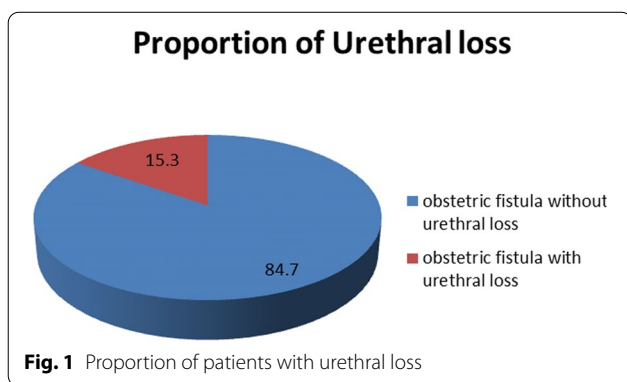


Table 1 Demographic and obstetric characteristics of participants

Variables	Mean	(SD)
Mean age (years)	32.14	(± 7.2)
	Frequency	Percentage (%)
Booking status		
Booked	2	8.7
Unbooked	13	56.5
No response	8	34.8
Number of pregnancies		
≤ 1	10	43.4
≥ 2	13	56.6
Mode of delivery		
SVD	14	60.9
Forceps	1	4.3
Caesarean section	7	30.4
No response	1	4.3
Outcome of delivery (foetal outcome)		
Alive	3	13.0
Stillbirth	19	82.6
No response	1	4.3

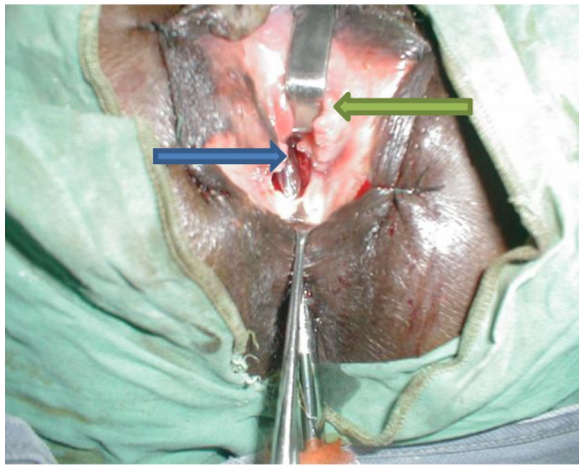


Fig. 2 Obstetric urinary fistula with complete urethral loss. Image shows vesico-vaginal fistula with complete urethral loss (green arrow) and rectovaginal fistula (blue arrow)

operative vaginal delivery (8.8%) and one patient who had CS, gynaecologic surgery and trauma (4.3%). Table 2 also shows the various sites in which the fistula coexisting with urethral loss was located, with the large circumferential fistula and mid-vaginal region being the most common (34.8% and 26.1%, respectively). More than half had a previous fistula repair (56.5%), had severe vaginal fibrosis (69.6%) and were deemed as complex fistula (52.2%) at evaluation. Eight patients were deemed irreparable (34.8%), two simple (8.7%) and one indeterminate (4.3%). Almost all participants had a successful repair (82.6%). Among these, stress (42.1%) and overflow (57.9%) incontinence were reported post-catheter removal in seven and one patients, respectively (Table 2). In Table 3, site of fistula, presentation, previous repair, degree of vaginal mucosa fibrosis and type of urethral loss were not associated with success of urethral reconstruction.

4 Discussion

This study evaluated the clinical characteristics of women with urethral loss and the outcome of urethral reconstructive surgery. The women had different degrees of urethral loss and genital tract fistula. In this study, the commonest clinical type was the proximal urethral loss with severe fibrosis from previous repeated repairs. The repair of urethra using urethral reconstruction was successful in more than half of the participants.

The prevalence of urethral loss was 15.3% in this study. Specifically, complete urethral loss was observed in about 5% of fistula patients, while partial urethral injury was found in about 30% [7]. Hamlin et al. reported a prevalence of 5% [8].

Table 2 Clinical presentation and fistula characteristics of participants

Variables	Frequency	Percent (%)
Presenting complaints		
Leakage of urine	20	87.0
Leakage of urine and faeces	3	13.0
Causes of fistula		
Obstructed labour	18	78.3
Operative vaginal delivery	2	8.7
Caesarean section	1	4.3
Gynaecologic surgery	1	4.3
Trauma	1	4.3
Site of other fistula ^a		
Juxtaurethral	2	8.7
Mid-vaginal	6	26.1
Juxtacervical	2	8.7
Uterovesical	1	4.3
Combined	3	13.0
Large circumferential	8	34.8
Vault	1	4.3
Previous repair		
Yes (1–4 repairs)	13	56.5
No	10	43.5
Degree of vaginal mucosa fibrosis		
Mild	4	17.4
Moderate	3	13.0
Severe	16	69.6
Complexity of repair		
Simple	2	8.7
Complex	12	52.2
Irreparable	8	34.8
Indeterminate	1	4.3
Outcome of repair		
Successful	19	82.6
Failed	4	17.4
Incontinence post removal of catheter following successful repair (n = 19)		
Yes (7—stress incontinence, overflow—1)	8	42.1
No	11	57.9

^a Location of the fistula in addition to urethral loss

In this study, the participants had a mean duration of labour of about 3 days prior to delivery which gives an insight into the duration of obstruction, tissue ischaemia, pressure necrosis and resultant extensive tissue damage that may account for the urethral loss and vesico-vaginal fistula. Long-standing labour obstruction with prolonged pressure of foetal head on vesico-urethral junction leads to ischaemia, tissue devitalization, necrosis and sloughing off of the vaginal tissues, bladder and urethral tissue anteriorly. The tissue loss will eventually manifest as

Table 3 Factors associated with successful urethral reconstruction

Variable	Successful	Failed	Total	Chi-square	p value
Site of fistula					
Juxtaurethral	2 (10.5)	0 (0.0)	2 (8.7)	2.118	0.908
Mid-vaginal	5 (26.3)	1 (25.0)	6 (26.1)		
Juxtacervical	2 (10.5)	0 (0.0)	2 (8.7)		
Uterovesical	1 (5.3)	0 (0.0)	1 (4.3)		
Combined	2 (10.5)	1 (25.0)	3 (13.0)		
Large circumferential	6 (31.6)	2 (50.0)	8 (34.8)		
Vault	1 (5.3)	0 (0.0)	1 (4.3)		
Presenting complaints					
Leakage of urine	17 (89.5)	3 (75.0)	19 (82.6)	0.610	0.435
Leakage of urine and faeces	2 (10.5)	1 (25.0)	3 (13.0)		
Previous repair					
Yes (1–4 repairs)	10 (52.6)	3 (75.0)	13 (56.5)	0.673	0.412
No	9 (47.4)	1 (25.0)	10 (43.5)		
Degree of vaginal mucosa fibrosis					
Mild/moderate	6 (31.6)	1 (25.0)	7 (30.4)	0.068	0.795
Severe	13 (68.4)	3 (75.0)	16 (69.6)		
Type of urethral loss					
Total	7 (36.8)	2 (50.0)	9 (39.1)	0.240	0.624
Proximal/distal	12 (63.2)	2 (50.0)	14 (60.9)		

a defect in the bladder, vagina and urethral injury [21]. Urethral injury with urethral loss may also follow pelvic fractures or gynaecologic surgery [17].

About a third of the women had total urethral loss; proximal urethral loss was the most common type seen. Proximal urethral loss is more common and occurs usually concurrently with vesico-vaginal fistula located at the bladder neck [21]. This is common in the juxtaurethral and circumferential fistula. Total urethral loss is less common and occurs commonly with large or circumferential fistula [21]. It is associated with obstruction of labour at the pelvic outlet [14]. There was no patient with urethral stenosis in this cohort of women living with obstetric fistula and urethral involvement. The mechanism of urethral injury in obstetric fistula patients commonly involves tissue ischaemia, necrosis and devitalization from obstructed labour. However, in addition to this, iatrogenic injury to the bladder, bladder neck and proximal urethra may occur during caesarean section and dis-impaction of the foetal head in obstructed labour. Difficult urethral catheterization in obstructed labour may also contribute to urethral injury, inflammation and damage. One patient had vault fistula and proximal urethral loss from a gynaecological surgery with iatrogenic injury to the bladder and upper urethra.

The female urethral reconstructive surgery includes a series of surgical techniques for the repair of the urethra; the choice of the procedure and technique is based

on whether urethral injury involves urethral loss/damage or urethral stenosis. The techniques of repair for urethral stenosis/stricture include vaginal wall flap urethroplasty, graft urethroplasty and distal urethrectomy with advancement meatoplasty [22], while the techniques of repair in urethral loss or damage include primary closure of the defect, vaginal wall flap urethroplasty and bladder flap urethroplasty. Surgical techniques using vaginal wall flap with well-vascularized grafts and buccal mucosal grafts have high success rates [22]. The choice of technique used will depend on whether injury involves partial or total urethral loss, bladder neck and urethral closure mechanism. In this cohort, the most common repair technique used was the vaginal flap method with insertion of a pubo-vaginal sling to maintain continence. Only one patient with total urethral loss had a bladder flap technique in this cohort. The placement of peri-urethral fixation stitches bilaterally, and the use of long-lasting absorbable sutures prevents retraction of the bladder neck backwards. Primary closure is suitable for small defects, but larger defects require a flap for best outcomes. Urethral reconstruction techniques also include the use of buccal mucosa graft; engineered tissue grafts are being investigated as novel management modalities. These include mesothelial cell-seeded autogenous granulation tissue tube and cell-based tissue engineering approach [23, 24]. Ansari and Karram reported female urethral reconstruction for complete urethral loss using

acellular porcine urinary bladder matrix with successful clinical outcomes [25].

Majority of the patients had successful fistula repair; more than half of the women had successful closure of fistula and urinary continence. The success rate in this study is 57.9%. This is low compared to Sawant et al. who reported a success rate of 86% among seven patients repaired and mild incontinence in 14% of patients treated [26]. Flisser et al. also found a continence rate of 87% [27]. The success rate in this study may be due to the fact that women in this cohort presented with complex fistula and some of the women were referred from other fistula centres with ‘fistula deemed inoperable’.

Less than half of the women had residual urinary incontinence after repair. The genital tract injury involved the urethra by varying extent among these women; and the extent of injury, tissue and urethral damage is a major determinant of success in fistula surgery [18, 19, 28]. Stress incontinence occurs in about 10% of OF; it is associated with large fistula. The urethral involvement in obstetric fistula is a known risk factor for residual incontinence following fistula repair and one of the leading causes as demonstrated by previous studies [20, 29]. Factors which independently predict residual incontinence after repair include urethral involvement, small bladder, vaginal scarring and size of the fistula. Other factors include previous repair/number of previous repair, large fistula, multiple fistula, combined fistula and mode of delivery. Accompanying vaginal scarring which is commonly seen and multiple repairs may also contribute to this, suggesting the possible role of a combination of factors [29]. Large fistula size and vaginal scarring in OF constitute factors associated with poor prognosis. Persistent urinary incontinence was managed by sling procedure using the pubo-vaginal sling.

The main complication documented in this study was residual incontinence despite successful closure—stress incontinence.

During the period of this study, there was no facility for urodynamic testing unit and we were unable to conduct urodynamic evaluation for the patients with residual incontinence. We relied on clinical evaluation for the management of these patients.

5 Conclusion

Urethral loss can occur following prolonged obstructed labour. Surgical repair by experienced surgeon could provide a better outcome and improved quality of life for the women.

Abbreviations

UL: urethral loss; OF: obstetric fistula; IBM SPSS: International Business Machine; Statistical Product and Service Solutions.

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Authors' contributions

All authors contributed to the preparation of this manuscript. OL, RA, OB, IM and OO contributed to the conceptualization, design, data collection manuscript writing and manuscript review; RA and OL contributed to the data analysis. All authors read and approved the final manuscript.

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Availability of data and materials

The data sets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics review committee—Oyo State, Research Ethical Review Committee, Oyo State Ministry of Health, Secretariat, Oyo State, Nigeria; Reference number AD/13/479. Informed consent was obtained from the participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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References

1. Federal Ministry of Health (2011) National strategic framework for the elimination of obstetric fistula in Nigeria. [Cited 2019 Feb 24]. https://fistulacare.org/archive/files/5/5.4/Nigeria_National_Strategy_2011-2015.pdf
2. Daru P, Karshima J, Mikah S, Nyango D (2011) The burden of vesico-vaginal fistula in north central Nigeria. *J West Afr Coll Surg* 1(2):50–62
3. Kelly J, Kwast BE (1993) Obstetric vesicovaginal fistulas: evaluation of failed repairs. *Int Urogynecol J* 4(5):271–3. <https://doi.org/10.1007/BF00372737>
4. World Health Organization (WHO) (2018) 10 facts on obstetric fistula. World Health Organization (WHO). [Cited 2019 July 5]. https://www.who.int/features/factfiles/obstetric_fistula/en/
5. United Nations Population Fund (UNFPA) (2018) Obstetric fistula | UNFPA—United Nations Population Fund. United Nations Population Fund (UNFPA). [Cited 2018 June 3]. <https://www.unfpa.org/obstetric-fistula>
6. EngenderHealth (2010) Strengthening fistula prevention and treatment services in Nigeria: an environmental scan. EngenderHealth, New York
7. Wall LL, Arrowsmith SD, Briggs ND, Browning A, Lassey A (2005) The obstetric vesicovaginal fistula in the developing world. *Obstet Gynecol Surv* 60(7 Suppl 1):S3–51
8. Hamlin RHJ, Nicholson EC, Obst DRCOG (1969) Reconstruction of urethra totally destroyed in labour. *Br Med J* 2:147–150
9. Stamatakis M, Sargedji C, Stasinou T, Kontzoglou K (2014) Vesicovaginal fistula: diagnosis and management. *Indian J Surg* 76:131–136
10. Waaldijk K (1993) 993 VVF-projects Babbar Ruga Fistula Hospital KATSINA and Laure Fistula Center KANO. [Cited 2019 Feb 24]. http://www.isofo.org/wp-content/uploads/2014/05/report_004_1993b_full_report-1.pdf
11. Waaldijk K (2004) The immediate management of fresh obstetric fistulas. *Am J Obstet Gynecol* 191(3):795–799

12. Goh JTW (2004) A new classification for female genital tract fistula. *Aust New Zeal J Obstet Gynaecol* 44(6):502–504. <https://doi.org/10.1111/j.1479-828X.2004.00315.x>
13. Bird GC (1967) Obstetric vesico-vaginal and allied fistulae. A report on 70 cases. https://www.unboundmedicine.com/medline/citation/6058539/Obstetric-vesico-vaginal-and-allied-fistulae__A-report-on-70-cases_. Accessed 24 Feb 2019
14. Elkins TE (1994) Surgery for the obstetric vesicovaginal fistula: a review of 100 operations in 82 patients. *Am J Obstet Gynecol* 170(4):1108–1120
15. Mahfouz N (1957) Urinary fistulae in women. *J Obstet Gynaecol Br Emp* 64(1):23–34
16. Moir CJ (1967) The vesico-vaginal fistula. Edited by J. Chassar Moir, C.B.E., M.D., M.A., D.M., F.R.C.S., F.R.C.O.G., Nuffield Professor of Obstetrics and Gynaecology, University of Oxford. Second edition. *Br J Surg* 54(12):1041. <https://doi.org/10.1002/bjs.1800541235>
17. Blaivas JG, Purohit RS (2008) Post-traumatic female urethral reconstruction. *Curr Urol Rep* 9(5):397–404
18. Kayondo M, Wasswa S, Kabakyenga J, Mukibi N, Senkungu J, Stenson A et al (2011) Predictors and outcome of surgical repair of obstetric fistula at a regional referral hospital, Mbarara, western Uganda. *BMC Urol* 11(1):23
19. Barone MA, Frajzyngier V, Ruminjo J, Asimwe F, Barry TH, Bello A et al (2012) Determinants of postoperative outcomes of female genital fistula repair surgery. *Obs Gynecol* 120(3):524–531
20. Nardos R, Browning A, Chen CCG (2009) Risk factors that predict failure after vaginal repair of obstetric vesicovaginal fistulae. *Am J Obstet Gynecol* 200(5):578.e1–578.e4
21. Hancock B, Browning A (2009) *Practical obstetric fistula surgery*. Royal Society of Medicine Press Ltd, London
22. Faiena I, Koprowski C, Tunuguntla H (2016) Female urethral reconstruction. *J Urol* 195:557–567
23. Jiang S, Xu Z, Zhao Y, Yan L, Zhou Z, Gu G (2017) Urethral reconstruction using mesothelial cell-seeded autogenous granulation tissue tube: an experimental study in male rabbits. *Biomed Res Int* 2017:1–9
24. Chokalingam K, Gottipamula S, Sridhar KN (2018) Urethral reconstruction using cell-based tissue engineering approaches. [Cited 2019 July 12]. <https://emj.europeanmedical-group.com/wp-content/uploads/sites/2/2018/05/Urethral-Reconstruction-Using-Cell-Based-Tissue-Engineering-Approaches.pdf>
25. Ansari S, Karraam M (2017) Two cases of female urethral reconstruction with acellular porcine urinary bladder matrix. *Int Urogynecol J* 28(8):1257–1260
26. Sawant A, Kasat GV, Kumar V, Pawar P, Tamhankar A, Bansal S et al (2016) Reconstruction of female urethra with tubularized anterior vaginal flap. *J Clin Diagn Res* 10(7):PC01–3
27. Flisser AJ, Blaivas JG (2003) Outcome of urethral reconstructive surgery in a series of 74 women. *J Urol* 169(6):2246–2249
28. Frajzyngier V, Ruminjo J, Barone MA (2012) Factors influencing urinary fistula repair outcomes in developing countries: a systematic review. *Am J Obs Gynecol* 207(4):248
29. Browning A (2006) Risk factors for developing residual urinary incontinence after obstetric fistula repair. *BJOG Int J Obstet Gynaecol* 113(4):482–485

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