"ROLE OF MR URETHROGRAPHY COMPARED TO CONVENTIONAL URETHROGRAPHY (RETROGRADE URETHROGRAPHY AND OPPOSING URETHROGRAPHY) IN THE SURGICAL MANAGEMENT OF OBLITERATIVE URETHRAL STRICTURE"

Dissertation submitted for partial fulfilment of requirements of

M.D. DEGREE EXAMINATION

BRANCH VIII – RADIODIAGNOSIS

MADRAS MEDICAL COLLEGE &
RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
CHENNAI – 600 003

THE TAMIL NADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI – 600 032

APRIL 2013

CERTIFICATE

This is to certify that Dr. SUDHAKAR .V has been a post graduate student during the period May 2010 to April 2013 at Barnard Institute of Radiology, Madras Medical College, & Rajiv Gandhi Government General Hospital, Chennai.

This Dissertation titled "ROLE OF MR URETHROGRAPHY COMPARED TO CONVENTIONAL URETHROGRAPHY (RETROGRADE URETHROGRAPHY AND OPPOSING URETHROGRAPHY) IN THE SURGICAL MANAGEMENT OF OBLITERATIVE URETHRAL STRICTURE" is a bonafide work done by him during the study period and is being submitted to the Tamilnadu Dr. M.G.R. Medical University in a partial fulfilment of the M.D. Branch VIII Radiodiagnosis Examination.

Prof. D.RAMESH, MD,
Guide & Associate Professor,
Barnard Institute of Radiology,
Madras Medical College &
Rajiv Gandhi Government General
Hospital, Chennai – 600 003

Prof.N.KAILASANATHAN, MD, DMRD
Professor & Head of the Department,
Barnard Institute of Radiology,
Madras Medical College & Rajiv Gandhi
Government General Hospital
Chennai - 600 003.

Prof. K.VANITHA, MD, DMRD, DRM, DHA
Director & Professor
Barnard Institute Of Radiology
Madras Medical College & Rajiv Gandhi
Government General Hospital
Chennai - 600 003.

Prof.V.KANAGASABAI, MD
Dean
Madras Medical College & Rajiv Gandhi
Government General Hospital,
Chennai - 600003

DECLARATION

I **Dr. SUDHAKAR .V** solemnly declare that this dissertation entitled, **"ROLE OF MR URETHROGRAPHY COMPARED TO CONVENTIONAL URETHROGRAPHY (RETROGRADE URETHROGRAPHY AND OPPOSING URETHROGRAPHY) IN THE SURGICAL MANAGEMENT OF OBLITERATIVE URETHRAL STRICTURE"** is a bonafide work done by me at the Barnard Institute of Radiology, Madras Medical College and Rajiv Gandhi Government General Hospital during the period 2010 – 2012 under the supervision of **Professor K. Vanitha**, Director, Barnard Institute of Radiology, Madras Medical College and Rajiv Gandhi Government General Hospital**.**

This dissertation is submitted to The Tamil Nadu Dr.M.G.R Medical University, towards a partial fulfilment of requirement for the award of **M.D. Degree Radiodiagnosis.**

Place: Chennai

Date : **Dr. SUDHAKAR .V**

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I would extend my thanks to the Faculty, Department of Urology for their kindness and support.

Last but not the least, I thank all my patients for their cooperation, without whom this study would not have been possible.

CONTENTS

ABBREVIATIONS

MRU	-	MRURETHROGRAPHY
RARE	-	RAPID ACQUISITION WITH RELAXATION ENHANCEMENT.
HASTE	-	HALF FOURIER ACQUISITION OF SINGLE SHOT TURBO SPIN ECHO
FLAIR	-	FLUID ATTENUATION INVERSION RECOVERY SEQUENCE.
IVU	-	INTRAVENOUS UROGRAPHY
USG	-	ULTRASONOGRAPHY
AUG	-	ASCENDING URETHROGRAPHY
RUG	-	RETROGRADE URETHROGRAPHY
OUG	-	OPPOSING URETHROGRAPHY
CT	-	COMPUTED TOMOGRAPHY

INTRODUCTION

AIM

REVIEW OF LITERATURE

ANATOMY PATHOLOGY AND IMAGING OF THE URETHRA

MATERIALS AND METHODS

RESULTS AND ANALYSIS

REPRESENTATIVE IMAGES

DISCUSSION

CONCLUSION

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PROFORMA

TITLE OF STUDY

Role of MR Urethrography compared to conventional Urethrography (Retrograde Urethrography and Opposing urethrography) in the surgical management of obliterative urethral stricture

AIM OF STUDY

To prospectively assess the role of MR urethrography compared to conventional urethrography (Retrograde urethrography and Opposing urethrography) in the surgical management of obliterative urethral stricture.

TYPE OF STUDY

Prospective study

SOURCE OF PATIENTS

Patients with symptoms of urethral stricture were referred from Department of Urology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai.

TARGET POPULATION

Male patients in the age group of 20-65 years.

INCLUSION CRITERIA

Patients in whom Retrograde Urethrography or Opposing urethrography done for suspected urethral stricture.

EXCLUSION CRITERIA

Patients with implants like cardiac pacemakers, Implanted cardiac defibrillator, Cochlear implants/ Prostheses etc.

METHODOLOGY

Patients reffered from urology department were evaluated with RUG or Opposing urethrography as the case may be using non-ionic iohexol. They underwent MRU employing a pelvic phased array surface coil on a 1.5 T SIEMENS MAGNETOM unit and the following parameters were evaluated.

Clinical information

H/O of straddle injury, pelvic bone fracture. time interval between trauma and development of symptoms.

H/O transurethral instrument manipulation or radical prostatectomy,

H/O infection

Duration of symptoms

Symptoms of urinary tract obstruction

Blood urea, Serum creatinine

Retrograde urethrography

Site of stricture

Length of stricture

Extravasation of contrast

Opposing urethrography

Site of stricture

Length of stricture

Extravasation of contrast

Bladder neck opened or not

Filling of prostatic urethra

MR Urethrography

Site of stricture

Length of stricture

Extravasation of srerile jel infused

Periurethral fibrosis

Prostatic apex displacement

Surgical findings

Type of surgery

Endoscopy or urethroplasty

Flap procedure done or not

Site of stricture

Length of stricture

Periurethral fibrosis

Prostatic apex displacement

METHOD OF ANALYSIS

The findings of Retrograde urethrography/ Opposing urethrography and MR Urethrography were correlated individually with the surgical findings.The sensitivity, specificity,positive predictive value, negative predictive value and accuracy of Retrograde urethrography/ Opposing urethrography were indually determined and compared.

MR Urethrography Date:

Name:

Age/sex:

Present history:

Past history:

Trauma – Nature and Time interval.

INVESTIGATIONS	RUG	OPP UG	MRU
ANTERIOR STRICTURE PENILE BULBAR			
POSTERIOR STRICTURE MEMBRANOUS PROSTATIC			
LENGTH (cm)			
PROSTATIC APEX DISPLACEMENT (cm)			
ASSOCIATED FINDINGS			

SURGERY: Approach/ Findings

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr.V. Sudhakar
PG in MD Radiodiagnosis
Madras Medical College, Chennai -3

Dear Dr.V. Sudhakar

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "Role of MR Urethrograpy compared to conventional Urethrography(Retrograde Urethrography and Opposing urethrography) in the surgical management of obliterative urethral stricture" No.45092012.

The following members of Ethics Committee were present in the meeting held on 13.09.2012 conducted at Madras Medical College, Chennai -3.

1. Dr. S.K. Rajan. M.D.,FRCP.,DSc	-- Chairperson
2. Prof. Pregna B. Dolia MD Vice Principal, Madras Medical College, Chennai -3 Director , Institute of Biochemistry, MMC, Ch-3	--Member Secretary
3. Prof. B. Vasanthi MD Professor of Pharmacology ,MMC, Ch-3	-- Member
4. Prof. M. Reghu MD Director, Inst. Of Internal Medicine, MMC, Ch-3	-- Member
5. Prof. MD. Ali. MD.DM Prof & HOD of MGE, MMC, Ch-3	-- Member
6. Prof. P. Karkuzhali. MD Director i/c, Prof., Inst. of Pathology, MMC, Ch-3	-- Member
7. Prof. Bavani Shankar. MS Prof of General Surgery, MMC, Ch-3	-- Member
8. Thiru. S. Govindsamy. BABL	-- Lawyer
9. Tmt. Arnold Soulina MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

PATIENT CONSENT FORM

STUDY TITLE : **"ROLE OF MR URETHROGRAPHY COMPARED TO CONVENTIONAL URETHROGRAPHY (RETROGRADE URETHROGRAPHY AND OPPOSING URETHROGRAPHY) IN THE SURGICAL MANAGEMENT OF OBLITERATIVE URETHRAL STRICTURE"**

Patient may check (✓) these boxes.

PARTICIPANT NAME : DATE:

AGE: SEX: I.P.NO. :

The details of the study have been provided to me in writing and explained to me in my own language. ☐

I confirm that I have understood the purpose of the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected. ☐

I understand that investigator, the institution, regulatory authorities and the ethical committee will not need my permission to look at my health records both in respect to the current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I hereby consent to,undergo complete physical examination ,and diagnostic tests including hematological,biochemical,radiological and urine examinations ☐

I have been given an information sheet giving details of the study . ☐

I hereby consent to participate in the above study

Signature of the Participant

MASTER CHART

ANTIERIOR STRICTURE										
SL. NO	NAME	AGE	HISTORY	Conventional Retrograde Urethrography		MR Urethrography		Associated findings onMRU	Surgical length(cm)	Surgical procedure
				LENGTH (cm)	FINDINGS	LENGTH (cm)	FINDINGS			
1	Narayanasamy	52	Urethritis	1.4	short urethral stricture	1.9	Short urethral stricture	Well defined poximal urethra,urethrocutaneousfistula	1.8	Primary urethroplasty
2	Baskar	29	Straddle injury	1.1	short urethral stricture	1.4	Short urethral stricture	Periurethral fibrosis	1.5	Endoscopic urethrotomy
3	Gnanaseker	48	Straddle injury	2.4	short urethral stricture	3.1	Long urethral stricture	Periurethral fibrosis	3.3	Complex urethroplasty
4	Mangala kallaya	40	Urethritis	1.2	short urethral stricture	1.5	Short urethral stricture	Well defined poximal urethra,bladder wall thickenning	1.4	Endoscopic urethrotomy
5	Ramasamy	46	Straddle injury	2	short urethral stricture	3.5	Long urethral stricture	Multiple strictures	3.3	Complex urethroplasty
6	Pandian	43	Straddle injury	1.3	short urethral stricture	1.8	Short urethral stricture	Contrast extravasation in to Cowper's glands	1.8	Primary urethroplasty
7	Marimuthu	38	Straddle injury	1.8	short urethral stricture	1.3	Short urethral stricture	Bladder wall thickenning	1.4	Endoscopic urethrotomy
8	Thamburaj	35	Control							
9	Sriram	22	Urethritis	6	Long urethral stricture	5.2	Long urethral stricture	Diffuse periurethral fibrosis	5.6	Complex urethroplasty

10	Mani	35	Straddle injury	1.5	short urethral stricture	2.3	Short urethral stricture	Periurethral fibrosis	2.5	Primary urethroplasty
11	Kaliappan	55	Control							
12	Narayanan	40	Straddle injury	0.9	short urethral stricture	1.5	Short urethral stricture	Multiple strictures	1.2	Endoscopic urethrotomy
13	Murugan	54	Urethritis	1	short urethral stricture	0.7	Short urethral stricture	Periurethral fibrosis	0.8	Endoscopic urethrotomy
14	Rajakumar	44	Straddle injury	1.4	short urethral stricture	1.2	Short urethral stricture	Periurethral fibrosis	0.9	Endoscopic urethrotomy
15	Dhanapal	36	Straddle injury	1.2	short urethral stricture	1.8	Short urethral stricture	Periurethral fibrosis	1.6	Primary urethroplasty
16	Soundaram	28	Straddle injury	1.1	short urethral stricture	1.4	Short urethral stricture	Periurethral fibrosis	1.2	Endoscopic urethrotomy
17	Munusamy	48	Straddle injury	1.2	short urethral stricture	1.9	Short urethral stricture	Periurethral fibrosis	2.3	Primary urethroplasty

POSTERIOR URETHRAL STRICTURE										
SL. NO	NAME	AGE	HISTORY	Conventional Opposing Urethrography		MR Urethrography		Associated findings on MRU	Surgical length(cm)	Surgical procedure
				LENGTH (cm)	FINDINGS	LENGTH (cm)	FINDINGS			
1	Gopal	48	RTA with pelvic bone fracture	4.2	Long urethral stricture	2.1	Short urethral stricture	Well defined poximal urethra,urethral sinus tract	2	Primary urethroplasty
2	Saravanan	33	RTA with pelvic bone fracture	4	Long urethral stricture	1.4	Short urethral stricture	Anterior prostatic displacement	1.1	Endoscopic urethrotomy
3	Settu	20	RTA with pelvic bone fracture	5.8	Long urethral stricture	4.4	Long urethral stricture	Posterior prostatic displacement	4.5	Complex urethroplastsy
4	Sampath	38	RTA with pelvic bone fracture	5.4	Long urethral stricture	3.1	Long urethral stricture	Anterior prostatic displacement	3.4	Complex urethroplastsy
5	Selveraj	40	Control							
6	Ganesh	21	RTA with pelvic bone fracture	1.8	Short urethral stricture	1.4	Short urethral stricture	Posterior prostatic displacement,urethral sinus tract	1.5	Endoscopic urethrotomy
7	Kuppusamy	64	RTA with pelvic bone fracture	5.4	Long urethral stricture	3	Long urethral stricture	Urethroscrotal fistula	3.4	Complex urethroplastsy
8	Chinnasamy	52	RTA with pelvic bone fracture	3.8	Long urethral stricture	2.1	Short urethral stricture	Periurethral fibrosis	2.5	Primary urethroplasty
9	Murugesan	54	Control							
10	Varadharajan	36	RTA with pelvic bone fracture	2.3	Short urethral stricture	1.5	Short urethral stricture	Periurethral fibrosis	1.3	Endoscopic urethrotomy

11	Mohammed Ali	38	RTA with pelvic bone fracture	2.7	Long urethral stricture	1.1	Short urethral stricture	Periurethral fibrosis	1.4	Endoscopic urethrotomy
12	Govindaraj	42	RTA with pelvic bone fracture	3.3	Long urethral stricture	2.2	Short urethral stricture	Periurethral fibrosis	2.5	Primary urethroplasty
13	Ponnusamy	32	RTA with pelvic bone fracture	2.8	Long urethral stricture	1.8	Short urethral stricture	Periurethral fibrosis	2.2	Primary urethroplasty
14	Sukumar	44	RTA with pelvic bone fracture	4.2	Long urethral stricture	1.7	Short urethral stricture	Urethrocutaneous fistula	1.9	Primary urethroplasty

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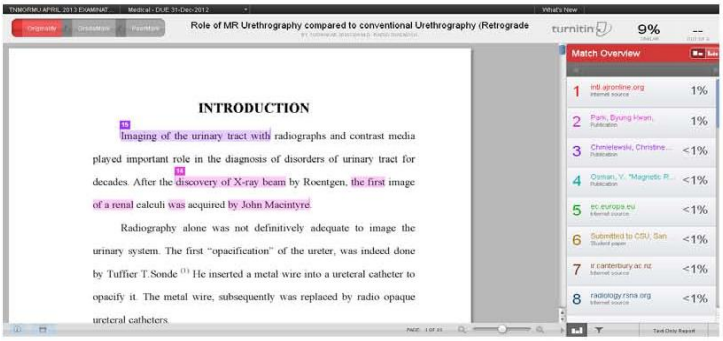
INTRODUCTION Imaging of the urinary tract with radiographs and contrast media played important role in the diagnosis of disorders of urinary tract for decades. After the discovery of X-ray beam by Roentgen, the first image of a renal calculi was acquired by John Macintyre. Radiography alone was not definitively adequate to image the urinary system. The first "opacification" of the ureter, was indeed done by Tuffier T.Sonde (1). He inserted a metal wire into a ureteral catheter to opacify it. The metal wire, subsequently was replaced by radio opaque ureteral catheters. Following this, air had been injected as a contrast media to image the ureter which soon was again replaced by liquid...



INTRODUCTION

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Following this, air had been injected as a contrast media to image the ureter which soon was again replaced by liquid contrast media consisting silver colloid. The first ever retrograde pyelogram was done by Voelcker F,Von Lichtenberg [(2).] Though its usefulness was proven, the dangers associated with the silver-containing contrast agents quickly recognized. Therefore search for safer contrast materials began.

Cameron [(3)] in 1918 first described Sodium iodide solutions,which was considered became the contrast media of choice in doing retrograde pyelography.

Osborne et al [4] in 1923, used intravenous sodium iodide in large doses to image the ureters and bladder on radiography. But it was highly toxic and also the images of the urinary system were not optimal. This was followed by development of numerous contrast suspensions for intravenous administration and subsequently excreted into the urine, with the central element being iodine. Swick 1929 [5], introduced the first among the contrast media to give better quality urographic images were iodinated compounds of pyridine.

In 1952, the compounds of pyridine were replaced by the more safer iodinated derivatives of benzoic acid. From this level onwards, the development of contrast media had reached new heights to the present stage of non ionic contrast media which were considered more safe.

Intravenous urography gives a good anatomic detail of the urinary system and provides semi quantitative details about the renal function. Asending urethrography and opposing urethrography are considered the investigations of choice to image urethra.

In imaging of the urethra Magnetic resonance imaging (MRI) is an excellent alternative tool. It is possible to rapidly acquire images of the urethra which are more informative than Retrograde urethrography (RUG) and opposing urethrography (OUG) even without the administration of contrast media with the RARE (Rapid acquisition with relaxation enhancement) and HASTE (Half Fourier Acquisition of Single

Shot Turbo Spin Echo) sequences. This can overcome many of the drawbacks associated with Conventional Retrograde Urethrography and Opposing urethrography. With few of its drawbacks, MR urethrography can be done to study the abnormalities of the urethra in a variety of situations, successfully.

This dissertation is an attempt to study the diagnostic capability and efficacy of MR urethrography, in the visualization of the anterior and posterior urethra in comparison to conventional retrograde urethrography and opposing urethrography as the case may be. Most importantly, its role in providing the information required by the surgeon to plan the most appropriate surgical procedure.

AIM

The purpose of the study is to prospectively assess the role of MR urethrography compared to conventional urethrography (Retrograde urethrography and Opposing urethrography) in the surgical management of obliterative urethral stricture.

REVIEW OF LITERATURE

Nielsen and Nordling[6] gave the most acceptable clinical definition of urethral stricture. According to them, urethral stricture is present when any of portion of the urethra measuring less than 22Fr in size. They also suggested that the stricture will be symptomatic when its calibre reduces to 18 Fr size or less, based on their study performed in over 4000 male urethra.

Cunningham[7] in 1910 popularised retrograde urethrogram / Ascending urethrogram, a gold standard investigation modality in assessing urethral stricture.

However some authors reported that retrograde urethrogram was not ideal for imaging the posterior urethral strictures.

It also tends to under estimate the length of proximal bulbar urethra while evaluating the anterior urethral strictures as this segment is aligned and fixed to the same axis as that of pelvis leading to end on view in the radiograph. This problem can be overcome by proper patient position and penile traction. [8]

RUG combined with micturating cystourethrography (MCUG) gives more information in the evaluation of posterior urethra because RUG alone may fail to depict the proximal extent of the stricture.

Nash PA, McAninch J [9] studied the anterior urethral strictures by RGU and showed that , there was good correlation of penile urethral

stricture when compared to bulbar urethral stricture with a significant difference in the P value, which was 0.74 for penile and 0.007 for bulbar urethral stricture.

Syed Mamun Mahmud et al [(10)] in a study to evaluate the role of ascending urethrogram with suspected urethral strictures concluded that Retrograde Urethrogram cannot rule out the presence of urethral stricture completely with a negative predictive value of 76% . They found that even though suggested in RUG, the urethral stricture may not be present with a positive predictive value of 89%. According to them the ascending urethrogram has a sensitivity and specificity was 91% and 72% in the diagnosis of urethral stricture.

Calapinto V. 1997[(11)] reported newer classification of the membranus urethral rupture depending upon RGU findings in 15 patients with pelvic bone fracture. Accordingly it is classified in to 3 types such as type I – The prostate is displaced but the membranous urethra is not severed, Type II – membranous urethra severed above the urogenital diaphragm at the apex of prostate, Type III – membranous urethral tear both above and below the urogenital diaphragm.

Goldman SM, 1997[(12)] provided comprehensive anatomical classification of urethral injury due to blunt trauma depending on the RUG findings, which eliminated the previous non precise classification such as anterior or posterior urethral injury. The proposed types are

I – stretched but intact posterior urethra, II – pure posterior injury either complete or partial with membranous urethral tear above the urogenital diaphragm, III – combined anterior or posterior urethral injury either partial or complete with disruption of the urogenital diaphragm, IV – tears involving the bladder neck extending into urethra, IV A – IV with peirurethral extravasation, V – pure anterior urethral injury either complete or partial. This classification helped to provide optimal management for the patients.

Ingram MD 2008, explained the technical aspects of RUG and VCUG such as positioning of the patient, angulation of the X-ray tube, and criteria for localization of urethral lesions. In addition they demonstrated the urethrographic findings in various lesions of the urethra such as congenital anomalies, inflammatory conditions, trauma, tumor etc. They also outlined the Goldman's classification of urethral trauma.

Nolte-Ernstring[(13)] published an article on a new MR technique that provided images comparable to that of conventional X ray myelography and x ray urography. It had been found extremely useful in clinical diagnostic radiology. On the contrary to conventional radiographic methods, RARE (Rapid Acquisition with relaxation enhancement technique) does not need the administration of contrast media. The low flip angle variant known as Fluid attenuated Inversion Recovery (FLAIR)

also made the imaging of high fluid systems for example the urinary system more ideal.

Friedburg and Wimmer[14] in 1987 studied the usefulness of RARE-MR-Urography and concluded that more valuable findings provided by this technique, which are not available with ultrasound or conventional radiology. The images are extremely T2-weighted and depict unbounded free water for example, urine as a bright signal.These images were acquired in 4-32 seconds time even without use of contrast agents.

Garcia-Valtuille [15] R, performed magnetic resonance urography (MRU) with highly T2 weighted images using turbo spin echo (TSE) sequence . These provided excellent images of the urinary system than the conventional X ray urography and are safe and accurate diagnostic tool when compared to other urological imaging methods.

Vinee P, et al [16] performed a study on the urinary tract obstruction using RARE sequence on the basis of hydrographic property of the urinary imaging. Similar to the methods used in MR cholangiopancreatography and MR myelography, the static fluid appears bright. The dilatation proximal to obstruction was clearly seen by heavily T2- weighted images on MR imaging. They shown urinary tract can be entirely visualised on a single image with a spatial resolution much superior to ultrasonography and intravenous urography. More faster and

stronger gradients gave rise to development of ultrafast heavily T2-weighted images that are obtained in one breath hold namely the HASTE sequence.

The technical aspects of HASTE was explained by Patric Aerts, L.Van Hoe [17] in1995. They established that the HASTE sequence had the capability of excellent demonstration of renal parenchyma and the urinary tract within few seconds even without motion related artefacts and also superimposition of fluid filled bowel loops was not a significant problem. They added that post processing methods such as maximum intensity projection images gave no further information.

Regan F, Bohlman ME [18] studied the performance of HASTE (Half Fourier Acquisition of Single Shot Turbo Spin Echo)

MR urography (MRU), in acute ureteric obstruction which showed perirenal fluid and ureteric dilatation with a greater sensitivity , specificity and accuracy (93%, 95% and 94%) than unenhanced spiral CT (80%, 85% and 81%) with lesser observer variability.

J. Eaton, MS FRCS, et al[19] in 2005, established the current status of urethral imaging in the BJR journals. They quoted that the trauma and stricture formation are much common in the male urethra than the female urethra and MRI plays the key role in the diagnosis and treatment of urethral pathologies such as the stricture, fistulae, and malignancies.

Jeong-ah ryu [20], received the Certificate of Merit award in 2000 RSNA at the scientific meet conducted in on March 2001 and concluded in their study on MR imaging of the urethra, that conventional urethrographic methods using contrast agents such as RUG,VCUG and ultrasonography though when useful in evaluating urethral anatomy have generally limitted role in showing the anatomic abnormalities of adjacent structures. MR imaging shows the anatomic structures and its adjacent tissues with good spatial resolution by non invasive method. MR image shows a fistula as a channel directly communicating to the adjacent organ . In cases of intersex or complex genitourinary anomalies MR is much essential in the evaluation of internal organs as this is not possible by RUG and VCUG. In inflammatory conditions of the urethra MR imaging shows not only the urethral abnormality but also the associated lesions like fistula, sinus tracts and periurethral abscess. MR can predict the occurrence and outcome of complications in cases of urethral trauma and to helpful evaluate the level and severity of posterior or anterior urethral injury. MR imaging plays a major role in the locating and local staging of urethral tumours.

Moon-Hae Choi [21] envisaged the role of MR imaging in penile fracture and proved its usefulness as a diagnostic imaging tool in showing the tunica albuginea tear ,intracavernosal or extra-tunical hematoma and the associated injuries of urethra and corpus spongiosum due to its

multiplanar imaging capability and excellent soft tissue contrast even in the presence of swelling and severe pain.

Y Osman [22], compared RUG and MR urethrography in 20 male patients with urethral strictures from January to April 2004 and published in European Urology. All their patients were subjected to RUG and MR urethrography before endoscopic or open surgical procedures. Endoscopic and operative findings were compared with the radiologic findings. Though the overall accuracy for diagnosing urethral strictures in both the modalities were closely similar (85%), MR urethrography showed additional lesions in 35% like urethral tumors, bladder growth, site of urethro-rectal fistula and spongiofibrosis which was not determined by RUG. It also gave accurate measurement of the stricture length. Hence it was concluded that MR urethrography is a helpful imaging tool in accurately measuring the stricture length and guiding the surgeons to plan the most appropriate surgical procedure.

MA El-Ghar et al[23], compared the superiority of MR urethrography compared to AUG and sonourethrography (SUG) in the depiction of urethral stricture from March 2006 to February 2007 in 30 male patients with urethral strictures. All their patients subjected to MR urethrogram, RUG and SUG. The overall sensitivity, specificity of AUG was 91% and 90% respectively for anterior stricture and 89% and 91.7%

respectively for posterior urethral stricture. The sensitivity and specificity of MR urethrography for anterior and posterior urethral stricture was 100% and 91.7% respectively. On SUG the overall accuracy for anterior stricture was 100%, but for posterior stricture is only 60%.The conclusion of their study is that though combined SUG and RUG had comparable results regarding the location and extent of urethral strictures MR is much superior in depicting the associated pathologies.

BK park et al,[24] conducted comparative a study on MR urethrography using SSFSE (Single Shot Fast Spin Echo) MRU and FRFSE (Fast Recovery Fast Spin Echo) MRU to determine the anterior urethral stricture. They injected sterile lubricating gel in to the anterior urethra in order to distend it, and tied the tip of glans using long gaze. The two images were compared with their ability to show stricture length, the timing required for imaging and the spatial resolution. They were also evaluated for depicting the urethra in a single image. In their study conducted in 10 patients, they found that the time taken for SSFSE MRU was 2 seconds and that of FRFSE MRU is 194 seconds. Even though the SSFSE MRU showed the entire urethra in one image the quality was poor than FRFSE MRU which imaged the entire urethra in one image in only 5 patients. Both showed the periurethral anatomy well.

Wy Hahn, [25] in his article on female urethra imaging showed that MRI with its excellent soft tissue contrast and multiplanar imaging capacity, showed not only the lesions associated with urethra but also the periurethral tissues especially cystic lesion when compared to the conventional cystourethrography and proved its importance in the surgical management of their patients. They used multishot turbo spin echo sequences and HASTE sequences.

H. Hricak et al,[26] in his study on female urethral abnormality with MR imaging in 64 patients using, T_1 , T_2 and post contrast T_1 weighted images. They accurately determined the urethral pathologies like diverticula, inflammatory and neoplastic conditions – both the primary and metastatic. They found that among the 11 patients, MR was much useful in local staging of malignancy in 10 patients.

KJ Macura 2006[27] in their study on the evaluation of urinary incompetence in women showed that high resolution MRI demonstrated not only the urethral sphincter but also the laxity of the supporting ligaments, which causes urethral hypermobility.

UV Chaudhari 2010, [28] In their study on imaging the disorders of the female urethra concluded that both MRI and real time ultrasonogram provided comprehensive analysis of the complex lesions involving the

female urethra and the periurethral tissues and also conditions associated with urinary incontinence with excellent detail.

Parlica – 2002,[29] substantiated in their study that evolving techniques of MR urethrography and sonourethrography not only showed the urethral lesions but also the periurethral abnormalities such as tumours, trauma, inflammatory conditions which are not provided by the conventional retrograde urethrography and voiding cystourethrography. They also found that these investigations involve only simple infusions of saline / lubricating jell into anterior urethra instead of iodinated contrast media.

Rosenstein D.I,[30] Urethral injuries may be caused by various etiologies and because they are associated with complications like stricture, impotence, incontinence their prompt diagnosis is important.

L. Martinez pinciro 2010,[31] Classified to urethral trauma into Grades I to V which are stretch injury, contusion, partial disruption, complete disruption and complete or partial disruption with associated injuries of the bladder neck, vagina or rectum. They described the imaging findings and management options for various grades of urethral injuries.

Mi Mi Oh, Myeong Heon Jin 2009,[32] In their study on 25 patients with complete posterior urethral strictures compared the capability of MRU and conventional RGU combined with VCUG in determining the length of stricture. They showed that MR imaging showed low mean standard error when compared to RGU / VCUG and also MR measurements showed strong linear correction with surgical stricture length with $P<0.01$ in linear regression analysis.

Ramchandani P, 2009, [33] In their observation showed that MR imaging of the urethra played key role in the management in cases of penetrating and blunt urethral trauma though contrast enhanced CT and urethrography may remain useful in the initial evaluation and follow up.

Mamdouh M. Koraitim 2007, [34] evaluated the usefulness of MR imaging in posterior urethral distraction defects. They analysed 21 patients with history of pelvic trauma presenting with obliterative urethral strictures. All patients underwent MR imaging prior to perineal or transpubic urethroplasty. MR clearly depicted the extent of urethral defect, prostatic displacement (which was considered when the distance between the prostatic apex and the pubic ramus on sagittal or the prostatic apex and the proximal bulbar urethra on coronal images is more than 1cm). Furthermore MR images showed avulsion of corpora cavernosa which may result in impotence and also associated fistulas and sinus

tracts. In their study, they concluded that MR imaging played crucial role in helping the surgeons to select the most appropriate surgical procedure and the route of approach.

Bohyun Kim, 2007,[35] concluded in their study that, conventional radiographic contrast studies initially used in diagnosing the male urethral lesions. Whereas MR imaging can show both the luminal and extra luminal pathologies like periurethral fibrosis, displacement defects in cases of trauma, congenital anomalies, inflammatory conditions and tumours. It also help explain the impotence as a consequence of pelvic trauma by demonstrating the cavernosal avulsion.

JW Mc Aninch 1993, [36] evaluated 15 patients with impotence as a consequence of pelvic trauma. MRI and duplex ultrasound were used to dictate the anatomic and pathological criteria. In their study 12 of the patients showed vasogenic and 3 showed neurogenic causes of impotence. Intracavernosal injection therapy was used for neurogenic impotence. The vasogenic impotence was treated by vascular reconstruction procedures. In these patients MRI showed prostatic displacement and duplex USG differentiated vasogenic and neurogenic causes of impotence. Thus the detailed anatomic depiction with MRI and functional imaging by duplex USG provided information to cause specific therapy.

Kawashima MD 2004, [37] in an article suggested that when RUG is the primary modality for imaging of urethra it cannot depict the periurethral pathologies. Growing cross sectional madolities such as MRU, CTU, Sonourethrography are useful in showing the periurethral lesions. Among these MR imaging has high sensitivity and specificity than other modalities in showing the pathology of the urethra and periurethral tissues. It is accurate in the stricture length measurement and also local staging of urethral tumours.

Pretorius 2001, [38] described the role of MR imaging in various conditions of the penile urethra such as strictures, periurethral absecess, tumours, vasogenic impotence, penile prosthesis, Peyronie's disease etc. due to its excellent spatial resolution, multiplanar imaging, soft tissue contrast and angiographic imaging capabilities.

Griffith D.J. 2005,[39] evaluated 5 normal volunteers to show the integrity of the pelvic floor structures and supporting ligaments using MR imaging, during sitting and supine positions. They found that the parameters such as the distance between the pubic symphysis to the urethra and that of bladder neck and PC line were stable in sitting position and the key parameter is the posterior urethrovesical angle which has been increased. They concluded that the vertically open configuration

of the MR favours evaluation of prolapse and stress incontinence in women.

SB Brandes 2007,[40] in their study showed that VCUG, RUG are the initial modalities of choice in the diagnosis of stricture urethra. Also it may be appropriate in post surgical follow up of patients. Sonourethrography may show the stricture length accurately and also associated periurethral fibrosis. There is no risk of radiation, non invasive, also precise and dynamic.

The MR imaging however provided additional information about the prostatic displacement, along with accurate measurement of the stricture length which is most important for the surgeon to select the most appropriate procedure and approach (whether perineal or transpubic) in the surgical repair of urethral strictures.

Deuk jae sung,[41] studied prospectively the role of MR urethrography in diagnosing the obliterative urethral stricture in 12 patients and compared the results with conventional retrograde urethrography (RGU) combined with voiding cystourethrography (VCUG) preoperatively. The results of both the investigative methods also compared with the surgical findings to determine which method estimated the accurate length of stricture. The MR imaging was done using plain T1-weighted, post contrast T1-weighted and T2-weighted

images of the urethra after injecting 8-10 ml of sterile lubricating jel to distend it adequately.

They demonstrated that the MR measurements of stricture length comparitively showed lower errors ($P < 0.05$) and stronger linear correlation than does the conventional RGU combined with VCUG. The results being P< .001, $r^2 = 0.85$ for MR urethrography and $P > .05$. $r^2 = 0.03$ for conventional RGU combined with VCUG. They proved that MR imaging with distension of urethra using a sterile lubricating jelly as as an effective method in accurately diagnosing the urethral strictures.

Y Narumi et al, [42] evaluated the role of MRU in posterior urethral trauma prior to surgery in the surgical intervention. The findings of MR imaging correlated with surgical findings and the patients were followed up for a period of 12 months. Finally they concluded that MR imaging showed accurate measurement of length of the urethral injury with only 0.5 cm variation. It also determined the prostatic apex displacement. These findings prompted the surgeons to change the previously planned surgical procedures.

Avulsions involving corpus cavernosum and corporeal body, and superior and lateral prostatic displacements which are causes for permanent impotence were more clearly showed by MR imaging in more than 90%. Therefore they concluded that MR imaging provided the effective role to select the most appropriate surgical procedure and also used to assess the injuries that may result in permanent impotence.

ANATOMY, PATHOLOGY & IMAGING OF THE URETHRA

ANATOMY

The urinary tract consists of the kidneys, ureters, bladder and urethra. The kidneys are vascular tissues that provide excretory, secretory and regulatory functions.

The kidneys are bean shaped situated on either sides of T12 to L3 vertebral level along the retroperitoneal space. It measures 12 cm in length, 6 cm in width and 2.5cm in thickness, and weighs 120 to 170 grams in normal adults. When compared to left, right kidney is little inferior in location due to presence of liver. The kidneys are physically protected by their situation in the rib cage and by the perinephric tissues. Each Kidney is covered by a thick fibrous capsule. The renal fascia and perirenal fat acts as a cushion for the renal bed.

BLOOD SUPPLY

The kidneys have rich vascular supply. It receives about 20% of cardiac outputs. Hence the blood flow to the kidney is about 1,200 ml/min. The renal artery arises from the aorta and reaches the kidney at its hilum. It then gives more smaller branches, namely, segmental artery, interlobar artery, inter-lobular and arcuate branches. In renal medulla, vasa recta, form loops of straight vessels which then passes parallel to the

loops of Henle situated in the juxtamedullary nephrons. The vasa recta has contributory function in the dilution and concentration of urine. The venous drainage is via the renal vein which in turn drains in to the inferior vena cava.

URETERS

These are fibromuscular tubes which originates from the kidneys and enter the bladder by passing retroperitoneally in a downward direction. Urine flows from the kidneys above to the bladder by peristalsis.

URINARY BLADDER

The urinary bladder is a spherical hollow muscular organ situated in the pelvis having a capacity of about 300 to 500 ml. The urine from the kidneys passes via the ureter and into the bladder through the orifices which in turn is excreted into the urethra.

URETHRA

The urethra communicates the bladder with the external urethral orifice. It has dual function in males such as excreting the urine and also acts as reproductive organ in sperm passage. The external urethral sphincter is made up of striated muscles and helps in voluntary control of micturition.

MALE URETHRA

It measures above 17.5cm in length and contains a spiral groove which allows urine to pass in a wide stream. It opens at the tip of penis via the external urethral orifice. The major divisions of urethra are the anterior and posterior urethra.

The anterior urethra consists of from distal to proximal external urethral meatus, a dilated part namely fossa navicularis, followed by penile and bulbar urethra.

The posterior urethra is made up of membranous and prostatic urethra from distal to proximal.

At rest the lumen of the urethra is a transverse slit like orifice with close opposition of the ventral and dorsal aspect, which at the level of external urethral meatus becomes a vertical slit. The lumen of the membranous urethra is irregular and that of bulbar urethra is arch like.

POSTERIOR URETHRA - PROSTATIC PART

The prostatic urethra measures 3cm in length. It is the most widest and dilatable part. In the prostatic parenchyma it lies little close to the anterior aspect from base to apex. Its narrowest part is where it communicates with the membranous urethra. It is spindle shaped with the dilated middle part when compared to the ends. On cut section through the prostate it is horse shoe shaped with its apex pointing forward.

On the posterior wall of the prostatic urethra there is a narrow longitudinal ridge, formed by the mucosal membrane elevation with its subjacent tissue called the urethral crest or the verumontanum. It measures 1.5cm in length and 0.3cm in height. It consists of muscular erectile tissue. During dilatation, it acts like a valve and hence prevents retrograde passage of semen into the bladder.

At each side of the verumontanum there are minimally depressed fossa. Numerous prostatic ducts originating from lateral lobes open in the floor of the prostatic sinus, where as ducts from the middle lobe perforate the posterior aspect of the crest. The central elevation namely the colliculus seminalis is in the proximal part of the crest just below the summit. The ejaculatory duct passes along the margins of the prostatic utricle via slit like openings. Posterior to the middle lobe the prostatic utricle forms a sac of 6mm long running upwards and backwards in the prostatic tissue. The wall of the prostatic utricle is made up of mucus membrane, fibrous tissue, muscle fibres and also multiple tiny glands which open on the inner surface.

POSTERIOR URETHRA – MEMBRANOUS PART

The membranous portion is the shortest, least dilatable and the narrowest part of the canal with the exception of the external urethral meatus. It passes downward and forward, with a minimal anterior concavity, from prostatic apex to the bulb of urethra penetrating the urogenital diaphragm. It measures 2.5cm in length. The proximal end of the bulbar urethra is closely opposed to the urogenital diaphragm. So the anterior wall of the membranous urethra extends inferior to urogenital diaphragm. The posterior wall is apposed to inferior facia. The membranous urethra is fully covered by sphinter urethra fibers. The deep dorsal vein of penis which lies anterior to membranous urethra passes in to the pelvis in between the two ligaments namely the transverse and arcuate pubic ligaments.

ANTERIOR URETHRA - CAVERNOUS PART

The cavernous portion or spongy or penile part is the longest of the urethra, situated within corpora cavernosa. It measures 15cm in length and communicates membranous urethra to the external urethral orifice. From below the level of urogenital diaphragm it extends to the anterior aspect of symphysis pubis. Its diameter is 6mm and turns downward, farward in the flaccid condition. Its dilated portions are in the bulb and in the glans penis forming the fossa navicularis.

The external urethral meatus is the narrowest portion of the urethra. It forms a vertical slit of 6mm length and is bounded on each side by small labia.

HISTOLOGY OF URETHRA

The mucus membrane of urethra is attached to the periurethral tissue by submucosa. There are numbers orifices for the mucus glands and follicles, namely the urethral glands situated in the submucous tissue are especially located on the floor of the cavernous portion. There are also numerous pit like recesses of varying sizes in the submucosa, the largest of which called the lacuna magna situated in the fossa navicularis on the upper surface.

The mucosa forms part of genitourinary mucous coat which is continous with ureters, bladder, kidneys and externally opens via the integument surrounding the glans penis. It prolongs in to the ducts of urethral glands viz the prostate and the bulbourethral glands and in to the duct of deferens and seminal vesicle via ejaculatory ducts. Within the cavernous and membranous urethra when lumen is empty the mucous membrane is thrown into folds in longitudinal fashion.

Near external urethral meatus there are small papillae which contains columnar epithelium and at the external orifice it is stratified squamous. Just outside the vascular erentile layer of submucous tissue, a

layer of unstriped circular muscle fibers divide these structures from the corpora cavernosa.

BLOOD SUPPLY OF THE URETHRA

The superficial blood supply of the penis is by the external pudental artery which arises from the femoral artery. The branches of the external pudental artery namely the superficial dorsal penile arteries runs along the shaft of penis and and supply skin and dortos facia.

The common penile artery arising from the internal pudental artery supply the deep structures of the penis. It gives off branches namely bulbourethral, cavernosal and deep dorsal penile arteries. A dual supply of the corpus spongiosm is from the rich vascular anastomosis between branches of dorsal artery of penis and urethral artery in the glans penis. The scrotum is supplied by the branches from both internal and external pudental vessels.

PATHOLOGY

Congenital causes of urethral stricture in male

Urethral valves

Mucosal folds in the floor of posterior urethra,in boys, can have valve like abnormality which can obstruct the flow of urine.

These urethral valves may give rise to complications such as urinary tract infection, urinary incontinence, bladder malfunction, vesico ureteric reflux, and renal failure. The posterior urethral valve can occur in association with a patent urachus.

Diagnosis of this condition made by prenatal ultrasonography. The cases when present postnatally may be diagnosed by voiding cysto urethrography. Endoscopic surgery is done to prevent complications.

Vifik A. 2012[43] reported in their case that, though routine fetal USG used in the diagnosis of posterior urethral valve, MRI plays a complementary role and is expecially useful when the diagnosis is uncertain. In their patient they showed that MRI findings such as renal pelvicalyceal dilatation, dilated, tortuous ureters, marked dilatation of bladder and posterior urethra in addition to the key hole apperarance. They validated that MRI help in early diagnosis and intervention in their case in which the diagnosis was uncertain with USG.

Kundam. P.R.-2010[44] reported an uncommon anomaly of posterior urethral diverticulum. Even through VCUG is the most common modality used to diagnose this condition, Dynamic MR using fast gradient echo sequences provided excellent images of the complex urethral and associated anomalies thus giving adquete anatomical and functional information to the operating surgeon. Even through transrectal ultrasound shows the anatomy with good special resolution, it is much more operator dependent.

Wachsberg R.H.[45] reported a case of dilated utricle or midline prostatic cyst due to cystic degeneration of the Mullerian duct presented as a cystic lesion in the midline of prostate nicely demonstrated by MRI and USG with good spatial resolution.

Effman Eric L,[46] evaluated 10 patients having patent urethral duplication either ventral or dorsal. The urethral channels originated from bladder or posterior urethra. Those duplications with ventral origin were found to be more functional than those with dorsal origins which are epispadiac in position. MRI proved functionally and anatomically significant in revealing the lesion.

Congenital urethral stricture

It manifest in a similar way as posterior urethral valves and can be diagnosed by routine prenatal sonography and when suspected postnatally it is comfirmed by RUG. Endoscopic urethrotomy is the treatment of choice though some cases need open urethroplasty.

Aquired causes of urethral stricture

Infection mainly by Neisseria gonococci,acquired by sexual contact. It is the most common cause of stricture. Other organisms which can cause stricrure are Chlamydia and ureaplasma. Bacterial cystitis do not result in urethral stricture.

The urethritis caused by either TB or Reiter's syndrome, syphilitic and non specific urethritis may rarely result in stricture.

Trauma due to direct hit by hard objects in the region of base of perineumresult in straddle injury.

Pelvic bone fractures can lead result in urethral strictures.

Strictures can result from endoscopic or open surgical procedures of the urethra.

Urethral catheterisation can rarely lead to stricture.

Passage of renal calculi via the urethra can cause inflammation and subsequently produce strictures.

Following circumcision, stricture may result which may not be noticeable in a child until toilet trainning. It can be noticed as a deflected urinary stream in a trained child during straining.

Pathogenesis of urethral strictures.

Aquired urethral strictures commonly result from injury to the urothelium or corpora spongiosa due to scar tissue formation.

Congenital urethral strictures may occur due to defect in fusion between anterior and posterior urethra. The urethra in this condition is short and is unassociated with inflammatory changes

Symptoms

- Eneuresis resistant to conservative therapy in cases of Congenital urethral strictures.
- Difficulty in urination.
- Painful micturition.
- Slow urine stream.
- Urinary urgency.
- Unusually frequent urination.
- Incontinence.
- Discharge from the urethra
- Blood in urine or semen.

- Penile swelling.
- Pain in the pelvis or lower abdomen.

Signs

Back pressure leading to hydronephrosis.

Complications

Urinary infections

Urinary calculus

Bilateral hydronephrosis

Peri urethral abscess

Urinary retention

Urethral fistula

Hernia, Haemorrhoids or rectal prolapsed due to straining.

SITE OF STRICTURE

Congenital

These are short strictures involving the bulbar urethra may be due to membrane forming in between the proximal and distal urethral segments.

Aquired

The inflammatory strictures involve the bulbar urethra since it is dependent in position and containing the greatest number of paraurethral glands. Inflammatory strictures frequently extend in to the adjacent corpus spongiosm.

Strictures caused by instrumentation are often found at fulcrum sites along the naturally narrowed segments of the urethra. These strictures usually involve only the mucosa and sub mucosa.

Traumatic strictures frequently occur in the membranous urethra though the proximal bulbar urethra may also be involved.

Straddle injuries usually involve the bulbar urethra, where as direct injuries affect the penile urethra.

Strictures due to injury develop acutely and are usually solitary in contrast to inflammatory strictures.

IMAGING OF THE URETHRA

We have only a handful of investigations to evaluate the urethral stricture. The renal functional status of the patient is to be determined before subjecting to contrast studies.

Ascending urethrogram or Retrograde urethrogram

The technique was first introduced by Cunningham in 1910 (49).It is simple and cost effective investigation. It ruled over centuries in the evaluation of urethral pathologies. Fluoroscopy unit is a must.

This needs no patient preparation except for the local area cleanliness. About 20 ml of water soluable contrast either HOCM or LOCM can be used. Prewarming of the contrast helps to reduce urethral spasm. Coned supine PA view of bladder base and urethra is taken. With aseptic precautions penile clamp is applied or tip of the balloon catheter placed in fossa navicularis and its balloon is filled with 1-2ml water.

Contrast medium is infused in to the anterior urethra under fluoroscopic guidance and films are taken in the following positions.

1. Supine PA
2. 30 degree LAO, with leg abducted and knee flexed
3. 30 degree RAO ,with left leg abducted and knee flexed

Image analysis

Full length of urethra is viewed for narrowing mucosal irregularities, any fistulas, sinus tracts.

The stricture length is measured between the tapered ends.

Limitations

The length of the stricture involving bulbar urethra is slightly under estimated by this modality, whereas Posterior stricture length is grossly over estimated by this modality. It also causes 0.5-1.6% of infections. There is risk of allergic reactions due to contrast , radiation exposure to testis (5-9 msv), equal 230 chest radiographs. It does not give information about the extent of periurethral fibrosis. Intravasation of contrast can occur if excessive pressure is given to when injecting the contrast to overcome a stricture. Also urethral spasm may sometime occur which hinders the assessment of urethral pathology.

Opposing urethrography

In cases of posterior urethral stricture, OUG is the preferred technique to messure the length of stricture. 300-400 ml of iodinated contrast mixed with normal saline instilled in to the bladder via a suprapubic cystostomy catheter . Then images were taken in 30 degree, right or left anterior oblique positions.

Sonourethrography

Sonourethrography was first popularised by McAninch JW (50). Now with developed technologies the resolution is further refined.

Sono urethrography is done using linear array high frequency 7.5 MHz transducer. Real time images of the urethra acquired simultaneouly while normal saline is infused in to the urethra slowly. This procedure has better patient compliance and accurately determines the anterior urethral stricture and periurethral fibrosis. However it is not suitable for posterior urethral strictures.

Limitations

They are small field of view and poor resolution of the lumen in the stricturous segment. It is also not ideal for evaluating the posterior urethral strictures. It is more operator dependent.

Darja Babnik Peskar 2004,[51] In their study in 50 men with urethral stricture using SUG and RUG showed that both the modalities graded the stricture and evaluated the lumen of urethra similarly. However the length of the urethral stricture is overestimated by RUG due to magnification factor. If this point is taken in to account the error in stricture length measurement may be avoided. Also SUG provided additional information about the periurethral fibrosis which is a significant factor in the surgical management i.e, even through the stricture is short segment measuring <1.5cm it is not amenable to be treated by endoscopic urethrotomy where

primary anastomotic uretroplasty with complete resection of the fibrotic segment is required.

Computed tomography[52]

CT is the preliminary investigation as soon as the patient comes after pelvic trauma which commonly result in urethral stricture. MDCT is new state of art for radiologists to help surgeons in acute trauma.

The technique of CT voiding urethrography is similar to conventional VCUG. The imaging is done within 6 seconds with a 0.75mm collimation and subsequently reformatted. The better spatial resolution of the images lead to development of virtual urethroscopy [52].The micturating ability of the patient should be checked before CT examination.

M.Ali 2003[53] Estabilised the CT signs in cases of urethral injuries. Patients who had pelvic fractures and urethraographically shown to have posterior urethral injuries were taken up for the study. They demonstrated contrast extravasation above and below the diaphragm with elevation of the prostate are consistent signs of type I, II, and III urethral injuries. If extraperitoneol bladder rapture was present there is type IV or IV A injury. Additionally it showed findings such as obliteration of fat plane of urogenital diaphragm, bulbocavernosus and obturator internus muscles, obscuration of prostate contour, haemotoma of the pelvic floor muscles which are are all more common in complex pelvic injuries with fracture.

MR Urethrography [54, 55]

It is considered first technically relavant investigation in the imaging of urinary tract. The T_2 weighted images treat the entire urinary system as a column of fluid by making use of its long T_2 relaxation times. Technically it is similar to MR cholangiopancreatography.

Conventional MR imaging cannot, demonstrate the patency of the urethral lumen and the distal extent of urethral stricture. A sterile lubricating jell can be instilled retrogradely to fill the distal portion of the urethra through the external urethral meatus allow MR depiction of the distal end of urethral stricture.

Initially bladder is filled to its capacity with normal saline via supra pubic cystostomy. The MR Urethrography technique involves injection of 8-10 of sterile lubricating jel into the anterior urethra followed tying a long gauze to the penile end around the glans sulcus to keep the urethra distended and to avoid spillage of the jel. The penis is secured in the midline sagittal position by tapping the ends of the gauze to the abdomen.

Images are acquired using sagittal high resolution T2 images of the penis and bladder. The images are reformatted at all the 3 orthogonal planes to image the entire urethra. It also characterizes the adjacent soft

tissue intensity such as periurethral fibrosis and accurately determine the stricture length. Coronal and sagittal images were particularly useful.

TREATMENT

Treatment depends upon the stricture location length, extent of periurethral fibrosis, prostatic displacements and associated complications like fistulas, sinus tracts. Various treatment options are, dilatation, Endoscopic or External urethrotomy for short segment anterior stricture. For long strictures primary or complex urethroplasty procedures aided by flap may be required. RUG often used in the diagnosis of stricture. Sometimes high frequency USG can de done to evaluavate the stricture length which also shows periurethral fibrosis.

These methods may clear depict the stricture length, location and aids in surgical planning.

MEDICAL TREATMENT

In isolated epithelial stricture without involving the corpora spongiosa, periodic dilatations can be done. Main objective is to stretch the stricture without causing additional scaring

Endoscopic urethrotomy

Using the urethrotome core under direct vision. The urethra incised at 12 O'clock position without injuring the corpora spongiosa. The positive result depends upon the successful epithelialisation before the

wound contraction. During this procedure if corpora spongiosa is injured it may resut in erectile disfunction. Hence proper care should be taken during the procedure. The patient is left with urethral catheter for 3-5 days to allow wound healing.

Complications

The most common complication is the recurrence of stricture. Others include, bleeding fibrotic changes and extravasation of irrigation fluid which may result in recurrences. The success rate is 20-25%. Self cathetarisation improve the cure rate.

Permanent urethral stents

It is especially indicated in morbid patients who cannot tolerate lengthy urethroplasy procedures. These stents can be placed endoscopically inorder to keep the lumen patent. However this procedure is contraindicated in patients with previous reconstruction procedure. As this may induce hypertropic changes. An important complication is stent migration. It is most successful in short strictures of the anterior urethra.

SURGICAL THERAPY

The options of urethral strictures includes simple dilations, internal urethrotomy, stent placement and also a spectrum of reconstructive surgical procedures. A brief discussion about some of these procedures are as follows.

OPEN RECONSTRUCTION

Primary Repair

Primary strictures measuring 1.5-2.5cm can be treated by this method. Technique involves complete excision of the fibrotic segment followed by tensionless patent anastamosis. With extensive mobilisation of corpora spongiosa strictures upto 3-4 cm can be placed inside the urethra following the procedure and the bladder is drained via supra pubic cystostomy.

R.P. Shrinivas 2010,[47] proposed two kinds of management in patients with traumatic posterior urethral disruption. ie, initial suprapubic cystostomy followed by definitive repair after 6 months and primary urethral realignment. They took 3 main complications such as stricture, impotence and incontinence into account for posterior urethral disruption. They found that stricture complication was more common with delayed repair (97%), where as impotence and incontinence are less common, 19% and 4% respectively. The rates of stricture formation, impotence and incontinence were 52%, 34%, and 4% respectively for primary urethral realignment.

TISSUE TRANFER TECHIQUE

The stricturous area of urethra is exposed and incised via penile or trans perineal approach. Tissue graft from desired structures namely the

buccal mucosa or skin harvested and sutured to the edges of the urethrotomy. Wound closed in layers using absorbable sutures and a Pendrose drain is left in situ in a separate perineal or suprapubic regions.

FULL THICKNESS SKIN GRAFT

Graft is obtained from the non-hair bearing area of skin. It is most suited for bulbar urethral strictures.

SPLIT THICKNESS SKIN GRAFT

It is not a recommended procedure as it involves multiple sittings and also due to the contraction characteristics of the graft material. It is especially indicated when the local skin is not sufficient.

BUCCAL MUCOSAL GRAFT

It is the most preferred graft as it is resistant to infection, trauma and also easy to handle. Its epithelium is thick and the lamina propria is thin which allows easy imbibition and inosculation. The graft is sutured to the edges of the urethrotomy. 16F urethral catheter for 1 week and suprapubic cystrostomy for 2 weeks is left in situ. A pendrose drain is placed for 1-2 days following the procedure.

W.Britt Zimmerman 2011,[(48)] proved the ideality of buccal mucosal graft having negligible complication, rates and good long and short term results, due to its tough epithelium and thin lamina propria and rich vascular supply when used in urethroplasty procedures. More over it is much easier to harvest and implant.

BLADDER MUCOSAL FLAP

Since it is difficult to harvest and handle, not the preferred technique.

PEDICLED SKIN GRAFT

The non hair bearing skin is harvested along with its facia to provide its own blood supply. It is considered more ideal because of its thin and rich vascular characteristics.

SKIN ISLAND ONLAY FLAPS

The technique involves incision of the penile skin deep to dortos facia and elevating flaps from the dortos facia in order to provide blood supply. The dorsal or ventral onlay are with respect to their positions. The skin island flap is sutured to the edge of lateral urethrotomy made at the stricturous segment using absorbable sutures. Then the skin is closed by interrupted sutures.

HAIRLESS SCROTAL ISLAND FLAP

It is done in association with complex urethroplastic procedures in order to provide additional blood supply. The middle non-hair bearing area of scrotum is chosen and the flap harvested along with the scrotal dortos and is sutured to the edges of the urethrotomy.

SKIN ISLAND TUBULARISED FLAP

It involves tabularising the pedicle skin graft around a sound and anastomosing its tabularised edge to the edges of the native stump of urethra. It is mainly done in combination with onlay flap procedures in cases of long segment urethral strictures.

MATERIALS AND METHODS

30 male patients along with 10 controls in the age group of 20-65, who presented to the radiology department with symptoms of urinary retention and in whom Retrograde Urethrography or Opposing urethrography had been performed were taken up for study.

The study was performed in SIEMENS MAGNETOM Symphony 1.5 Tesla MRI scanner available at our institute.

HASTE sequence was obtained in each patient using a torso pelvic phased array coil, as described below.

Period of Study: 3 Years

PATIENT SELECTION

Inclusion Criteria

Cases

30 Male patients in the age group of 20-65 years with history of straddle injury, pelvic bone fracture, transurethral instrument manipulation or radical prostatectomy, urethritis presenting with symptoms of urethral stricture

Patients in whom Retrograde Urethrography or Opposing urethrography done for suspected urethral stricture.

After a time interval of about 4 to 10 days MR Urethrography was performed in these patients.

Controls

10 male patients who underwent screening for symptoms of urethral stricture for whom MR urethrography is normal.

EXCLUSION CRITERIA

- Patients with metallic implants like cardiac pacemakers, Implanted cardiac defibrillator, Cochlear implants etc.
- Severe hypersensitivity or previous allergic reactions
- Clausrophobia
- Critically ill patients

Patient preparation

No specific preparation.

Patient position

Head first and supine.

Sequence employed

HASTE Sequence

Slices	:	15
FOV read	:	300 mm
FOV phase	:	100
Slice thickness	:	2 mm
TR	:	4000-6000 ms
TE	:	80-120 ms

Averages	:	1
Flip angle	:	150
Turbo factor	:	218
Echo spacing	:	8 ms

Procedure

Patient is placed in Torso pelvic phased array coil.

Initially, 150–300 mL of normal saline was infused slowly into the emptied bladder through the supurapubic cystostomy catheter until the patient felt the need to void.

The tip of a 10-mL syringe filled with 8–10 mL of sterile lubricating jelly was inserted into the external urethral meatus.

The sterile lubricating jelly was infused in to the anterior urethra until resistance was felt and some of the lubricating jelly overflowed from the urethral meatus.

The glans sulcus of the penis was then gently tied by using long gauze in order to avoid escape of the lubricating jelly.

The penile shaft was secured in the midsagittal position of the pelvis by using an upward traction and taping the edges of the tying gauze to the abdomen.

High resolution sagittal T2 weighted images of penis and bladder was acquired. Coronal and axial images images were also obtained.

The center of the localizer was placed over the symphysis to cover the the bladder and urethra.

Patient was then asked to strain and images were again obtained during straining in an attempt to by open the bladder neck.

Image analysis

MRU

Obtained images were analysed and it was focussed on location, number, length and the signal intensity of the stricture in MRU.

Anterior urethral stricture is measured along the long axis of the fibrotic segment shown as low signal intensity on the sagittal T2-weighted images.

Posterior urethral stricture is determined to be the distance between the proximal limit of the distal distended urethra and the prostatic apex on the sagittal T2-weighted images.

Additionally, MR findings were evaluated with regard to the urethra proximal to the stricture, the corpora spongiosa surrounding the stricture, adjacent organ injuries, and the associated complications like prostatic apex displacement, fistulas, sinus tracts etc.,

Conventional retrograde urethrography and opposing urethrography

Stricture length on conventional retrograde urethrography and opposing urethrography was determined by measuring the distance between the proximal end of the distal distended urethra and the distal end of the open proximal urethra.

Stricrures with length of < 2.5 were defined as “short strictures”, where as those > 2.5 as “long strictures”.

Extent of periurethral fibrosis was assessed by characterizing the surrounding depth and intensity of periurethral tissue. Assessment of prostatic apex displacement.

- Superior to inferior displacement is measured between prostatic apex and inferior pubic ramus of >1cm is considered significant.
- Anteroposterior displacement is the distance between apex of prostate and urethral insertion at the roof of the penile bulb.
- Lateral displacement is the distance between prostatic apex and bulbous urethra on the coronal image.

Retrograde urethrography

- Stricture location
- Stricture length
- Extravasation of contrast
- Fistulous/ sinus tracts

Opposing urethrography

- Stricture location
- Stricture length
- Extravasation of contrast
- Bladder neck opened or not
- Filling of prostatic urethra
- Fistulous/ sinus tracts

MR Urethrography

- Stricture location
- Stricture length
- Extravasation of sterile jell infused
- Periurethral fibrosis
- Prostatic apex displacement
- Fistulous/ sinus tracts

Surgical findings

- Type of surgery - Endoscopy or urethroplasty
- Flap procedure done or not
- Site of stricture
- Length of stricture
- Periurethral fibrosis
- Prostatic apex displacement

RESULTS AND ANALYSIS

Conventional RUG – OUG - Findings * Stricture

Crosstab

			Stricture		Total
			Antierior	**Postierior**	
Conventional RUG ,OUG - Findings	Short urethral stricture	**Count**	14	2	16
		% within Conventional RUG – OUG Findings	87.5%	12.5%	100.0%
		% within Stricture	93.3%	16.7%	59.3%
	Long urethral stricture	**Count**	1	10	11
		% within Conventional RUG – OUG Findings	9.1%	90.9%	100.0%
		% within Stricture	6.7%	83.3%	40.7%
Total		**Count**	15	12	27
		% within Conventional RUG – OUG - Findings	55.6%	44.4%	100.0%
		% within Stricture	100.0%	100.0%	100.0%

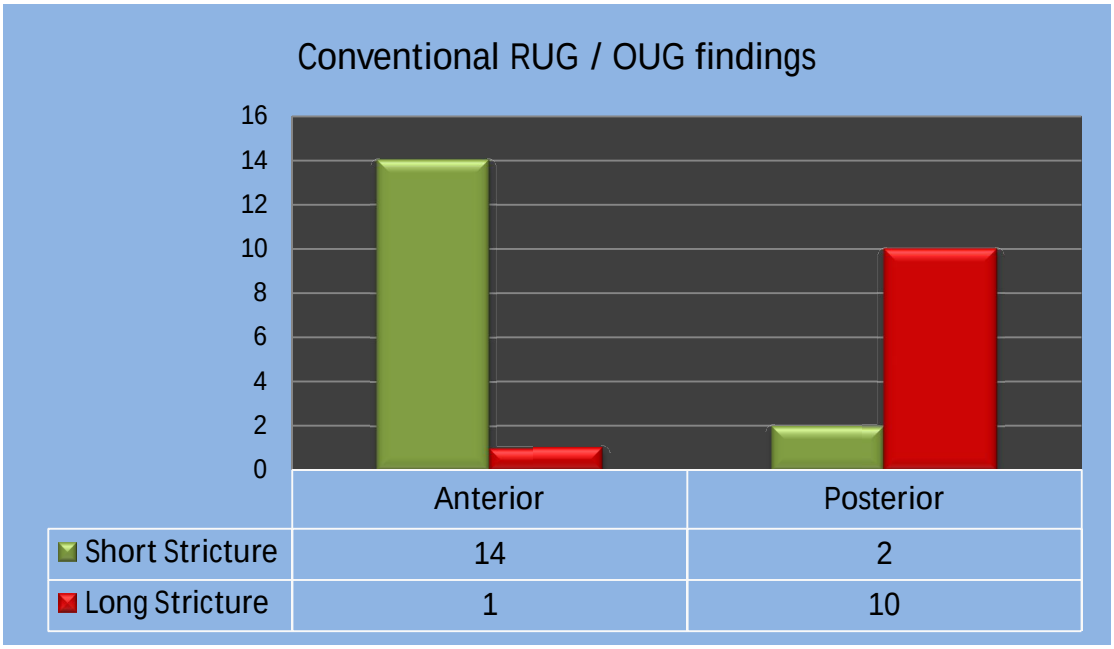
Conventional RUG / OUG

Short urethral stricture –

There were 14 (93.3%) anterior and 2 (16.7%) posterior urethral strictures.

Long urethral strictures –

There were 1 (6.7%) anterior and 10 (83.3%) posterior urethral strictures.



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16.231(b)	1	**.001**		
Continuity Correction(a)	13.210	1	.001		
Likelihood Ratio	18.337	1	.001		
Fisher's Exact Test				**.001**	**.001**
Linear-by-Linear Association	15.630	1	.001		
N of Valid Cases	27				

a Computed only for a 2x2 table
b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.89.

With conventional RUG / OUG the P value is <0.001 and hence shows **statistically significant difference**.ie, there is significant difference in the stricture length measurement on conventional RUG/OUG imaging.

MR Urethrography - Findings * Stricture - Crosstab

			Stricture		Total
			Antierior	**Postierior**	
MR Urethrography - Findings	Short urethral stricture	**Count**	12	9	21
		% within MR Urethrography - Findings	57.1%	42.9%	100.0%
		% within Stricture	80.0%	75.0%	77.8%
	Long urethral stricture	**Count**	3	3	6
		% within MR Urethrography - Findings	50.0%	50.0%	100.0%
		% within Stricture	20.0%	25.0%	22.2%
Total		**Count**	15	12	27
		% within MR Urethrography - Findings	55.6%	44.4%	100.0%
		% within Stricture	100.0%	100.0%	100.0%

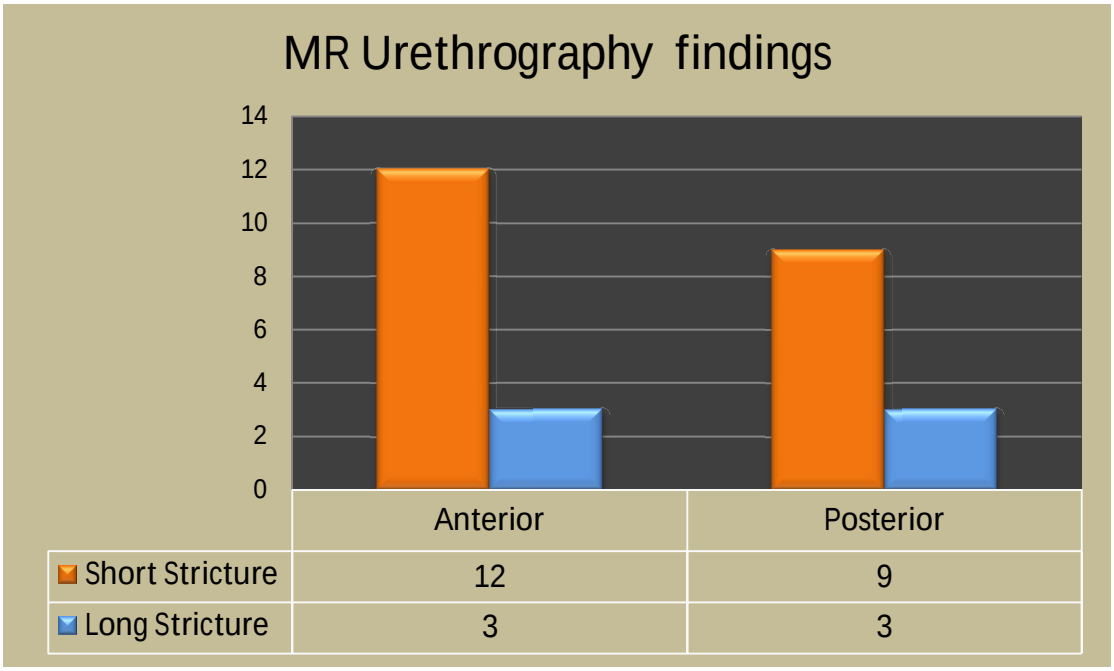
MR urethrography findings

Short urethral stricture –

There were 12 (80%) anterior and 9 (75%) posterior urethral strictures which are short.

Long urethral stricture –

There were 3 (55.6%) anterior and 3 (44.4%) posterior urethral strictures which are long.



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.096(b)	1	.756		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.096	1	.757		
Fisher's Exact Test				1.000	.557
Linear-by-Linear Association	.093	1	.761		
N of Valid Cases	27				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.67.

With MR urethrography findings the P value is 0.756 (>0.05) and hence statistically shows no significant difference.ie , no significant difference from the actual length of stricture.

Surgical procedure * Stricture - Crosstab

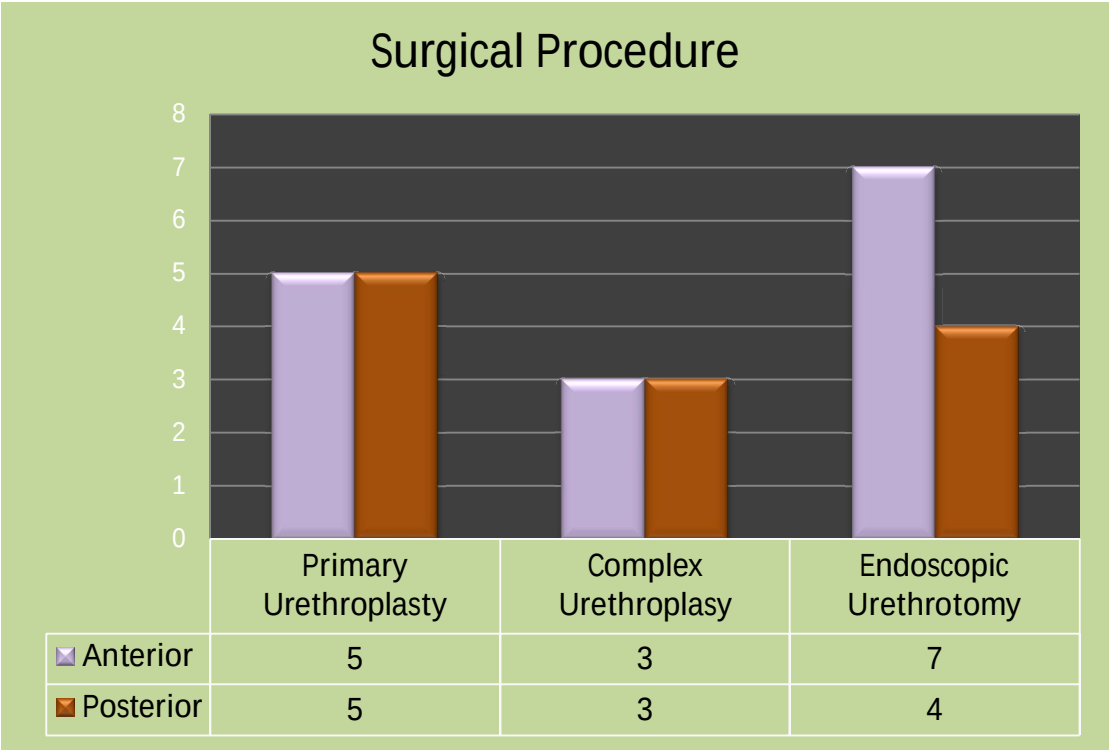
			Stricture		Total
			Antierior	Postierior	
surgical procedure	Primary urethroplasty	**Count**	5	5	10
		% within surgical procedure	50.0%	50.0%	100.0%
		% within Stricture	33.3%	41.7%	37.0%
	Complex urethroplasty	**Count**	3	3	6
		% within surgical procedure	50.0%	50.0%	100.0%
		% within Stricture	20.0%	25.0%	22.2%
	Endoscopic urethrotomy	**Count**	7	4	11
		% within surgical procedure	63.6%	36.4%	100.0%
		% within Stricture	46.7%	33.3%	40.7%
Total		**Count**	15	12	27
		% within surgical procedure	55.6%	44.4%	100.0%
		% within Stricture	100.0%	100.0%	100.0%

Surgical procedure:

5 (33.3%) patients with anterior and 5 (41.7%) posterior strictures underwent primary urethroplasty.

3 (20%) patients with anterior and 3 (25%) posterior urethral strictures were treated by complex urethroplasty procedures.

7 (46.7%) patients with anterior and 4 (33.3%) posterior strictures underwent endoscopic urethrotomy.



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.491(a)	2	**.782**
Likelihood Ratio	.495	2	**.781**
Linear-by-Linear Association	.388	1	**.533**
N of Valid Cases	27		

a 4 cells (66.7%) have expected count less than 5. The minimum expected count is 2.67.

Here the P value is 0.782 (>0.05) and showed no statistically significant difference from the actual stricture length measurement.

T-Test - Group Statistics

	Stricture	N	Mean (cm)	Std. Deviation	Std. Error Mean (cm)
Conventional RUG /OUG – Length	Antierior	15	1.700	1.2553	**.3241**
	Postierior	12	3.808	1.2859	**.3712**
MR Urethrography - Length	Antierior	15	2.033	1.1312	**.2921**
	Postierior	12	2.150	.9376	**.2707**
Surgical length	Antierior	15	2.040	1.2477	**.3222**
	Postierior	12	2.308	1.0220	**.2950**

Length in conventional RUG/OUG - show standard error of mean of 0.32 and 0.37 for anterior and posterior strictures respectively

Length in MRU -- show standard error of mean of 0.29 and 0.27 for anterior and posterior strictures respectively

Surgical Length show standard error of mean of 0.32 and 0.29 for anterior and posterior strictures respectively

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Age in years	Equal variances assumed	.518	.477	.140	29	.890	.55	3.932	-7.490	8.591
	Equal variances not assumed			.136	23.655	.893	.55	4.045	-7.803	8.904
Conventional Retrograde Urethrography - Length	Equal variances assumed	.780	.385	-4.290	25	**.001**	-2.108	.4914	-3.1204	-1.0962
	Equal variances not assumed			-4.278	23.454	**.001**	-2.108	.4928	-3.1267	-1.0900
MR Urethrography - Length	Equal variances assumed	.168	.685	-.287	25	.777	-.117	.4068	-.9545	.7212
	Equal variances not assumed			-.293	24.951	.772	-.117	.3982	-.9368	.7035
Surgical length	Equal variances assumed	.160	.692	-.600	25	.554	-.268	.4469	-1.1887	.6521
	Equal variances not assumed			-.614	24.974	.545	-.268	.4368	-1.1681	.6314

The independent samples test shows P value of <0.001 with conventional RUG / OUG length which infers **statistically significant difference** in the length of stricture.

T-Test – Anterior urethral strictures

Paired Samples Statistics

		Mean (cm)	N	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Pair 1	Conventional RUG,OUG-Length	1.700	15	1.2553	.3241	**.043**
	MR Urethrography - Length	2.033	15	1.1312	.2921	
Pair 2	Conventional RUG,OUG - Length	1.700	15	1.2553	.3241	**.035**
	Surgical length	2.040	15	1.2477	.3222	
Pair 3	MR Urethrography - Length	2.033	15	1.1312	.2921	**.913**
	Surgical length	2.040	15	1.2477	.3222	

15 patients with anterior urethral stricture on paired sample statistics showed standard mean error of 0.32 cm and 0.29 cm for conventional RUG / OUG and MRU respectively.ie .there is comparatively less std error of mean.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Conventional Retrograde Urethrography - Length & MR Urethrography - Length	15	.887	**.001**
Pair 2	Conventional Retrograde Urethrography - Length & Surgical length	15	.898	**.001**
Pair 3	MR Urethrography - Length & Surgical length	15	.986	**.001**

The paired samples correlations were **statistically significant** in all the 3 pairs with P value of <0.001.ie, when comparing the individual pairs there is strong correlation in the measurement of length.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Conventional RUG,OUG - Length - MR Urethrography - Length	-.333	.5802	.1498	-.655	-.012	-2.225	14	**.043**
Pair 2	Conventional – RUG,OUG Length - Surgical length	-.340	.5642	.1457	-.652	-.028	-2.334	14	**.035**
Pair 3	MR Urethrography - Length - Surgical length	-.007	.2314	.0597	-.135	.121	-.112	14	**.913**

P value is (>0.05) and hence not statistically significant in Pair 3.ie. no difference in measurement of stricture length.

Pair 1 and Pair 2 showed P value 0.01 to 0.05 which is significant at 5% level.(moderate significance) ie, moderate difference in the stricture length measurement.

T-Test - Posterior urethral strictures - Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean(cm)	Sig. (2-tailed)
Pair 1	Conventional RUG,OUG- Length	3.808	12	1.2859	.3712	
	MR Urethrography - Length	2.150	12	.9376	.2707	**.001**
Pair 2	Conventional RUG,OUG- Length	3.808	12	1.2859	.3712	
	Surgical length	2.308	12	1.0220	.2950	**.001**
Pair 3	MR Urethrography - Length	2.150	12	.9376	.2707	
	Surgical length	2.308	12	1.0220	.2950	**.045**

12 patients with posterior urethral strictures on paired samples statistics showed standard error of mean of 1.2 and 0.9 cm for conventional RUG / OUG and MRU respectively.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Conventional Retrograde Urethrography - Length & MR Urethrography - Length	12	.828	**.001**
Pair 2	Conventional Retrograde Urethrography - Length & Surgical length	12	.795	**.002**
Pair 3	MR Urethrography - Length & Surgical length	12	.973	**.001**

Paired samples correlations were statistically significant in all the 3 pairs as for as the posterior urethral strictures are concerned (P<0.001).

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	**Conventional RUG,OUG- Length - MR Urethrography - Length**	1.658	.7317	.2112	1.193	2.123	7.851	11	**.001**
Pair 2	**Conventional RUG,OUG- Length - Surgical length**	1.500	.7804	.2253	1.004	1.996	6.658	11	**.001**
Pair 3	**MR Urethrography - Length - Surgical length**	-.158	.2429	.0701	-.313	-.004	-2.258	11	**.045**

Pair 1 and Pair 2 on paired sample test are statistically significant with P value of <0.001 . However the significance for pair 3 ie, MRU Vs surgical length it was 0.045,which indicate that there is no statistically significant difference in length measurement.

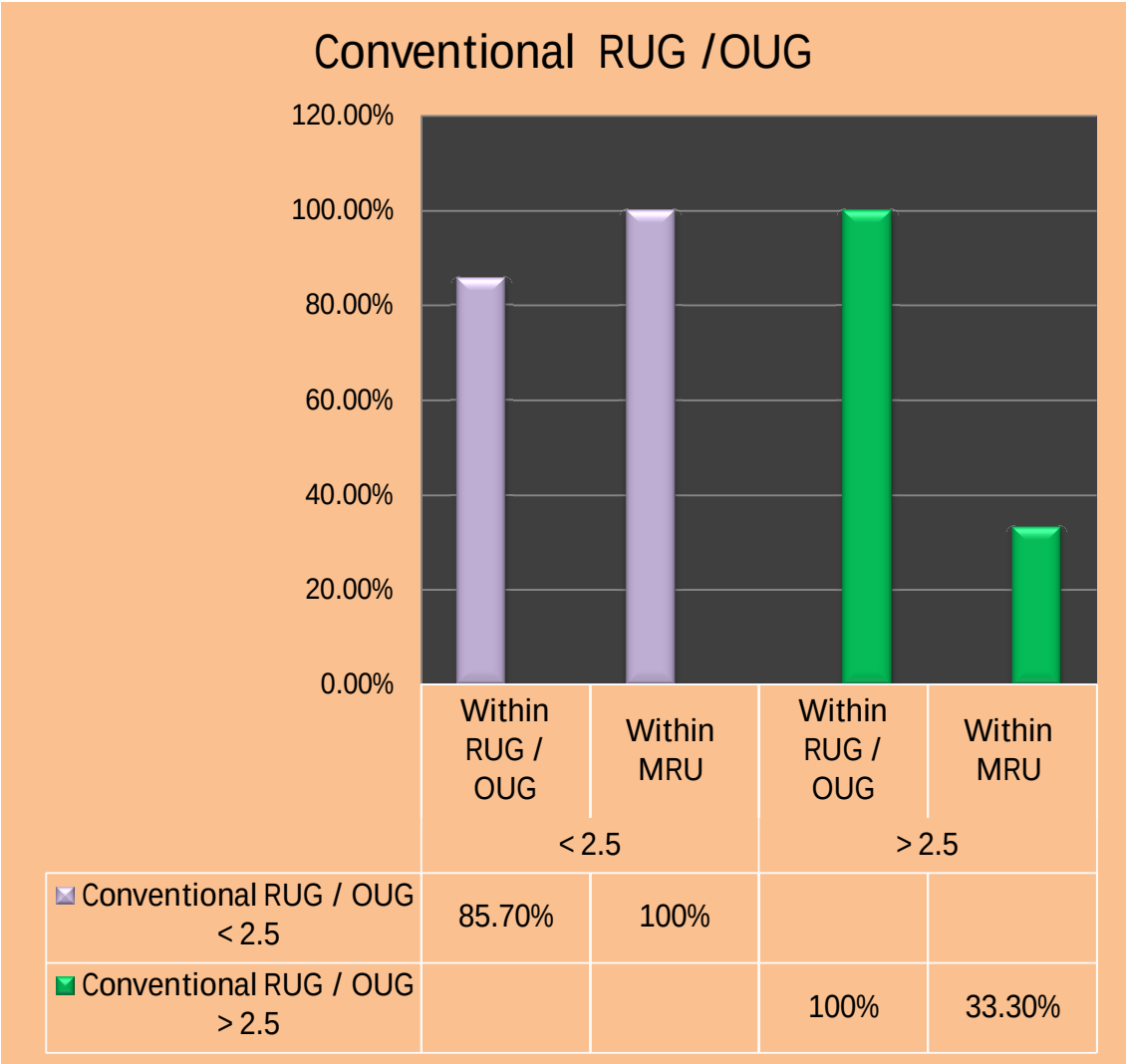
CROSSTABS

Conventional RUG / OUG - MR Urethrography – Stricture Length

Stricture				MR Urethrography - Length		Total
				< 2.5	> 2.5	
Antierior	Conventional RUG,OUG - Length	**< 2.5**	Count	12	2	14
			% within Conventional RUG,OUG- Length	**85.7%**	14.3%	100.0%
			% within MR Urethrography - Length	**100.0%**	66.7%	93.3%
		> 2.5	Count	0	1	1
			% within Conventional RUG,OUG - Length	.0%	**100.0%**	100.0%
			% within MR Urethrography - Length	.0%	**33.3%**	6.7%
	Total		Count	12	3	15
			% within Conventional RUG,OUG - Length	80.0%	20.0%	100.0%
			% within MR Urethrography - Length	100.0%	100.0%	100.0%
Postierior	Conventional RUG,OUG - Length	**< 2.5**	Count	2	0	2
			% within Conventional RUG,OUG - Length	**100.0%**	.0%	100.0%
			% within MR Urethrography - Length	**22.2%**	.0%	16.7%
		> 2.5	Count	7	3	10
			% within Conventional RUG,OUG - Length	70.0%	**30.0%**	100.0%
			% within MR Urethrography - Length	77.8%	**100.0%**	83.3%
	Total		Count	9	3	12
			% within Conventional RUG,OUG - Length	75.0%	25.0%	100.0%
			% within MR Urethrography - Length	100.0%	100.0%	100.0%

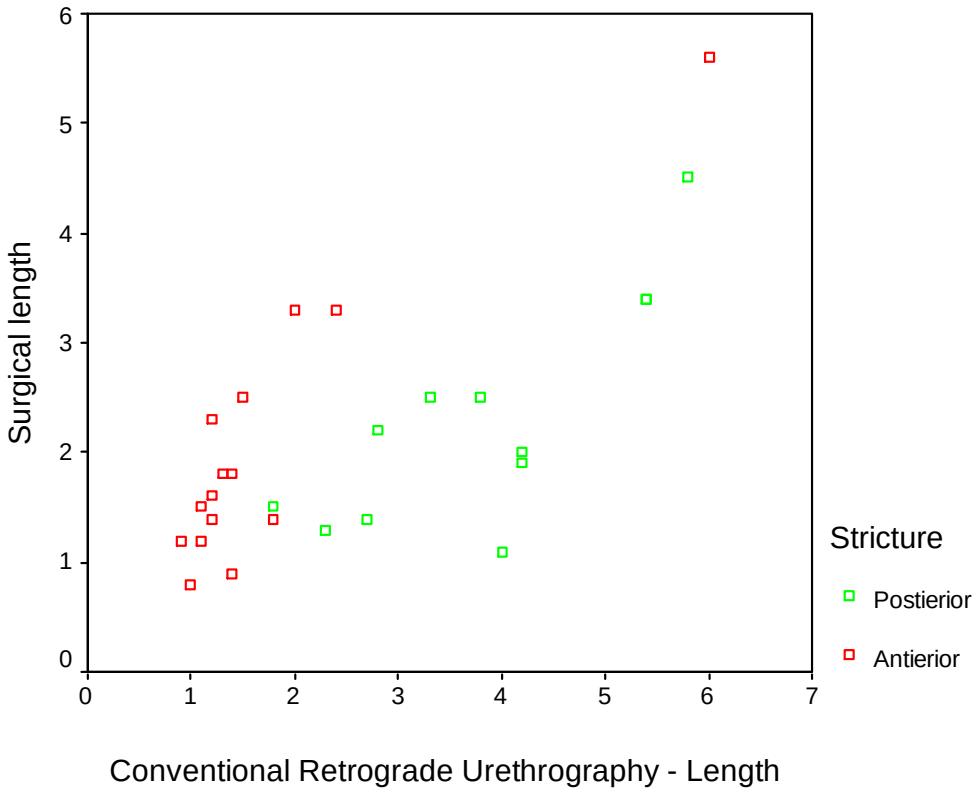
The sensitivity, specificity, positive predictive value, negative predictive value for conventional RUG / OUG are 100%, 33.3%, 85.7%, 100%, whereas it is 100% for MR urethrography for anterior urethral strictures.

The sensitivity, specificity, positive predictive value, negative predictive value for conventional RUG / OUG are 22%, 100%, 100%, 30%, whereas it is 100% for MR urethrography for posterior urethral strictures.



SCATTER DIAGRAM

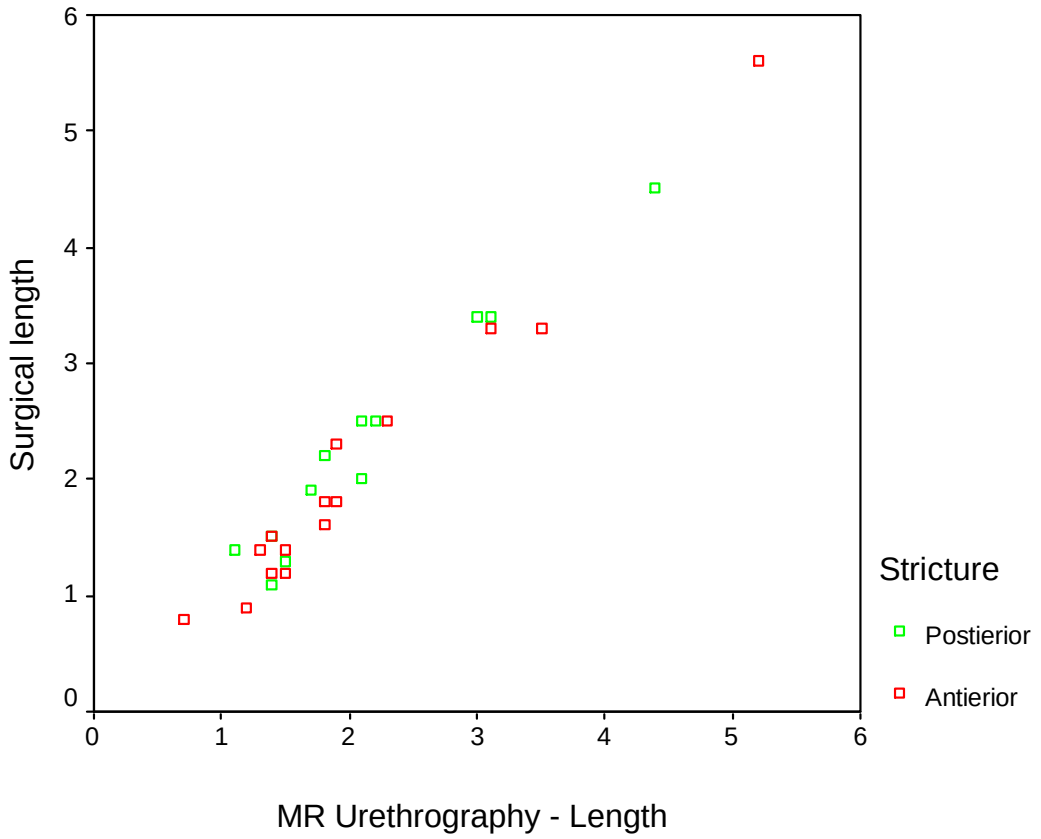
CONVENTIONAL RUG/OUG LENGTH VS SURGICAL LENGTH



There is evidence that majority of anterior urethral strictures were under estimated and majority of posterior urethral strictures were over estimated by conventional RUG/OUG.

SCATTER DIAGRAM

MR URETHROGRAPHY VS SURGICAL LENGTH



There is evidence that MR urethrography length shows linear correlation with surgical length for both anterior and posterior urethral strictures

DISCUSSION

Strictures with length of <2.5 cm were defined as “short strictures”, where as >2.5 cm as “long strictures”.

There are many treatment options for obliterative urethral strictures. The options chosen depends on several factors. Most important being the stricture length[56] .Endoscopic treatment can be useful for a thin septum like stricture 0.5 – 1.5 cm [57] . A short urethral stricture measuring <2.5 cm, is amenable to be managed with primary anastomotic urethroplasty . Whereas a complex technique involving a graft or flap is generally performed in patients with a long urethral stricture measuring >2.5 cm [58].

Primary anastomotic urethroplasry is mainly done by the perineal route. The transpubic approach is done for long strictures associated with fistulous tracts, cavities in the periurethral region or opened bladder neck.

The other factors that determine the choice of repair include the stricture causes, the extent of fibrosis of the corpora spongiosa, prior surgical treatment and the surgeon’s option. Therefore a careful evaluation of the obliterative urethral stricture is most important in the surgical management of obliterative urethral strictures.

Conventional retrograde urethrography/ Opposing urethrography is the method of choice in investigative procedures for the planning of a urethral reconstruction. This technique, however it cannot provide an accurate measurement of the stricture length because of the poor prostatic urethral filling and provides no information regarding periurethral fibrosis or displacement of the prostate. A stricture length could be over estimated if the bladder neck does not relax.[59]

The extent of the stricture can be determined if the patient opens the bladder neck. But it is only rarely possible, because the will be in long term suprapubic catheterisation to allow urinary diversion which causes reduced bladder capacity. For the same reason the patient may not be able tolerate bladder distention which is sufficient enough to voluntarily open the bladder neck.

In an attempt to open the bladder neck, failure to demonstrate the prostatic urethra by no means imply a bladder neck obstruction or an urethral stricture is present right up to the level of bladder neck.[60]

In this regard in order to identify the proximal limit of the stricture, a metal sound can be introduced via the suprapubic cystostomy track to accommodate the indwelling suprapubic catheter into the bladder, down through the bladder neck. However it is a cumbersome procedure

associated with complications such as severe pain and hematuria resulting from bladder neck injury.

As for as the anterior urethral stricture, its length is underestimated if the patient is not properly positioned due to normal anatomical fixity of the bulbar urethra along the plane of axis of the pelvis leading to" end on view". It requires a steep oblique position for exact localisation while performing RGU [(61)].

An underestimation of stricture length, can occur due to an urinoma cavity that overlaps the prostatic urethra as shown on the conventional RGU and opposing urethrography image. The cavity can be mistaken for the proximal urethral segment and be falsely anastomosed to the bulbar urethra.[(62)]

In our study, MR urethrography clearly showed the stricture length with surrounding periurethral fibrosis, prostatic displacements and associated complications such as fistulas and sinus tracts.

According to the findings on RUG in anterior urethral stricture, most are short segment strictures except one among the 15 patients. The initially planned surgery, depending on RUG finding then changed according MRU findings. In 9 of the patients with anterior stricture 2 are long and 7 are short strictures. In these patients MRU showed accurate measurement of the stricture length and periurethral fibrosis. RUG under estimated most of the anterior urethral strictures.

As for as the posterior urethral strictures are concerned, most of them were over estimated by OUG because of patients inability to open the bladder neck. MRU accurately measured the posterior urethral strictures and associated complications in 12 patients with posterior strictures. In 9 among the 12 patients with posterior strictures the treatment strategy has been changed according to MRU findings. Hence MRU can be a promising modality in helping the surgeons to choose the most appropriate surgical procedure in patients with urethral stricture.

CONCLUSION

Conventional retrograde urethrography and Opposing urethrography were well known established techniques in delineating urethral strictures both and posterior. These modalities although readily available and cost effective do not determine the accurate length and periurethral fibrosis. Furthermore, if the patient cannot relax the bladder neck the length of stricture can be grossly overestimated in a case of posterior urethral stricture. The anterior urethral stricture may be underestimated due to problems of positioning. These studies also requires adequate degrees of renal function for contrast excretion, the need for administration of potentially risk contrast media, the relatively significant amount of radiation exposure especially in younger patients.

MR Urethrography can be a valuable means of imaging patients with urethral strictures. T2 weighted sequences are excellent for demonstrating urethra as well as rest of urinary system. MR imaging is especially useful in planning the surgical procedure in cases of posterior urethral strictures with displacement the prostatic apex due to pelvic trauma. It also determines the avulsion of corpus cavernosum from the ischaemia which result in impotence . It accurately shows the stricture length and prostatic apical displacement and dictataes the surgeon to plan

the surgery via the perineal (or) transpubic approach. A combined perineal and transpubic approaches may be needed in larger defects measuring more than 6 cm with extensive suprolateral displacement. It also plays important role in the surgical treatment of anterior urethral strictures by accurate measurement of the stricture length and associated periurethral fibrosis. In this condition only strictures upto 1.5 cm are amenable for endoscopic urethrotomy. Even with these short strictures extensive periurethral fibrosis precludes dilatations and endoscopic urethrotomy requiring primary anastomotic urethroplasty.

MRU can be successfully performed in patients in whom contrast studies are contraindicated. Paediatric population can also be subjected to MRU without radiation to testis.

From our study, it is evident that MR Urethrography depicts stricture length, periurethral fibrosis, displacement of the prostatic apex and also associated pathologies with accuracy, there by assisting the surgeons to the select most appropriate surgical procedure for the patients with oblitrative urethral stricture.

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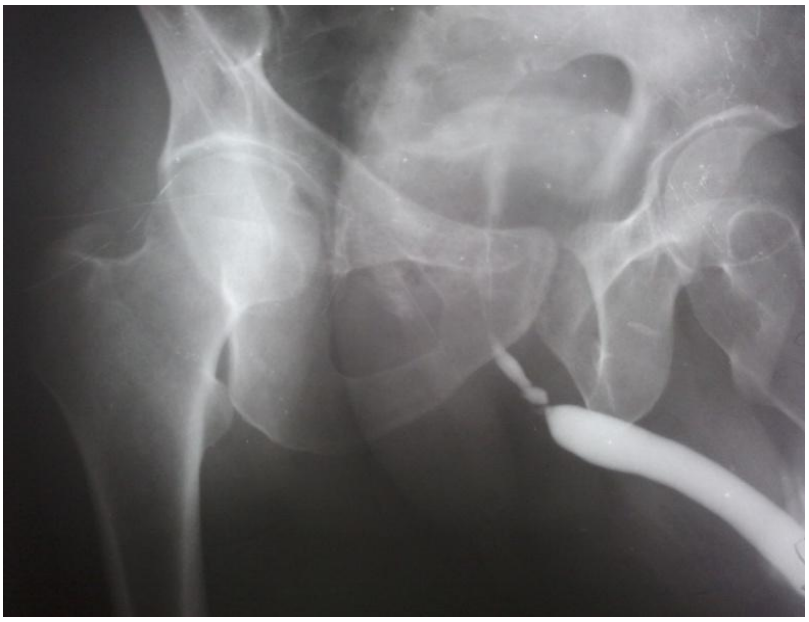
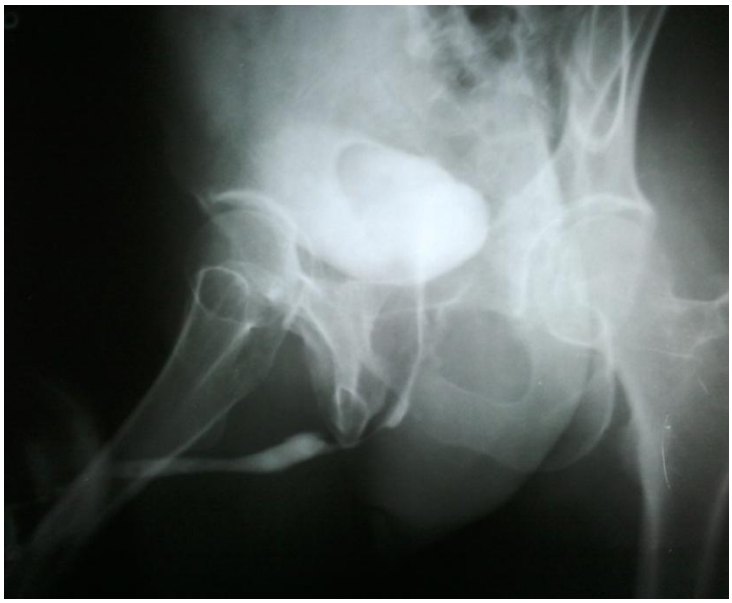
CASE 1



Short segment stricture involving the bulbar urethra on RUG and MRU.

Case 2



Long segment bulbar urethral stricture on both RUG and MRU with extensive periurethral fibrosis shown in MRU.

Case 3

RUG -long stricture in the bulbar urethra

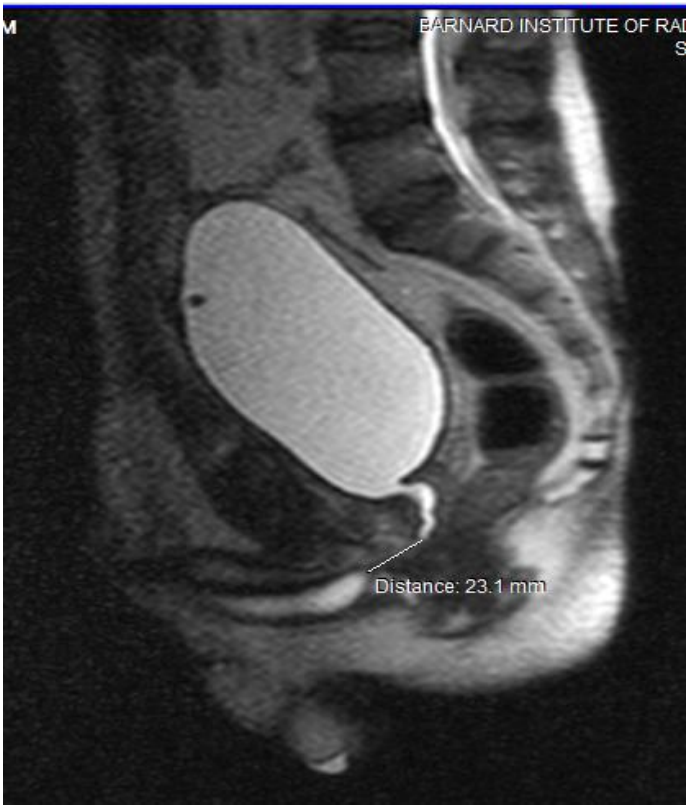
MRU- Multiple strictures involving the bulbar and proximal penile urethra with periurethral fibrosis

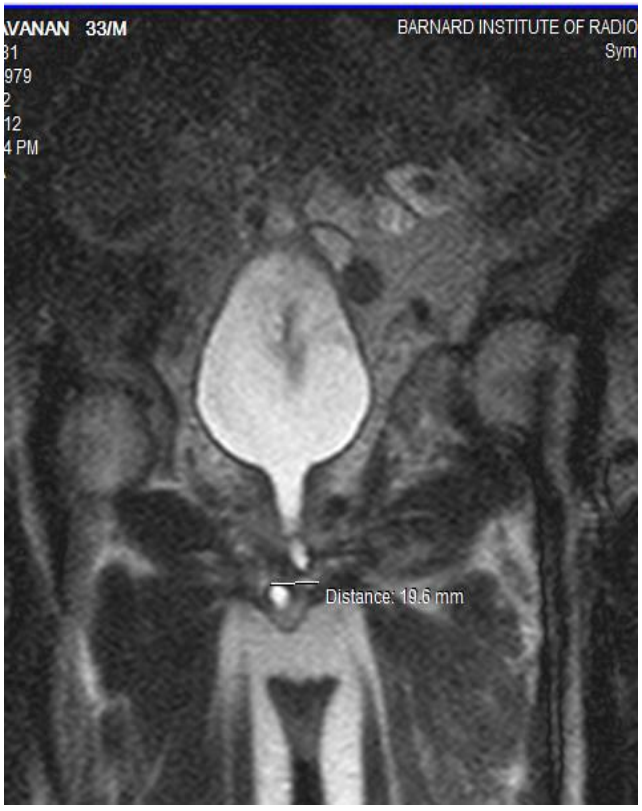
Case 4

OUG - Long posterior urethral stricture.

MRU - Short stricture of membranous urethra with urethral axis deviation.

case 5

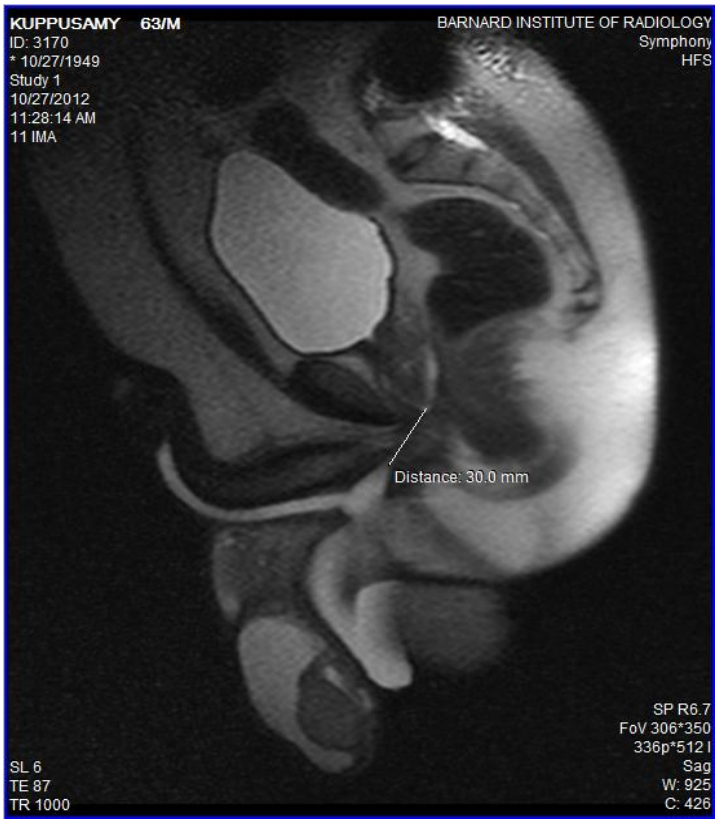




OUG - Long posterior urethral stricture.

MRU - Short stricture of membranous urethra with urethral axis deviation.

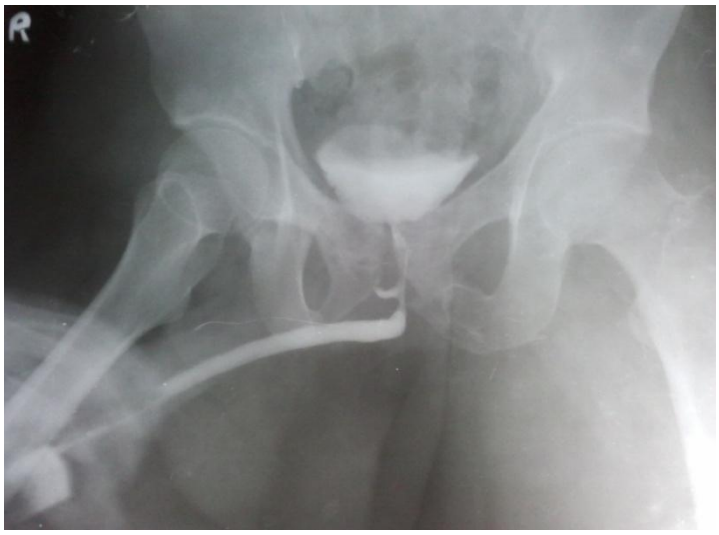
Case6

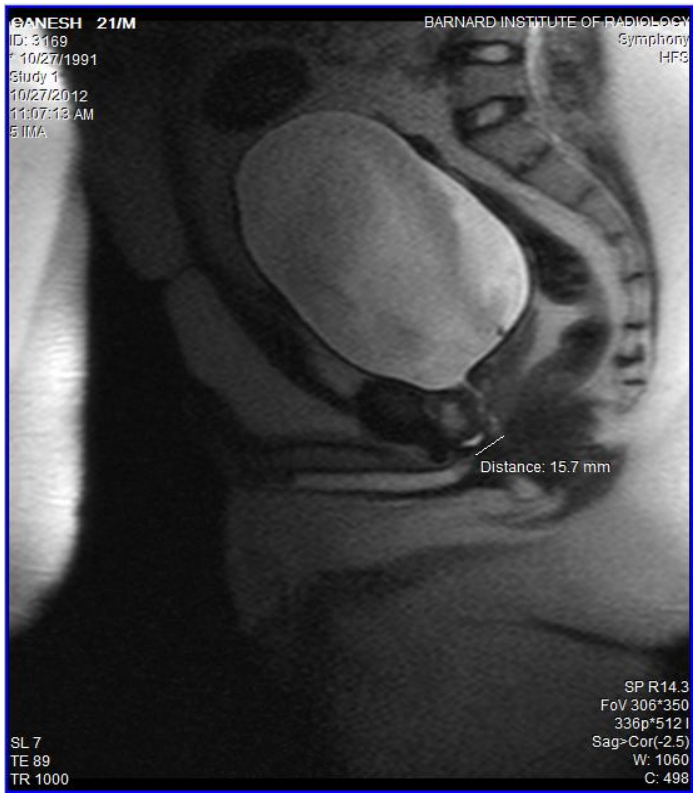


OUG - Long posterior urethral stricture.

MRU- Long posterior urethral stricture with urethroscrotal fistula and urethral axis deviation

Case 7





OUG - **Short stricture of membranous urethra with periurethral sinus**

MRU- Short stricture of membranous urethra with periurethral sinus tract and displacement of prostatic apex

NORMAL ANATOMY OF URETHRA