

# Magnetic Resonance Imaging (MRI) in Pelvic Fracture Urethral Injuries to Evaluate Urethral Gap: A Protocol Based Study

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**Citation:** Joshi PM, Desai DJ, Joshi D, Shah D, Atre A, et al. (2017) Magnetic Resonance Imaging (MRI) in Pelvic Fracture Urethral Injuries to Evaluate Urethral Gap: A Protocol Based Study. J Urol Ren Dis: JURD-133. DOI: 10.29011/2575-7903.000033

**Received Date:** 03 May, 2017; **Accepted Date:** 03 July, 2017; **Published Date:** 10 July, 2017

## Abstract

**Introduction and Objectives:** MRI is indicated in complex cases of PFUI (Pelvic fracture urethral injuries), which includes patients with long gaps, floating bone chips, rectourethral fistula and bladder neck injury. Urethral gap is assessed using traditional Voiding Cystourethrogram (VCUG) and Retrograde Urethrogram (RGU) studies. We aim to evaluate the urethral gap on MRI using a protocol based study.

**Methods:** Our institute is a tertiary referral center for PFUI cases. More than 1032 cases of PFUI have been operated in last 20 years. A protocol based MRI study was undertaken in consenting patients with PFUI over 6 months from January to July 2016. We prospectively evaluated 10 complex cases of pelvic fracture urethral injuries with our technique of MRI. A traditional RGU and VCUG was initially performed and urethral gap was measured. Subsequently an 3T MRI was performed. Radiologists tend to acquire images in a set protocol. We formulated a technique where the images could be more helpful, without giving IV contrast and using urine as a natural MRI contrast. Initially a T2 image acquisition was performed. Urethral gap measurements by 4 radiologists were recorded for each case. Subsequently a T2 image acquisition was performed with patient lying on the table with a full bladder, SPC clamped, straining to pass urine post administration of Tamsulosin 400 mcg while at the same time a premixed solution of sterile saline and lubricating jelly is instilled in the urethra. The bladder was filled physiologically with patient drinking water prior to the study. Urethral gap assessments were repeated using the same 4 radiologists and results recorded. 4 urologists were also shown images from each study for individual study and their visual score was recorded - very satisfactory (4), satisfactory (3), disappointed (2) and extremely disappointed (1).

**Results:** We included 10 patients with PFUI in our study. These patients were referred to us between 3-6 months of initial trauma. After initial traditional RGU and VCUG, all patients underwent MRI pelvis, using a standard protocol and our refined protocol. After acquisition of images these were shown to four radiologists and four urologists. The urethral gap assessment was noted and plotted for each patient. These patients then went on to have their pelvic fracture urethral injury repaired and the type of surgical approach was noted for each case. We noted that there was a difference of 0.3 to 1.1 cm in the urethral gap measurement between MRI performed using the standard versus our refined technique. This measurement on MRI, using our protocol, closely correlated to the gap measurement on RGU and VCUG performed on these patients. Urologist's satisfaction scores were noted as very satisfactory.

**Conclusion:** Our technique of MR assessment of urethral gap in pelvic fracture urethral injuries shows promising results and reflects a true reflection of the actual urethral gap which helps in planning surgical approach. The simple modification of having a full bladder, use of selective alpha blocker and straining (dynamic images) helps to mimic a conventional MCU RGU along with advantages of MRI. Urologists can easily interpret the acquired images.

## Introduction

Pelvic Fracture Urethral Injuries (PFUI) occur in 5-25% cases of pelvic fractures [1,2]. Motor vehicle collisions are the commonest cause for pelvic fractures. The incidence of urethral strictures as a result of motor vehicles varies between 36% in India to 15% in Italy and USA [3]. Pelvic fracture results in urethral injury at the membranobulbar junction [4-6]. As a resultant disruption of the ligamentous attachments of the urethra and injury to the periprostatic venous plexus a hematoma ensues which displaces the prostate cephalad and posterior [7]. In PFUI there is no loss of urethral tissue [8].

The assessment of urethral gap preoperatively is important in deciding the type of approach. In most cases a gap of less than 2.5 cms can be treated by a simple perineal approach while larger gaps may need an elaborated perineal approach or transpubic procedure [9-13]. Therefore, preoperative gap assessment aids in determining the type of approach. Conventionally a Retrograde Urethrogram (RGU) along with a Voiding Cystourethrogram (VCUG) is performed and in complex cases an MRI pelvis is performed to assess the urethral gap. MRI performed by radiologists is performed on an empty bladder whereby it is difficult to assess the urethral gap. We present our protocol for MRI pelvis, which mimics a traditional RGU and VCUG, giving a true estimate of urethral gap.

Accurate surgical assessment of urethral gap is difficult. There is no set method of measuring urethral gap while the urethral ends and scar tissue are still in situ. One can only presume the stepwise approach to surgery depending on preoperative assessment of urethral gap. The lower the urethral gap the lower the requirement for a more elaborated perineal approach.

## Material and Methods

Our institute is a tertiary referral center for PFUI cases. 1032 cases of PFUI have been treated over the last two decades. All cases were referred to us within 3-6 months of initial trauma management. A traditional RGU and VCUG was performed and urethral gap was measured. Subsequently a 3T MRI was performed. The traditional protocol for acquiring MRI images is using iv contrast and on an empty bladder. This makes assessment of the urethral gap difficult. We modified the protocol where the images could be more helpful, without giving IV contrast and using urine as a natural MRI contrast. We prospectively evaluated 10 complex cases of PFUI. Initially a T2 weighted image acquisition was performed. Urethral gap measurements by 4 radiologists were recorded for each case.

Subsequently a T2 weighted image acquisition was performed with patient lying on the table with a full bladder, SPC clamped, straining to pass urine post administration of 400 mcg of Tamsulosin while at the same time a premixed solution of sterile saline and lubricating jelly is instilled in the urethra. The bladder

was filled physiologically with patient drinking water prior to the study. Urethral gap assessments were repeated using the same four radiologists and results recorded. We also performed conventional RGU and VCUG using pre-procedure Tamsulosin to evaluate the urethral gap. All patients had contrast in membranous urethra during VCUG. Four urologists were also shown images from each study for individual study and their visual score was recorded - very satisfactory (4), satisfactory (3), disappointed (2) and extremely disappointed (1)

## Results

Our study included 10 male patients who suffered PFUI due to motor vehicle collision. The average age was 31.2 years (21 to 43 years). We assessed the urethral gap utilising our refined MRI protocol. During the standard MRI, the distal urethral outline and membranous urethra was not well defined. Hence, assessment of urethral gap was difficult. On repeating the MRI image acquisition using our protocol the edges of the urethra were better visualized and gap assessment was easier. This was seen by the comparison of gap assessments done by four radiologists with the standard and our protocol (Figures 1 and 2).

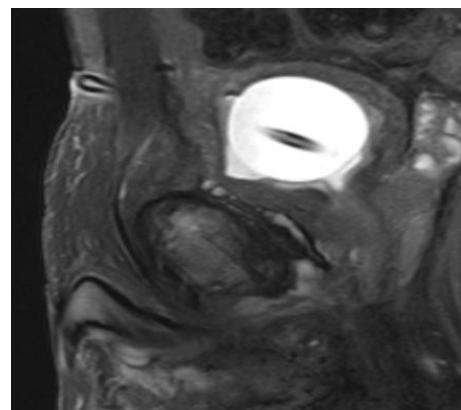


Figure 1: MRI with standard protocol.

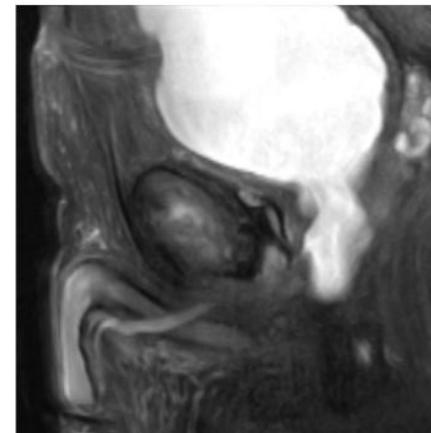


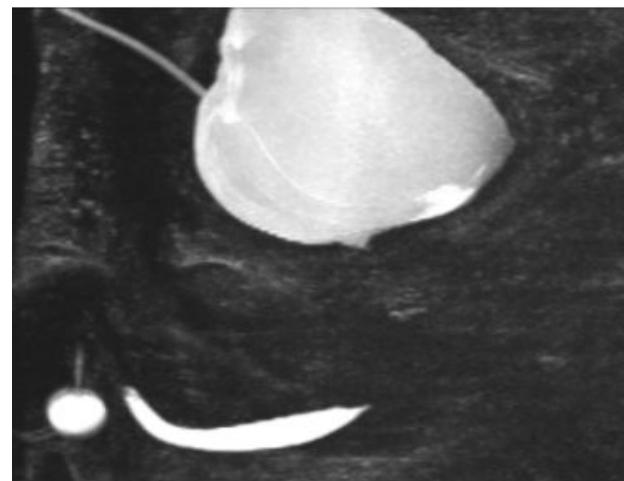
Figure 2: MRI with our protocol.

Outlines the MRI of the same patient with standard and our protocol (Figure 3).



**Figure 3:** RGU and VCUG.

Depicts the gap on RGU and VCUG. We also performed MRI in long gap pelvic fracture cases as shown in (Figure 4).



**Figure 4:** MRI in long gap PFUI.

The results of our study are outlined in (Table 1).

Patient number	Age	MRI standard	MR our technique	Difference	RGU + VCUG	Surgical Approach	Urologist Assessment
1	28	4	3.2	0.8	3.1	Step3	4
2	32	3.5	2.7	0.8	2.7	Step3	4
3	43	3	2.4	0.6	2.4	Step3	4
4	21	4	3.3	0.7	3.2	Step3	4
5	31	5	4	1	4	Step4	4
6	27	4	3	1	2.8	Step3	4
7	26	3.5	2.4	1.1	3.5	Step3	4
8	33	3	2.6	0.4	3	Step3	3
9	34	2.8	2.1	0.7	2	Step3	4
10	37	3	2.7	0.3	2.8	Step3	3

**Table 1:** Results of Study.

Urethral gap assessment differed between the standard MRI and protocol MRI in the range of 0.3 to 1.1 cm. MRI performed using our protocol very closely mimicked the gap assessment on conventional RGU and VCUG. The opinion of participating urologists conferred that MRI image acquisition with our protocol essentially mirrored the findings those of conventional RGU and VCUG and therefore was easy to interpret.

Surgical correlation was utilized. As depicted in Table 1 most cases required a step 3 approach keeping in with the preoperative assessment of urethral gaps. Intraoperative accurate surgical urethral gap assessment is difficult. There is no defined technique which can be replicated while leaving the two ends of the urethra and scar tissue in situ. Hence, the assumption is that smaller the urethral gap the lower the need for an elaborated perineal approach. This can be seen in the cases managed by our center.

## Discussion

Assessment of the urethral gap in PFUI is of relevance in deciding approach to anastomotic urethroplasty. Conventional assessment includes RGU and VCUG. The limitations of conventional RGU and VCUG are inaccurate assessment of urethral gap in patients where the bladder neck does not open, prostatic displacement on horizontal or vertical axis and complications such as fistula, diverticula or false passages. MRI has been used in complex PFUI to overcome these limitations [14]. In a study done by [14], on 18 patients, a T2 weighted MR image was acquired to evaluate PFUI. In our protocol, we use a similar image but with additional steps of a full bladder, pre-MRI alpha blocker administration and urethral instillation of premixed solution of sterile saline and jelly in the urethra. Another study done by Oh et al [15] on 25 patients with PFUI compared MRI with conventional RGU and VCUG and

concluded that MRI was more accurate than conventional imaging. Our study compares the standard and our protocol of MRI image acquisition. Our results show that MRI with our protocol very closely mimics conventional RGU and VCUG and is easy for urologists to interpret even with little experience in MRI. Our MRI protocol provides both anatomical definition and assessment of urethral gap and may replace the need for conventional RGU and VCUG in complex cases of PFUI.

## Limitations

The small sample size is the limitation of the study. Nonetheless, even in the small sample size, there is a significant change in the assessment of urethral gap in patients with PFUI. A larger randomised study would be recommended to study our MR protocol in patients with PFUI to assess the urethral gaps.

## Conclusion

Our technique of MR assessment of urethral gap in pelvic fracture urethral injuries shows promising results and reflects a true reflection of the actual urethral gap which helps in planning surgical approach. The simple modification of having a full bladder, use of Tamsulosin and straining (dynamic images) helps to mimic a conventional MCU RGU along with advantages of MRI. Urologists can easily interpret the acquired images.

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