CHAPTER 7

WOUNDS OF THE POSTERIOR URETHRA AND PROSTATE

GU Tract Structure	Ch 2 Kidney	Ch 3 Ureter	Ch 4,5 Bladder	Ch 6,7,8,11 Urethra	Ch 8,9 Scrotum Testis	Ch 8,9 Spermatic Cord	Ch 8,10 Penis
No. Patients With Injury to Structure	132	36	72	83	199	14	128
% of Total GU Injuries	19.1	5.2	10.4	12.0	32.8	2.0	18.5

GU: genitourinary

INTRODUCTION AND CLASSIFICATION OF URETHRAL INJURIES

The gravity of "deep" urethral wounds, especially those caused by gunshot, was recognized as far back as the American Civil War. Fatalities were common and survivors were routinely afflicted with strictures and or fistulae.[1] Since then, although significant overall progress has evolved in the techniques of diagnosis and management, these wounds still result in severe local and associated organ injuries and extensive short- and long-term morbidity.[2–6] The overall management of these wounds continues to challenge and tax the expertise and ingenuity of the attending urologist and surgeons. This challenge is well summarized in the following quotation from Ormond S. Culp in the official history of the Medical Department of the US Army in World War II:

> Although trauma of the urethra has failed to attain statistical prominence during any U.S. war, few, if any, nonfatal injuries have been capable of being more disastrous. Urethral trauma has a tremendous potential for creating urologic cripples.[1(p407)]

Urethral injuries are assigned as to the cause of trauma: either external blunt factors or penetrating forces from bullets and missile fragments and from nonmissile punctures. Traditionally, and in this book, urethral injuries have been divided and clinically classified based on whether the rupture of the urethra is anterior (distal) or posterior (proximal) to the urogenital diaphragm, regardless of cause. In this chapter, posterior urethral injuries involve the prostate, the prostatomembranous urethra, and the prostato–bladder neck region. Only those injuries caused by penetrating forces (ie, *wounds*) are considered here; blunt injuries are discussed in

Chapter 6, Blunt Pelvic Trauma With Posterior Urethral Disruption. Anterior urethral penetrating and blunt injuries are the subject of, and are reviewed in, Chapter 11, Anterior Urethral Penetrating and Blunt Injuries.

In the Republic of Vietnam (RVN) during the Vietnam War, approximately 12% of all urological injuries involved the urethra[7,8] (see Table 2-1) compared with 15% during World War II[5,6] (Table 7-1). In RVN and in our (JNW and JWW, the authors) experience in hospitals in Japan, primarily at the US Army Hospital, Camp Zama, anterior urethral trauma was slightly more common than penetrating and blunt injuries to the posterior urethra (Table 7-2). Penetrating wounds of the prostate and prostatomembranous urethra were more common than posterior urethral ruptures from blunt external forces. Twenty (57%) of the 35 patients we managed in Japan were victims of penetrating trauma (Table 7-3); these 20 devastating wounds are the focus of this chapter.

In reports from World War I[2] and World War II,[1,3–6] the majority of penetrat-

TABLE 7-1
COMPARISON OF SPECIFIC SITES OF WOUNDS OF THE EXTERNAL GENITALIA IN THREE WARS

GU Organ Wounded	Wounds as Percentage of Total GU Wounds		
	World War I[1]	World War II[2]	Vietnam
Scrotal Testis	—	34.9	32.8
Penis	—	18.7	18.5
Urethra	—	14.5	11.9
Total Percentages:	**29.4**	**68.1**	**63.2**

GU: genitourinary
Data sources: (1) Young HH. Wounds of the urogenital tract in modern warfare. *J Urol.* 1942;47:59–108.
(2) Kimbrough JC. War wounds of the urogenital tract. *J Urol.* 1946;55:179–189.

TABLE 7-2
WOUNDS OF THE EXTERNAL GENITALIA

Organ	No. Patients*	Wounds No.†	Wounds %
Scrotum and Testis	199	227	50.2
Penis	128	128	28.3
Urethra			
Anterior	48	48	10.6
Posterior	35	35	7.8
Spermatic Cord	14	14	3.1
Totals:		**452**	**100.0**

*Total patients with wounds of the external genitalia: 303
†Total wounds of the external genitalia: 452

TABLE 7-3
DISTRIBUTION OF URETHRAL WOUNDS

Location	Nature of Injury	No. Patients
Anterior Urethra		
Penile	Penetrating	33
Bulbus	Penetrating	13
	Blunt straddle	2
Posterior Urethra		
Prostato-membranous	Penetrating	20
	Blunt	15
Total:		**83**

ing urethral wounds were from explosive shells and fragments predominantly involving the anterior urethra. There were few accumulated or tabulated data from these reports dealing with the incidence and management and follow-up of penetrating posterior urethral wounds. However, several case studies detailed the frequency of serious other associated major pelvic organ injuries from these prostatourethral wounds. Two reports[7,8] from the Vietnam War experience emphasized the severe problems from high-velocity wounds of the prostate and posterior urethra: anatomical destruction and derangement of the prostate and prostatic urethra and adjacent bladder, and severe bleeding. Surgical management of these injuries was directed at controlling hemorrhage and reestablishing posterior urethral continuity.

All of these reports from experience with combat casualties with prostatourethral wounds and associated injuries emphasize the need for

- thorough wound and abdominal pelvic exploration and debridement,
- drainage and repair of the injuries,
- attempts at early reconstruction or realignment and stenting of the urethral injury,
- suprapubic cystotomy,
- colostomy for colorectal wounds, and
- dependent pelvic drainage.

Aside from the reports of wartime experience, there is little else in the literature regarding experience with managing penetrating missile wounds of the posterior urethra.

WOUND ANALYSIS

Twenty (57%) of the 35 patients we managed with posterior urethral trauma in Japan had penetrating wounds (see Table 7-3). Herein we present a wound analysis of these 20 patients. To our knowledge, this is the largest single personal experience published of combat wartime penetrating posterior urethral wounds.

The causes of the 20 wounds of the prostate are detailed in Table 7-4. Fourteen (70%) of the 20 were gunshot wounds (GSWs). Fragment wounds resulted in penetrating posterior urethral trauma in 3 (15%) of 20 of patients. One of the 3 puncture wounds was due to trauma from a *punji* stick; these sharpened wooden stakes were usually covered with human feces and were designed to inflict a disabling puncture wound.

TABLE 7-4
ETIOLOGY OF WOUNDS OF THE POSTERIOR URETHRA AND PROSTATE

Wounding Agent	Wounds No.	Wounds %
GSW	14	70
Fragment	3	15
Puncture	3	15
Punji stick	1	
Ax handle	1	
Stick or root	1	
Total Wounds:	**20**	

GSW: gunshot wound

All 20 wounds involved the prostate. However, from the data available in case records and from examination of patients, we were unable to determine the exact number of prostate wounds that had urethral involvement as well. Clearly, 8 (40%) of the 20 had urethral injury and probably most of the 12 remaining patients did also.

Associated Injuries

Twelve (60%) of 20 patients had 1 or more associated genitourinary (GU) organ injuries, totaling 19 other GU organ injuries (Table 7-5). The bladder was the organ most frequently injured (45%), and scrotal–perineal injury occurred in 4 of 20 (20%) of all patients. The testis was injured in 2 patients, resulting in orchiectomy in 1 and bilateral orchiectomy in the other. One patient experienced a significant soft-tissue penile wound, and another an anterior urethral penile fragment wound. There was 1 distal ureteral wound. One patient had 6 associated GU wounds to the bladder, penile urethra, bilateral scrotal, perineum, and bilateral testis.

All 20 patients had injury of 1 or more other nonurological organ systems (Table 7-6). The rectum was the most common other organ injured (13 [65%] of 20 cases). Extremity wounds occurred in 9 (45%) of 20 patients. There was only 1 instance of injuries to the upper extremity, whereas 8 patients had lower extremity wounds, 1 of which was bilateral. The bony pelvis (most often the pubis) was injured in 8 (40%) of 20 patients. Buttock injuries occurred in one quarter of the patients. Three patients had injuries to the small bowel, and 3 others had extensive injury to the abdominal wall. Injuries to the

TABLE 7-5
GENITOURINARY WOUNDS ASSOCIATED WITH WOUNDS OF THE POSTERIOR URETHRA AND PROSTATE

Wounded Organ	No. Wounds	% of 12 Patients
Bladder	9	45
Scrotum	4	20
Testis*	3	10
Penis	1	5
Penile Urethra	1	5
Ureter	1	5
Total Wounds:	**19**	

*1 with bilateral injury

TABLE 7-6
NONUROLOGICAL WOUNDS ASSOCIATED WITH WOUNDS OF THE POSTERIOR URETHRA AND PROSTATE

Organ	No. Wounds	%* of 20 Patients With Wound
Rectum	13	65
Extremities	9	45
Upper	1	
Lower	8†	
Bony Pelvis	8	40
Buttock	5	25
Small Bowel	3	15
Abdominal Wall	3	15
Colon	1	5
Coccyx	1	5
Sacrum	1	5
Total Wounds:	**44**	

*Total wounds are more than 100% because many patients had > 1 associated wound

†1 bilateral

colon, coccyx, and sacrum were each experienced by 5% of patients. Forty-four significant nonurological wounds involving 9 other organ systems were identified in this group of 20 patients.

Complications

A urethrorectal fistula was the only major complication in the 3 patients with fragment wounds. This fistula closed with prolonged Foley and suprapubic drainage, and the only sequela from his wound was dry ejaculation for 2 years after the injury.

Only 1 of 3 puncture wounds of the prostate and posterior urethra was complicated. The punji stick wound resulted in an abscess of the prostatic and subtrigonal bladder, which required transurethral "unroofing" and evacuation of purulent and foreign material. This injury resulted in prolonged hospitalization and convalescence but had no known sequelae.

The complications of the 14 patients who had GSWs of the prostate and posterior urethra are tabulated in Table 7-7. Ten of 14 (71%) of patients had significant complications either secondary to the initial wound or from their treatment, which we managed in Japan. Pelvic abscess occurred in 4 patients and urethral stricture in 4. Three patients had destruction of the bladder-posterior urethral sphincteric mechanism. Two patients developed urethrocutaneous fistulae, 1 of which drained through the hip joint. Massive urinary extravasation occurred in 2 patients secondary to extensive wound damage to the bladder and posterior urethra. Gram-negative shock developed after urethral instrumentation in 1 patient. One patient developed severe pulmonary fibrosis of his entire right lung, which resulted from poor placement of an obstructing endotracheal tube. Another patient developed tension pneumothorax, which required surgery. Persistent wound drainage from osteomyelitis and devitalized pelvic bone fragments occurred in 1 patient. After the primary repair of his rectal injury (done in RVN) broke down, 1 soldier developed a wound infection that required extensive anorectal redebridement, resection of the infection, and drainage. A total of 21 significant complications developed in 10 of the 14 patients with GSWs of the posterior urethra. Many patients experi-

TABLE 7-7
COMPLICATIONS IN PATIENTS WITH GUNSHOT WOUNDS OF THE POSTERIOR URETHRA AND PROSTATE

Complication	No. Patients With Complication*
Pelvic Abscess	4
Stricture	4
Destruction of Sphincteric Mechanisms	3
Urethrocutaneous Fistula (one through hip joint)	2
Massive Urinary Extravasation	2
Gram-Negative Shock	1
Pulmonary Fibrosis	1
Osteomyelitis	1
Adhesions—Bowel Obstruction	1
Tension Pneumothorax	1
Disruption of Rectal Repair	1
Total Complications:	**21**

*Total of 14 patients; some had more than 1 complication

enced multiple complications, which often required surgery and resulted in prolonged morbidity).

Six (43%) of 14 patients with GSWs of the posterior urethra required surgical procedures with anesthetic agents in Japan (see Table 7-8). Minor procedures, including wound irrigation; nonanesthetic debridement; and replacement of drains, tube changes, and cystoscopic and urethroscopic examinations are excluded from Table 7-8. Four patients had incision and drainage of abscesses. Three had difficult urethral strictures requiring frequent repeat dilation, and 2 had wound redebridement. One case of intestinal obstruction required lysis of adhesions and resection of 39 cm of small bowel. A ureteroileal conduit urinary diversion was performed for a totally destroyed prostate and extensively injured bladder with massive tissue loss. One patient had delayed primary closure of a thigh wound and a colostomy closure.

By the time the patients were evacuated to the continental United States (CONUS), only 1 of the 14 with GSWs of the posterior urethra was voiding free of both suprapubic and Foley catheters. Some of the patients who were voiding were evacuated with suprapubic tubes to avoid complications of retention on evacuation or to facilitate anticipated complications that were likely to occur in CONUS, especially those with severe strictures.

It is clear that GSWs to the prostate and posterior urethra result in severe injuries with a high incidence of complications, and long-term and often permanent disability. No information is available concerning the incidence of stricture, incontinence, and impotency in these patients. Certainly erectile dysfunction, ejaculatory disorders, and infertility will have occurred in some as sequelae of these wounds, and many of these patients will have required long-term management and reconstruction of the urethral strictures and urinary incontinence.

TABLE 7-8
DELAYED SURGERY IN JAPAN FOR GUNSHOT WOUNDS OF THE PROSTATE AND POSTERIOR URETHRA

Type of Surgery	No. Operations
Incision, Drainage of Wounds and Abscesses	6
Urethral Dilation	3
Redebridement of Wound	2
Lysis of Adhesions and Small-Bowel Resection	1
Bilateral Cutaneous Ureteroileostomy	1
Delayed Primary Closure of Wound	1
Colostomy Closure	1
Total Operations:	**15**

CASE STUDIES

Several cases are presented that demonstrate the wide spectrum of injury to the prostate and posterior urethra as well as associated organs. The severity, complexity, and devastation of these wounds are described in some of the cases that follow.

Puncture Wounds

Case 7-1

R. A., a 19-year-old soldier, fell in a sitting position into a pit trap, incurring a puncture wound of the perianal perineum, rectum, and prostate from a punji stick. He had

mild gross hematuria and some dysuria, in addition to some rectal bleeding. A Foley catheter was placed without difficulty and maintained for several days. He had intermittent bleeding and significant dysuria after the catheter was removed. Five weeks postinjury he was evacuated to Japan where proctoscopy showed granulation around the perforation in the anterior rectal wall, and digital rectal examination revealed a tender induration in the mid-prostate base. At panendoscopy, chronic inflammatory changes were noted at the base of the prostatic urethra and adjacent trigone of the bladder, and abdominal pelvic examination suggested an intraprostatic and a subtrigonal mass. Subsequent transurethral unroofing of a chronic inflammatory intraprostatic and subtrigonal abscess, with removal of an apparent piece of bark, was accomplished. Three weeks later, proctoscopy revealed an opening in the anterior rectal mucosa with protruding granulation tissue, and that induration of the midbase of the prostate persisted, consistent with persistent foreign body reaction. Because of lack of symptoms, further surgery was deferred, and 15 weeks after his injury, the patient was discharged for reassignment and follow-up.

Comment on Case 7-1

Punji sticks were sharpened, wooden stakes that were covered with human excrement and concealed in the ground. These sticks often inflicted disabling soft-tissue wounds, which were complicated by severe infection. This patient had a prolonged postinjury course that was complicated by local infection and foreign body reaction, but his condition responded to conservative debridement. More-aggressive initial debridement including fecal diversion may have been considered by some, but in retrospect, this may have caused more-extensive patient morbidity.

Case 7-2

J. C., a 21-year-old soldier, suffered a puncture wound of the anterior rectum and prostate after falling on an ax handle. The rectal perforation was demonstrated at proctosigmoidoscopy. The urine was grossly bloody on catheterization and voiding cystourethrography revealed an intact bladder and urethra. The Foley catheter was removed at 3 weeks postinjury when his voiding cystourethrogram and digital rectal exam were normal; the urine was clear and he was discharged to duty.

Comment on Case 7-2

This patient was fortunate not to have developed a perirectal or a periprostatic pelvic abscess. Such rectal perforations should preferably be managed by debridement, surgical closure, diverting colostomy, and dependent pelvic drainage.

Case 7-3

W. H., a 21-year-old soldier, fell from a tank onto a stick and incurred a puncture wound of the anterior rectum, bladder, and prostatic urethra. At pelvic exploration, the bladder and rectal perforation were debrided and repaired, a suprapubic and Foley catheter placed, and after sigmoid colostomy, pararectal drainage was established. After the patient arrived in Japan 5 days postinjury, the incision was clean, the tubes were functioning well, and so the pararectal drains were removed. Two and one half weeks postinjury, the patient was evacuated to CONUS with suprapubic and Foley catheters maintained and without complications. No follow-up was available.

Comment on Case 7-3

This patient had ideal treatment of a puncture wound of the rectum and bladder or prostatic urethra: pelvic exploration, debridement and repair of the bladder and rectal wounds, suprapubic cystotomy, Foley catheter–stenting of the urethra, and diverting colostomy.[9] Approximately 3 weeks after the injury, cystourethrography should be accomplished to establish healing and to rule out urinary extravasation or fistula.

Fragment and Gunshot Wounds

Case 7-4

R. G., a 23-year-old soldier, was wounded in the left buttock by a hand grenade fragment. The fragment penetrated his rectum just above the anal verge on the left, traversed the left lobe of the prostate and the bladder near the vesicle neck, and exited the abdomen anteriorly through the rectus sheath. The patient had debridement and closure of the rectal wound; debridement and open dressing of the buttock wound; abdominal pelvic exploration with debridement of the bladder; and repair of the bladder and suprapubic cystostomy, Foley catheter drainage, and sigmoid double-barrel colostomy. Four days postinjury he had a delayed primary closure of the buttock wound. Cystourethrography, panendoscopy, and proctoscopy, done 18 days later in Japan (by JNW), demonstrated a small prostatourethral rectal fistula, which eventually healed without sequelae on continued suprapubic and Foley catheter bladder drainage. Closure of the colostomy was accomplished in CONUS. Two years later the patient was seen in Japan again (by JWW) complaining of a dry ejaculation but without voiding abnormalities.

Comment on Case 7-4

This case illustrates the value of complete urological evaluation of the urethral wound (cystourethrography and panendoscopy) and the rectal wound with proctoscopy to establish the degree of healing. The prostatorectal fistula healed after prolonged catheter drainage. Dry ejaculation presumably was secondary to destruction, fibrosis, or both of the prostate and ejaculatory ducts from the fragment wound.

Case 7-5

R. C., a 22-year-old soldier, incurred massive GSWs of the buttocks, rectum, bladder, prostate,and bony pubis and had a large soft-tissue loss to the right thigh, buttocks, and anus. At midline abdominal pelvic exploration, a divided diverting colostomy was performed, along with debridement; repair of the bladder and drainage with a suprapubic cystostomy; pelvic and perineal and soft-tissue wound debridement; and Foley catheter stenting of the prostatic wound. An intravenous pyelogram was normal; specifically, there was no ureteral injury shown. He received intravenous penicillin and streptomycin and oral Gantrisin (sulfisoxazole; Roche Laboratories, Nutley, NJ). The patient was evacuated to Japan 20 days postinjury with a healing midline incision and well-functioning suprapubic and Foley catheters and colostomy; no overt infection was seen from the pelvis, the large, soft-tissue defect of the right thigh and buttock, or the destroyed posterior rectum. The Foley catheter was removed but the patient was unable to void at attempted cystourethrography. He was soon evacuated to CONUS with the suprapubic catheter. His massive wounds about the rectum were clean and granulating and responding favorably to local daily irrigations.

Comment on Case 7-5

This patient had a massive wound to multiple organs that was well managed and without early complications. He will require significant revisional and reconstructive surgery and is likely to have long-term disability. Longitudinal follow-up of patients with extensive wounds like this is vital to establish guidelines for future therapy of such wounds.

Case 7-6

A. H., a 24-year-old soldier, was wounded by an AK-47 gunshot to his pelvis and had a second separate wound to his left arm. His pelvic abdominal wound of entry was in the left perineum and the missile exited in the left inguinal area. The notes from the original surgeon in RVN said that the transabdominal pelvic exploration revealed "complete destruction of the dome and the anterior wall of the bladder down through the prostatic urethra with the bladder floating freely." The wound involved the prostate and prostatomembranous urethra. All the structures were virtually destroyed. After-debridement of the pelvic wound and passage of a Foley urethral stent into the bladder, the bladder was repaired and drained by suprapubic cystostomy. Small-bowel resection was done for multiple perforations. A diverting loop colostomy was done to avoid possible fecal contamination. The patient required 6,500 mL whole blood. The perianal and wounds of the left arm were debrided. The next day, the pelvic bladder wound was reexplored for bleeding; 2,500 mL blood and replacement of a Foley catheter were required to attempt to control bleeding. Over the next several days, the patient developed massive urinary drainage from all pelvic perineal wound sites.

Sixteen days postinjury the patient was evacuated to Japan and immediately had reexploration of the pelvis with evacuation of clots and debris from the pelvis, drainage of a retropubic abscess, and placement of perivesical sump drainage and a 3-way Foley catheter for irrigation. An intravenous pyelogram ruled out ureteral injury. Reexploration of the bladder and pelvis occurred 5 days later for continuing urinary wound drainage and nonfuctioning Foley and suprapubic tubes. These tubes were changed but the anterior left wall of the bladder was absent and the posterior bladder and peritoneum were intact. The bladder could not be closed surgically and the prostatic urethra appeared to be completely destroyed. Loose bony fragments were debrided from the pelvic fractures. A large Malecot catheter was brought through the wound of entry in the perineum, which was used for drainage and suction was applied. The patient developed a generalized sepsis during his hospitalization. He was evacuated to CONUS 8 weeks postinjury (with no follow-up) with all his drainage tubes in place; urinary drainage was primarily from the pelvic perineal catheter.

Comment on Case 7-6

This case illustrates the difficulty in managing massive, high-velocity, devitalizing wounds. The bullet destroyed a large segment of the bladder and prostate and caused severe pelvic hemorrhage, much of which was from the prostatic and periprostatic area. Establishing control of urinary drainage is a major problem and challenge in these extensive injuries. This patient was lost to follow-up but we (JNW and JWW) assumed then that he most probably would have required permanent urinary diversion because of the extensive bladder and prostatic urethral destruction.

Case 7-7

S. T., a 23-year-old soldier, suffered multiple, high-velocity GSWs to both legs, perineum, external genitalia, bony pelvis, and small bowel; and essentially complete destruction of the anterior bladder and prostatic urethra, scrotal contents, and much of the pubic bone. After wound debridement, he had bilateral orchiectomy and attempted bladder repair and suprapubic cystostomy. Over the next several days, he had redebridement of the perineum and extremity wounds, a high above-the-knee amputation on the right, a diverting left colostomy, and reexploration and attempt at secondary repair of the bladder for complete separation of the initial repair. He received intravenous quinine for falciparum malaria. On evacuation to Japan 2 weeks later, the abdominal examination revealed a functioning colostomy, massive soft-tissue destruction of the lower abdomen and perineum, and absence of the scrotum and testis. The anterior aspect of the bladder had been destroyed, and the open bladder resembled a bladder extrophy. One could observe the trigone with the ureteral orifices effluxing urine, which extravasated down into the wound. The soft tissues about the prostate and urethral sphincter were absent. The rectum was intact. Because of continued urinary extravasation, poor healing, intermittent sepsis, a nonreconstructible bladder, and absence of the prostatic urethra, approximately 3 weeks postinjury a cutaneous bilateral ureteroileostomy was performed. The patient's lower abdomen and perineum wounds required redebridement. During the remainder of his hospitalization, the urinary diversion functioned well, but he developed numerous complications: acute liver failure, hypertensive encephalopathy, Gram-negative pneumonia, and lung abscess, septicemia from *Herellea* [a genus of bacteria now included in the genus *Acinetobacter*—DEL, ed], and an obstruction of the small bowel. The patient was evacuated to CONUS 65 days postinjury with a need for extensive further surgery and rehabilitation.

Comment on Case 7-7

Urinary diversion presented a difficult problem in light of this patient's massive complicated wounds. The method of choice for permanent urinary diversion at the time these injuries were treated was cutaneous bilateral ureteroileostomy. The need for urinary diversion presents numerous surgical challenges and potential complications in these patients with severe multiple wounds—poor healing, negative nitrogen balance, infection, and sepsis—especially in patients with trauma to the abdominal wall associated with extensive loss of soft tissue. Urologists today might consider percutaneous nephrostomy or internal ureteral stenting to provide temporary definitive urinary diversion for some of these patients with massive bladder and pelvic destruction with extensive urinary extravasation. But such techniques and equipment were not available during the Vietnam War, which made it difficult to adequately drain the urinary tract with these extensive wounds.

Case 7-8

C. R., a 24-year-old soldier, was wounded by a gunshot missile to the buttocks and pelvis, incurring wounds to the bladder, prostate, pubic rami and ischial tuberosity, and small and large bowel. At abdominal pelvic exploration, the bladder was repaired and drained with a suprapubic tube, a Foley catheter stented the urethra, and the wound was debrided and the retropubic space and buttocks area drained. Multiple small-bowel lacerations were repaired and a sigmoid colostomy performed. In Japan 3 weeks postinjury, voiding

cystourethrography (after removal of the patient's Foley catheter) showed a posttraumatic defect in the prostatic urethra without fistula or extravasation. The patient voided well at the time of evacuation but required urethral dilations for his proximal urethral stricture, and he had considerable necrotic dead bone with persistent wound drainage.

Comment on Case 7-8

Urethral stricture is not an unexpected event from the posterior urethral traumatic wound. Initially, these strictures should be treated with dilation. This patient will have required further surgical debridement of the necrotic dead bone. Patients with bony pelvic wounds often required redebridement with removal of bone fragments.

Case 7-9

D. R., a 20-year-old soldier, had a GSW of the pelvis; the missile entered the base of the left scrotum and exited through the coccyx, injuring the testes, prostatic urethra, prostate, rectum, and coccyx. At abdominal pelvic exploration the patient received a divided left colostomy, urethral catheterization, suprapubic cystostomy, coccygectomy, and left orchiectomy, with retropubic and pelvic floor drains. Shortly after evacuation to Japan, the patient experienced a small-bowel obstruction secondary to an intraabdominal abscess and was treated with partial small-bowel resection and drainage of the abscess. On rectal examination, induration of the periprostatic area was found, as well as a hole in the posterior rectal wall that allowed the rectal finger to enter the sacral wound. Three weeks postinjury, urethrography revealed a posterior urethrocutaneous fistula, and the patient was evacuated to CONUS with a Foley catheter and suprapubic tube.

Comment on Case 7-9

Prostatourethrorectal fistulae occur after penetrating prostatic urethral wounds. Such wounds need postinjury urethrography to rule out fistulae and define urethral integrity before the Foley catheter is removed. These fistulae generally heal with more-prolonged urethral catheter drainage. Coccygectomy was often performed in RVN as part of initial treatment to facilitate pelvic drainage in these complex pelvic urinary tract wounds with rectal and sacral or coccygeal involvement.

Case 7-10

J. S., a 21-year-old soldier, was shot by an AK-47. The bullet went through the perineal buttocks area, exited through the sacrum, and wounded the prostatomembranous urethra, sacrum, inferior pubic rami, and rectum. Initial treatment consisted of wound exploration and debridement, after which a suprapubic tube and Foley catheter were inserted, the rectal laceration was repaired, and a proximal diverting colostomy was performed. The rectal repair suture line separated in RVN, and the patient developed septicemia, which required reoperation with resection of a major portion of the rectum and anal sphincter. In Japan, the patient developed a tension pneumothorax that required surgery, urethral dilations for a severe stricture of the prostatomembranous urethra, and Gram-negative shock from a urinary tract infection caused by a *Klebsiella-Aerobacter* species. He was evacuated to CONUS 2 months after his initial trauma with a suprapubic tube and with the sacral wound virtually healed.

Comment on Case 7-10

Urethral strictures are common sequelae from traumatic urethral injury. This patient had complete transsection of the prostatomembranous urethra, which is a severe injury, and his stricture may well have required surgical reconstruction. The patient, however, was lost to our follow-up.

Case 7-11

P. S., a 19-year-old soldier, sustained GSWs with injuries to the penis, prostate and prostatic urethra, rectum, and left femur. His wounds were explored and debrided; the rectum was repaired, and a colostomy was performed. Both a suprapubic and a Foley catheter were inserted, and the pelvis was drained. A perineal abscess required surgical drainage in RVN. On evacuation to Japan, 16 days postinjury, the patient was found to have a 26 French (F) Foley urethral catheter indwelling and marked purulent urethritis. The catheter was removed and the bladder was periodically rinsed with neomycin over the next 3 days, at which time the patient was unable to void. He required periodic urethral dilations of his penoscrotal urethral stricture for a presumed large-catheter-induced urethritis. At the time of medical evacuation to CONUS, the patient was voiding through his urethra, but a suprapubic tube was maintained because of the severity of his urethral stricture.

Comment on Case 7-11

Catheter care in the wounded casualty was a low priority in RVN and in the evacuation chain. Catheter urethritis occurred frequently and was often associated with postcatheterization strictures. Ideally, a 16F or 18F Foley catheter is the optimal size to stent the urethra and drain the bladder. In this case, the 26F Foley may well have contributed to the urethral stricture. The incidence of catheter-induced stricture can be reduced significantly by routine use of the smaller catheters and taping and fixing the catheter up on the abdomen, thus avoiding pressure necrosis to the penoscrotal urethra.

Case 7-12

L. R., a 22-year-old soldier, incurred a GSW of the lower abdomen and pelvis; the wound of entry was in the right base of the penis, the wound of exit in the right buttock. No intraperitoneal injury was found at abdominal pelvic exploration. Retroperitoneal pelvic exploration revealed a bullet tract through the prostatic urethra and rectum. Prostatic bleeding was controlled with 0-chromic catgut suture ligatures, 2 drains were placed in the space of Retzius, and a sigmoid double-barreled colostomy was performed. A Foley urethral catheter and suprapubic cystostomy were inserted, and the bladder wound was debrided and left open. Two weeks after injury, the patient was evacuated to Japan, where digital rectal examination revealed an edematous and tender prostate. Intravenous pyelography was normal, and cystography showed an intact bladder but some puddling of iodine contrast in a posttraumatic defect in the prostatic urethra without extravasation of contrast material into the periprostatic tissue. Approximately 1 month postinjury, cystourethrography revealed a deformity of the prostatic urethra but no stricture or extravasation. The patient voided to completion, and 2 days later the suprapubic tube was removed; 6 weeks after the injury, a size 24 van Buren sound was easily passed into the bladder. The colostomy was subsequently closed and the patient was evacuated to CONUS.

Comment on Case 7-12

This case reflects that bleeding from a traumatic wound of the prostate can often be satisfactorily controlled with direct suturing with chromic catgut. Depending on the severity of the wound and the hemorrhage, we feel that such an approach should be strongly considered initially to obtain hemostasis. Other approaches in managing prostatic and periprostatic hemorrhage from penetrating wounds are discussed below.

DIAGNOSIS AND MANAGEMENT

Although uncommon, penetrating war wounds of the posterior urethra, most often from either bullets or fragments and frequently of high velocity, not only result in extensive local tissue damage to the prostate, prostatomembranous urethra, and adjacent bladder but also have a high incidence of serious injury to other adjacent organ systems. In his chapter entitled Urethral Injuries in the US Army Medical Department's official history of surgery in World War II, Culp,[1] emphasized that

> wounds of the deep urethra rarely existed independently of other wounds. The buttocks, thighs, hips, sacrum or perineum usually were involved. Occasionally, the rectum was included. Furthermore, injury to the deep urethra had to be suspected in all instances of trauma of any of the aforementioned regions.[1(p416)]

To recapitulate, of the 20 penetrating posterior urethral wounds that we managed in Japan, 17 were caused by gunshots or missile fragments and 3 were puncture wounds (see Table 7-4). Twelve patients had 1 or more concomitant injuries to the GU tract (see Table 7-5) with damage to the bladder being most common (45% of patients), and all patients had injury to 1 or more nonurological organ systems, with damage to the rectum (65% of patients) and bony pelvis (40% of patients) the most common. This group of 20 patients had 44 major nonurological organ system wounds (see Table 7-6).

Diagnosis

There are several signs of posterior urethral disruptive injury: blood at the urethral meatus; inability to void or pass a catheter; gross hematuria; bladder distension, a high-riding prostate, or both on physical exam; and periurethral or perivesical pelvic urinary extravasation on retrograde urography, if performed (this is discussed in Chapter 6, Blunt Pelvic Trauma With Posterior Urethral Disruption). However, the diagnosis was most often suspected by the path of the missile or missiles, the locus of wounds, a high index of suspicion because of associated organ injury (rectum, bony pelvis, buttocks, and perineum), and the findings at abdominopelvic and wound exploration. Proctosigmoidoscopy was routinely performed to rule out colorectal injury.

Management of Posterior Urethral Wounds

All the posterior urethral injuries discussed in this chapter were stented with a Foley catheter. Suprapubic cystostomy was used for all major posterior urethral wounds and after primary repair of any bladder injuries. Preferably, rectal injuries were treated by debridement, primary repair when possible, and diverting colostomy in all. After pelvic and wound debridement, dependent pararectal and retropubic pelvic drainage was established. All soft-tissue wounds were debrided and had subsequent delayed primary closure. The general techniques of diagnosis and treatment that were employed in RVN for managing these wounds meet current recommendations of care for such wounds (Exhibit 7-1).

Exhibit 7-1
General Principles In Management Of Posterior Urethral Wounds

- Complete wound and abdominal pelvic exploration and debridement
- Repair and drainage of all injuries
- Control of hemorrhage
- Suprapubic cystostomy in all
- Early urethral reconstruction or realignment and catheter stenting of the urethral injury
- Colostomy for colorectal wounds
- Adequate dependent pelvic drainage

Urethral Catheter and Suprapubic Cystostomy

Urethral catheters and suprapubic cystostomies are essential components of postwounding urethral reconstructions (see Exhibit 6-2). Stenting of the urethra should be accomplished with a 16F silicone-coated Foley catheter, although some[10] advocate the use of larger catheters (up to 22F). During the Vietnam War, many urologists recommended Foley catheter traction in the initial management of the posterior urethral disruptive injuries. Current thinking, however, is that catheter traction is contraindicated as it may cause urinary incontinence and does not enhance healing.[11,12] Ideally, the urethral catheter should be stabilized to the lower abdominal wall with the penis directed upward in a gentle curve (1) to obviate pressure on the penoscrotal urethra and (2) to minimize urethral pressure necrosis and subsequent secondary stricture formation. The urethral catheter should be maintained for at least 6 weeks in the major wounds, and is removed if a voiding cystourethrogram or a pericatheter urethrogram does not reveal urinary extravasation.[13]

Generally, a 26F to 32F Malecot suprapubic cystostomy tube should be placed in all these wounded casualties, preferably through the anterior dome of the bladder, emerging extraperitoneally from the bladder. When properly placed, the shaft of the catheter should be firmly fixed in the bladder wall with a single suture and then made to exit through either the abdominal wound or a separate stab incision in the abdominal wall, sloping ventrally and cranially and stabilized on the abdominal wall by suture fixation and adhesive tape.

After the Foley catheter has been removed, the suprapubic tube should remain for an additional 7 to 14 days and be removed only if the patient voids satisfactorily after a voiding cystourethrogram has demonstrated an intact urethra without stricture. Suprapubic drainage should remain in place until any urethral stricture has satisfactorily resolved. Of the patients we managed in Japan, most who had penetrating missile wounds of the posterior urethra were evacuated to CONUS with suprapubic tubes, even if they were voiding satisfactorily, because of the short-term follow-up and the high risk for subsequent urethral stricture.

Fragment and Puncture Wounds

For the most part, the management of fragment and puncture wounds of the posterior urethra presented few problems in either their initial treatment in RVN or subsequent treatment in Japan. These wounds were much less severe than GSWs and had no significant complications or known late sequelae. Generally, these casualties had diagnostic proctosigmoidoscopy for suspected colorectal wounds and to define posterior urethral and bladder injuries: either panendoscopy, retrograde urethrography, and cystography (see Chapter 6, Blunt Pelvic Trauma With Posterior Urethral Disruption), or abdominal pelvic exploration, or both.

High-Energy-Transfer Missiles

As opposed to puncture and low-velocity missile and fragment wounds, GSWs of the prostate and posterior urethral structures often resulted in extensive serious shattering, devitalizing, and disruptive wounds to the prostate, prostatomembranous urethra, and adjacent bladder, creating both anatomical derangement and severe bleeding. Two reports[7,8] from urologists during the Vietnam War describe several patients with essentially complete destruction of the prostate and prostatic urethra, and major bladder destruction without distal prostate and urethral attachments, with obliteration of the internal and external sphincteric urethral mechanisms, usually associated with massive pelvic and subsymphyseal hemorrhage, associated with other major pelvic organ wounds. The surgical management in those extensive wounds was aimed at controlling hemorrhage and reestablishing bladder posterior urethral continuity.

Control of Bleeding

Pelvic, periprostatic, and retropubic subsymphyseal hemorrhage was treated by transfusion, pelvic packing and compression, bilateral hypogastric artery ligation, and direct suture ligation of the bleeding prostate and its dorsal venous plexus. Today, all of these techniques are still employed to manage bleeding associated with these injuries. However, experience with bilateral hypogastric artery ligation for control of pelvic hemorrhage has been somewhat disappointing.[8,14,15]

One urologist in Vietnam[14] used symphysiotomy successfully in 3 instances to adequately define and control massive pelvic bleeding and to facilitate bladder prostatourethral reconstruction and continuity, after experiencing 3 deaths from hemorrhage, tissue necrosis, and infection when using conventional abdominal pelvic exploration in treating these wounds.

Subsequently, Selikowitz[14] recommended symphysiotomy in select cases to (1) stop severe uncontrollable subsymphyseal hemorrhage and (2) facilitate more-adequate debridement and more-controlled, accurate, prostate and posterior urethral reconstruction. In experienced hands, a more-traditional transpubic approach with partial pubectomy[16,17] should be considered to stop bleeding in the rare instances of refractory, uncontrolled, subsymphyseal hemorrhage in these wounded casualties. Currently, angio-infarction of a well-defined bleeding pelvic artery with severe hemorrhage is employed selectively in well-equipped and -staffed medical facilities to control bleeding.[18]

Posterior Urethral Reconstruction

Essentially all high-velocity penetrating wounds of the prostatomembranous urethra were explored through a transabdominal suprapubic incision. All had suprapubic cystostomy and urethral Foley catheter stenting. To reestablish continuity between the posterior urethra and the bladder, several techniques were employed depending on the extent of injury and the experience and bias of the urologist or general surgeon. In less-severe wounds (those with incomplete or complete posterior urethral disruption, without significant tissue loss and distraction, and with controlled bleeding), urethral continuity was established by primary realignment over an indwelling, stenting Foley catheter, usually without traction and often without attempts at direct surgical repair and anastomosis (for further discussion, please see Chapter 6, Blunt Pelvic Trauma With Posterior Urethral Disruption). Direct suturing of opposing ends of the prostate to the prostatomembranous urethra was employed by some; others used extravesical sutures placed through the bladder, periprostatic tissue, and periurethral urogenital diaphragm, closely approximating and buttressing the severed ends of the prostatomembranous urethra.[7,8] One urologist[8] preferred to use 2 mattress sutures of number 1 nylon passed intravesically through each lateral aspect of the bladder neck, then passed directly through the GU diaphragm on to the perineum and tied over a bolster, for reapproximation of the posterior urethra in wide disruptive distraction wounds; these sutures were removed 2 to 3 weeks later. A similar “sling” technique has also been used for urethral realignment after extensive blunt posterior disruptive injuries.[19] In 1 completely destroyed prostate, the bladder was approximated to the membranous urethra by direct suturing.[7]

COMPLICATIONS

The major complications experienced in the 20 penetrating posterior urethral wounds that we managed in Japan were outlined above in the Wound

Analysis section of this chapter. Puncture and fragment wounds were generally uncomplicated and resulted in little morbidity. However, 10 of 14 (71%) patients with GSWs developed major complications (see Table 7-7). These 10 patients had 21 major complications that required 15 anesthetic operative procedures in Japan (see Table 7-8).

In general, the complications of penetrating posterior urethral wounds can be classified as early or delayed (Exhibit 7-2) and arise primarily from (1) the severity of the original wounds, (2) attempts at repair of the posterior urethral bladder disruption, and (3) postoperative management.

Early Complications

Massive Genitourinary Injury and Urinary Extravasation

Three patients experienced massive (essentially complete) destruction of the posterior urethra and the external and internal sphincteric mechanisms. Two of these patients developed uncontrollable urinary extravasation associated with massive destruction of the lower abdominal wall and anterior bladder and pelvic abscesses. One patient required a complete urinary diversion (bilateral cutaneous ureteroileostomy) in Japan, and the other patient was evacuated with persistent urinary extravasation and most likely had a urinary diversion in CONUS.

Most urologists and surgeons have no experience treating such extensive wounds. No algorithm is available to define the preferred treatment for these severe tissue- and organ-destroying wounds; treatment should be individualized. "Damage control" with hemostasis and suprapubic cystotomy, or nephro-uretero stenting with delayed reconstitution of the lower urinary tract, might be indicated in some of these massive wounds. Adequate control of urinary drainage in these extensive wounds was not possible during the Vietnam War—either in RVN or Japan—because appropriate tubes and stents were lacking. Today, a myriad of suitable, well-designed and -tolerated nephro tubes, internal ureteral stents, and sumps are available to enhance control of urinary drainage and extravasation.

Bleeding

The techniques used in RVN for managing severe bleeding (intraoperative and perioperative, pelvic and retroperitoneal) from these wounds were presented earlier in this chapter. The preferred approach to obtaining hemostasis remains undefined and depends on the severity of both the bleeding and the associated wounds; the stability of the patient; and the experience, expertise, and judgment of the urologist or general surgeon. Current (2004) recommendations, in order of experienced urologists' preference, are

- direct suture ligation of bleeding vessels and tissues;
- "damage control" with pelvic hemostatic packing, suprapubic cystostomy, and delayed urethral realignment or reconstruction[20];

- select angio-infarction for defined arterial bleeding, if available,[18] and
- partial pubectomy or symphysiotomy for intractable, uncontrollable, life-threatening hemorrhage, only by a urologist experienced in these techniques.[14,16,17]

Pelvic Abscess and Urethral Fistula

The frequency of pelvic abscesses is not surprising in light of the high incidence of contaminating associated organ system injuries. However, at-times-inadequate dependent pelvic drainage contributed to such infections.

Urethral fistulae occurred early in 3 patients: 1 whose wound was caused by a fragment and 2 whose wounds were caused by gunshots. All healed with continuous Foley catheter stenting and suprapubic cystotomy without known sequelae.

Urethral Stricture

Urethral stricture occurred early in 4 patients who required periodic urethral dilation in Japan. Calibration of all repaired urethras was routinely accomplished after Foley catheter removal to detect and treat early strictures. Mild strictures will often respond to a few dilations. Because many patients were evacuated with indwelling urethral catheters and suprapubic tubes, and because longitudinal follow-up was lacking, the incidences of early and delayed stricture formation is unknown but expected to be high. No published data of any substance document the frequency of urethral stricture following partial or complete disruptive wounds of the posterior urethra that are treated by any of the techniques of repair, realignment, and urethral stenting. The experience from civilian trauma centers with partial or complete urethral rupture from blunt trauma indicate that following urethral realignment and stenting, the incidence of significant stricture is 50% to 65%.[12,21] Most urologists in major civilian trauma centers dealing with blunt posterior urethral disrupting injuries favor urethral realignment within 72 hours of surgery primarily to promote healing and reduce serious stricture formation.[22] In complete distraction injuries, some[18] have successfully performed urethral realignment and stenting 11 to 19 days after the injury. However, early urethral catheter placement is preferred and can shorten the length of the subsequent stricture.[23] Case experience from World War II favors early urethral realignment to reduce both the extent of stricture and the incidence of fistula.[1]

Patients with complete urethral disruption that is managed with suprapubic tubes only *always* develop a urethral stricture that requires a major urethral reconstruction.[24] It is reasonable to assume that a high percentage of patients with major posterior urethral wounds suffered in RVN developed significant urethral strictures that required surgical intervention and reconstruction (urethroplasty).

Delayed Complications

In addition to urethral stricture, which can be both an early and a delayed complication, delayed complications are listed in Exhibit 7-2. Their true incidence is unknown: not tabulated in reports from prior wars, and not available from the Vietnam War experience because of lack of longitudinal follow-up and documentation. What is known, however, is that these delayed complications stem primarily from the extent of the initial injury and secondarily from the treatment of the wounds. Available data on complications come from the civilian trauma community and pertains to external blunt disrupting posterior urethral injuries (see Chapter 6, Blunt Pelvic Trauma With Posterior Urethral Disruption). For purposes of this chapter, the lack of data on wound complications is regrettable for two reasons: (1) civilian blunt injuries are generally not comparable with penetrating war injuries, and (2) many of the statistical data are from patients who are posturethroplasty for major stricture disease.

EXHIBIT 7-2
COMPLICATIONS OF POSTERIOR URETHRAL WOUNDS

Early Complications
- Bleeding
- Urinary extravasation
- Pelvic abscess
- Destruction of posterior urethra
- Urinary diversion
- Urethral fistulae
- Urethral stricture

Delayed Complications
- Urethral stricture
- Impotence
- Anejaculation
- Infertility
- Incontinence
- Urinary diversion
- Psychological trauma

Impotence and Anejaculatory Dysfunction

The incidence of impotence in a population of patients with severe complete posterior urethral ruptures who ultimately required open repair varied from 48% to 72%[25,26] and an additional 32% of patients in this group reported "poor erections" after the injury.[25] In these injuries, impotence is secondary to damage to the penile parasympathetic nerves[27] and from arterial insufficiency.[28,29] Anejaculation occurs in 15% of patients with urethral distraction injury and is secondary to vesicle neck scarring or damage to the parasympathetic nerves.[12] The incidence of impotence and anejaculatory dysfunction is unknown in the 17 patients whom we managed in Japan with penetrating gunshot and fragment wounds, but it is presumed to be high in those with more-extensive wounds.

Incontinence

Because most patients with major posterior blunt urethral distraction injuries have injury to the external (striated) sphincter (prostatomembranous urethra), uri-

nary incontinence comes from concomitant injury to the internal sphincter (bladder neck).[30] The overall incidence of urinary incontinence in these posterior urethral distraction injuries is low (2%–4%).[18] There are no data from any of the past US wars regarding the incidence of urinary incontinence from these "deep" penetrating posterior urethral wounds. Certainly, a high percentage of patients whose wounds disrupt the internal sphincter at the bladder neck will have some degree of incontinence.

Bladder areflexia can occur from the initial injury and may require intermittent catheterization.[26] Mild stress and urge incontinence is uncommon after major posterior urethral-bladder neck injury.

Urinary Diversion and Psychosocial Trauma

The number of patients requiring definitive urinary diversion is unknown. It is clear that significant temporary and permanent psychosocial trauma resulted from the anatomical and functional derangement secondary to these wounds and resulting complications; however, such data are not available.

SUMMARY

Urethral wounds were uncommon in RVN, accounting for about 12% of all urological injuries. Wounds of the posterior urethra were less common, occurring in only 20 of the 692 RVN-incurred urological injuries to be managed in Japan. Of the 20 wounds of the posterior urethra, 3 were caused by punctures, 3 by fragmentation missiles, and the remaining 14 by gunshots (resulting in more severe wounds). The bladder was injured in 9 patients and there were 44 associated nonurological organ wounds; the most common were damage to the rectum in 13 (65%) patients and to the bony pelvis in 8 (40%).

The diagnosis was suspected by the missile path, the location of the wounds, and the presence of other associated organ injuries; and was established by the findings at abdominal pelvic exploration. Extensive anatomical destruction and derangement and severe hemorrhage resulted from many of these high-velocity GSWs, and treatment was aimed at controlling hemorrhage and reestablishing bladder–posterior urethral continuity. Urethral realignment over a stenting Foley catheter with or without suture anastomosis of the opposing ends of the deranged or distracted tissue was most often used to reestablish posterior urethral continuity. Recommended techniques for control of hemorrhage were outlined above in this chapter. Current practice for severe disrupting wounds should include obtaining hemostasis and suprapubic cystostomy in all, and nephrocutaneous stenting selectively, with delayed reconstruction of the lower urinary tract.

In the 20 patients we managed in Japan, most of the major complications were secondary to GSWs: pelvic abscess, urethral stricture, destruction of urinary sphincteric mechanisms, massive urinary extravasation, and urethral fistulae. These 21 complications occurred in 10 patients and required 15 anesthetic-operative procedures, including definitive urinary diversion in 1 patient.

Delayed complications of posterior urethral wounds include urethral stricture, impotence, anejaculation, infertility, incontinence, urinary diversion, and psychosocial trauma. The lack of follow-up data has prevented us from knowing the incidence of delayed complications in our patients. It is clear, however, that the most common delayed complication, *urethral stricture*, will occur in a significant number of patients with posterior urethral wounds.

Because of their infrequency, posterior urethral wounds from past wars are known to us primarily through case reports. Few or no tabulated data define the extent of the initial wounds and their treatment, the details of complications, the results, and long-term follow-up. However, the general principles of management have not changed substantially since World War II and still apply to the management of these wounds.

Today's technical and technological advances, the availability of highly trained ancillary medical personnel, and the military's enhanced logistical capability including aeromedical evacuation—all of which are superior to that available during the Vietnam War—may change the initial management of some of these posterior urethral wounds. A host of effective inert tubes, catheters, stents, and drainage systems has been developed to enhance control of temporary urinary diversion, and innovative endourological equipment and techniques to facilitate urethral realignment and stenting may currently be available in some of the forward medical treatment facilities. Angiographic embolization, capability, and expertise may well be available relatively close to the battle zone. All the above developments could allow improved initial treatment of hemodynamically unstable casualties with extensive, destructive wounds of the posterior urethra and prostate.

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