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# Complex Genital Trauma: Lessons Learned from Operation Iraqi Freedom and Operation Enduring Freedom

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**Abstract**
*Purpose of Review* To discuss the contemporary management of genital trauma focusing on innovations that occurred as a result of the increased number of patients with genital trauma treated during contemporary armed conflicts.
*Recent Findings* An unprecedented number of US service members sustained genital injuries during the recent wars in Iraq and Afghanistan. Genital injuries were commonly one component of a complex pattern of polytrauma, usually including extremity amputation(s), pelvic fracture, and colorectal injuries. The initial management of genital injuries must adhere to damage control principles while ensuring adequate urinary drainage, genital tissue preservation, and early psychological assistance when needed. Long-term management must focus on the restoration of urinary, sexual, and reproductive function, each of which can be challenged by the negative impact polytrauma can have on each of these functions in the long term.
*Summary* Restoration and rehabilitation of urinary, sexual, and reproductive function is achievable in the majority of patients who sustain complex genital trauma provided a patient centered, multidisciplinary approach is followed. Future studies should focus on evaluating the long-term outcomes of genital trauma as well as investigating novel methods of genital reconstruction and fertility restoration.

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## Introduction

Traumatic injuries to the external genitalia are infrequently addressed in the contemporary scientific literature. This is likely due to a multitude of factors: relative rarity of genital injuries, non-life threatening nature of genital injuries, and the sensitive and personal nature of functional changes after genital injury. Indeed, a recently published collection of clinical guidelines for the evaluation and management of urotrauma focused mainly on abdominal urologic organs (kidney, ureter, bladder) because the paucity of data on genital injury limited the guideline panel's ability to develop a large number of evidence based clinical guidelines pertaining to genital trauma [1•].

During recent US involvement in armed conflicts in Iraq and Afghanistan, an unprecedented number of US service members (SMs) sustained genital injuries [2••]. Thus, a unique opportunity for clinical skill development, data collection, and long-term outcome analysis has arisen which will hopefully improve the early care and long-term outcomes for future patients who sustain genital trauma either in peacetime or in war. The objective of this review is to discuss lessons-learned from genital injury care during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) and offer potential applications of these wartime lessons relevant to non-military settings.

## Battlefield Genital Injury, Twentieth Century Conflicts

Genitourinary (GU) trauma data from the twentieth century conflicts was limited in scope and detail. Battlefield injury

data collection was not standardized, and thus the few publications pertaining to GU trauma from World War I, World War II, the Korean War, and the Vietnam War were based on the case series of individual surgeons and/or hospitals [3]. However, despite limitations in the data acquired across this large span of time, two broad epidemiological observations remained unchanged. First, GU trauma was relatively rare (0.7–8% of all casualties) and second, renal and bladder trauma predominated over injuries to the external genitalia [3].

An important shift in the distribution of GU injuries occurred by the end of the twentieth century. During the first Gulf War (1991), renal injuries had become less common and genital injuries were observed more frequently [4, 5]. While the true cause of this shift is not entirely clear, some authors hypothesized that Kevlar® body armor (the use of which had become widespread among US ground forces) afforded protection to abdominal urologic organs but not the more exposed external genitalia [4]. Detailed data on the initial and long-term management of genital injuries remained virtually nonexistent.

## Genital Injury during OIF/OEF

During US involvement in Iraq and Afghanistan, a number of factors converged which ultimately resulted in the frequency of genital injuries increasing to a level never before reported in the history of war. The majority of injuries sustained during these conflicts were caused by explosive mechanisms and frequently resulted in a unique injury pattern known as dismounted complex blast injury (DCBI), defined as blast injury to a dismounted troop resulting in multiple extremity amputations, pelvic fractures, and extensive genital/perineal wounds [6•]. This complex injury pattern was not reported in previous conflicts because of the high mortality of polytraumatic explosive injuries. Fortunately, a number of twenty-first century advances in combat casualty care (rapid casualty evacuation, tourniquet application, advanced resuscitation techniques, multidisciplinary damage control surgery) improved the survival of complex blast injury which in previous conflicts were uniformly fatal [6•]. An unfortunate consequence of decreased mortality rates after complex blast injury was that an unprecedented number of US SMs survived only to face the challenges of recovery from catastrophic genital injuries which in prior conflicts were not survivable.

OIF and OEF also saw the development and expansion of the Department of Defense Trauma Registry (DoDTR, formerly known as the Joint Theater Trauma Registry). Managed by the Joint Trauma System in San Antonio, Texas, the goal of the DoDTR is to document and analyze US military injury demographics, mechanisms, diagnosis, treatment, and outcomes from the point of wounding to final disposition [7]. Given the increased frequency and unique nature of GU injuries observed by military physicians during OIF/OEF, several groups have queried the DoDTR and other data sources to report the epidemiology and clinical picture of GU injury observed during this time [2••, 8, 9, 10–12].

In 2007, Paquette identified 98 GU injuries among 76 patients from a group of 2712 US SMs and coalition forces injured in Iraq (2.8%). Half of the patients were injured by explosions, and genital and/or urethral injuries comprised 55% of all GU injuries [11]. Later in the conflict, Serkin et al. published a report on 819 US SMs with 887 GU injuries, 90% of which were sustained in Iraq with the remainder sustained in Afghanistan. Explosive mechanisms injured 65.3% of the patients, and genital injuries comprised 53% overall [12].

As the conflicts ensued, strategic focus shifted away from Iraq and toward Afghanistan. Here, the rugged terrain limited vehicular movement, and thus, dismounted (on foot) maneuvers were more common placing SMs at risk for injury from ground-based explosive munitions resulting in the complex injury pattern (DCBI) discussed above. Banti et al. were the first to report DoDTR data after this shift occurred. They reviewed military electronic health records to confirm combat-related genital and/or urethral injury(−ies) in 501 men among 890 SMs with GU injuries identified in the DoDTR. Explosive mechanisms predominated, and 96% of patients sustained concomitant non-GU injuries, most commonly limb amputation (36%), soft tissue injury (18%), and fractures (17%), thus illustrating the high complexity of explosive battlefield GU polytrauma [8].

After the formal conclusion of OIF and OEF, Janak et al. published a comprehensive review of the DoDTR for GU injuries sustained by US SMs in Iraq and Afghanistan, representing the largest series of military GU injuries ever reported. Nearly 30,000 US SMs had injury codes available for review in the DoDTR during the 12 years analyzed. Among them, 1462 (5.3%) US SMs sustained one or more GU injuries. All but 20 were male and 75 of the SMs died of their wounds. Among the 1367 male survivors, 88.6% of the injuries were sustained in battle, 74.1% were caused by an explosive mechanism, and 1000 (73.2%) had at least one injury to the external genitalia. This included 760 men with scrotal injuries, 451 with testicular injuries, 423 with penile injuries, and 125 with urethral injuries [2••].

Severe polytraumatic injury was common among the male survivors with 62.1% having an injury severity score (ISS) of 16 or higher. Injuries reflective of the complexity of DCBI were common, including colorectal injury in 21.7%, pelvic fracture in 25.0%, traumatic brain injury in 40.2%, and lower extremity amputation(s) in 28.3% [2••]. Severe GU injury was identified in 502 men (36.7%). Those with severe GU injury had higher rates of ISS ≥ 16, colorectal injury, pelvic fracture, and lower extremity amputation, [2••] suggesting that the complexity of GU injury is a surrogate for overall injury severity.

A sub-analysis of this same patient cohort sought to further elucidate the relationship between genital injury and extremity amputation. Among the 1367 surviving males with GU injury, 433 (31.7%) had one or more extremity amputations including 3.4% with upper extremity amputation(s) only, 19.4% with lower extremity amputation(s) only, and 8.9% with both upper and lower extremity amputations. As anticipated, those with extremity amputations were more commonly injured in battle and by an explosive mechanism, had higher ISS, and were more likely to sustain a severe GU injury. Lower extremity amputations were usually at a high level, with 300 of the 387 men (77.5%) with lower extremity amputations located at or above the knee. Polyamputation was common among men with GU injury: 133 had two extremity amputations (one upper extremity and one lower extremity, or two lower extremities), and approximately 79 had three or more extremity amputations [10].

The recently published reports on contemporary battlefield GU injury discussed above provide a robust account of the high frequency and severity of complex genital injuries observed in modern warfare. Unfortunately, no studies have comprehensively evaluated the long-term outcomes following GU injury in this setting. However, prospective evaluation of the large cohort of men who sustained GU injury during OIF/OEF is underway [2••] and will hopefully provide much needed information on this topic.

## Initial Management of Complex Genital Injury

In isolation, complex genital injury is not life threatening. Therefore, genital injury management must adhere to damage control principles while comorbid life-threatening injuries are initially staged and managed. Urinary drainage must be established as soon as possible [13]. If disfiguring genitourethral injuries preclude successful passage of a transurethral catheter, a suprapubic cystostomy should be placed either percutaneously (using commonly available prepackaged kits) or in an open manner at the time of trauma laparotomy. A 16 French foley catheter placed through a small cystostomy in the anterior bladder wall, secured with a purse-string suture and brought out through a separate stab incision provides prompt, safe bladder drainage throughout the initial resuscitative period. Concomitant bladder rupture is not uncommon and can be ruled out with plain-film or CT cystography if not adequately evaluated intraoperatively.

Once urinary drainage is established, genital injuries should be irrigated with copious low-pressure saline solution, especially when explosive mechanisms (or other complex penetrating causes) lead to extensive wound contamination. Any transected, actively bleeding penile, scrotal, and/or spermatic cord vessels can be ligated or fulgurated; although, significant hemorrhage is rare given the small caliber of genital end-arteries. Extensive debridement should be avoided at this time, given the unique structure and difficult to replace nature of the genital structures (i.e., phallus, clitoris, testis). The genital wound can then be packed with moist gauze secured with a mesh undergarment while the patient is further resuscitated.

On secondary operative evaluation (or if the patient is stable at the time of initial evaluation), comprehensive genital injury staging must be completed [14•]. Urology involvement is imperative, when available. After dressing takedown, low-pressure irrigation is repeated, and each genital structure is examined to rule out injury. For males, this includes the paired corporal bodies, the pendulous and bulbar urethra, each testicle/spermatic cord, and the genital skin and soft tissue. The lithotomy position is helpful, especially when the wound extends into the perineum. Each injured structure is assessed for continuity and viability. Corporal lacerations are closed with 2–0 polydioxanone suture. Urethral transections are realigned over a foley catheter and closed with 4–0 polydioxanone suture; lacerations are similarly closed over a catheter. Simple testicular lacerations are closed with 4–0 polyglactin suture after debriding any necrotic or protuberant seminiferous tubules. Large defects in the tunica albuginea can be covered with a small graft of parietal tunica vaginalis, secured with 4–0 polyglactin suture [1•]. Orchiectomy is appropriate for unilateral testicular injuries deemed non-salvageable. However, even a small remnant of the body of one testicle can maintain androgen function and thus preclude the need for long-term testosterone replacement. When orchiectomy is needed, the cord should be suture-ligated in two separate packets with 0 or 2–0 polyglactin suture. Innovative (but logistically challenging) sperm salvage techniques are discussed below.

Once the deep genital structures are fully staged, the skin and soft tissue is assessed for viability and quantity. For less complex, non-contaminated injuries without tissue loss, the skin and underlying dartos tissues are closed in layers over one or several surgical drains. For complex, contaminated, blast-type injuries with extensive tissue loss, heroic attempts at full tissue coverage are not appropriate in the initial setting [14•]. Rather, a vacuum-assisted wound dressing is appropriate and simplifies wound care compared to twice daily wet-to-dry dressing changes.

The interval of wound re-evaluation will depend greatly upon the complexity of both the genital and comorbid injuries. Blast injuries with extensive contamination and questionable tissue viability may require daily or every-other-day reevaluation in the operating room [14•]. With each examination under anesthesia, low-pressure wound irrigation is repeated and tissue viability is reassessed. Deep debridement of the penile glans and corpora should be avoided when possible as the tissues are highly vascularized, resistant to infection, and difficult (if not impossible) to replace. However, clearly necrotic genital skin and soft tissue should be debrided when necessary

to prevent secondary infection. The vacuum-assisted dressing is then replaced, and the cycle is repeated until the wound has stabilized and granulation tissue has formed.

## Definitive Management of Complex Genital Injury

### Surgical Management

Once the wound has stabilized and adequate granulation tissue has formed, genital reconstruction can ensue. A comprehensive discussion of surgical decision making and techniques for reconstructive surgery after complex genital injury is beyond the scope of this review. However, there are several broad principles that are germane to all manners of genital reconstruction.

When the deep structures are preserved, split thickness skin grafts (STSG) are preferred for wound coverage and initial reconstruction. Penile resurfacing (after degloving injuries or burns) with thick STSGs (0.016″) provides excellent cosmetic and functional outcomes. A 4″ sheet graft is harvested with the seam placed on the ventrum of the penile shaft. Graft take is improved (and normal cosmesis preserved) by manually piecrusting the graft or meshing it in a 1:1, non-expanded manner. If extensive scrotal skin has been lost, the testes (when present) are secured to one another in the midline, thus providing an excellent scaffold for skin graft placement and functional neo-scrotal reconstruction. Due to the mobility and irregular contour of the testes, a thinner (0.010″) STSG meshed 1:1.5 optimizes graft take. The intersticies of the meshing heals with a cosmetic appearance that approximates normal scrotal rugations.

Genital injuries associated with more extensive tissue loss is a much more challenging scenario. Extensive soft tissue loss of the genitalia, pelvis, and perineum may require local flap coverage, depending on the location of the injury and availability of uninjured donor tissue. The distal-most aspect of the injured urethra should be matured to the skin as distal as possible to facilitate delayed urethral reconstruction. When present, any remnant penile shaft should be circumferentially grafted to maintain a phallic shape as even a foreshortened phallus can maintain a male habitus, permit voiding from a standing position, and even provide erogenous sensation once healed.

Complete penile loss is a devastating injury with few options for surgical reconstruction. The mainstay for phallic reconstruction is creation of a neophallus with either a radial artery-based forearm free flap [15] or pedicled flap from the anteriolateral thigh [16]. While the radial artery free flap has satisfactory results in the transgender surgery population [15, 17], men with genital blast injury frequently have concomitant upper and/or lower extremity injury(−ies) and/or amputation(s) [10], thus limiting potential flap donor sites. Additionally, outcomes data after flap-based penile reconstruction in the blast injured population are essentially nonexistent [15].

Due to the limitations in flap-based genital reconstruction and ongoing evolution of reconstructive transplantation techniques for other body regions (i.e., face, hand, abdominal wall), there has been much interest in applying penile allotransplantation to the blast-injured military population [18, 19]. To date, there have been only two successful penile transplantations performed worldwide, one in a South African man who lost his phallus as a complication of a ritualistic circumcision [20] and the other in an American man who underwent total penectomy for organ-confined penile cancer [18]. Men who sustain severe injuries to their phallus due to blast injury are profoundly different, both locally (due to the direct effects of the blast injury on the recipient urethral, corporal, and vascular beds) and systemically (due to the high prevalence of comorbid amputations, colorectal injury, traumatic brain injury, and prior blood transfusions) [2••]. Thus, the future of penile transplantation for men with complex polytraumatic genital injury remains uncertain.

### Medical Management

Medical management of sexual and reproductive dysfunction after genital injury involves the administration of some medications and (when possible) the tapering or elimination of others. Erectile dysfunction (ED) is common among male combat veterans, especially those with a history of genital injury [21]. The etiology of ED among genital trauma patients is universally multifactorial. The anatomical impact of the genital injury(−ies) themselves will depend on the severity of the injury and the amount of tissue lost. Concomitant pelvic injury can result in vascular and/or neurogenic ED when neurovascular structures proximal to the penis are involved. Medications to treat chronic complications of polytrauma, such as antidepressants, benzodiazepines, and narcotics can cause ED and should be tapered as soon as possible. However, comorbid psychiatric diagnoses such as depression, post-traumatic stress disorder, and chronic pain can also exacerbate ED thus emphasizing the importance of coordinated medical, surgical, and psychiatric care. Fortunately, the young age and excellent baseline health among male SMs who sustain genital trauma virtually guarantees their response to first line medical therapy for ED, most commonly phosphodiesterase inhibitors such as sildenafil, vardenafil, and tadalafil. Rare nonresponders should be offered intracavernous injections, intraurethral suppositories, or penile prosthesis surgery.

Hypogonadism can exacerbate erectile dysfunction, and its treatment can facilitate physical and sexual rehabilitation [22]. Physiologic hypogonadism is common among the critically injured even when GU injury is not present [23], and may be protective [24]. Thus, screening for, or treatment of

hypogonadism is not necessary until the patient is discharged from the intensive care unit. Anorchic patients should have testosterone replacement started at this time. Men who sustain any degree of scrotal injury should be screened for hypogonadism (even in the absence of testis injury) then followed monthly as the need for testosterone replacement has been shown to correlate with the initial testosterone level and rate of recovery [25]. Testosterone production may be compromised even when no visible testicular injuries occur, likely due to delayed effects of blast injury [2••, 25]. Long-term fertility plans should be discussed prior to testosterone replacement as exogenous testosterone administration suppresses the entire gonadal axis, suppressing spermatogenesis and thus fertility.

## Fertility Care

Management of infertility after genital injury depends primarily on whether the infertility is due to loss of gonadal tissue (i.e., traumatic orchiectomy), injury to the penis, urethra, or vagina (thus impairing sperm delivery and subsequent fertilization), and/or a non-anatomic complication such as exogenous testosterone administration (discussed above) or mental health problems which impair intimacy (discussed below).

Once lost, gonadal tissue cannot be replaced. Therefore, bilateral testicular (or ovarian) trauma can lead to permanent infertility. Additionally, even in the absence of visible bilateral testicular injury, testicular atrophy and azoospermia can occur after pelvic polytrauma, presumptively from the delayed effects of blast forces. While sperm can rarely be salvaged immediately after the injury from the vas deferens [26] or seminal vesicle [27], such efforts are financially, ethically, and logistically challenging in polytrauma patients and thus are at this time not the standard of care. SMs deployed to a war zone where blast injury is expected are at an increased risk of sustaining genital trauma, and thus pre-deployment gamete cryopreservation could serve as a means to prevent infertility should genital trauma occur. A pilot program evaluating the feasibility of widespread gamate cryopreservation among US SMs is underway [2••] but given the isolated nature of complex genital trauma among civilians, such a program would not be practical.

When functional gonadal tissue persists despite complex genital trauma, a comprehensive fertility evaluation is warranted, even if the injured individual is not currently interested in paternity/maternity. Patients with injuries to the urethra, penis, vagina, etc., which limit intercourse or impair normal ejaculation should be referred to the appropriate genitourinary reconstructive surgeon for definitive surgical care. Men who sustain complex pelvic blast injury (even in the absence of visible testicular injury) should seek care from a urologist specializing in male infertility so sperm function can be evaluated and if adequate, cryopreserved, so a lasting source of sperm is present should delayed testicular atrophy occur. Men with low testosterone who desire fertility can be challenging to manage as exogenous testosterone replacement can suppress spermatogenesis. Thus, referral to an andrologist in consideration of medication regimens that stimulate both testosterone production and spermatogenesis is prudent. Finally, when mental health and/or relationship problems are the sources of sexual problems and thus infertility, referral to the appropriate specialists is necessary.

## Psychological

The large number of male SMs who sustained genital injury during OIF/OEF has provided insight into the psychological implications of disfiguring genital wounds. Small qualitative series have indicated that genital injuries have a profound impact on the overall well-being of complex polytrauma patients. In one study, eight out of 13 men with genital injuries and transfemoral amputation(s) described their genital injuries as having a greater impact than losing one or both legs, likely due to established prosthetic replacement options for the latter but not the former [28]. The psychological impact of genital injuries may be greater among military casualties given the young age in which they are injured (mean age 25 years; 94% younger than 36 years old [2••]). The long-term mental health outcomes of genital injuries sustained by men in their peak ages of sexual identity development and reproductive potential is an area where long-term data is greatly needed.

Genital injuries have little to no impact on mortality among complex polytrauma patients. Therefore, it is not uncommon for low surgical priority to be placed on the initial management of genital injuries. This is usually both necessary and appropriate. However, what is entirely inappropriate is to assume that low surgical priority equates to low overall priority, thus completely neglecting the potential psychological impact genital wounds have on the patient and his/her sexual partner. In some instances, this has resulted in many weeks of a critically injured patient's spouse having no tangible knowledge of the severity of the genital injury, the degree of potential sexual, urinary, and reproductive disability, and the hope for potential recovery. Thus, in our institution, we discuss the nature and prognosis of the genital injury with the patient as soon as feasible (i.e., in the first day or two after extubation). Repeat visits and discussions are often necessary to ensure full understanding. Involvement of the patient's spouse or intimate partner is imperative. Limited data has suggested that patients prefer clinical information delivered by the proper specialist (usually a urologist) so, a full appreciation of long-term prognosis can be obtained [28]. We also involve a clinical health psychologist well versed in sexual medicine as soon as possible. Not discussing a genital injury due to embarrassment on the part of the medical provider can be viewed by patients as neglecting the genital injury and its manifestations [28]. We have found that long-term follow up with urology and clinical health

psychology is helpful to maximize functional recovery and minimize secondary mental health problems.

### Rehabilitation

Although not widely regarded as such, sexual activity is an activity of daily living and thus rehabilitation efforts should address sexual function in the same light as other federally recognized ADLs, such as bathing, dressing, transferring, toileting, and eating. Unfortunately, no formal post-traumatic sexual rehabilitation programs exist. We have adopted many of the principles used in a more commonly encountered cause of sexual dysfunction: prostate cancer treatment. Much like polytrauma, radical surgical removal of the prostate can cause an immediate and profound decrease in sexual function of unknown duration. Some studies have suggested that sexual rehabilitation after prostatectomy can improve long-term sexual function and possibly decrease the risk of long-term fibrosis of the smooth muscle components of the penis which can result in permanent erectile dysfunction and loss of penile length [29]. We have adopted an approach to sexual rehabilitation which mirrors that of the post-prostatectomy literature: encourage sexual activity (with oneself or with the injured patient's respective intimate partner) as soon as the genital wounds have healed, and the patient has the physical ability to do so (i.e., after hospital discharge). If spontaneous erections are not attainable, daily or on demand medical therapy with type-5 phosphodiesterase inhibitors (i.e., sildenafil) should be initiated. If ineffective, intracavernous injections, urethral suppositories, and/or vacuum erection devices may be needed. Once an effective regimen is identified, periodic erections should be stimulated at least three times per week (even if sexual activity is not pursued) until spontaneous erectile function is restored. Periodic erections oxygenate the corporal tissues and thus may prevent smooth muscle fibrosis and its negative effects (ED and penile shortening) [29]. Assistance with testosterone replacement and sexual health counseling may be required and should be pursued as soon as the need is identified.

Sexual activity is also a physical function, especially when polytraumatic orthopedic injuries are present. Lower extremity injuries can impact sexual positioning in the same way they alter a wounded individual's ability to stand, walk, and run. Thus, physical therapists and rehabilitation medicine specialists should discuss the physical aspects of sexual positioning with all patients requiring extensive physical therapy after pelvic and lower extremity polytrauma, even when a history of genital injury is absent or unknown. Severe upper extremity injury and amputation may affect sexual function as well. Hand injuries will affect an injured individual's ability to caress his/her intimate partner and to stimulate him/herself or his/her partner erotically. Thus, occupational therapists should consider these unique upper extremity functions when assisting with the rehabilitation of patients with comorbid upper extremity and genital injuries. A recently published handbook provides a practical guide to rehabilitation specialists who have limited comfort and experience in this highly sensitive topic [30].

## Summary and Conclusions

The severity of genital trauma sustained by US service members who survived combat injuries on the contemporary battlefield has eclipsed that of any period in history. This has provided a unique opportunity for improving the immediate and long-term care of patients with complex genital trauma both in peacetime and in war. A focus on early multidisciplinary care of the unique surgical, medical, psychological, reproductive, and rehabilitative needs of genital trauma patients can improve the long-term functional outcomes and thus maximize quality of life after recovery.

#### Compliance with Ethical Standards

**Conflict of Interest** The author declares that he has no conflicts of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

**Disclaimer** The views expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army or the Department of Defense, or the U.S. Government.

## References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1.• Morey AF, Brandes S, Dugi DD 3rd, Armstrong JH, Breyer BN, Broghammer JA, et al. Urotrauma: AUA guideline. J Urol. 2014;192(2):327–35. doi:10.1016/j.juro.2014.05.004. **Comprehensive document identifying clinical guidelines for the evaluation and management of genitourinary trauma.**

2.•• Janak JC, Orman JA, Soderdahl DW, Hudak SJ. Epidemiology of genitourinary injuries among male U.S. service members deployed to Iraq and Afghanistan: early findings from the trauma outcomes and urogenital health (TOUGH) project. J Urol. 2017;197(2):414–9. doi:10.1016/j.juro.2016.08.005. **Largest ever reported series of battlefield genitourinary injuries. Male genital injuries predominated and were frequently associated with complex polytrauma.**

3. Hudak SJ, Morey AF, Rozanski TA, Fox CW Jr. Battlefield urogenital injuries: changing patterns during the past century. Urology. 2005;65(6):1041–6.
4. Thompson IM, Flaherty SF, Morey AF. Battlefield urologic injuries: the Gulf War experience. J Am Coll Surg. 1998;187(2):139–41.
5. Abu-Zidan FM, Al-Tawheed A, Ali YM. Urologic injuries in the Gulf War. Int Urol Nephrol. 1999;31(5):577–83.
6.• Cannon JW, Hofmann LJ, Glasgow SC, Potter BK, Rodriguez CJ, Cancio LC, et al. Dismounted complex blast injuries: a comprehensive review of the modern combat experience. J Am Coll Surg. 2016;223(4):652–64 e8. doi:10.1016/j.jamcollsurg.2016.07.009. **Multidisciplinary review of the complex clinical scenario caused by dismounted complex blast injuries.**
7. The Joint Trauma System. http://www.usaisr.amedd.army.mil/10_jts.html. Accessed 25 June 2017.
8. Banti M, Walter J, Hudak S, Soderdahl D. Improvised explosive device-related lower genitourinary trauma in current overseas combat operations. J Trauma Acute Care Surg. 2016;80(1):131–4. doi:10.1097/TA.0000000000000864.
9. Hudak SJ, Hakim S. Operative management of wartime genitourinary injuries at Balad Air Force Theater Hospital, 2005 to 2008. J Urol. 2009;182(1):180–3. doi:10.1016/j.juro.2009.02.150.
10. Nnamani NS, Janak JC, Hudak SJ, Rivera JC, Lewis EA, Soderdahl DW, et al. Genitourinary injuries and extremity amputation in operations enduring and iraqi freedom: early findings from the trauma outcomes and urogenital health (tough) project. J Trauma Acute Care Surg. 2016; doi:10.1097/TA.0000000000001122.
11. Paquette EL. Genitourinary trauma at a combat support hospital during operation Iraqi freedom: the impact of body armor. J Urol. 2007;177(6):2196–9. discussion 9.
12. Serkin FB, Soderdahl DW, Hernandez J, Patterson M, Blackbourne L, Wade CE. Combat urologic trauma in US military overseas contingency operations. J Trauma. 2010;69(Suppl 1):S175–8. doi:10.1097/TA.0b013e3181e45cd1.
13. Sharma DM, Bowley DM. Immediate surgical management of combat-related injury to the external genitalia. J R Army Med Corps. 2013;159(Suppl 1):i18–20.
14.• Williams M, Jezior J. Management of combat-related urological trauma in the modern era. Nat Rev Urol. 2013;10(9):504–12. doi:10.1038/nrurol.2013.148. **Important review identifying key clinical steps in the management of combat-related urological trauma.**
15. Garaffa G, Ralph DJ. Free flap phalloplasty for female to male gender dysphoria. J Sex Med. 2016;13(12):1942–7. doi:10.1016/j.jsxm.2016.10.004.
16. Gurjala AN, Nazerali RS, Salim A, Lee GK. World's first baby born through natural insemination by father with total phalloplasty reconstruction. Ann Plast Surg. 2016;76(Suppl 3):S179–83. doi:10.1097/SAP.0000000000000769.
17. Neuville P, Morel-Journel N, Maucourt-Boulch D, Ruffion A, Paparel P, Terrier JE. Surgical outcomes of erectile implants after phalloplasty: retrospective analysis of 95 procedures. J Sex Med. 2016;13(11):1758–64. doi:10.1016/j.jsxm.2016.09.013.
18. Sopko NA, Tuffaha SH, Lough D, Brandacher G, Lee WPA, Bivalacqua TJ, et al. Penile allotransplantation for complex genitourinary reconstruction. J Urol. 2017; doi:10.1016/j.juro.2016.10.134.
19. Tuffaha SH, Cooney DS, Sopko NA, Bivalacqua TJ, Lough DM, Cooney CM, et al. Penile transplantation: an emerging option for genitourinary reconstruction. Transpl Int. 2017;30(5):441–50. doi:10.1111/tri.12928.
20. Bateman C. World's first successful penis transplant at Tygerberg Hospital. S Afr Med J. 2015;105(4):251–2.
21. Wilcox SL, Redmond S, Hassan AM. Sexual functioning in military personnel: preliminary estimates and predictors. J Sex Med. 2014;11(10):2537–45. doi:10.1111/jsm.12643.
22. Woods DR, Phillip R, Quinton R. Managing endocrine dysfunction following blast injury to the male external genitalia. J R Army Med Corps. 2013;159(Suppl 1):i45–8.
23. Cernak I, Savic J, Lazarov A. Relations among plasma prolactin, testosterone, and injury severity in war casualties. World J Surg. 1997;21(3):240–5. discussion 6.
24. Gee AC, Sawai RS, Differding J, Muller P, Underwood S, Schreiber MA. The influence of sex hormones on coagulation and inflammation in the trauma patient. Shock. 2008;29(3):334–41.
25. Williams M, Rosner I, Chen Y, Cullen J, Jezior J, Dean R. Testosterone recovery after polytrauma and scrotal injury in patients from operation enduring freedom and operation Iraqi freedom. J Urol. 2015;193(2):618–22. doi:10.1016/j.juro.2014.08.105.
26. Sharma DM, Genitourinary WG. The management of genitourinary war injuries: a multidisciplinary consensus. J R Army Med Corps. 2013;159(Suppl 1):i57–9.
27. Healy MW, Yauger BJ, James AN, Jezior JR, Parker P, Dean RC. Seminal vesicle sperm aspiration from wounded warriors. Fertil Steril. 2016;106(3):579–83. doi:10.1016/j.fertnstert.2016.05.028.
28. Lucas PA, Page PR, Phillip RD, Bennett AN. The impact of genital trauma on wounded servicemen: qualitative study. Injury. 2014;45(5):825–9. doi:10.1016/j.injury.2013.12.009.
29. Clavell-Hernandez J, Wang R. Penile rehabilitation following prostate cancer treatment: review of current literature. Asian J Androl. 2015;17(6):916–922; discussion 21. doi:10.4103/1008-682X.150838.
30. Ellis K, Dennison C. Sex and intimacy for wounded veterans: a guide to embracing change. Los Angeles: The Sager Group; 2014.