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RADIOLOGICAL RE-EVALUATION OF FAILED ANASTOMOTIC URETHROPLASTY FOR PELVIC FRACTURES URETHRAL DISTRACTION DEFECT INJURIES; EXPERIENCE IN 41 PATIENTS

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INTRODUCTION

Pelvic fracture urethral distraction defect injuries (PFUDDIs) are complex pathologic injuries. It involves displacement and malalignment of the severed urethral ends with an intervening and surrounding fibrosis, detached bony fragments and callus formation[(1-4).]

Successful repair of PFUDDI depends on multiple factors including: identifying the anatomy of the distraction defect, its length, its direction and the degree of alignment of the prostato-membranous complex with the proximal bulbar urethra, the presence of fistulae or false passages and identification of bone anatomy particularly ectopic bone or callus from healed fractures.[1]

The classic evaluation of PFUDDI is through retrograde urethrogram (RUG) and micturating cystourethrogram (MCU).[(5-7)]

However, this modality cannot provide an accurate determination of the defect length because of poor prostatic urethral filling. Also, it provides little information about the extent of corpus spongiosum fibrosis or prostatic displacement.[(8-11)]

Three dimensional computed tomographic urethrocystography (3D CTCUG) image allows the surgeon to view the injury through several planes and identify precisely its anatomy.[12] In-addition, it helps in detection of the prostatic displacement antero-posterior or lateral which has a strong impact on the outcome. Therefore, the condition can be classified primarily as a simple or complex surgical problem, the procedure is easily planned and the patient is adequately counseled.[(1-13)]

In the current study, we evaluate the benefits of 3D CTCUG in the diagnosis of failed anastomotic urethroplasty for PFUDDI by comparing the data obtained by it and RUG & MCU with the intra-operative findings.

MATERIALS AND METHODS

Between April 2016 and February 2019, out of 161 patients who underwent previous urethroplasty for PFUDDI, 41 (25.4%) patients with failed urethroplasty were included in this prospective cohort study. The definition of failure in our study was the inability to void or voiding with marked difficulty for which supra pubic tube was required. Patients with PFUDDI with no prior urethroplasty, post-prostatectomy posterior urethral stricture were excluded.

Detailed history including the presenting symptoms, time of repair, time between surgery and reappearance of symptoms, type of pelvic fracture, history of suprapubic tube fixation and spinal cord injury were reported. Physical examination was performed in the lithotomy position to assess hip flexion and the ability of the patients to tolerate this position. Some patients may have unresolved back or other orthopedic problems which may be exacerbated by prolonged lithotomy positioning. Presence of suprapubic tube or fistula was reported.

Laboratory tests including urine analysis and culture, blood grouping, renal and liver function test, complete blood picture and coagulation profile, random blood glucose and serology were performed.

All patients initially underwent RUG & MCU followed by 3D CTCUG. In both studies, we started by filling the bladder through a suprapubic catheter with diluted contrast medium (normal saline 2:1). Filing was continued till the patient perceives the sensation of full bladder. Contrast medium is then injected retrograde through a catheter fixed at the fossa navicularis. Scanning extends from the iliac crest above to the end of the urethra below. This was followed by another scan with the same parameters while the patient is attempting to void in 3D CTCUG. The transverse thin sections were transferred to a workstation with manufacturer-provided software that allows generation of 2D maximum intensity projection, 2D multiplanar reconstruction, and 3D shaded-surface display. One experienced radiologist prospectively and independently interpreted the CT urethrography. The urethra was evaluated with 2D transverse images and a soft-tissue window setting. Measuring of PFUDDI length with ascending urethrography was done using the Magic View Picture.

All soft tissue densities were subtracted from the volume of interest, leaving only the high-density images like the pelvic bony structures, contrast medium-filled bladder and the urethra. These images were used to assess the bony pelvic structures and their relation with the bladder and urethra, together with any displaced bony fragments. The bone images were then subtracted to isolate any urethral pathology (Fig.1). These data will be compared to the intraoperative finding to determine the value of 3D CTCUG. Intra-operatively, the defect length was measured using a ruler after identifying both proximal and distal urethral ends after division.

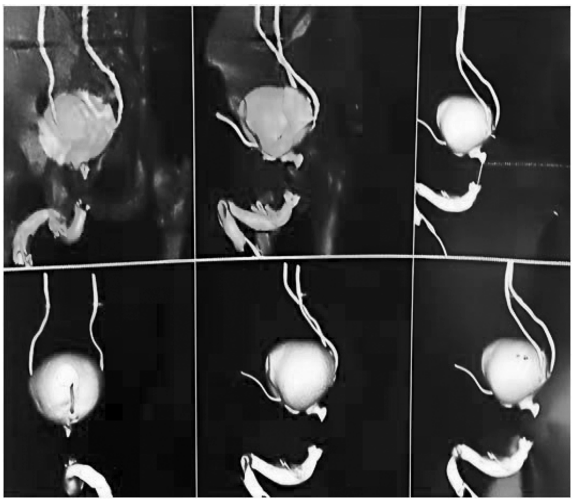

Figure 1: 3D CTCUG film showing PFUDDI measuring the exact length of the defect, degree of lateral and AP alignment, relationship between the defect and pelvic bones and bilateral vesicoureteric reflux.

The sample size was calculated according to Epi-Info version 7.1 for statistical calculation using the following parameters: power of study 80%, margin of error 10%, confidence level 80%, population size 1500 and a probability value of 0.5%. This yielded a sample size that should not be less than 40 cases according to Raosoft sample size calculation program.

The Kolmogorov-Smirnov test was applied to test the normality of quantitative data. The Mann-Whitney U-test was used to compare mean values of continuous variable. The Pearson chi-square test or Fisher's exact test was used to analyses the frequency of categorical variables where appropriate. A P-value of <0.05 was considered statistically significant. All statistical analysis was performed using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 20).

RESULTS

This prospective study initially included 50 patients with failed PFUDDI anastomotic urethroplasty. Five patients refused to participate in the study and 4 patients missed the follow up. The remaining 41 patients underwent the study evaluation. The mean age was 29.85 ± 10.41 (range 17-52) years. Thirty eight (92.7%) patients managed at the time of trauma by suprapubic tube insertion. Three (7.3%) patients underwent primary endoscopic realignment. Later on, all patients were managed by anastomotic urethroplasty.

The duration between the primary urethroplasty and its failure ranged between 6-18 months, 28 (68.2%) patients presented before one year and 13 (31.8%) presented after one year. Thirty five (85.4%) patients presented with suprapubic tube and 6 (14.6%) with acute urinary retention for which suprapubic tube was inserted. Pelvic fracture due to motor car accident (MCA) was present in 19 (46.3%) patients, motor bike accident (MBA) in 13 (31.7%) and fall from height (FFH) in 9 (22 %).

(Table 1): The clinical characteristics of the patients

	No. (41)	%
Type of pelvic fracture:		
Type A	14	34.1
Type B	15	36.6
Type C	12	29.3
Presentation with SP tube:		
Yes	35	85.4
No	6	14.6
Cause of trauma:		
MCA	19	46.3
MBA	13	31.7
FFH	9	22.0
Presentation after previous failed urethroplasty:		
<1year	28	68.2
> 1year	13	31.7
Type of urethroplasty:		
Anastomotic urethroplasty	41	100.0
Primary management:		
SP tube	38	92.7
Endoscopic realignment	3	7.3

The site of PFUDDI was bulbo-membranous in 37 (90.2%) patients, prostato-membranous in 3 (7.3%) and membranous in 1 (2.4%) before the primary urethroplasty. The site of stricture recurrence and the measured length by RUG & MCU, 3D CTCUG and intraoperatively are shown in table-2 with no statistical significance. However, there was a significant difference between the mean defect length (MDL) measured by RUG and intraoperatively (p 0.003).

Table (2) shows comparison between 3D CTCUG and RUG with MCU relative to the intraoperative findings.

	CT (n= 41)	RUG (n= 41)	Operative (n= 41)	P-value[1]	P-value[2]
	No. (%)	No. (%)	No. (%)		
Site					
Anastomotic site	35 (85.4)	39 (95.1)	36 (87.8)	0.746	0.432
Bulbar urethra	6 (14.6)	2 (4.9)	5 (12.2)		
Length (cm)					
Mean ± SD	3.92 ± 0.77	3.47 ± 0.67	3.90 ± 0.76	0.094	0.003*
Range	2.5 – 5.5	2.0 – 4.5	2.5– 5.3		
Stones					
Present	5 (12.2)	-	5 (12.2)	1.000	
Not present	36 (87.8)	-	36 (87.8)		
URF					
Present	4 (9.8)	4 (9.8)	5 (12.2)	1.000	
Not present	37 (90.2)	37 (90.2)	36 (87.8)		
Ectopic bone fragment					
Present	18 (43.9)	-	20 (48.8)	0.658	
Not present	23 (56.1)	-	21 (51.2)		
Alignment					
Aligned	13 (31.7)	-	15 (36.6)	0.641	
Not aligned	28 (68.3)	-	26 (63.4)		

P-value [1]; represents the relation between the defect length by 3D CTCUG and the intraoperative length, while p-value [2] represents the relation between that of RUG and the intraoperative length

Urethro-rectal fistula (URF) was detected in 4 (9.8%) patients by both 3D CTCUG and combined RUG and MCU with a detection rate 80% (figure-2). Intraoperatively, 5 patients were found to have URF after confirmation by methylene blue which exactly determines the site of first leakage of the coloured agent. The relationship between URF by 3D CTCUG and duration of operation, the need for blood transfusion (estimated blood loss [EBL]) and inferior pubectomy were shown in table-3. Four patients with URF had an operative time of 180-220 minutes (p 0.042*).

Five (12.2%) patients have a prostatic urethral stone with a detection rate of 100% by 3D CTCUG, which was not detected by KUB or combined RUG & MCU (figure-3). Eighteen (43.9%) patients found to have ectopic bone fragment related to urethral defect by 3D CTCUG while intraoperatively this was found in 20 (48.8%) (p 0.658). Combined RUG & MUG cannot asses the presence of ectopic bone fragment and their relation to PFUDDI [Table-2]. Eight patients who have ectopic bone fragments by 3D CTCUG received blood transfusion ≥ 500 cc, 5 of them underwent inferior pubectomy with no significant value (0.632). 15/18 patients had an operative time ≥ 180 minutes (P 0.430).

The longer the length of PFUDDI by 3D CTCUG, the more dissection needed with a longer operative time. In our study, the operative time was < 180 minutes for a mean defect length of 3.03 ± 0.32 cm in 11(26.8%) patients, about 180 minutes for a mean length of 3.96 ± 0.45 cm in 20 (48.8%) and >180 minutes for a mean length of 4.84 ± 0.45 cm in 10 (24.4%) patients (p 0.004).

Inferior pubectomy was needed in 13 (31.7%) patients with MDL of 4.57 ± 0.62 cm. There was no need for inferior pubectomy for patients with MDL of 3.62 ± 0.65 cm. Eighteen (43.9 %) patients with MDL of 4.34 ± 0.66 cm had an EBL > 500 cc, while 23 patients with a MDL of 3.60 ± 0.71 cm had EBL < 500 cc [table-3].

Figure-2: 3DCTCUG showing Complex PFUDDI with urethrorectal fistula.

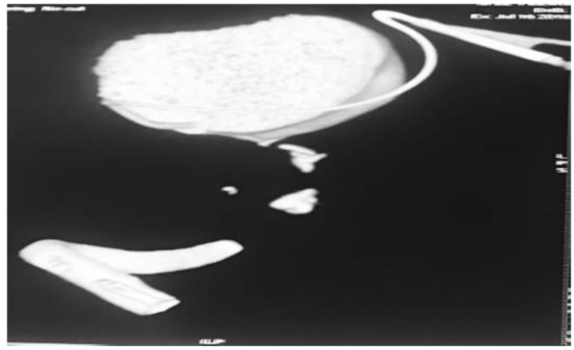

Figure-3: 3D CTCUG film showing PFUDDI with stone at prostatic urethra

Table (3) shows the relationship between detection of URFs, presence of ectopic bone fragment and the length of PFUDDI by 3D CTCUG and the operative time, estimated blood loss and the need for inferior pubectomy.

	Fistula		P-value	Bony fragment		P-value	Length by CT in cm	P-value
	Present	Not present		Present	Not present			
	No. (%)	No. (%)		No. (%)	No. (%)		Mean ± SD	
Operative time (min)								
< 180	-	11 (29.7)		3 (16.7)	8 (34.8)		3.03 ± 0.32	
180	1 (25)	19 (51.4)		10 (55.6)	10 (43.5)	0.430	3.96 ± 0.45	0.004
> 180	3 (75)	7 (18.9)	0.042*	5 (27.8)	5 (21.7)		4.84 ± 0.45	
Mean ± SD	202.50 ± 15.00	172.86 ± 22.93	0.016*	181.00 ± 17.73	171.65 ± 27.42	0.217		
Range	180 – 210	120 – 210		150 – 210	120 – 210			
Inferior pubectomy:								
Present	3 (75)	10 (27)	0.086	5 (27.8)	8 (34.8)	0.632	4.57 ± 0.62	0.003
Not present	1 (25)	27 (73)		13 (72.2)	15 (65.2)		3.62 ± 0.65	
Estimated blood loss								
EBL > 500 cc	3 (75)	15 (40.5)	0.303	8 (44.4)	10 (43.5)	0.951	4.34 ± 0.66	0.002*
EBL < 500 cc	1 (25)	22 (59.5)		10 (55.6)	13 (56.5)		3.60 ± 0.71	

DISCUSSION

Proper surgical planning is the key of successful repair of a PFUDDI. This entails selecting the appropriate surgical approach, anticipating the need for bone or callus resection, pubectomy, blood transfusion and preoperative patient counseling particularly about impotence and incontinence. Such surgical planning necessitates a thorough knowledge of the length of the urethral defect, the direction and degree of alignment of the prostato-membranous complex with the bulbar urethra, the presence of fistulae or false passages, ectopic bone fragment or callus formation which is a normal process of bone reformation.[1, 8, 14]

Conventional imaging may fail to fully characterize the PFUDDI; the overlap of bone fragments might hinder proper visualization of the urethra.[8, 13, 15,16] 3D CTCUG provides more details including: accurate measurement of lesions without magnification or distortion, visualization of intraluminal anatomy and pathology. So, surgeons can use the virtual results to plan surgery and characterize the lesion on the workstation rather than in the operative room.[15, 17, 18] In conventional radiographs, multiple views including bilateral oblique may be required. However, in 3D CCTUG, patients will adopt only one position and the scanning time is only 6 seconds at maximum.[9, 12, 18]

In a study by Bhagat et al., combined RUG & MCU were used to evaluate 43 men who underwent redo-urethroplasty. The urethral defect was bulbo-membranous in 27 patients, membranous in 8, prostato-membranous in 6 and peno-bulbar in 2 patients.[19] In our study, by RUG & MCU, the site of recurrence was at the anastomotic site in 39 (95.1%) patients and at the bulbar urethra in 2 (4.9%). By 3D CTCUG, the recurrence was at the anastomotic site in 35 (85.4%) patients and at the bulbar urethra in 6 (14.6%). Intraoperatively, the stricture was at the anastomotic site in 36 (87.8%) patients and at the bulbar urethra in 5 (12.2%). Although, no significant statistical difference between both modalities in determining the site of the defect, the intraoperative findings raise the value of 3D CTCUG for better determination of site of PFUDDI.

A study evaluating the MDL of PFUDDI, it was (4.31 ± 2.28 cm) by 3D CTCUG and (4.02 ± 3.12 cm) when measured by conventional urethrography ($p > 0.05$)[20]. In our study, the measured length using 3D CTCUG was (3.92 ± 0.77 cm) and (3.47 ± 0.67cm) by RUG. Intraoperatively, it was (3.90 ± 0.76 cm) with no significant statistical difference with 3D CTCUG (P 0.094), but with a significant difference with the length measured by RUG (p 0.003).This supports the accuracy of 3D CTUCG in accurate determination of length of PFUDDI. However, the intraoperative length is usually more than the radiology one even by CT CCUG, as all fibrous tissue that tether the both end of urethra will be removed and after transaction the healthy elastic urethra tends to retracted.

Regarding the degree of alignment or malalignment of the urethral defect, 3D CTUCG provides more details if compared to combined RUG & MCU. This is essential for predicting the need for inferior pubectomy or blood transfusion. In our study, 13 (31.7%) patients had both end of urethral defect aligned by 3D CTCUG, while intraoperatively; this was found in 15 (36.6%) (p 0.641). Malalignment was detected in 28 (68.3%) patients by 3D CTCUG and in 26 (63.4%) intraoperatively (p 0.641) (Fog. 4).

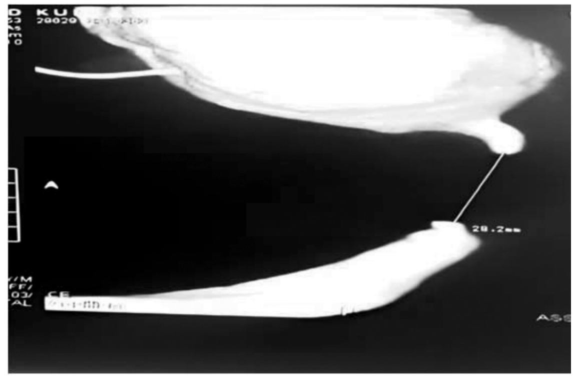

Figure 4: 3D CTCUG showing PFUDDI LT lateral misalignment with measured length of 28.2 mm.

A comparative study evaluating PFUDDI associated with URF, the accuracy in locating the stricture was higher with 3D CTCUG (93.1%) than with conventional urethrography (70.6%) ($p < 0.05$). The fistula detection rate of 3D CTCUG was reported to be 87.9%[18]. Another study included 38 patients reported that 3D CTCUG clearly define the relationship between URF and urethral stricture in all its patients. Whereas, URFs were observed in 27/38 (71%) patients who underwent conventional urethrography ($p<0.05$).[20] In our study, both 3D CTCUG and combined RUG and MCU have the same detection fistula rate of 80% (4/5). But, 3D CTCUG was more descriptive for URF and its relation to the PFUDDI. Another advantage of 3D CTCUG in this respect is the ability to pinpoint the location of URF which was confirmed by intra urethral injection of methylene blue dye during the operation. This shortens the duration of surgery and minimizes damage to the area surrounding the urethra[20]. In our study, the 4 patients with URF had an operative time of (180-220 minutes) (p 0.042).

Secondary pathologic lesions as stones which need preoperative planning are clearly defined by 3D CTCUG. In our study, 5 (12.2%) patients had a stone at prostatic urethra with detection rate 100%. It was not detected by KUB or combined RUG & MCU where it appear as faint filling defect or not appeared at all.

In our study, ectopic bone fragment related to the urethral defect was found in 18 (43.9%) patients by 3D CTCUG and in 20 (48.8%) patients intraoperatively (p 0.658). Combined RUG & MCU failed to assess the presence of ectopic bone fragment and its relation to PFUDDI. Eight patients with ectopic bone fragments by 3D CTCUG received blood transfusion > 500 cc (p 0.951) and 5 underwent inferior pubectomy (p 0.632). Also, 15/18 had an operation time ≥180 minutes (P 0.430).

Inferior pubectomy in the current study was required in 13 patients (31.7%) with MDL of (4.57 ± 0.62 cm) and there was no need for inferior pubectomy for MDL of (3.62 ± 0.65cm) by 3D CTCUG (p 0.003). Three out of four patients with URF by 3D CTCUG underwent inferior pubectomy (p 0.086). This supports the value of 3D CTCUG for planning the operation.

A proportional relationship between the defect length by 3D CTCUG and the need for blood transfusion may be present. The EBL was > 500 cc in 18 patients (43.9 %) with MDL of (4.34 ± 0.66 cm) by 3D CTCUG, while it was < 500 cc for MDL of (3.60 ± 0.71 cm) (p 0.002).

The Limitations of the current study are the small sample size, lack of information about the pelvic vascularity which may affect the healing process and its expenses in comparison to RUG and MCU.

CONCLUSION

3D CTCUG is a promising tool for detailed diagnosis of PFUDDI. It allows urethral examination in short time in only one position without distortion and with generation of 3D images. It can accurately determine the PFUDDI length and the associated pathological conditions as URF, stones and ectopic bone fragments.

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Abbreviations:
PFUDDI: Pelvic fracture urethral distraction defect injury
RUG: Retrograde urethrogram
MCU: Micturating cystourethrogram
3D CTCUG: Three dimensional computed tomographic urethrocystography
MCA: Motor car accident
MBA: Motor bike accident
MDL: Mean defect length
URF: Urethro-rectal fistula
EBL: Estimated blood loss
FFH: Fall from height

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