

## THE NATURE OF URETHRAL INJURY IN CASES OF PELVIC FRACTURE URETHRAL TRAUMA

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### ABSTRACT

**Purpose:** We examine the urethral injury associated with pelvic fracture that is said to be due to a shearing force through the membranous urethra which inevitably destroys the urethral sphincter mechanism.

**Materials and Methods:** A total of 20 asymptomatic cases were prospectively studied, including symptomatically, radiologically, endoscopically and urodynamically, 1 to 4 years after an apparently successful anastomotic repair of a pelvic fracture urethral distraction defect.

**Results:** There was evidence of urethral sphincter function, including urodynamically in 11 (55%), endoscopically in 13 (65%) and functionally in 17 (85%) patients.

**Conclusions:** These findings, coupled with surgical observation, suggest that the urethral injury associated with pelvic fracture is avulsion of the membranous urethra from the bulbar urethra rather than a shearing through the membranous urethra, and that some degree of urethral sphincter function is preserved in a significant percentage of patients.

**KEY WORDS:** wounds and injuries, urethra

Urethral injury associated with pelvic fracture is traditionally regarded as being the result of a shearing force through the membranous urethra where it is fixed by the urogenital diaphragm.<sup>1</sup> As a result of this it is said that the intrinsic striated muscle component of the urethral sphincter mechanism is destroyed, and continence thereafter is dependent on the normal function of the bladder neck.<sup>2</sup> Therefore, subsequent prostatectomy, by interfering with the bladder neck sphincter mechanism, will render the patient incontinent.

There are several problems with this traditional view. 1) The original suggestion that the injury is a result of a shearing force through the membranous urethra where it is fixed by the urogenital diaphragm was a largely hypothetical explanation based on a small series of observations.<sup>1</sup> 2) It is now generally agreed that there is no urogenital diaphragm.<sup>3,4</sup> 3) Urethrography at the time of injury regularly shows extravasation into the perineum,<sup>5,6</sup> that is below the perineal membrane which is a less disputed structure than the urogenital diaphragm. 4) There are anecdotal reports of patients being completely continent after urethroplasty across the urethral sphincter mechanism, although these were not traumatic strictures, and subsequent prostatectomy.<sup>7-10</sup> Therefore, we have prospectively studied a series of 20 patients with pelvic fracture urethral distraction defects to determine the site of the urethral injury and state of urethral sphincter function.

### PATIENTS AND METHODS

A total of 20 men age 19 to 51 years were studied. All patients had received a pelvic fracture due to a vehicular accident and had a posterior urethral injury as a consequence. The 20 patients were treated with suprapubic catheterization for 3 to 6 months at which time transperineal anastomotic urethroplasty was performed, with complete obliteration of the posterior urethra on ascending urethro-

gram and voiding cystogram. No patient had undergone any other surgery on the urinary tract before, at the time of or after injury until urethroplasty, nor have they had other surgery since. Studies were performed 1 to 4 years after anastomotic urethroplasty for a pelvic fracture urethral distraction defect at which time all patients were apparently cured. All patients completed an American Urological Association symptom score, had an ascending urethrogram and voiding cystogram, a cystourethroscopy and a video urodynamic study. The video urodynamic studies were performed in the manner recommended by the International Continence Society using fast fill (50 to 100 ml. per minute). Function of the urethral splinter mechanism was assessed by a stop test during voiding on videourodynamic study.

### RESULTS

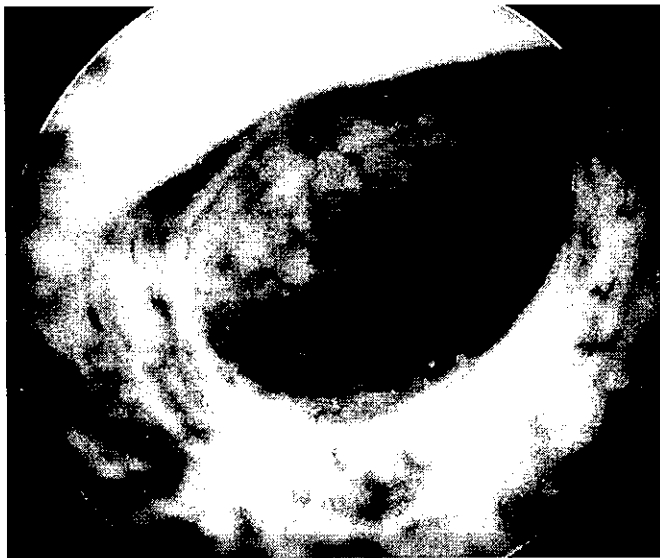
There were 3 patients who had some degree of stress incontinence, usually with a full bladder only. The other 17 (85%) patients were completely continent and asymptomatic, and 17 were able to interrupt the urinary stream. Endoscopically the urethral sphincter mechanism was visible and apparently functional proximal to the anastomosis in 13 patients (65%) (see figure). On videourodynamic evaluation, which was otherwise normal in all patients, 11 (55%) were not only able to interrupt the stream, but visible milk back of contrast material into the bladder and interruption of the stream was prompt, on demand and due to sphincteric contraction not inhibition of the detrusor contraction.

### DISCUSSION

To our knowledge it has always been assumed that the nature of the urethral injury associated with pelvic fracture was a shearing force through the membranous urethra "where it is fixed by the urogenital diaphragm," since the paper by Pokorny et al in 1979.<sup>1</sup> Subsequently, Turner-Warwick hypothesized that continence thereafter, with or without later urethroplasty, was dependent on the normal functioning of the bladder neck.<sup>2</sup> To our knowledge this view was never challenged nor, indeed, did we ourselves question

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Endoscopic photograph of functioning urethral sphincter mechanism proximal to scar of anastomotic urethroplasty performed 3 months after pelvic fracture urethral injury.

otherwise until it became policy recently in our department to follow patients who underwent urethroplasty by flexible cystoscopy rather than radiology or symptomatic assessment alone. As a result we noticed that many patients had a functioning urethral sphincter mechanism as shown by urethral occlusion at the verumontanum approximately 1 cm. above the anastomotic scar (see figure). This result did not mean that the sphincter was normally functional, but it did suggest that there was some potential sphincter function, which would explain why many patients were remarkably asymptomatic after such surgery. This effect and the anatomical observation derived from our previously published experience<sup>11</sup> of delayed primary repair of the ruptured urethra led us to reconsider the nature and functional effect of pelvic fracture injury to the sphincter mechanism.

Most of our patients did not have a urethrogram at the time of injury, so we could not be sure of the exact site of injury. However, all patients had received pelvic fracture urethral injury as a consequence of vehicular accidents, and we believe there was a sufficient number of them in our series to be a representative sample of this type of injury. From our own observations and the literature an assessment could be made about the nature and site of such injury and the functional effects.

At the time of exploration, either acutely to repair a rupture or at urethroplasty 3 months later, the distal end of the urethra below the injury site is always in the perineum, not above the perineal membrane in the pelvis.<sup>11</sup> In other words the lower end of the injury is at the origin of the bulbar urethra and no higher. The position of the bulbar urethra is fixed by attachments to the corpora cavernosa of the penis and to the perineal membrane. The proximal end of the ruptured urethra has a much more variable position. It is 1 or 2 cm. above the site of obliteration if continuity is more or less retained, high in the pelvis if there has been gross distraction or posterior to the proximal limit of the bulbar urethra if the distraction has been less marked.

After having identified the healthy proximal urethra at the time of repair or urethroplasty and cut back into this section of the urethra to allow a spatulated anastomosis, the verumontanum is almost always visible above the proximal point of spatulation.<sup>12</sup> It is exceedingly uncommon to find the verumontanum at or below the level of the obliteration except in children. No matter how much spatulation is performed, the

surgeon rarely gets high into the prostatic urethra, although the procedure is called bulbo-prostatic anastomosis.

It has been anatomically noted that two thirds of the intrinsic urethral sphincter mechanism is at or above the level of the verumontanum, generally a third at, above and below the level of the verumontanum.<sup>13</sup> Thus, if the verumontanum is preserved, as much as two thirds of the sphincter mechanism might still be present and functional, assuming that function has not been injured directly or indirectly by damage to the nerve supply.

Those who have studied the mechanics of urethral injury after a pelvic fracture have shown that as much as 76% of fractures are due to a lateral compression force.<sup>14</sup> This force seems more likely to produce avulsion by compression than a shearing through the urethra. It seems likely that urethral injury associated with pelvic fracture is due to avulsion rather than a shearing force and avulsion of the membranous urethra from the bulbar urethra<sup>15</sup> (or even through the proximal bulbar urethra in more severe injuries that disrupts the perineal membrane), rather than through the membranous urethra or of the prostatic urethra from the membranous urethra.

The results of our study suggest that the urethral sphincter mechanism is still present and is potentially functional in a significant percentage of patients after pelvic fracture even if sphincter function is compromised by the trauma itself or damage to innervation, and may be impaired further by subsequent surgery. It is noteworthy that there are significant medicolegal implications. Currently, it is likely that some patients with pelvic fracture injuries receive compensation on the grounds that any subsequent prostatic or bladder neck surgery might render them incontinent. This consequence is clearly not necessarily the case.

Patient followup after anastomotic urethroplasty for a pelvic fracture urethral distraction defect should include a radiological or endoscopic assessment. Indeed, 4 potential candidates for recruitment in our study had to be excluded because there was radiological or endoscopic evidence of a recurrent stricture, although in all instances it was possible to pass through a 19Fr endoscope. These patients were asymptomatic and, indeed, were otherwise normal with normal urinary flow rates. The point is that symptoms and flow rate alone are not a reliable guide to the presence of a urethral stricture even if the stricture is not urodynamically significant. Urethral sphincter function in these patients may have implications for ejaculatory function as well as continence. It was not possible to evaluate this in our present study.

It can be argued that, although indicators of urethral sphincter function, milk back and the ability to interrupt the urinary stream may not be overall indicators of intrinsic urethral striated sphincter function, but simply the periurethral levator ani (pubourethralis) alone. However, the absence of any symptoms and ability to hold urine under all circumstances coupled with the ability to milk back into the bladder on urodynamic study suggest that it is indeed intrinsic urethral striated muscle function. More detailed studies of urethral sphincter function would be the next logical step to study these observations further.

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#### EDITORIAL COMMENTS

This article addresses an important question, "After urethroplasty for a prostamembranous urethral rupture, will subsequent transurethral prostatectomy render the patient incontinent?" However, I am not sure the data presented here give us the answer. I do not believe striated muscle in this area, commonly called the external sphincter, has anything to do with passive continence. Spinal anesthesia does not render intact cases incontinent. These patients only have difficulty quickly interrupting the stream during voiding.

Visual inspection of the area, especially in the patient who is not anesthetized can show a closed urethra at this level (striated muscle activity) in a patient who has a dysfunctional internal urethral (passive) mechanism. Striated (voluntary) contraction can cause the sphincter to close but it will eventually fatigue. I know of no urodynamic test that will only test the internal urethral mechanism. The "milk back" the authors demonstrate could occur with active striated muscle contraction. All of the other studies measure bladder neck and internal urethral mechanism continence.

Finally, what is the one preoperative finding that warns us the patient may be incontinent after urethroplasty? It is an open bladder neck on a static cystogram. I think a closed bladder neck on this study will guarantee a patient who is continent postoperatively.

Having said all of the aforementioned, I do not believe that all patients who have a posterior urethral rupture and undergo subsequent urethroplasty will be incontinent after transurethral prostatic resection. In some of them the internal urethral mechanism will be preserved. Unfortunately, I do not know how to predict which patients will and which patients will not, and I am afraid this article does not help answer this question.

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In this careful study of an unusually large series of patients with urethral injury at the time of a fractured pelvis the authors confirm what has been suggested by previous authors, that the urethra is severed downstream from the sphincter. Far from being destroyed, as is often stated in the literature, the sphincter so familiar to us all during transurethral prostatic resection, can be clearly seen at surgery to repair the urethra, and it can be demonstrated on a urethro-

gram or by urodynamic measurements afterwards. This procedure has important consequences when calculating the compensation due to these men, up to this time it has been believed that they must face inevitable incontinence should they require prostatectomy at some later date. I hope these authors will continue their study into the equally important effect on ejaculation.

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The authors address the clinically significant questions about the site of urethral injury associated with pelvic fracture and the state of urethral sphincter function after anastomotic urethroplasty in these cases. The concept that avulsion of the membranous urethra occurs at the junction with the bulbar urethra has been described, and well explained in many reports (references 5 & 15 in article) and documented in this study. Recent cadaveric studies have demonstrated that the so-called "external sphincter" is not a horizontal plane associated just with the membranous urethra as shown in some textbook diagrams, but it extends from the bladder to the perineal membrane and is associated throughout with the prostate.<sup>1</sup> Also, whereas the muscles of the membranous urethra are continued uninterrupted into the prostatic urethra, they end abruptly at the perineal membrane and are not present in the bulbar urethra. Thus, the whole posterior urethra above the perineal membrane constitutes a single anatomical unit and, consequently, the bulbo-membranous junction is the frail spot at which the urethra is liable to be avulsed in cases of pelvic fracture.

The authors found that urethral sphincter function is preserved in these patients. However, they did not define whether this is applied to all or part of the sphincter. Normally, the sphincter active urethra extends from the bladder neck down to the distal margin of the membranous urethra, and it may be considered in 2 parts or mechanisms proximal and distal to the verumontanum. Apparently the authors mean that part of the sphincter proximal to the anastomosis, usually is just distal to verumontanum, which constitutes the proximal urethral mechanism. This result actually is what is to be expected as the distal mechanism had been damaged by initial trauma and/or excised during surgery before anastomosing the bulbar to prostatic urethra. This view has been proved and documented as early as 1986 and more recently in 2000.<sup>2,3</sup>

I do have some difficulties with the methods used to assess the urethral sphincter function. Interruption of urinary stream does not necessarily indicate a functioning intrinsic urethral striated sphincter. This result can be achieved by the bladder neck (proximal) mechanism, albeit after a slight delay characteristic of smooth muscle function (reference 2 in article). Moreover, contraction of periurethral perineal muscles may contribute to this function.<sup>3</sup> Deductions of function based on endoscopic appearance, especially with uncontrolled movements of patient pelvis or instrument, are commonly erroneous (reference 13 in article).

The reports of patients being continent after urethroplasty and prostatectomy should be carefully interpreted. Strictures in these reports were not the result of pelvic fracture urethral disruption, but rather iatrogenic in origin and mostly occurred after prostatic operation (reference 9 in article). Also, urethroplasty was in the form of a 2-stage scrotal inlay that involves a clean cut incision of the distal urethral sphincter at the 6 o'clock position only, leaving the rest of the circumference intact and functioning. This result is completely different from anastomotic urethroplasty, which entails excision of the scarred membranous and most of inframontanal prostatic urethra.

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#### REPLY BY AUTHORS

The point of our study is that there is evidence, which we presented, of the possibility of a functioning urethral sphincter mechanism after pelvic fracture injury, which to our knowledge has not been previously reported. In fact and quite the opposite, it is widely assumed that the sphincter is destroyed by such injury. We do not

state that the sphincter is always preserved or that when it is preserved after injury it will still be preserved after subsequent urethroplasty or that if it is preserved it will function normally. Clearly the sphincter or its innervation might be partly damaged by the injury, and both may be made worse by subsequent surgery. However, in some patients there will be useful function. Our report does not answer the question of how to predict which sphincter mechanism will or will not be preserved nor does it answer the question of how to predict who will be continent by virtue of the urethral sphincter.