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Research Article

PROSPECTIVE STUDY OF ROLE OF CONVENTIONAL URETHROGRAPHY VERSUS MAGNETIC RESONANCE URETHROGRAPHY IN THE EVALUATION AND MANAGEMENT OF MALE STRICTURE URETHRA

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A B S T R A C T

Introduction: Male urethral stricture is common entity encountered in urology practice. Urethral stricture could be the sequel of trauma, instrumentation, inflammation or Idiopathic and can involve anterior, posterior or both segments of urethra. Stricture disease of male urethra has long been evaluated by conventional Ascending Urethrography, which is considered as the standard imaging technique of urethra. Magnetic Resonance Urethrography (MRU) has the ability to delineate anatomic details of urethra and periurethral tissue with 3D orientation of the lesion.

Methods: It is hospital based cross sectional study conducted on 36 clinically suspected male urethral stricture patient. All patients were evaluated with AUG/OUG and MRU with regards to location, number, length of stricture, false tracts, spongiofibrosis and were compared with intra-operative findings.

Results: Conventional Urethrography and MRU both have equal sensitivity and specificity for detection of location and number of strictures. Length of stricture measured by MRU is well correlated with surgical findings also the extent of Spongiofibrosis were accurately detected by MRU in all patients.

Conclusion: Conventional Urethrography and MRU both are equally helpful in detecting stricture urethra but MRU was superior for accurate assessment of length of the stricture, extent of spongiofibrosis, density of scar tissue and degree of prostatic displacement.

INTRODUCTION

The term urethral stricture is generally used to refer to obstructive conditions of the anterior urethra [1] that result from compressive trauma (straddle injury, iatrogenic instrumentation), inflammation (infection, balanitis xerotica obliterans), Idiopathic or rarely congenital. Posterior urethral stricture usually develops as a consequence of pelvic trauma resulting in partial or complete disruption of urethra with displacement of urethral axis and urethral obliteration from spongiofibrosis, so preferably termed as PFUDD. Spongiofibrosis refers to the scar formed in the corpus spongiosum surrounding the urethra in response to the initiating factor. Rarely, urethral strictures involve both anterior and posterior segments spontaneously [2].

Stricture disease of male urethra has long been evaluated by conventional AUG, which is considered as the standard imaging technique of urethra. It has limitations like poor definition of stricture length (that varies according to patient position and the degree of stretch of penis) and no information about periurethral tissue [3-8]. Magnetic Resonance Urethrography has the ability to delineate clear anatomic details regarding the urethra and periurethral tissue with 3D orientation of the lesion [9]. Magnetic resonance (MR) imaging has been reported to be accurate in demonstrating the stricture length and displacement of the prostate apex [10,11]. The purpose of this study is to compare efficacy of conventional Ascending Urethrography and Opposing Urethrogram versus Magnetic Resonance Urethrography in the evaluation of stricture urethra, all of these imaging techniques compared with intra-operative findings which can be considered as gold standard.

MATERIALS AND METHODS

Study design: Prospective cross-sectional study

Study setting: Department of Urology, Government Royapettah Hospital, Chennai-600014

Inclusion criteria: Male patients admitted in Department of Urology with clinical symptoms of urethral stricture such as strain to void, thin and weak stream of urine, dribbling of urine and acute urinary retention were included in the study.

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Exclusion criteria

1. Patient unwilling to participate
2. Claustrophobic patient
3. Patient with known contraindications to MRI such as cochlear implant, pacemaker
4. Patient with severe hypersensitivity or previous allergic reaction to contrast material

Participants: The present study was carried out on indoor patients admitted in department of Urology Govt. Royapettah hospital, Chennai. The patients were recruited consecutively into the study

Time frame: From Dec 2019- July 2021

Patient preparation: All the imaging studies was conducted after confirming no growth on urine culture. All the patient had normal renal function tests prior to the procedure.

Methodology

All cases were first evaluated with conventional AUG and OUG (For PFUDD) followed by MR Urethrography. After anesthesia assessment all cases were schedule for endoscopic or open surgical intervention. The radiological data were compared by endoscopic or operative findings in all these patients.

Conventional Ascending Urethrography (AUG) Technique: AUG was done with patient placed in right oblique (45^0) supine position with right leg flexed at knee joint and left leg extended over right leg. Water soluble iodine based LOCM (Iohexol) was injected with help of cut end 8 FR feeding tube. External urethral meatus was pressed tightly against feeding tube to prevent spillage of contrast material. During contrast injection gentle traction was applied to straighten the penis along the soft tissue of thigh as parallel to femur as possible. About 20 ml of diluted contrast (10 ml Contrast + 10 ml Distilled water) injected and spot film was obtained.

Conventional Opposing Urethrography Technique: It is the combination of AUG and Voiding Cystourethrography. About 300 ml of diluted water-soluble Iodine based LOCM was instilled into bladder through suprapubic cathter. 20 ml of diluted contrast was injected into urethra and patient is advised to strain and spot film was taken.

MR Urethrography Technique: In supine position 200-300 ml of normal saline was instilled slowly into the bladder via supra-pubic catheter or through small feeding tube. 10 ml of sterile jelly was injected into the urethra until the resistance was felt or some of the lubricating jelly overflowed from meatus. The glans sulcus of the penis was gently tied by gauze to avoid escape of the jelly. In the midsagittal plane of the pelvis, the penile shaft was secured with the help of upward traction by tying gauze to the abdomen. MR imaging was performed with the 1.5 Tesla signal unit with T1, T2- weighted sequences. The images at different axial, coronal, and sagittal planes were obtained to delineate the entire length of the urethra with surrounding soft tissue. Patient was then asked to strain in order to open bladder neck and images were again taken.

Image Analysis

Image analysis was focused on number, location, length, signal intensity, spongiofibrosis, sinus tracts and associated pathology.

In anterior urethral stricture, length was measured along the long axis of the fibrotic segment shown as low signal intensity on sagittal T2-weighted and contrast-enhanced T1-weighted images.

In posterior distraction defect, length was estimated by the distance between the proximal limit of the distended distal urethra and the prostatic apex on the sagittal T2-weighted and contrast enhanced T1-weighted images.

Prostatic apex displacement

Superior to inferior- Measured between prostatic apex and inferior pubic ramus (> 1 cm is significant)

Antero-posterior – Distance between apex of prostate and urethra at penile bulb

Lateral – Distance between prostatic apex and bulbar urethra on coronal images

Stricture severity was classified based degree of luminal narrowing (Mild- < 1/3 of luminal narrowing, Moderate- 1/3 to ½ of luminal narrowing, >1/2- Severe luminal narrowing)

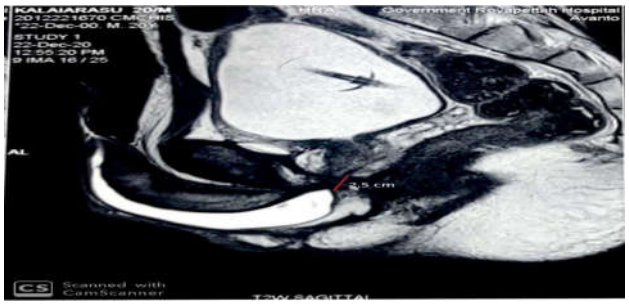

Fig 1 MR Urethrogram showing 2.5 cm bulbo-membranous defect with periurethral fibrosis

Spongiofibrosis was interpreted when T2W and post contrast T1W images showed hypo-intense area in the periurethral spongiosum with normal and intact surrounding spongiosum showing strong contrast enhancement.

Severity of spongiofibrosis was classified based on depth of involvement of corpus spongiosum (Mild- < 1/3, Moderate- 1/3 to 1/2 and Severe- > ½ of spongiosum involvement) The extent of spongiofibrosis was assessed intra-operatively by color of urethral mucosa (Mild- Pink, Moderate- Grey, Severe- White).

Stricture Length on AUG and OUG was determined by measuring the luminal narrowing between the proximal end of the distal distended urethra and the distal end of the proximal urethra.

Fig 2 Ascending Urethrogram showing 0.5 cm distal bulbar stricture

Fig 3 Opposing Urethrogram showing 2 cm bulbar stricture with false passage

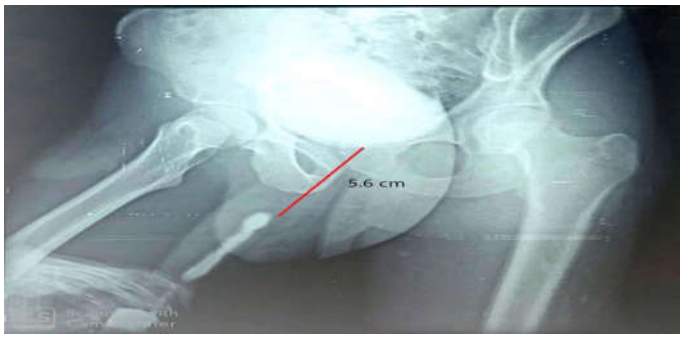

Fig 4 AUG and OUG showing obliterative blind bulbar urethra with 5.6 cm long posterior urethral defect, bladder neck not opened

The results of each imaging method were compared with either a definitive Endoscopic or surgical procedure

Statistical Analysis

The statistical correlation of the length of strictures between the AUG/OUG and MRU with the intra-operative findings was assessed using chi-square statistics. A p-value of <0.05 was considered as statistically significant. SPSS (trial version 20) was used for statistical analysis.

RESULTS

Our study based on evaluation of 36 of suspected cases of stricture urethra

Table 1 Etiology of stricture

Etiology	Count	Percentage
1. Post-instrumentation	16	44.44
2. Post-inflammatory	10	27.78
3. Post- traumatic	8	22.22
4. Idiopathic	2	5.56
Total count	36	100

In our study most common cause of stricture formation is post-instrumentation which is seen is 16 patients and account for 44.44 % of cause for stricture urethra which is followed by post-inflammatory in 10 patient (27.78%) and 8 patient (22.22%) have post- traumatic urethral distraction defect.

Table 2 Age group wise Location of stricture

Age (years)		Location of stricture		
		Anterior urethra	Posterior urethra	Total
21-30	Count	3	1	4
	% of total	8.33	2.78	11.1
31-40	Count	7	2	9
	% of total	19.44	5.56	25
41-50	Count	14	2	16
	% of total	38.89	5.56	44.44
51-60	Count	2	2	4
	% of total	5.56	5.56	11.12
>61	Count	2	1	3
	% of total	5.56	2.78	8.33
Total count		28	8	36
% of total		77.78	22.22	100

In 36 cases most of the patient were belongs to age between 41-50 years and account for 44.44% of total number of cases and anterior urethra is the most common site of stricture formation which accounts for 38.89% of all stricture cases included in this study.

The chi-square statistic is 2.8929, the p-value is 0.9409 (>0.05) which is non-significant, so there is no relation between age and location of strictures. Although most of cases were belongs to middle age group.

Table 3 Location and Number of strictures

Stricture		Aug/Oug	MRU	Intra-operative Finding
Location and number	Penile	2	2	2
	% of total	5.56	5.56	5.40
	Distal Bulbar	17	17	17
	% of total	47.22	47.22	45.94
	Proximal Bulbar	5	5	6
	% of total	13.89	13.89	16.21
	Blind end bulbar	8	8	8
	% of total	22.22	22.22	21.62
	Diffuse anterior	4	4	4
	% of total	11.11	11.11	10.81
	Total count	36	36	37

Among 36 cases, AUG and MRU shows 28 cases (77.78%) have stricture in anterior urethra whereas 8 cases (22.22%) blind ending bulbar urethra.

Most common site of stricture is distal bulbar urethra which is seen in 47.22 % cases.

In one patient there is stricture in proximal bulbar urethra on AUG and MRU but intra-operatively there is proximal as well as distal short segment bulbar stricture but this intra-operative finding doesn't change the plan of intervention.

So, Sensitivity and specificity of location and number of stricture detection by conventional and MRU are equal and are well correlated with intra-operative findings.

The chi-square statistic is 0.1057, the p-value is 1 (>0.05) so non-significant. There for there is no significant difference between AUG/OUG and MRU in relation to site and number of stricture detection and are well correlated with intra-operative findings.

Table 4 Length of stricture

Stricture Length	AUG/OUG	MRU	Intra-operative finding
< 1.5 Anterior urethra	22	18	19
% < 1.5	61.11	50	51.35
Posterior urethra	0	0	0
% < 1.5	0	0	0
Total Count	22	18	19
% of total	61.11	50	51.35
>1.5 Anterior urethra	6	10	10
% > 1.5	16.67	27.78	27.02
Posterior urethra	8	8	821.62
% > 1.5	22.22	22.22	
Total count	14	18	18
% of total	38.89	50	48.65

AUG shows 22 short anterior, 6 long anterior and 8 cases shows blind ending bulbar end.

These 8 obliterative bulbar stricture are associated with trauma and sustained pelvis fracture and was on supra-pubic catheter so Opposing Urethrogram was performed to look for proximal urethra which shows long segment defect.

MRU shows 18 short segment anterior stricture and 10 long segment anterior stricture and 8 long segment posterior urethral defect.

Table 5 Intra-operative findings and Intervention

Stricture segment	Location	Count	Surgery
Short	Anterior urethra	19	Optical Internal Urethrotomy
Long	Anterior urethra	4	Substitution Urethroplasty
Long	Anterior urethra	2	Augmented Anastomotic Urethroplasty
Diffuse	Anterior urethra	2	Johansons 2 stage repair
Diffuse	Anterior urethra	1	Perineal Urethrostomy
Diffuse	Anterior urethra	1	Graded Urethral Dilatation
Long	Posterior urethra	6	End to End Anastomotic Urethroplasty
Long	Posterior urethra	2	Augmented Anastomotic Urethroplasty

Intra-operatively there were 19 short segment anterior stricture all of them undergo OIU, among 8 long segment posterior urethral defect 6 undergo End to End Anastomotic Urethroplasty whereas 2 cases need Augmented Anastomotic Urethroplasty.

Among 10 long segment anterior stricture 4 patient undergo Substitution Urethroplasty with Buccal mucosal graft, 2 cases undergo Augmented Anastomotic Urethroplasty and among 4 cases with diffuse pan-anterior urethral stricture 2 undergo Johansons 2 stage repair,1 patient opted for Perineal Urethrostomy and 1 case choose GUD.

When we correlate imaging with intra-operative finding we can conclude that for short segment anterior urethral stricture AUG and MRU both are equally efficacious but AUG underestimate the length in long anterior urethral stricture whereas length measured by MRU is closely correlated with intra-operative findings.

4 anterior urethral stricture which were originally diagnosed to be short segment stricture on AUG and were planned for OIU later on MRU found to be long segment stricture > 2.5 cm with moderate spongiofibrosis, so plane of management is changed in these cases and all of them underwent Substitution Urethroplasty with buccal mucosal graft.

Chi square statistics for stricture > 1.5 cm is 0.6512, and the p-value is 0.96 so there is not much difference between length stricture measured by AUG and MRU but still the measure of agreement between MRU length & Surgical length was higher than AUG & Surgical length.

With respect to above findings we can say MRU may change plan of management.

Table 6 AUG/OUG/MRU- Other Findings

		AUG	MRU	Intra-Operative Finding
FALSE TRACT	Anterior urethra	6	4	6
	Posterior urethra	0	0	0
	NIL	30	32	30
SPONGIOFIBROSIS	Anterior urethra	0	7	9
	Posterior urethra	0	8	8
	NIL	0	21	19

Contrast extravasation which likely s/o false tract seen in 6 patients on AUG whereas MRU fails to detect in 2 patient, intra-operatively false tract were noted in all 6 cases.
AUG/ OUG fails to detect spongiofibrosis in all cases.

In MRU Dense spongiofibrosis seen in 8 patient of posterior urethral distraction defect while moderate spongiofibrosis seen in 7 cases of long anterior urethral stricture Intra-operatively 9 cases of anterior urethral stricture showed spongiofibrosis out of them 7 have severe and 2 cases have mild to moderate spongiofibrosis. In posterior urethra out of 8 cases, 6 cases showed severe periurethral spongiofibrosis and 2 patient shows posterior displacement of prostate with dense periurethral spongiofibrosis.

DISCUSSION

Stricture with length < 2.5 cm were classified as short stricture whereas > 2.5 cm as long stricture. Number of factors determines the choice of stricture repair which includes length and location, extent of spongiofibrosis, prior surgical intervention and surgeon choice. So careful evaluation of urethral stricture with imaging is important before planning for operative intervention. AUG/OUG is the method of choice among investigative procedure for the planning of a urethral reconstruction [12]. However, AUG/OUG cannot provide accurate measurement of stricture length, in fact they overestimated stricture length if bladder neck does not relax [13] also it does not provide information regarding periurethral fibrosis or displacement of the prostate.

MRU was explored as an alternative tool with few studies demonstrating the urethral stricture by luminal distension using either saline or gel [14,15].

In our study all the strictures detected by AUG were also detected by MRU and confirmed intra-operatively. Both AUG and MRU have 100% sensitivity and specificity in the detection of location and number of urethral strictures.

Many previous studies showed consistent poor correlation of stricture length between AUG and operative findings [3-8], more marked in strictures affecting the bulbar urethra. However, Babnik PD *et al*., has reported that AUG does not underestimate stricture length if the tapered segments were included in the measurement [16]. Osman Y *et al*., in their study of obliterative posterior urethral strictures showed that the mean length as measured by AUG and MRU showed no statistically significant difference between the modalities [14]. A similar study by Sung DJ *et al*., concluded that MRU measurement of stricture length demonstrated significantly lower errors than did AUG combined with Voiding Cystourethrography (VCUG) [17].

In our study length of stricture segment detected by MRU is strongly correlated with intra-operative findings while AUG underestimate length of stricture in 4 cases.

In a previous study, MRU findings were reported to have made the urologists to change the operative procedure in seven of the patients that would have otherwise been planned based on RUG findings [17]. Also Oh MM *et al*., stated that MR findings can cause a change in the surgical procedure due to defect length and spongiofibrosis. This change in the decision of operative intervention based on the fact that short segment stricture with minimal or no spongiofibrosis are well managed with Internal Urethrotomy and long segment urethral strictures

with spongiofibrosis are best managed with end to end anastomotic urethroplasty for post-traumatic stricture or augmented anastomotic urethroplasty/ substitution urethroplasty with BMG for long segment strictures.

In our study, 4 anterior urethral stricture which were originally diagnosed to be short segment stricture on AUG and were planned for OIU later on MRU found to be long segment stricture > 2.5 cm with moderate spongiofibrosis, so plane of management is changed to substitution urethroplasty with buccal mucosal graft in 2 cases and Augmented anastomotic urethroplasty in 2 cases.

False tract seen in 6 patients on AUG whereas MRU fails to detect in 2 patient, intra-operatively false tract were noted in all 6 cases.

The depth and extent of spongiofibrosis could be accurately delineated in MRU. Although detection of spongiofibrosis in MRU has been elucidated in previous studies [12,14,18] depth/thickness of the same with surgical correlation has also been reported. MRU is more sensitive for detection of moderate to severe spongiofibrosis.

In our study, MRU showed spongiofibrosis in 7 anterior urethral strictures while intraoperatively 2 cases of anterior urethral stricture had mild to moderate spongiofibrosis and 7 cases had severe periurethral fibrosis. MRU detected 8 posterior urethral distraction defects with severe spongiofibrosis which was consistent with intra-operative finding.

CONCLISIONS

Conventionally AUG and OUG were most commonly employed imaging modalities for delineation of stricture urethra. Although cost effective and readily available they do not provide accurate length of the stricture segment and also periurethral fibrosis. Other drawbacks associated with conventional urethrography are potential contrast related reaction and significant amount of radiation exposure especially in young patient.

T2 MRI sequences are excellent imaging modality for demonstration of urethra and periurethral soft tissue component. MR Urethrogram accurately measures stricture length, prostatic apical displacement also avulsion of corpora cavernosa and periurethral spongiofibrosis thereby plays important role in planning of surgical intervention.

From our study we can conclude that MRU is promising, non-invasive technique for the evaluation of male stricture urethra. Conventional Urethrography should be complimented with MRU for the evaluation of urethral stricture especially complex urethral strictures.

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