Focus on male urethral stricture

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Authors: B. LONGERE, P. Puech, L. Lemaitre; Lille/FR
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Learning objectives

To illustrate how multimodal imaging can complete male urethral stricture analysis.

In this poster, we show how sonourethrography (SG) and urethra-MRI can be complementary to retrograde urethrography (RUG) and void cystourethrography (VCUG) for length stricture measurement and extent of periurethral fibrosis.

We illustrate our purpose, with cases of retrograde urethral catheterism induced stricture, post-infectious stricture, transurethral resection of the prostate (TURP) induced stricture and urethral rupture.

Background

Due to X-ray beam geometry, RUG and VCUG may misestimate bulbar stricture length, especially if RUG and CUG are not shot with the same incidence [Fig. 1], but an accurate measurement is critical in surgical decision: strictures shorter than 1 cm are good indications for urethrotomy or urethral balloon dilatation while strictures longer than 2 cm are treated by urethroplasty [1].

Furthermore, stricture length is a prognostic factor of successful treatment: according to Guirrassy et al. [2] strictures shorter than 1 cm will successfully be treated for 80 % patients, 70 % for strictures between 1 and 1.5 cm and 20 % for structures longer than 2 cm. Concerning recurrences, Steekamp et al. [3] calculated that for each additional centimetre over the first one, relative risk of recurrence is 20 % increased.

Retrograde urethrography and void cystourethrography can localize stricture but often underestimate its length and is not able to analyse periurethral fibrosis that is a prognostic factor for recurrence.

We completed stricture exploration with sonourethrography and MRI for 18 patients from January 2010 to June 2011.

Images for this section:
Fig. 1: RUG can easily show passive dilatation (*) up to the distal limit of the stricture (a) while proximal limit of the stricture delineation is more uncertain on VCUG (b). See the retrograde opacification of Cowper gland and duct (arrow). When RUG (c) is not realized with the same obliquity than VCUG (d), it leads to stricture length misestimation. This bifocal urethra narrowing (arrow heads) is better analysed on RUG than VCUG.
Imaging findings OR Procedure details

Our population

We lead a prospective study from January 2010 to June 2011, recruiting 18 male patients presenting inaugural or recurrent urethral strictures with uroflowmetric significance (maximal urinary flow rate < 15 mL/s and post void residual > 100 mL). Iatrogenic traumatism was present for 11 patients (TURP or retrograde urethral catheterism), genital tract infection for 6 patients, traumatic urethra rupture for 2 patients and radiotherapy for 1 patient. 2 of them presented multiple aetiologies. Stricture concerned prostatic urethra for 4 patients, bulbar urethra for 15 patients and penile urethra for 1 patient. 2 patients had multiple or panurethral stricture.

We performed RUG-VCUG and SUG for 4 patients, RUG-VCUG and MRI for 4 patients, SUG and MRI for 2 patients and RUG-VCUG, SUG and MRI for 8 patients.

RUG and VCUG protocol

We used a 16-18 Foley catheter and inflated the balloon with 2 cc of physiologic saline just beyond the fossa navicularis. While we pulled the penis aside by a slight traction, we injected iodinated contrast under radioscopic control and performed straight and oblique incidences.

When bladder repletion was obtained, we performed voiding incidences for bladder neck opening analysis and prostatic urethra [Fig. 1a, Fig.1d, Fig. 2].

SUG protocol

Only penile and bulbar urethra strictures are accessible by SUG that require previous RUG-VCUG for stricture localization.

We performed urethral infusion with the same protocol than in RUG-VCUG but with physiological saline. We analyzed urethra with a end-fire probe (6.5 MHz) applied on perinea or with a lineal probe (8-12 MHz) applied on ventral face of the penis [Fig. 3, Fig. 4].

Prostatic urethra is not accessible to SUG and this method is not appropriated for urethral rupture in acute phase. As a consequence, RUG-VCUG is necessary to select which patients may be eligible for SUG.
MRI protocol

Previous RUG-VCUG is necessary to localize the stricture and focus MRI region of interest. We marked urethra as for SUG with physiological saline and used the natural hyperintense signal of water with T2-weighted MRI.

We performed T2-weighted MRI [Fig. 5] in the short and long axis of the stricture before and after injection of physiological saline and gradient echo T2-weighted MRI [Fig. 6, Fig. 7, Fig. 8]. Dynamic T1-weighted gadolinium enhanced MRI and late gadolinium enhanced T1-weighted MRI with fat signal suppression allows to analyse MR-spongiosography [Fig. 9] [4].

Three-step multimodal imaging

Step #1:

RUG and VCUG are both indispensable for male urethral stricture diagnosis and localization but also in order to focus SUG and/or MRI explorations. When stricture is distal, juxtameatal, antegrade opacification with suprapubic catheterism can show lesions that neither RUG, SUG or MRI can analyze [Fig. 10].

Step #2:

Bulbar urethra is a frequently injured site (48 % in literature, 15 out of our 18 included patients) that perineal sonourethrography can easily explore [Fig. 3]. It may be more accurate in terms of length than RUG-VCUG if stricture limits are well defined [6,7]. Indeed, it appears that SUG might sometimes misestimate stricture length too due to the progressive junction between maximal stricture and normal size urethra that causes difficulties to precisely define stricture limits [Fig. 4].

Step #3:

Gadolinium enhanced T1-weighted MRI and T2-weighted MRI can show periurethral changes and can estimate more precisely depth and localization of spongiofibrosis [Fig. 7, Fig. 8]. Urethro-MRI with combination of both retrograde instillation of physiological saline and void dynamic T2 weighted MRI [Fig. 11] can precise delineation of stricture length with multiplanar reconstructions [8], without any limitation of access (SUG cannot explore prostatic urethra) or geometric deformations. Urethro-MRI can also be performed during short T1-acquisition during micturition after intravenous injection of gadolinium contrast medium and injection of furosemide [Fig. 12]
**Fig. 1:** RUG can easily show passive dilatation (*) up to the distal limit of the stricture (a) while proximal limit of the stricture delineation is more uncertain on VCUG (b). See the retrograde opacification of Cowper gland and duct (arrow). When RUG (c) is not realized with the same obliquity than VCUG (d), it leads to stricture length misestimation. This bifocal urethra narrowing (arrow heads) is better analysed on RUG than VCUG.
**Fig. 2:** RUG (a.) shows passive dilatation up to distal limit of the stricture (*). This patient had long and irregular bulbar urethra stricture with two tight indentations due to TURP procedure (b): see the prostate resection cavity (arrow head) and bladder diverticulum (arrow).
**Fig. 3:** Bulbar post-catheterism stricture (a. & b.) or bulbar post-infectious stricture (c. & d.) that US can show after retrograde injection of physiological saline. SUG with high frequency probe can show hypoechogenic periurethral (*) tissue that might be a manifestation of fibrotic participation and US high spatial resolution allows more accurate stricture measurement.
Fig. 4: Physiological saline injection induces distal urethra dilatation up to the distal limit of the stricture. This is a long stricture: lack of expansion of urethral lumen makes difficult a precise measurement of the stricture and leads to search for periurethral fibrosis.

Fig. 5: Optimal urethra-MRI needs a 3-planed exploration (a. Coronal plan, b. Sagittal plan, c. Axial plan). T2-weighted MRI is the most anatomically relevant sequence and allows to see normal annular well-defined hypointense periurethral band (urethra is marked by retrograde opacification).
Fig. 6: RUG (a.) Irregularities of membranous urethra. Absence of prostatic urethra and bladder opacification. MRI (b. T2-weighted MRI, c. gradient echo T2-weighted MRI & d. gadolinium enhanced T1-weighted MRI): Distal urethra is distended by saline retrograde opacification) MRI shows typical incomplete rupture of membranous urethra (type II of Colapinto & McCallum [5])(arrows and arrow heads), without any abdomality of protate gland. Early gadolinium enhanced T1-weighted MRI with fat signal suppression (d.) assesses normal spongiosography (*).
Fig. 7: T2-weighted MRI (a.) shows important hypointense signal fitting with TURP induced urethral stricture (arrow) (a. T2-weighted spin echo and b. gradient echo T2-weighted MRI): hypointense fibrotic tissue extends from the inferior part of prostatic resection cavity (TURP) to membranous urethra. Early gadolinium enhanced T1-weighted MRI with fat signal suppression assesses spongious body enhancement defect (*); this delayed spongiosography might be a sign of spongiofibrosis.

Fig. 8: Axial T2-weighted MRI assesses in case of post-catheterism stricture (a.) a well defined urethral wall thickening (arrow) with periurethral hypointense T-2 signal (spongiofibrosis) while in case of post-infectious stricture (b.) a blurred urethral wall thickening is seen (arrow head).
Fig. 9: Sagittal dynamic gadolinium enhanced T1-weighted MRI with fat signal suppression shows spongious body peristructural enhancement defect (circles) that fits with post-infection stricture and associated spongiofibrosis.

Fig. 10: After urethroplasty, it might persist some non-specific wall irregularities (a.): this juxtameatal aspect can only be analysed with antegrade cystourethrography (suprapubic catheterism). This other patient (b.) suffers from posturethroplasty pseudodiverticula (*) in which urine is accumulating. Pseudodiverticula are responsible for delayed end of micturition while they are voiding. Antegrade cystourethrography shows a distal stricture (arrow) that causes a decreased void stream.
**Fig. 11:** Sagittal dynamic gradient echo T2-weighted MRI assesses for this patient whom suffering from post-catheterism stricture. The lesion is responsible for prestrictural urethra dilatation and delayed bladder voiding.

**Fig. 12:** Special case of a 25 year old patient with antecedents of surgically treated imperforate anus with clinical suspicion of rectourethral fistula. Void dynamic gadolinium
enhanced T1-weighted imaging with 3 Tesla MRI (1 mm slice thickness) after antegrade bladder opacification by intravenous injection of gadolinium and furosemide. This exam may show perifistular enhancement, but the most fascinating sign of fistula is the presence of rectal air in urethra while patient is voiding (arrow heads).
Conclusion

Retrograde cystography and void cystourethrography remain the gold standard for male urethral strictures diagnosis and are still both necessary for accurate stricture delineation. Sonourethrography offers a better appreciation of their length and of periurethral thickening. On the other hand, MRI allows good complementary outcomes in terms of length, localization, periurethral changes and can show spongious body enhancement defect that may be linked to spongiofibrosis.

Personal Information

References


