CLINICAL RELEVANCE OF MR URETHROGRAPHY IN OBLITERATIVE POSTERIOR URETHRAL STRICTURE AND COMPARISON WITH RETROGRADE URETHROGRAPHY

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CERTIFICATE

This is to certify that **DR. E.MANIMEKALA** has been a post graduate student during the period May 2006 to March 2009 at Department of Radiodiagnosis, Madras Medical College and Research Institute, Government General Hospital, Chennai.

This Dissertation titled **"CLINICAL RELEVANCE OF MR URETHROGRAPHY IN OBLITERATIVE POSTERIOR URETHRAL STRICTURE AND COMPARISON WITH RETROGRADE URETHROGRAPHY"** is a bonafide work done by her during the study period and is being submitted to the Tamilnadu Dr.M.G.R. Medical University in Partial fulfillment of the M.D. Branch VIII Radio Diagnosis Examination.

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CONTENTS

INTRODUCTION

Imaging of the urinary tract has traditionally revolved around the use of X-rays and contrast media.

The first "opacification" of the urinary system, ureters was performed by **Tuffier T. Sonde**[1]. He inserted a metal wire into a ureteral catheter. This technique was subsequently replaced by making the ureteral catheters themselves radiopaque.

Next, air was tried as a contrast agent to reveal the ureter on radiographs. Air was soon replaced by a liquid contrast agent containing a colloidal suspension of silver, and the first retrograde pyelogram was done by **Voelcker F, von Lichtenberg**[2]. The usefulness of this technique was quickly recognized but, unfortunately, so were the dangers associated with the silver-containing contrast agent. The search for safer materials began and sodium iodide solutions, first described by **Cameron**[3] in 1918, became the contrast agents of choice for retrograde pyelography.

In 1923 , a young dermatologist named **Osborne**[4] observed opacification of the urinary bladder in the X-ray films of the abdomen in syphilitic patients, whom underwent treatment with large intravenous and oral doses of sodium iodide. Purposeful attempts to exploit these findings were unsuccessful, because of high toxicity of substance when utilized in quantities necessary to opacify the urinary system.

Nevertheless, this recognition of the key element iodine set stage for all future developments in contrast material for radiographic imaging. From this stage extensive development of the quality of contrast medium has grown immensely to the present stage of non-ionic contrast media which is considered to be safe.

Intravenous urography is arguably, the initial mode of investigating the urinary tract. It provides excellent anatomical detail of the urinary tract while providing a semi qualitative assessment of renal function. Ascending urethrography and opposing urethrography is the investigation of choice to image urethra.

The use of ionizing radiation, the potential drawbacks of iodinated media, the inability to visualize the posterior urethra and risks involved in imaging pediatric patients constitute some of the principal drawbacks of Ascending urethrography.

Magnetic resonance imaging (MRI) constitutes an alternative to imaging the urethra. With the development of the RARE and HASTE sequences, it is now possible to rapidly acquire informative images of the urethra without the administration of contrast media. This may circumvent some of the drawbacks associated with Ascending urethrography

While MRI is not without its own drawbacks, MR urethrography may be employed successfully in a variety of situations to study the urethra.

This dissertation is an attempt to study the diagnostic capability of MR urethrography, its efficacy in visualization of posterior urethra, and also in assessing prostatic apex displacement, in comparison to ascending urethrography. Most importantly is the details it gives to the surgeon in planning surgical modalities.

AIM

The purpose of study is to prospectively evaluate the clinical relevance of MR urethrography in depiction of **OBLITERATIVE POSTERIOR URETHRAL STRICTURE** and comparing with retrograde urethrography combined with cystourethrography.

REVIEW OF LITERATURE

Urethral stricture has been variously defined clinically**. Nielsen and Nordling**[5] provided the most acceptable definition .They define it as any portion of urethra **calibrating less than 22Fr** based on a study conducted over 4000 male Urethrae. It is suggested that stricture becomes symptomatic only after its caliber narrows down to **18 Fr or less**.

RUG (retrograde urethrography) / AUG as popularized by **Cunningham** in 1910[6] remained the gold standard imaging study for evaluating Urethral Stricture[7] nearly a century.

However some authors have reported that this imaging study is not ideal for posterior urethral strictures. For posterior urethra, combining **ascending urethrogram with MCUG is more rewarding**, and for anterior urethral strictures it under estimates the length of proximal Bulbar urethral stricture. This has been elaborated as this segment of urethra is fixed in the same axis as pelvis.This leads to an 'End-on View' of bulbar strictures radiographically,which reduces their apparent length[8,9]

Syed Mamun Mahmud et al[10] conducted a study from January 2001 to December 2002 to determine the role of ascending urethrogram in decision making for patients with suspected urethral strictures.The study concluded that AUG does not completely rule out urethral stricture(Negative Predictive Value 76%) .It was also observed that urethral stricture may be non-existent even though suggested in AUG(Positive PredictiveValue 89%). AUG has a sensitivity of 91% and a low specificity of 72% in diagnosing urethral stricture,

Nolte–Ernstring[11] published a new MR technique which was an extremely useful tool for clinical diagnostic radiology, as the produced images were comparable to those produced with X -ray Myelography and X-ray urography. Contrary to these methods RARE (Rapid Acquisition with relaxation enhancement technique) does not need administration of contrast agents. A low flip angle variant called Fluid Attenuated Inversion Recovery (FLAIR) made this technique accessible for high fields systems.

Later in 1986, **Friedburg and Henniq**[12] in their article RARE MR Urography, citied a fast non-tomographic imaging procedure for demonstrating the afferent urinary pathways. Using Nuclear magnetic resonance they found that the image information of the morphology of the urinary system was similar to X- ray urography as the sequence was heavily T2 weighted showing the urine bright. Hence a need for a contrast administration was not necessary.

French Radiologist **Vinee. P. and Stover**(13) studied the RARE sequence and hydrographic application to the urinary imaging. In their study,it took short imaging time with no contrast medium and nonionizing radiation. They found entire urinary tract visualized on one image had spatial resolution superior to that of sonography and similar to that of intravenous urography. Stronger and Faster gradients led to the developments of ultrafast heavily T2 weighted sequences that could be performed in a single breath hold. The sequence came to be called **HASTE** (**Half Fourier Acquisition of Single Shot Turbo spin echo**)

The technical aspects about this sequence was published by **Patrik Aerts et al** in 1995(14). They concluded HASTE sequence had the advantage of visualization of renal parenchyma as well as urinary tract in a few seconds.

J Eaton, MS, FRCS(Uro) et al in 2005(15) has published the current status of urethral imaging in BJR journals. They have quoted , male urethra is more prone to disease than the female urethra, notably trauma and stricture formation and MRI is central in the diagnosis and management of urethral pathologies such as urethral fistulae ,stricture and malignancy.

Jeong-ah Ryu, MD and Bohyun Kim, MD et al (Recipient of a Certificate of Merit award for an education exhibit at the 2000 RSNA scientific assembly. (16)concluded in their study “MR Imaging of the Male and Female Urethra" that the anatomic details of both the urethra and periurethral tissues can be evaluated noninvasively with magnetic resonance (MR) imaging and it can be used as an adjunctive tool for evaluation of urethral abnormalities. In patients with congenital anomalies, MR imaging is reserved for cases of intersex anomalies or complex genitourinary anomalies, in which evaluation of internal organs is essential. MR imaging may demonstrate diverticula that are not seen on radiographic contrast-enhanced studies, including VCUG, RUG, or double-balloon catheter study. In cases of inflammation, MR imaging can demonstrate not only inflammatory infiltration around the urethra but also the presence of a periurethral abscess or sinus tract. In cases of trauma, MR imaging is helpful in assessing the presence and extent of anterior or posterior urethral injury and predicting the occurrence of complications. At MR imaging, a fistula can be seen as a direct communicating channel with an adjacent organ. In patients with urethral tumors, the major role of MR imaging is in local staging.

MRURETHROGRAPHY was done in 20 patients with urethral stricture from january 2004 to april 2004 and published in journal of European urology(17). All underwent went RUG prior to it. They concluded MRU as a promising tool for defining anterior and posterior male urethral stricture as it accurately measures the length of stricture,extent of spongiofibrosis and aids in proper surgical selection.

Deuk Jae Sung, MD, et al[18] prospectively evaluated magnetic resonance (MR) urethrography for the depiction of obliterative urethral stricture. Twelve patients with obliterative urethral stricture were examined preoperatively with T2-weighted, T1-weighted, and contrast material–enhanced T1-weighted MR imaging of a urethra distended with sterile lubricating jelly. Ten of the 12 patients were examined with conventional retrograde urethrography (RGU) combined with voiding cystourethrography (VCUG) prior to MR imaging. Each imaging result was compared with either a surgical specimen or a description of the surgical findings to determine which method allowed accurate estimation of stricture length. MR imaging of the urethra distended with sterile lubricating jelly is an effective tool for evaluating obliterative urethral strictures **MR** measurements of stricture length demonstrated significantly lower errors ($P < .05$) and better linear fit to surgical measurement than did conventional RGU combined with VCUG measurements ($r^2 = 0.85, P < .001$ and $r^2 = 0.03$, $P > .05$, respectively).

Y Narumi, et al[19] assessed the role of MR imaging in defining the surgical approach and in predicting permanent erectile dysfunction in patients with traumatic posterior urethral injury, 27 patients underwent MR imaging. MR findings were correlated with surgical findings, surgical approach, and sexual potency at 12-month follow-up. MR imaging correctly revealed the length of the urethral injury (allowing for 0.5-cm discrepancy) in 23 of 27 (85%) patients and displacement of the prostatic apex in 19 of 21 (90%) patients.

Urethral stricture disease has been cited as long ago as ancient Greek writings that report establishing bladder drainage with the passage of various catheters. Historically, the treatment consisted of urethral dilation with sounds. **Hamilton Russell**[20] described the first surgical procedure for repair of a urethral stricture in 1914. In contemporary times, an array of surgical options is available.

ANATOMY, PATHOLOGY & IMAGING OF THE URETHRA

ANATOMY

The renal system is comprised of the kidneys, ureters, bladder and urethra.

The kidneys are paired vascular organs that perform excretory, regulatory and secretory functions.

The kidneys are located bilaterally in retroperitoneal space at the level of T-12 to L-3. The organs are bean-shaped, measure approximately 12 cm in length, 6 cm in width, and 2.5 cm in thickness, and weigh 120 to 170 grams in the normal adult. The right kidney is slightly lower than the left because of the liver. The kidneys are protected, not only by their anatomical position within the rib cage, but also by the perinephric structures. A tough fibrous capsule covers each kidney. The renal fascia provides support and perirenal fat acts as a cushion.

Vascular Supply

The kidneys are highly vascularized organs and receive approximately 20% of the resting cardiac output. Thus, renal blood flow is about 1,200 ml/min.

The aorta gives rise to the renal artery, which enters the kidney at the hilar region. This, in turn, branches to increasingly smaller vessels, that is, the interlobar, arcuate, and inter-lobular arteries. In the medulla, vasa recta, form long straight loops that run parallel to the loops of Henle of the juxtamedullary nephrons and play an important role in the concentration and dilution of urine. Blood flow in the remainder of the venous system follows the same pattern as the arterial vessels and returns to the inferior vena cava.

Ureters

The ureters are hollow fibromuscular tubes that begin at the renal pelvis, extend downward retroperitoneally, and join the bladder. Urine flows away from the kidneys by peristalsis.

Urinary bladder

The urinary bladder, located in the pelvic region, is a spherical, muscular sac with a capacity of 300 ml to 500 ml in the normal adult. Urine enters via the ureteral orifices and is excreted through the urethra.

Urethra

The urethra connects the urinary bladder to external urethral meatus. The urethra has an excretory function in both sexes to pass urine to the outside, and also a reproductive function in the male, as a passage for semen.

The external urethral sphincter is a striated muscle that allows voluntary control over urination.

Male urethra

Male urethra is about 8 inches (17.5 cm) long and opens at the tip of the penis. The inside of the urethra has a spiral groove which makes the urine flow in a wide stream.

The urethra is divided into anterior and posterior urethra. The anterior urethra (from distal to proximal) includes the meatus, fossa navicularis, penile or pendulous urethra, and bulbar urethra.

The posterior urethra (from distal to proximal) includes the membranous urethra and the prostatic urethra

Except during the passage of the urine or semen, the greater part of the urethral canal is a mere transverse cleft or slit, with its upper and under surfaces in contact; at the external orifice the slit is vertical, in the membranous portion irregular or stellate, and in the prostatic portion somewhat arched.

Posterior urethra-Prostatic part

The prostatic portion, the widest and most dilatable part of the canal, is about 3 cm. long, It runs almost vertically through the prostate from its base to its apex, lying nearer its anterior than its posterior surface; the form of the canal is spindle-shaped, being wider in the middle than at either extremity, and narrowest below, where it joins the membranous portion. A transverse section of the canal as it lies in the prostate is horse-shoe-shaped, with the convexity directed forward.

Upon the posterior wall or floor is a narrow longitudinal ridge, the urethral crest (verumontanum), formed by an elevation of the mucous membrane and its subjacent tissue. It is from 15 to 17 mm. in length, and about 3 mm. in height, and contains muscular and erectile tissue. When distended, it may serve to prevent the passage of the semen backward into the bladder. On either side of the crest is a slightly depressed fossa, the prostatic sinus, the floor of which is perforated by numerous apertures, the orifices of the prostatic ducts from the lateral lobes of the prostate; the ducts of the middle lobe open behind the crest. At the forepart of the urethral crest, below its summit, is a median elevation, the colliculus seminalis, upon or within the margins of which are the orifices of the prostatic utricle and the slit-like openings of the ejaculatory ducts. The prostatic utricle forms a cul-de-sac about 6 mm long, which runs upward and backward in the substance of the prostate behind the middle lobe. Its walls are composed of fibrous tissue, muscular fibers, and mucous membrane, and numerous small glands open on its inner surface

Posterior urethra-Membranous part

The membranous portion is the shortest, least dilatable, and, with the exception of the external orifice, the narrowest part of the canal. It extends downward and forward, with a slight anterior concavity, between the apex of the prostate and the bulb of the urethra, perforating the urogenital diaphragm about 2.5 cm. below and behind the pubic symphysis. The hinder part of the urethral bulb lies in apposition with the inferior fascia of the urogenital diaphragm, but its upper portion diverges somewhat from this fascia: the anterior wall of the membranous urethra is thus prolonged for a short distance in front of the urogenital diaphragm; it measures about 2 cm. in length, while the posterior wall which is between the two fasciae of the diaphragm is only 1.25 cm. long. The membranous portion of the urethra is completely surrounded by the fibers of the sphincter urethræ membranaceae. In front of it the deep dorsal vein of the penis enters the pelvis between the transverse ligament of the pelvis and the arcuate pubic ligament; on either side near its termination are the bulbourethral glands.

Anterior urethra-Cavernous part

The cavernous portion (penile or spongy portion) is the longest part of the urethra, and is contained in the corpus cavernosum urethrae. It is about 15 cm. long, and extends from the termination of the membranous portion to the external urethral orifice. Commencing below the inferior fascia of the urogenital diaphragm it passes forward and upward to the front of the symphysis pubis; and then, in the flaccid condition of the penis, it bends downward and forward. It is narrow, and of uniform size in the body of the penis, measuring about 6 mm. in diameter; it is dilated behind, within the bulb, and again anteriorly within the glans penis, where it forms the fossa navicularis urethræ

The external urethral orifice is the most contracted part of the urethra; it is a vertical slit, about 6 mm. long, bounded on either side by two small labia.

Histology of urethra

The urethra is composed of mucous membrane, supported by a submucous tissue which connects it with the various structures through which it passes.

The lining membrane of the urethra, especially on the floor of the cavernous portion, presents the orifices of numerous mucous glands and follicles situated in the submucous tissue, and named the urethral glands

(Littré). Besides these there are a number of small pit-like recesses, or lacunæ, of varying sizes. Their orifices are directed forward, so that they may easily intercept the point of a catheter in its passage along the canal. One of these lacunæ, larger than the rest, is situated on the upper surface of the fossa navicularis; it is called the lacuna magna. The bulbo-urethral glands open into the cavernous portion about 2.5 cm. in front of the inferior fascia of the urogenital diaphragm.

The mucous coat forms part of the genito-urinary mucous membrane. It is continuous with the mucous membrane of the bladder, ureters, and kidneys; externally, with the integument covering the glans penis; and is prolonged into the ducts of the glands which open into the urethra, viz., the bulbo-urethral glands and the prostate; and into the ductus deferentes and vesiculæ seminales, through the ejaculatory ducts. In the cavernous and membranous portions the mucous membrane is arranged in longitudinal folds when the tube is empty. Small papillæ are found upon it, near the external urethral orifice; its epithelial lining is of the columnar variety except near the external orifice, where it is squamous and stratified.

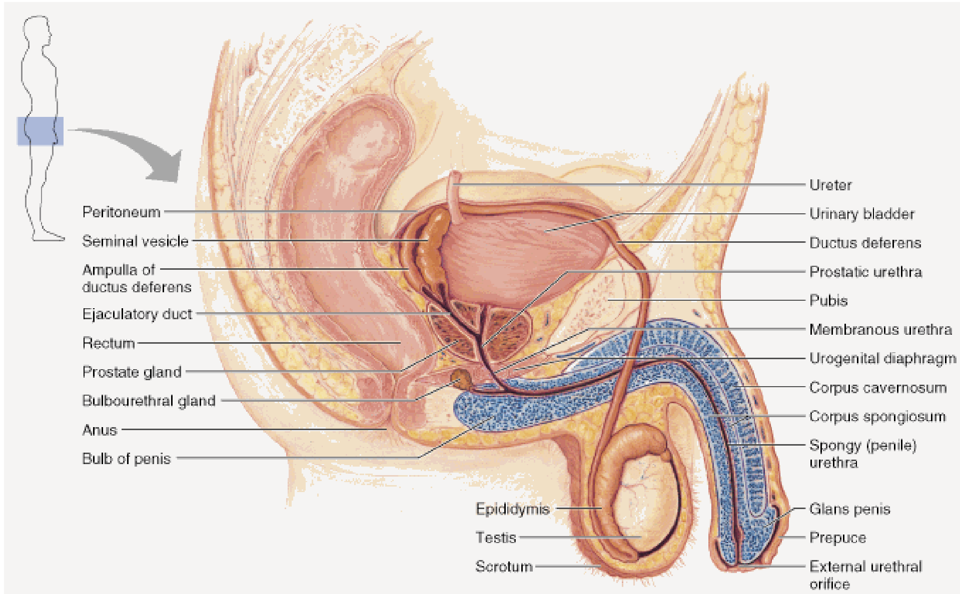
The submucous tissue consists of a vascular erectile layer; outside this is a layer of unstriped muscular fibers, arranged, in a circular direction, which separates the mucous membrane and submucous tissue from the tissue of the corpus cavernosum urethræ.

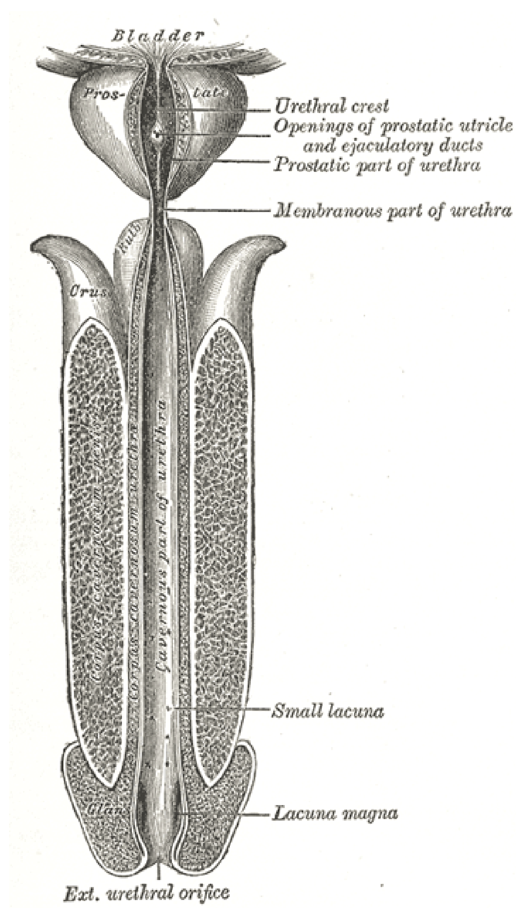
Blood supply of urethra

The superficial vascular supply to the penis comes from the external pudendal vessels, which arise from the femoral vessels. The external pudendal vessels give rise to the superficial dorsal penile vessels that run dorsolaterally and ventrolaterally along the penile shaft, providing a rich vascular supply to the dartos fascia and skin.

The deep penile structures receive their arterial supply from the common penile artery, which arises from the internal pudendal artery. The common penile artery gives off several branches that include the bulbourethral, cavernosal, and deep dorsal penile arteries. The corpus spongiosum receives a dual blood supply via anastomoses between dorsal and urethral artery branches in the glans.

The scrotum receives its vascular supply via branches from both the external and internal pudendal arteries


Peritoneum
Seminal vesicle
Ampulla of ductus deferens
Ejaculatory duct
Rectum
Prostate gland
Bulbourethral gland
Anus
Bulb of penis
Ureter
Urinary bladder
Ductus deferens
Prostatic urethra
Pubis
Membranous urethra
Urogenital diaphragm
Corpus cavernosum
Corpus spongiosum
Spongy (penile) urethra
Glans penis
Prepuce
External urethral orifice
Epididymis
Testis
Scrotum


Bladder
Urethral crest
Openings of prostatic utricle and ejaculatory ducts
Prostatic part of urethra
Membranous part of urethra
Crus
Small lacuna
Lacuna magna
Ext. urethral orifice

Pathology

Congenital Causes of urethral stricture in male

Urethral valves

In boys, folds in the posterior urethra may act as valves impairing urine flow. Urethral valves can cause urinary hesitancy and a weak urinary stream, UTI, overflow incontinence, myogenic bladder malfunction, vesicoureteral reflux, upper urinary tract damage, and renal insufficiency. They occasionally occur with a patent urachus.

Diagnosis is often made by routine prenatal ultrasonography; cases suspected postnatally are confirmed by voiding cystourethrography.

Surgery usually via endoscopy is done at time of diagnosis to prevent progressive renal deterioration.

Congenital urethral stricture

It may manifest similarly to urethral valves and be diagnosed by prenatal ultrasound, or postnatally by symptoms and signs of outlet obstruction or patent urachus and confirmed by retrograde urethrogram. Initial management is often with endoscopic urethrotomy, although open urethroplasty may be necessary.

Acquired causes

INFECTION mainly by Neisseria gonorrhoeae. The infection is usually acquired through sexual contact. It is the most common cause of urethral strictures. It is unclear if infections from chlamydia and ureaplasma cause strictures. Common urinary tract infections such as bacterial cystitis do not cause strictures.

The urethritis associated with either tuberculosis or Reiters syndrome may occasionally result in strictures, as may syphilitic and nonspecific urethritis, but these are less frequent causes

- external injuries, such as a straddle injury. This occurs when a hard object strikes the base of the perineum, such as on a bicycle.
- Pelvic fractures can also lead to strictures of the urethra.
- open or endoscopic surgery. Surgical procedures involving the urethra can result in stricture formation.
- Rarely, insertion of a urinary catheter can cause this problem.
- Passage of kidney stones through the urethra can be painful and subsequently can lead to urethral strictures
- In infants and toddlers, it can be as a result of inflammation following a circumcision and not noticeable until toilet training

when a deflected stream is observed or when the child must strain to produce a urinary stream.

Pathogenesis of stricture

Acquired Urethral strictures occur after an injury to the urothelium or corpus spongiosum which causes scar tissue to form.

Congenital stricture results from inadequate fusion of the anterior and posterior urethra, is short in length, and is not associated with an inflammatory process. This is an extremely rare cause.

Symptoms

Enuresis resistant to conservative therapy (in congenital)

Painful urination

Difficulty in urination

Slow urine stream

Unusually frequent urination

Urinary urgency

Incontinence

Blood in urine or semen

Discharge from the urethra

Penis swelling and

Pain in the pelvis or lower abdomen

Signs

Hydronephrotic Signs due to back pressure

Complications

Urinary retention

Urethral diverticulum

Periurethral abscess

Urethral fistula

Bilateral hydronephrosis

Urinary infections

Urinary calculus

Hernia, haemorrhoids or Rectal prolapse from straining

Site of stricture

Congenital

Short strictures in the bulbar urethra, particularly between the proximal 1/3 and distal 2/3 of the bulb, may be congenital. They probably form as a membrane at the junction between the posterior and anterior urethral segments.

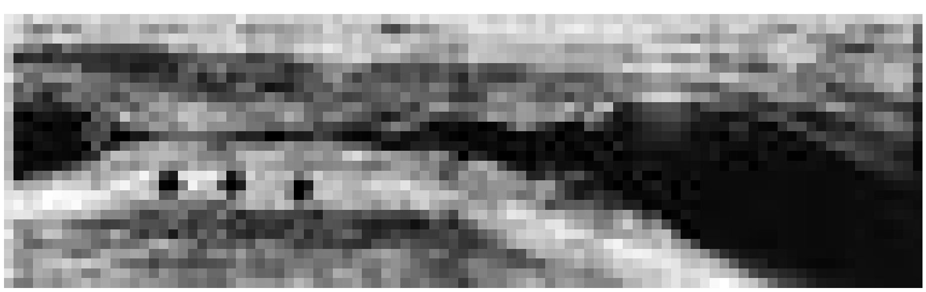
Acquired

The majority of ***inflammatory*** strictures occur in the bulb of the urethra because it is the most dependent part and it contains the greatest number of paraurethral glands. Inflammatory strictures frequently extend into the subjacent corpus spongiosum

Strictures caused by ***instrumentation*** often found at fulcrum sites and in the naturally narrowed segments of the urethra. These strictures may involve only the mucosa and submucosa.

Traumatic injury most frequently occurs at or near the membranous urethra, although the proximal bulbous urethra is often also involved. Straddle injuries most often affect the bulbar urethra, whereas direct blows may injure the pendulous urethra.

Traumatic strictures usually develop more quickly than inflammatory strictures, and are usually solitary.



Treatment

Treatment of urethral strictures is dictated by the characteristics (location, length, firmness) of the stricture and may include dilatation, internal and external urethrotomy, excision of the stricture with reanastomosis, marsupialization of the stricture with urethroplasty, pedicle flap repair and urethroplasty.

Imaging plays a major role in the diagnosis of urethral stricture. The study of choice is retrograde urethrogram The location, number and extent of the strictures are very well displayed. It has been recommended that a high-frequency ultrasound be used for evaluation of the stricture length. This has been especially advocated prior to surgical planning.

Treatment options

Medical therapy

Some patients opt to manage their stricture disease with periodic urethral dilations. The goal is to stretch the scar without producing additional scarring. It may be curative in patients with isolated epithelial strictures (no involvement of corpus spongiosum).

Surgical therapy

The options for urethral stricture include simple dilation, internal urethrotomy, stent placement, and a wide spectrum of reconstructive surgical techniques.

Internal urethrotomy – (Endoscopic Procedure)

Internal urethrotomy involves incising the stricture transurethrally using endoscopic equipment. The incision allows release of scar tissue. Success depends on the epithelialization process finishing before wound contraction significantly reduces the urethral lumen caliber. The incision is made under direct vision at the 12 o'clock position with a urethrotome. Care must be taken not to injure the corpora cavernosa because this could lead to erectile dysfunction.

Complications include recurrence of stricture, which is the most common complication, bleeding, extravasation of irrigation fluid into perispongial tissues, and increasing fibrotic response. The curative success rate is reported as 20-35%, with no increase in the success rate with a second internal urethrotomy procedure. Typically, an indwelling urethral catheter is left in place for 3-5 days to oppose wound contraction forces and allow epithelialization. Longer periods of catheterizations have not been shown to reduce failure rates. Self-catheterization after internal urethrotomy has been used to improve cure rates; however, strictures typically return once the patient stops.

Permanent urethral stents

Permanent urethral stents are endoscopically placed. Stents are designed to be incorporated into the wall of the urethra and provide a patent lumen. They are most successful in short-length strictures in the bulbous urethra. Complications occur when a stent is placed distal to the bulbous urethra, causing the patient pain while sitting or during intercourse. Other complications involve migration of the stent. This procedure is contraindicated in patients with dense strictures and in patients with prior substitution urethral reconstruction because it elicits hypertrophic reaction. It may be best reserved for patients who are medically unfit to undergo lengthy open urethral reconstruction procedures.

Open reconstruction

Primary repair

Primary repair involves complete excision of the fibrotic urethral segment with reanastomosis. The key technical points that must be followed include complete excision of the area of fibrosis, tension-free anastomosis, and widely patent anastomosis. Primary repair typically is used for stricture lengths of 1-2 cm. With extensive mobilization of the corpus spongiosum, strictures 3-4 cm in length can be repaired using this technique. The repair is left stented with a small silicone catheter in the urethra. The bladder is drained with a suprapubic catheter.

Repairs utilizing tissue transfer techniques

The urethra is exposed through a penile or perineal incision .The urethrotomy is made to open the area of the stricture. The tissue graft is harvested from the desired non–hair bearing location, bladder epithelium, or buccal mucosa. The graft is sutured to the edges of the urethrotomy. The graft is covered by the dartos fascia of the pendulous or bulbous urethra. Incisions are closed in 2 layers with an absorbable suture, and a Penrose drain is placed through a separate incision in the suprapubic or perineal areas.

- Full-thickness skin graft: Non–hair-bearing skin should be utilized. It is most successful in the bulbous urethra area.
- Split-thickness skin graft: The split-thickness skin graft is not preferred with single-stage repair because of the contraction characteristics of the graft. It typically is reserved for use in patients for whom multiple procedures have failed and in whom local skin is insufficient for further reconstruction. It is conducted as a 2-stage procedure. Periurethral area, and the skin is closed. The drain is removed on postoperative day 3. A 14F soft silicone

catheter is passed through the reconstructed urethra for stenting purposes. Urinary diversion is accomplished via suprapubic tube for 3 weeks.

- Buccal mucosal graft: The tissue is resistant to infection and trauma. The epithelium is thick, making it easy to handle. The lamina propria is thin and highly vascular, allowing efficient imbibition and inosculation. Harvesting is easier than other free grafts or pedicled flaps. A 15- to 20-mm graft is harvested from the oral mucosa. The graft is sutured to the edge of the urethra. A Penrose drain is left in the incision bed for 24 hours to allow drainage. A 16F urethral catheter is left for 7 days. Suprapubic urinary drainage is continued for 2 weeks. The suprapubic tube is removed in 2 weeks, after voiding cystourethrogram demonstrates no extravasation of urine. The graft may be placed as a ventral or dorsal onlay.

- Bladder mucosal graft: It is not as popular as other free tissue grafts because of difficulty in harvesting and handling the tissue.

Pedicled skin flaps

These procedures are based on the principal of mobilizing an island of epithelium-bearing tissue with a pedicle of fascia to provide its own blood supply. Penile skin represents an ideal tissue substitute because it is thin and mobile and has an excellent blood supply.

Skin island onlay flaps

Transverse, longitudinal, and circumferential island flaps refer to the type of skin incision made to fashion the tissue flap. Dorsal and ventral onlay refer to the position in which the flap is sutured to the edge of the incised urethra, as in the dorsal or ventral position with respect to the urethra and corpora cavernosa. Penile incision is carried out through the skin, dartos fascia, and down to the Buck fascia. A skin island flap is elevated on the penile dartos fascia, which serves as the vascular supply. A lateral urethrotomy is made along the course of the strictured area. The skin island flap then is transposed to the incised strictured area, oriented into proper position, and sutured to the edges of the urethrotomy incision with an absorbable monofilament suture. A watertight subepithelial suture line should complete the flap placement. The skin is closed with interrupted sutures.

Hairless scrotal island flap

A non–hair bearing area of skin in the midline of the scrotum is used. The tunica dartos of the scrotum is used as the vascular pedicle. This procedure typically is used in complex urethroplasty procedures and is combined with penile skin island flaps to provide additional vascularized tissue for reconstruction.

Skin island tubularized flap

It can be used in combination with onlay flap when a large obliterated segment of urethra is present. It involves tubularizing the pedicled skin flap over a sound and anastomosing the tubularized edge to the native urethral stump.

IMAGING OF THE URETHRA

We have only a handful of investigations to evaluate a patient with urethral stricture .

The renal functional status of the patient is to be determined before subjecting to contrast studies.

ASCENDING URETHROGRAM[(21)]

The technique was introduced by Cunningham in 1910[(6)], is no doubt a simple and readily available investigation. It rules over centuries in evaluation of urethral pathologies. Fluoroscopy unit is a must.

There is no need for patient preparation except for local area cleanliness 20 ml of 76% water-soluble contrast either HOCM/LOCM. is used. Pre warming of the contrast will help reduce spasm . Coned supine

PA of bladderbase and urethra is taken. Using aseptic technique, penile clamp is applied or the tip of catheter is inserted so that the balloon lies in fossa navicularis and its balloon is inflated with 1-2ml of water. Contrast medium is injected under fluoroscopic control and films are taken in the following positions.

a. 30°LAO, with right leg abducted and knee flexed
b. supine PA
c. 30°RAO with left leg abducted and knee flexed

Image analysis

Entire length of urethra is assessed for any narrowing or abnormal fistulous communications.

Length of the total stricture length is measured including the tapered segments on either side of the segment.

Limitations of study

Bulbar stricture length is under estimated by this modality. Posterior stricture length is over estimated by this modality It also contributes to 0.6% to 1.6% of all hospital acquired infections. There is risk of contrast related allergic reaction and Radiation Exposure which is of 5-9 msv, equivalent to 2.5 years of background radiation and 230 chest Xrays.[22] It does not give information about the extent of periurethral fibrosis.Intravasation of contrast medium sometimes occurs ,especially if excessive pressure is used to overcome a stricture.

OPPOSING URETHROGRAPHY[23]

In cases of posterior urethral distraction defect (PUDD), RUG is combined with a cystourethrography to measure the defect.

300-400 ml of iodinated contrast mixed with normal saline was instilled into the bladder through the suprapubic cystotomy catheter. Images were obtained with the patient in oblique position during maximum urethral distension.

SONOURETHROGRAPHY

Sonourethrography was first popularized by McAninch in 1985[24]. Resolution is further refined in the current era with improved technology. Sonourethrography is presently done with standard small parts 7.5 MHz linear array transducer. Normal Saline is slowly instilled into the urethra by a catheter tip syringe, while at the same time real time ultrasound imaging is sequentially performed from penile to deep bulbar urethral region. Stricture imaging is possible with sonourethrography even in completely disrupted urethra or severe fibrosis of urethral lumen. This procedure is well tolerated and its accuracy has been confirmed by many investigators

Limitations

It showes a small field of vision and difficulty in demonstrating urethral lumen.It is more operator dependent.

COMPUTED TOMOGRAPHY[25]

CT is the preliminary investigation as the patient lands after pelvic trauma which is the major contributor for urethral stricture. MDCT is new state of art for radiologists to aid surgeons in acute trauma.

CT voiding urethrography is a technique similar to conventional VCUG. Its protocol involves 0.75 mm collimation and reveals urethra in 6 seconds. And subsequent better quality of reformatted images has lead to what is named as virtual urethroscopy.[26] The micturating condition of patients was checked before examination

MR URETHROGRAPHY

T2-weighted techniques were the first clinically relevant means of visualizing the urinary tract with MR imaging. Static-fluid MR treats the urinary tract as a static column of fluid, using one of a variety of T2-weighted sequences that exploit the long T2 relaxation time of urine.Therefore, static-fluid MR techniques closely resemble those used for T2-weighted MR Cholangiopancreatography.

Conventional **MR** imaging cannot, however, demonstrate the patency of the urethral lumen and the distal end of the urethral defect. Sterile lubricating jelly instilled retrogradely into the distal portion of the urethra through the external urethral meatus would allow **MR** depiction of the distal end of a urethral stricture.

The MR technique includes injection of sterile gel into the urethra, then application of a soft clamp to the penile tip to keep the urethra distended. Bladder is filled with 150-300 ml of NS through suprapubic cystostomy

Then, sagittal high-resolution T2 imaging of the penis and urinary bladder was performed. The reformatted images at different axial, coronal, and sagittal oblique planes were obtained to delineate the entire length of the urethra, characterize the surrounding soft tissue with depth and density of periurethral fibrosis, and define stricture length.coronal and sagittal images were particularly useful [27,28]

MATERIALS & METHODS

Twenty male patients along with three controls ,in the age group of 25 to 45 years , who presented to the radiology department with symptoms of urinary retention and in whom retrograde urethrography combined with cystourethrography had been performed ,were taken up for study.

The study was performed on a **1.5 tesla siemens, Magnetom** symphony MRI scanner available at our institute.

HASTE sequence was obtained in each, employing a torso phased array, as described below.

PERIOD OF STUDY

From August 2007 to November 2008

PATIENT SELECTION: INCLUSION CRITERIA:

Patients with posterior stricture urethra were investigated retrograde urethrography combined with cystourethrography

After a time interval of 4-10 days, these patients were subjected to MR URETHROGRAPHY.

EXCLUSION CRITERIA

Patients were subjected to scanning after excluding the following conditions.

Cardiac pacemaker, Implanted cardiac defibrillator.

Cochlear Implants

Claustrophobia

Anterior urethral stricture

PATIENT PREPARATION

No specific preparation.

PATIENT POSITION

Head first and supine

SEQUENCES EMPLOYED

Single Slice Rapid Acquisition with relaxation enhancement

Scan time

FOV read	:	300 mm
FOV phase	:	100
Slice Thickness	:	80 mm
TR	:	2800ms

TE	:	1080ms
Averages	:	1
Flip Angle	:	150
Turbo Factor	:	256

HASTE SEQUENCE

Slices	:	15
FOV Read	:	300 mm
FOV phase	:	100
Slice Thickness	:	2 mm
TR	:	4000-6000 ms
TE	:	80-120ms
Averages	:	1
Flip angle	:	150
Turbo Factor	:	218
Echo Spacing	:	8 ms.

Procedure

Patient is placed in Torso phased array coil.

Sterile lignocaine gel is injected into the urethra.

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

Bladder is filled with 150-300 ml of NS through suprapubic cystostomy

High resolution sagittal T2 imaging of penis and bladder was performed. Coronal, axial imaging were also obtained.

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

Patient was asked to strain and images were again obtained by opening the bladder neck.

Image analysis

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

Stricture length on **conventional RGU or RGU combined with VCUG** images was determined by measuring the distance between the proximal end of the distal urethra and the distal end of the open proximal urethra

MRURETHROGRAPHY was accurate in demonstrating the stricture length and displacement of the prostate apex[29,30] **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.

For an anterior urethral stricture, stricture length was measured along the long axis of the fibrotic segment shown as low signal intensity on the sagittal T2-weighted image.

For a posterior distraction defect, stricture length was determined to be the distance between the proximal limit of the distended distal urethra and the prostatic apex on the sagittal T2-weighted image.

Regarding **Length of stricture –**Strictures with length <1.5cm were defined as “short strictures,” whereas >1.5cm long were defined as “long strictures”

Extent of periurethral fibrosis was assessed by characterizing the surrounding depth and density of periurethral tissue.

Assessment of Prostatic apex displacement - Superior - inferior displacement if the distance between prostatic apex &inferior pubic ramis > 1 cm;

Antero-posterior displacement if the distance between prostatic apex & urethral insertion in the roof of penile bulb;

Lateral displacement -distance between prostatic apex bulbous urethra on coronal image.

Ascending urethrography

Site of stricture

Length of stricture

Extravasation of contrast

Opposing urethrography

Site of stricture

Length of stricture

Extravasation of contrast

Bladder neck opened / not

Filling of prostatic urethra

MR urethrography

Site of stricture

Length of stricture

Periurethral fibrosis

Prostatic apex displacement

Extravasation of sterile gel injected

Surgical findings

Site of stricture

Length of stricture

Periurethral fibrosis

Prostatic apex displacement

Type of surgery / Endoscopy / Urethroplasty

Flap procedure done / not

RESULTS AND ANALYSIS

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
RUG Combined with Cystourethrogram	2.270	1.2917	20
MRU	1.590	.6398	20
Surgical Length	1.450	.7193	20

Correlations

		RUG Combined with Cystourethrogram	MRU	Surgical Length
RUG Combined with Cystourethrogram	Pearson Correlation	1	.373	.268
	Sig. (2-tailed)		.105	.253
	N	20	20	20
MRU	Pearson Correlation	.373	1	.947**
	Sig. (2-tailed)	.105		.000
	N	20	20	20
Surgical Length	Pearson Correlation	.268	.947**	1
	Sig. (2-tailed)	.253	.000	
	N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Nonparametric Correlations

Correlations

			RUG Combined with Cystourethrogram	MRU	Surgical Length
Kendall's tau_b	RUG Combined with Cystourethrogram	Correlation Coefficient	1.000	.378*	.387*
		Sig. (2-tailed)	.	.024	.023
		N	20	20	20
	MRU	Correlation Coefficient	.378*	1.000	.830**
		Sig. (2-tailed)	.024	.	.000
		N	20	20	20
	Surgical Length	Correlation Coefficient	.387*	.830**	1.000
		Sig. (2-tailed)	.023	.000	.
		N	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Frequencies

Frequency Table

RUG Combined with Cystourethrogram

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Short stricture	8	40.0	40.0	40.0
	Long Stricture	12	60.0	60.0	100.0
	Total	20	100.0	100.0	

MRU

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Short stricture	11	55.0	55.0	55.0
	Long Stricture	9	45.0	45.0	100.0
	Total	20	100.0	100.0	

Surgical Length

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EIU	13	65.0	65.0	65.0
	Urethroplasty	7	35.0	35.0	100.0
	Total	20	100.0	100.0	

Crosstabs

RUG Combined with Cystourethrogram * Surgical Length

Crosstab

			Surgical Length		Total
			EIU	Urethroplasty	
RUG Combined with Cystourethrogram	Short stricture	Count	7	1	8
		% of Total	35.0%	5.0%	40.0%
	Long Stricture	Count	6	6	12
		% of Total	30.0%	30.0%	60.0%
Total		Count	13	7	20
		% of Total	65.0%	35.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.967[b]	1	.085		
Continuity Correction[a]	1.548	1	.213		
Likelihood Ratio	3.234	1	.072		
Fisher's Exact Test				.158	.106
Linear-by-Linear Association	2.819	1	.093		
N of Valid Cases	20				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2. 80.

MRU * Surgical Length

Crosstab

			Surgical Length		Total
			EIU	Urethroplasty	
MRU	Short stricture	Count	11	0	11
		% of Total	55.0%	.0%	55.0%
	Long Stricture	Count	2	7	9
		% of Total	10.0%	35.0%	45.0%
Total		Count	13	7	20
		% of Total	65.0%	35.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13.162[b]	1	.000		
Continuity Correction[a]	9.966	1	.002		
Likelihood Ratio	16.363	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	12.504	1	.000		
N of Valid Cases	20				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3. 15.

ROC Curve

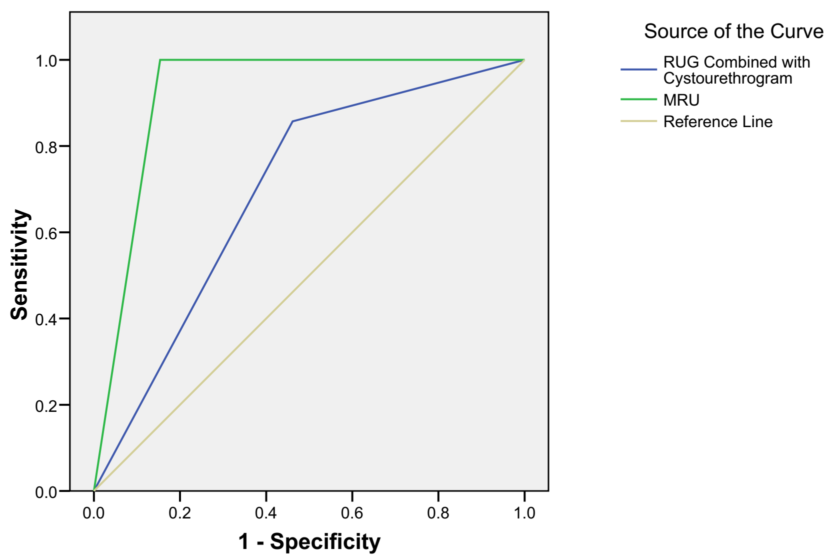
Case Processing Summary

Surgical Length	Valid N (listwise)
Positive[a]	7
Negative	13

Larger values of the test result variable(s) indicate stronger evidence for a positive actual state.

a. The positive actual state is Urethroplasty.

ROC Curve

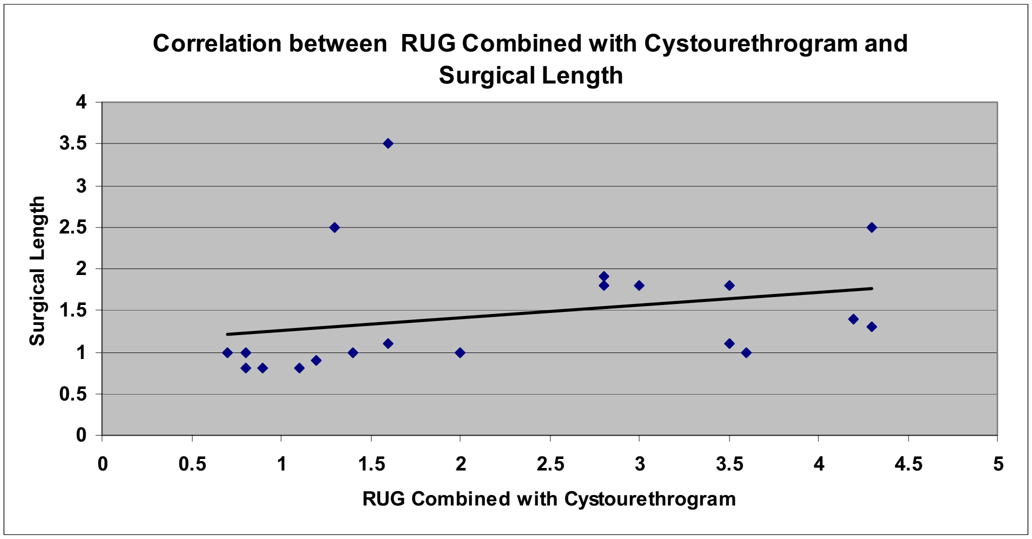


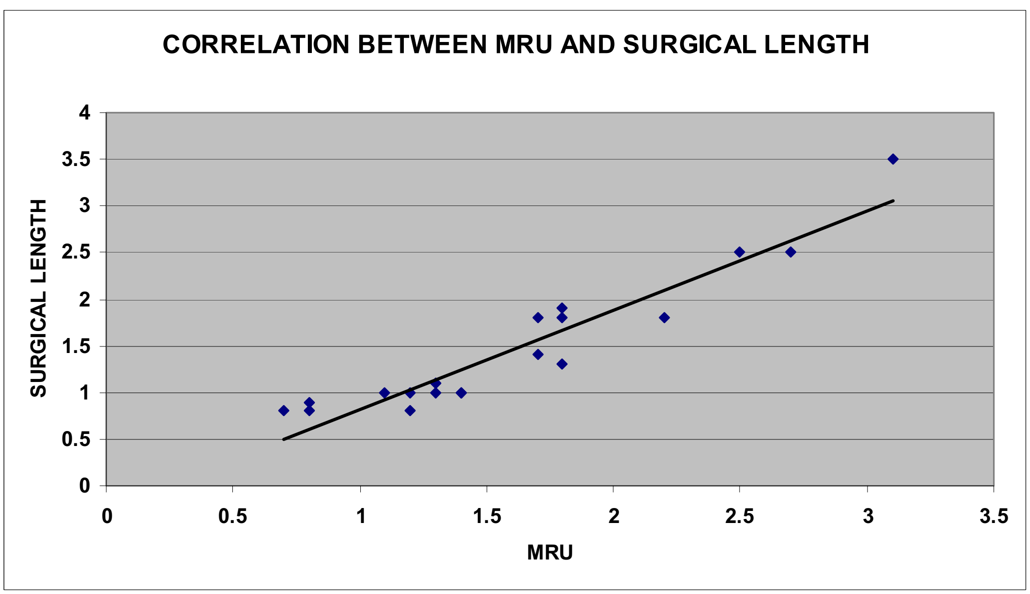
Diagonal segments are produced by ties.

Area Under the Curve

Test Result Variable(s)	Area
RUG Combined with Cystourethrogram	.698
MRU	.923

The test result variable(s): RUG Combined with Cystourethrogram, MRU has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.


Correlation between RUG Combined with Cystourethrogram and Surgical Length
Surgical Length
0
0.5
1
1.5
2
2.5
3
3.5
4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
RUG Combined with Cystourethrogram


CORRELATION BETWEEN MRU AND SURGICAL LENGTH
SURGICAL LENGTH
0
0.5
1
1.5
2
2.5
3
3.5
4
0
0.5
1
1.5
2
2.5
3
3.5
MRU

DISCUSSION

Strictures with length <1.5cm were defined as **"short strictures**," involving epithelium or superficial spongiosum whereas >1.5cm long were defined as **"long strictures"** involving full thickness**.**

There are many options for repair of obliterative urethral strictures; the option chosen depends on several factors, the most important being **stricture length.**

Endoscopic treatment can be useful for a thin septumlike stricture (0.5–1.5 cm)[31] . A long urethral stricture (<2.5 cm) is generally manageable with primary anastomotic urethroplasty [32,33]. A complex technique that involves a graft or flap is usually performed in patients with a long urethral stricture (>2.5 cm) [34].

Primary anastomotic urethroplasty is performed mainly with the perineal route. The transpubic approach is reserved for longer strictures and complex associations, such as perineal or rectourethral fistulas, periurethral cavities, or an open bladder neck[35]. The other factors that determine the choice of repair include the stricture cause, the extent of fibrosis of the corpora spongiosa, prior treatment, and the surgeon's preference. Therefore, a careful evaluation of the obliterative urethral stricture is important in the preoperative decision-making process.

Conventional RGU combined with VCUG is the method traditionally used for the planning of a urethral reconstruction. This technique, however, often cannot provide an accurate determination of the defect length because of the poor prostatic urethral filling, and it provides little information on the extent of fibrosis of the corpora spongiosa or the prostatic displacement. Stricture length may be grossly overestimated if the bladder neck does not relax [(36)]. Both the proximal and distal extents of the stricture can be demonstrated if the patient can open the bladder neck. It is rarely possible, however, to demonstrate the proximal limit of the stricture because patients often have a diminished bladder capacity after months of suprapubic diversion and are unable to tolerate bladder distention sufficient to open the bladder neck voluntarily [(37)]**.** A failure to demonstrate the prostatic urethra does not necessarily indicate a bladder neck obstruction or a stricture all the way up to the bladder neck[(38)]. To help identify the proximal limit of the stricture, a curved metal sound could be advanced through the suprapubic cystostomy track to accommodate an indwelling suprapubic catheter into the bladder and down through the bladder neck. The advancement of a metal sound through the bladder neck, however, can cause severe pain and hematuria from bladder neck injury. Stricture length can be underestimated if the patient is not placed in a steep oblique position for RGU[(39)]. An underestimation of stricture length, as shown on the conventional RGU combined with VCUG image, can also occur as a result of a urinoma cavity that overlaps or is continuous with the prostatic urethra[40]. The cavity then may be mistaken for the proximal urethral segment and be incorrectly anastomosed to the bulbar urethra

In our study of 20 patients , HASTE SEQUENCE was very useful to image urethra.In posterior distraction defect,conventional methods failed to delineate proximal urethra in 8 0f our cases.,whereas MRU clearly delineated it.Associated findings like Urethrocutaneous fistula in 2 cases was well imaged in MRU. Conventional methods has showed us overestimation as well as under estimation.

Short Strictures <1.5cm measued in MRU correlated well with conventional methods. Long Strictures >1.5cm measured in MRU were overestimated by conventional methods.This piece of information to the surgeons has made them to choose the route of surgery whether to approach via perineal route or transpubic .MRU matched with operative findings in almost all our cases .

Spongiofibrosis is a critical determinant of appropriate surgical method. Urethroplasty was provided for these patients.this concept was not popularized as conventional methods was unable to assess the extent beyond mucosal surface.

CONCLUSION

Retrograde urethrography and RUG combined with cystourethrography is a well established technique in delineating urethral strictures both anterior and posterior. These modalities although readily available and cost effective ,do not adequately show the accurate length ,extent of intervening stricture and periurethral fibrosis . Furthermore, if the bladder neck does not relax, stricture length can be **grossly overestimated**. These studies also requires adequate degree of renal function for contrast excretion,the need for administration of potentially risk contrast media,the relatively significant amount of radiationexposure especially in younger patients.

MRUrethrography can be a valuable means of imaging patients with strictures.T2 weighted sequences are excellent for demonstrating urethra as well as rest of urinary system. **MR** imaging is particularly helpful in the surgical planning of posterior urethroplasty for prostatomembranous disruption injury from pelvic fracture.. **MR** imaging can accurately show the displacement of the prostatic apex and thus stricture length, as well as help explain posttraumatic impotence by documenting cavernosal avulsion from the ischium. The degree of distraction determines the surgical plan, such as the need for corporal cavernosal body separation, inferior pubectomy, or urethral rerouting under the crus. A combined transpubic and retropubic approach is rarely, if ever, needed today. Typically, it is reserved for the most severe defects, usually greater than 6 cm with extensive superolateral displacement, or orthopedic deformities that preclude perineal access.

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 current study, it is evident that **MRUrethrography depicts** stricture length, periurethral fibrosis , displacement of the prostatic apex and also associated pathologies with accuracy ,thereby assisting the surgeons to choose the optimal procedure for the patients with obliteratve urethral stricture.

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GLOSSARY

MRU	–	MR URETHROGRAPHY
RARE	–	RAPID ACQUISITION WITH RELAXATION ENHANCEMENT
HASTE	–	HALF FOURIER ACQUISITION OF SINGLE SHOT TURBO SPIN ECHO
FLAIR	–	FLUID ATTENUATION INVERSION RECOVERYSEQUENCE
IVU	–	INTRAVENOUS UROGRAPHY
USG	–	ULTRASONOGRAPHY
AUG	–	ASCENDING URETHROGRAPHY
RUG	–	RETROGRADE URETHROGRAPHY
CT	–	COMPUTED TOMOGRAPHY

PROFORMA

TITLE OF STUDY

CLINICAL RELEVANCE OF MR URTHEROGRAPHY IN POSTERIOR URETHRAL STRICTURE AND COMPARISON WITH RETROGRADE URTHEROGRAPHY

AIM OF STUDY

1. To prospectively evaluate the clinical relevance of MR urethrography in depiction of **OBLITERATIVE POSTERIOR URETHRAL STRICTURE**

2. To compare with retrograde urethrography combined with cystourethrography

TYPE OF STUDY

Prospective study

SOURCE OF PATIENTS

Patient with symptoms of urethral stricture were referred from department of Urology,Madras medical college,Government medical college,Chennai

TARGET POPULATION

Male patients between 25 and 45 years

INCLUSION CRITERIA

Patients with symptoms of urinary retention .included were those having posterior stricture only.

Exclusion Criteria

Patients with anterior stricture

IVU

Known allergy to iodinated contrast media

Renal failure

Dehydration

Diabetic Nephropathy

Multiple Myeloma

MRU

Cardiac pacemakers

cochlear Implants / Prostheses

Methodology

Patients referred from urology department were evaluated with aug/opposing urethrography as the case may be using non ionic contrast iohexol.they underwent MRU employing a phased array surface coil on a 1.5 T Siemens ‘Magnetom’ unit and the following parameters were evaluated.

Clinical Information

H/o trauma /iatrogenic trauma

H/O infection

Duration of symptoms

Time interval between trauma & development of symptoms

Symptoms of urinary tract obstruction

Serum Urea, Creatinine

Ascending urethrography

Site of stricture

Length of stricture

Extravasation of contrast

Opposing urethrography

Site of stricture

Length of stricture

Extravasation of contrast

MR urethrography

Site of stricture

Length of stricture

Periurethral fibrosis

Prostatic apex displacement

Extravasation of sterile gel injected

Surgical findings

Site of stricture

Length of stricture

Periurethral fibrosis

Prostatic apex displacement

Method of Analysis

The findings from **Ascending urethrography combined with cystourethrography** and magnetic resonance **urethrography** were correlated individually with the surgical findings. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of **Ascending urethrography combined with cystourethrography** and magnetic resonance **urethrography** were individually determined and compared**.**

MRURETHROGRAM DATE:

NAME:

AGE/SEX:

PRESENT HISTORY:

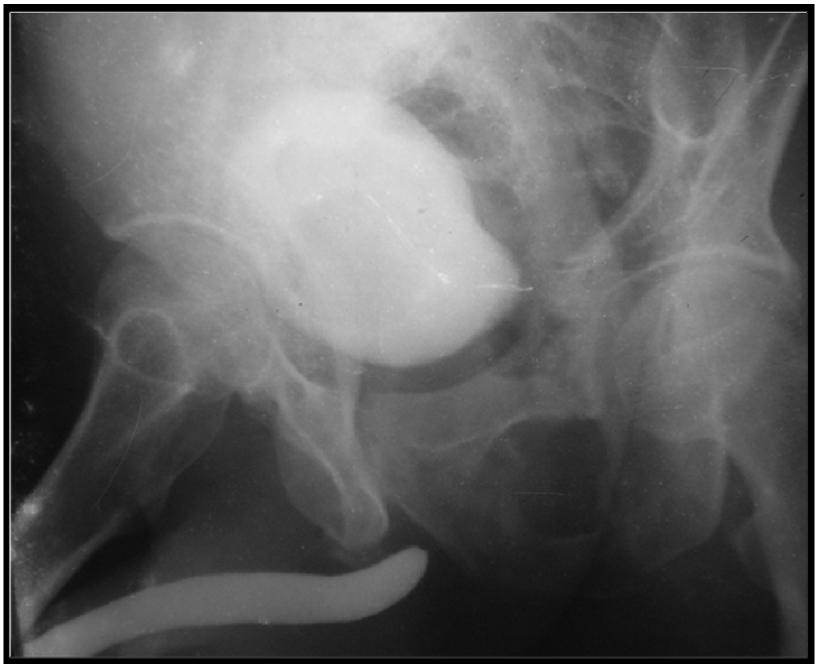
PAST HISTORY:

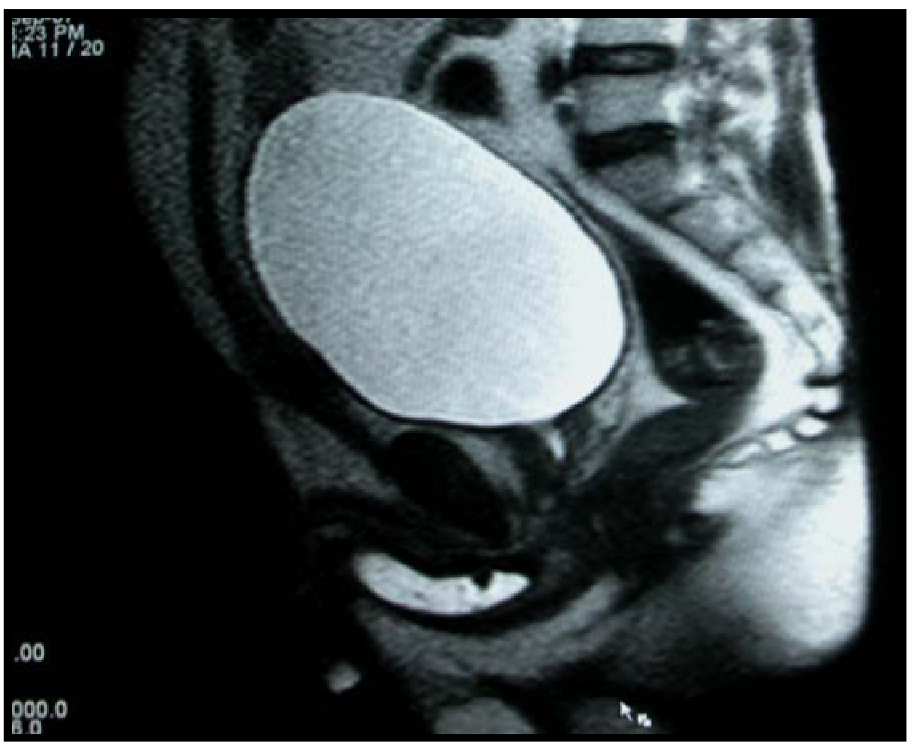
TRAUMA-time interval-nature

INVESTIGATIONS	AUG	OPP.UG	MRI
ANTERIOR – PENILE BULBAR			
POSTERIOR - MEMBRANOUS PROSTATE			
LENGTH(CM)			
PROSTIC APEX DISPLACEMENT(CM)			
ASSOCIATED FINDINGS			

SURGERY: APPROACH / FINDINGS —

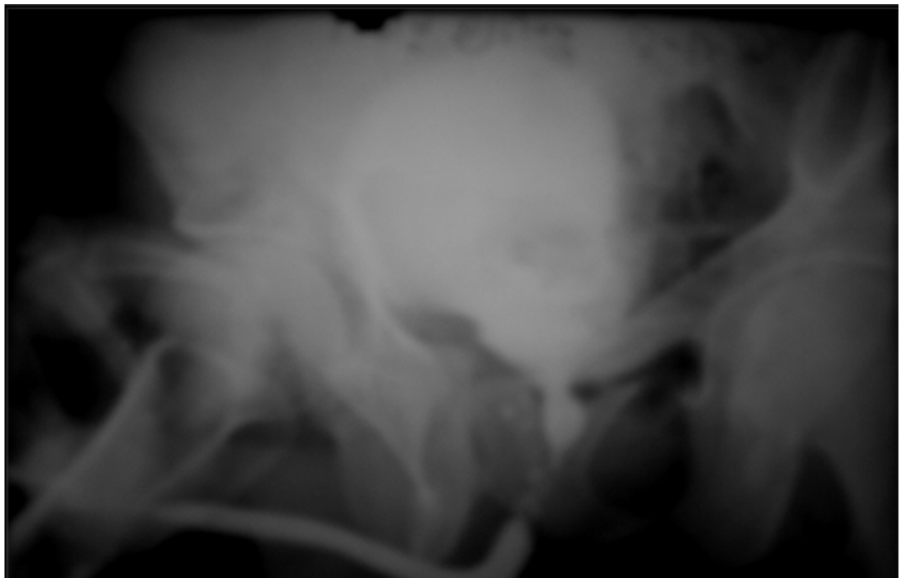
CASE 1





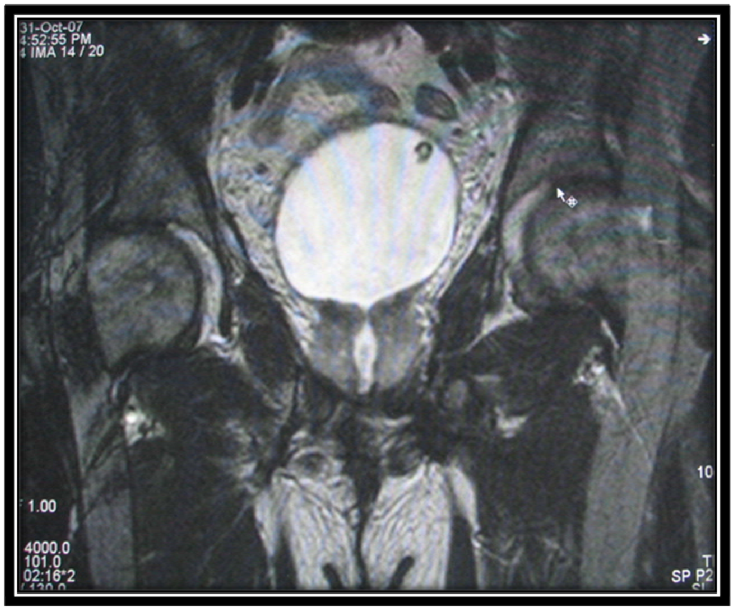
Absence of visualization of prostatic urethra in opposing urethrogram
Well delineated prostatic urethra in MRU

CASE 2



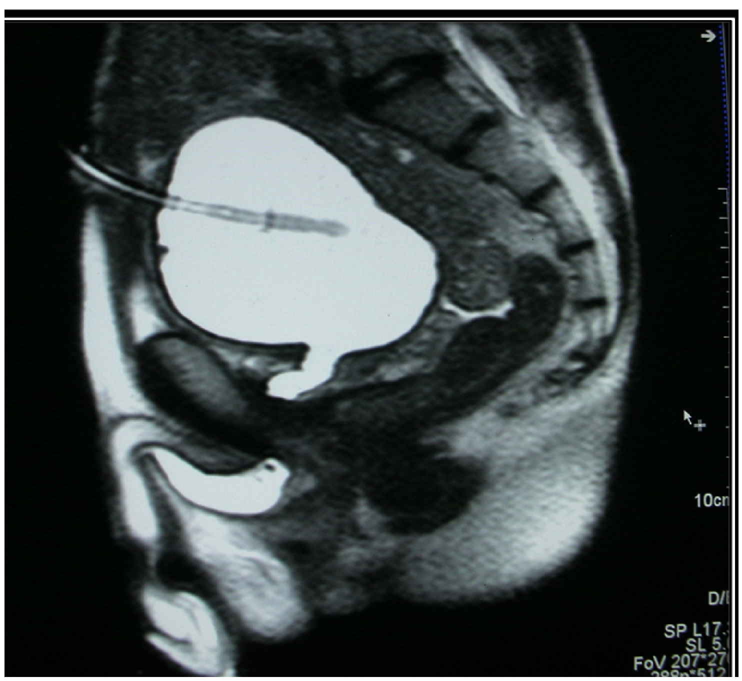
Short stricture in opposing urethrogram
Short stricture with urethral axis deviation in MRU

CASE 3



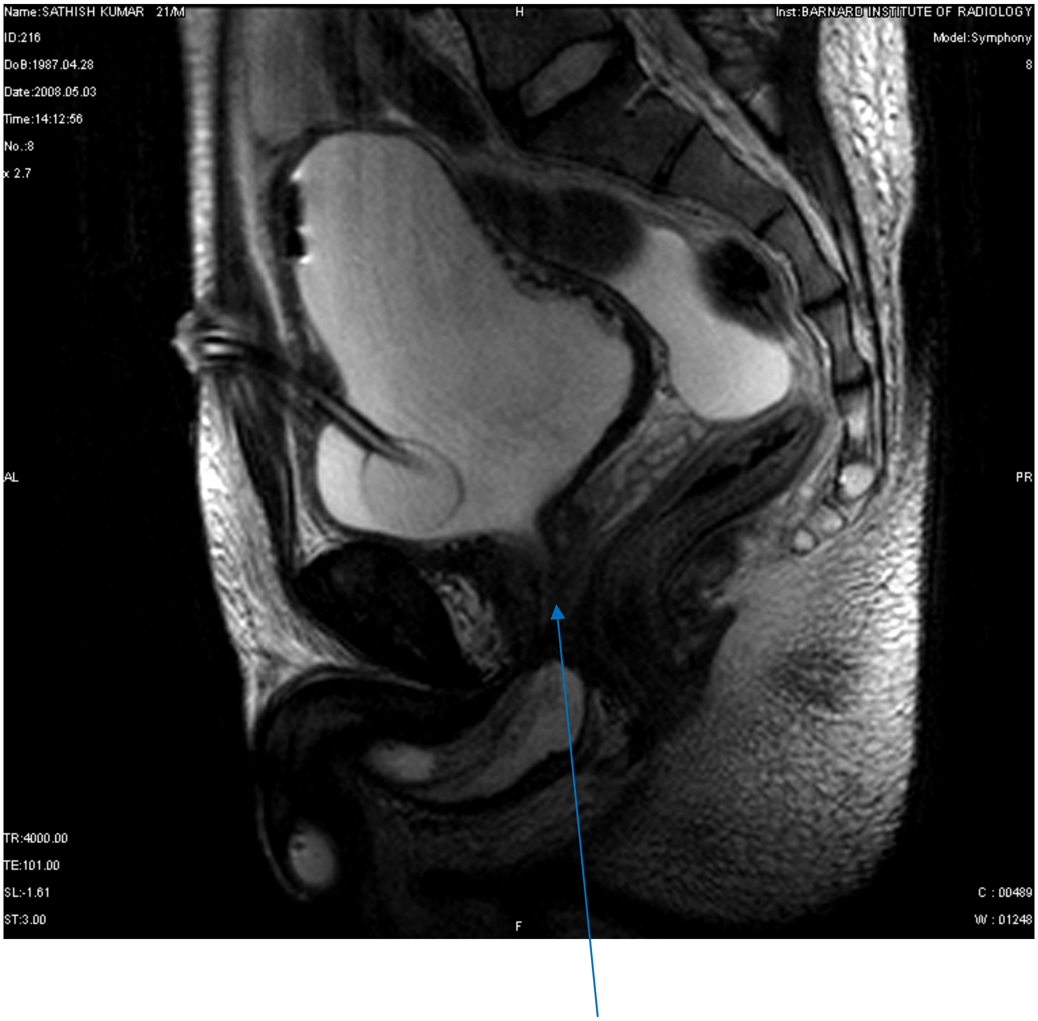
well delineated prostatic urethra

CASE 4



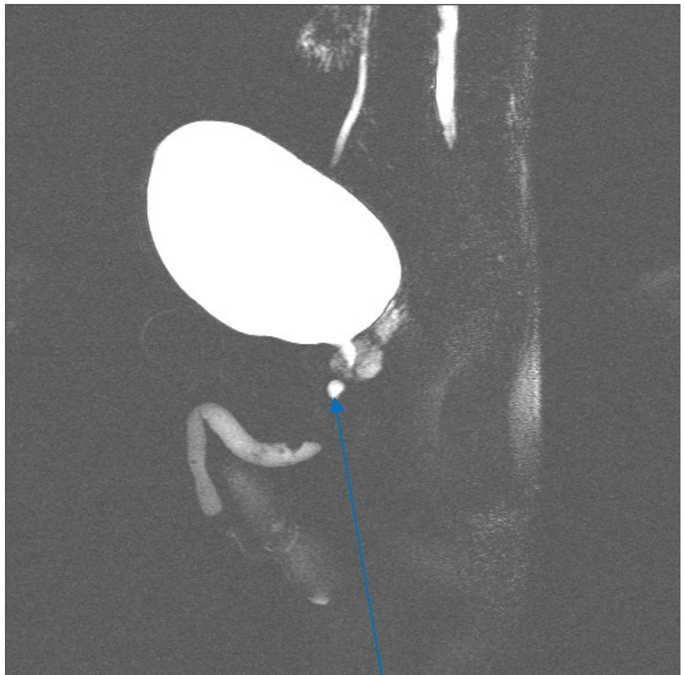
anterioposteriorly displacedurethra

CASE 5



Periurethral fibrosis

CASE 6



Urethral diverticulum

CASE 7

Urethrocutaneous fistula

p	Name	Age	History	RUG combined with cystourethrogram		MRU		Associated findings in MRU	Surgical length	Surgical procedure
				Length	Findings	Length	Findings			
1.	SRINIVASAN	29	RTA with pelvic #	0.8	Short stricture	0.7	Short stricture		0.8	EIU
2.	PONNUSWAMY	27	Straddle injury	1.4	Short stricture	1.4	Short stricture		1	EIU
3.	MANI	30	Straddle injury	1.6	Short stricture	1.3	Short stricture		1.1	EIU
4.	SARANGABANI	39	RTA with pelvic #	4.3	Long stricture	2.7	Long stricture	Well delineated proximal urethra	2.5	Urethroplasty
5.	BHARATHKUMAR	21	Straddle injury	3.5	Long stricture	1.7	Long stricture	Urethrocutaneous fistula	1.8	Urethroplasty
6.	MUNUSAMY	26	Straddle injury	3	Long stricture	1.8	Long stricture		1.8	Urethroplasty
7.	RAMASWAMY	34	Straddle injury	1.2	Short stricture	0.8	Short stricture		0.9	EIU
8.	SHANMUGAM	26	RTA with pelvic #	1.1	Short stricture	1.2	Short stricture	Short stricture with severe spongiofibrosis	0.8	Urethroplasty
9.	SATHISH	42	RTA with pelvic#	0.9	Short stricture	0.8	Short stricture		0.8	EIU
10.	DHANDIAPPAN	31	RTA with pelvic #	2.8	Long stricture	1.8	Long stricture	Urethrocutaneous fistula	1.9	Urethroplasty
11.	VISWANATHAN	35	Control							
12.	CHELLAIYAN	39	Straddle injury	0.7	Short stricture	1.2	Short stricture		1	EIU
13.	VENKATESAN	42	Straddle injury	2	Long stricture	1.4	Short stricture		1	EIU
14.	SELVARAJ	30	Straddle injury	1.6	Long stricture	3.1	Long stricture	Well delineated proximal urethra	3.5	Urethroplasty
15.	RAMKUMAR	29	Straddle injury	0.8	Short stricture	1.3	Short stricture		1	EIU
16.	SARAVANAN	32	control							
17.	BALU	26	RTA with pelvic #	3.6	Long stricture	1.1	Short stricture	Well delineated proximal urethra	1	EIU
18.	DINAKAR	27	RTA with pelvic #	1.3	Short stricture	2.5	Long stricture	Well delineated proximal urethra	2.5	Urethroplasty
19.	KRISHNA	24	Control							
20.	MURUGAN	28	RTA with pelvic #	3.5	Long stricture	1.3	Short stricture		1.1	EIU
21.	CHANDRASEKAR	32	RTA with pelvic #	4.3	Long stricture	1.8	Long stricture	Well delineated proximal urethra	1.3	EIU
22.	RAMANATHAN	37	Straddle injury	4.2	Long stricture	1.7	Long stricture	Well delineated proximal urethra	1.4	EIU
23.	KANDASAMY	33	Straddle injury	2.8	Long stricture	2.2	Long stricture		1.8	Urethroplasty