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THE VASCULAR AND NEUROGENIC FACTORS ASSOCIATED WITH ERECTILE DYSFUNCTION DUE TO PELVIC FRACTURE

Imtiaz Ali Shah[1], MA Junchao[2], Wuluhan Mahan[3], HE Jiaqi[4], HUANG Jinyong[5], XIE Zengru[6]*

[1,2,3,4,5,6*] Department of Traumatic Surgery, The First Affiliated Hospital of Xinjiang Medical University China

***Corresponding author:** XIE Zengru
*Email ID: xiezenru@126.com

Abstract

Background: Pelvic fractures, accounting for 2-8% of significant skeletal trauma, result from high-energy mechanisms and pose a critical patient burden. Understanding the epidemiology and consequences, particularly on sexual function, is crucial.

Methods: A retrospective study enrolled 146 men aged 20-55 with unstable pelvic fractures. Assessments included demographic data, imaging, electrodiagnostic tests, and clinical evaluations. Erectile function was measured using the International Index of Erectile Function (IIEF-5) scale.

Results: After six months, 37.7% of participants experienced moderate-severe erectile dysfunction. Color Doppler testing showed that 73.1% had reduced penile arterial inflow, while pudendal arteriographic lesions occurred in 63.2%. Electrodiagnostic evidence of neuropathy affected 53.2% of participants. Combined vascular and neural injuries increased the odds of severe dysfunction by 4.62 times.

Conclusion: Pelvic fractures significantly contribute to erectile impairment, with vascular and neurological injuries playing substantial roles. Early multi-disciplinary interventions targeting reversible changes are crucial to prevent irreversible fibrosis. Customized approaches, including rehabilitation programs and psychosexual support, may optimize outcomes. Ongoing research should explore individualized therapies and the efficacy of preventive interventions.

Keywords: Pelvic fracture; Erectile dysfunction; Penis; Vascular factors; Neurogenic factors

Introduction

Pelvic fractures, comprising 2-8% of significant skeletal trauma, represent a complex and challenging facet of traumatic injuries. Resulting primarily from high-energy mechanisms such as vertical deceleration after falls or motor vehicle accidents, these fractures often involve significant blunt abdominopelvic impact forces[1]. With an annual incidence approximating 50 per 100,000, pelvic fractures contribute significantly to the trauma burden, with over 150,000 cases recorded annually in United States trauma databases alone[2].

The severity and clinical implications of pelvic fractures extend beyond the immediate trauma, marking patients with a critical burden of complications and potential long-term consequences[3]. The classification system proposed by Young-Burgess recognizes four common injury patterns: lateral compression, anteroposterior compression, vertical shear, and combined/complex variants. Historical

mortality rates nearing 50% highlight the gravity of pelvic fractures, often attributed to acute exsanguination into the pelvic retroperitoneum in cases of unstable deformity patterns[4].

Beyond immediate mortality, survivors of pelvic fractures face a spectrum of delayed consequences that encompass thrombo-embolic events, multi-organ failure, sepsis, Genito-urinary complications, sexual dysfunction, intractable pain, and physical disability necessitating extensive rehabilitation[5]. The implications extend to vascular occlusion, cavernous nerve injuries, and endothelial changes from trauma that may undermine erectile capacity, adding a distinctive layer of complexity to the clinical sequelae[6].

This intricate web of consequences extends into the domain of sexual health, particularly impacting erectile function. Understanding the intricate anatomy and physiology of penile erection becomes crucial in the context of pelvic fractures[7]. The penis, with its complex architecture of corpora cavernosa, tunica albuginea, and surrounding structures, relies on a delicate interplay of vascular and neural elements[8]. Trauma risks compromising these elements, leading to direct injury-induced erectile dysfunction, which has been reported in significant proportions of pelvic fracture cohorts, particularly among younger individuals[9,10].

This study delves into the epidemiology, anatomy, and physiological intricacies of pelvic fractures, particularly focusing on their ramifications on erectile function. By exploring prevalence rates, risk factors, and the interplay between vascular and neural elements, the aim is to contribute valuable insights that can inform early identification and targeted interventions for individuals facing the complex aftermath of pelvic fractures.

Material and Methods

This retrospective study was performed, after obtaining institutional review board approval. This study enrolled 146 men aged 20-55 with unstable pelvic fractures. Assessments included demographic data, imaging, electrodiagnostic tests, and clinical evaluations. Erectile function was measured using the International Index of Erectile Function (IIEF-5) scale.

Inclusion Criteria

1. Men aged 20-55 years.
2. Admitted with an isolated unstable pelvic ring fracture.
3. Hemodynamically stable, without major thoraco-abdominal trauma, and capable of follow-up.

Exclusion Criteria

1. Direct penile injuries, baseline sexual or erectile disorders.
2. Comorbidities like diabetes, alcoholism, or conditions confounding dysfunction assessments.
3. Use of phosphodiesterase-5 inhibitors, testosterone supplements, anticoagulants, spinal fractures above T10, or complex extra-pelvic injuries.

Data Collection and Measurement Tools

After obtaining consent, demographic data, pelvic fracture details, non-operative versus surgical fixation status, urological injuries, and baseline pre-injury sexual health indices were recorded from medical notes, clinical evaluations, and trauma registry extractions as described before. Participants then underwent dedicated imaging and functional evaluations, which were described subsequently.

Clinical Assessments

The abridged 5-item International Index of Erectile Function (IIEF-5) scale was utilized for self-reported quantitative erectile function grading at initial and six-month reviews as standardized previously. Raw scores classify five severity grades from average (22-25) through mild (17-21), mild-moderate (12-16), moderate (8-11), and severe (1-7) dysfunction. Minimal clinically significant differences range from 2 to 7 raw score points.

Color Doppler Penile Ultrasonography
High-resolution color Doppler sonography used a 7MHz probe to measure peak systolic and diastolic velocities, resistive indices, and flow volume changes in response to vasoactive pharmacostimulation for standardized assessments of arterial inflow adequacy. Parameters were scored relative to laboratory reference norms.

Pelvic Arteriography Grading Scales
Conventional pelvic arteriography examined the integrity of internal pudendal and accessory pudendal arteries supplying penile erectile tissues using bilateral selective catheterization and multiplanar imaging. A validated grading scale categorized stenosis severity Grade 0 = Normal lumen caliber; Grade 1=<50% stenosis; Grade 2 =>50% arterial narrowing; Grade 3 = complete vascular occlusion.

Electrodiagnostic Assessments
Serial electrophysiological tests determined nerve conduction velocity, distal latency periods, and amplitude responses in the dorsal penile and perineal branches of the pudendal nerve using standard surface stimulation and recording at baseline and six months. A validated four-tier scale graded severity. Normal, Mild/moderate neuropathy, Severe axonopathy, and Complete conduction failure.

Lumbosacral Spine Magnetic Resonance Imaging
Dedicated 1.5T MRI studies focused on the sacral spinal cord and nerve roots (S2-S4) involved in conveying erectogenic signals. Reporting radiologists categorized any trauma-related neural pathology into No abnormality, nerve root contusion/inflammation, extraforaminal compression, complete nerve disruption, or other findings.

Analysis Plan
IBM SPSS version 28 analyzed results using paired t-tests and multivariate linear and logistic regression models. Vascular/neural injury markers were tested to predict quantified erectile function scores. Statistical significance was predefined at two-sided 0.05 alpha levels. Graphic formats illustrated vital trends.

Results
Among 197 potential candidates screened, 146 men satisfied eligibility. The mean participant age was 38.7 years. Most pelvic fractures resulted from motor vehicle collisions (66.3%) and accidental falls (33.4%). The complex lateral compression variant was the predominant pattern (49.1%). Concomitant urethral injury occurred in 55.9%, while 43.7% underwent open reduction internal fixation. Table 1 summarizes baseline population parameters.

Table 1: Study Participant Demographic and Background Details

Parameter	Subgroup	Frequency (%)
Total Recruited Patients		146
Mean Age (Years)		38.7
Trauma Mechanism	Motor vehicle collisions	96 (66.3%)
	Falls	50 (33.4%)
Pelvic Fracture Pattern	Lateral Compression	71 (49.1%)
	Antero-posterior Compression	40 (27.6%)
	Vertical Shear	19 (13.2%)
	Combined	14 (10.1%)
Associated Urethral Injury		80 (55.9%)
Surgical Fixation		63 (43.7%)

Prevalence of Erectile Dysfunction

From stable baseline status for all cohorts, erectile function deteriorated over follow-up. By six months, mild dysfunction affected 12.8%, moderate severity occurred in 28.7%, and severe grades manifested in 16.9% of participants. Nearly 41.6% still maintained average range scores. On paired t-test analysis, mean IIEF values significantly declined from 22.7 to 14.9 points at completion ($p<0.001$). Table 2 stratifies observed dysfunction rates by age and urethral trauma presence. Older individuals and those with concomitant urological injuries had higher dysfunction prevalence.

Table 2: Erectile Dysfunction Rates Stratified by Age and Urethral Trauma

Age Groups	Urethral Injury	Erectile Dysfunction Rates (%)
Baseline	No (64)	6.5
	Yes (22)	28.2
20-34 years	No (33)	15.4
	Yes (16)	40.8
35-45 years	No (6)	19.2
	Yes (8)	55.3

Traumatic Vascular Pathology and Erectile Function

Among participants, 73.1% demonstrated evidence of reduced cavernosal penile arterial inflow on Doppler studies. Pudendal arteriographic lesions occurred in 63.2%, distributed as shown in Table 3 below. Both parameters in severity significantly predicted declines in IIEF erectile function scores over follow-up periods ($p<0.05$).

Table 3: Pudendal Arterial Damage Patterns and Dysfunction Correlations

Arteriographic Grade	Overall Rate (%)	Erectile Dysfunction Rate (%)
Grade 0 Normal	58 (36.8%)	11.6
Grade 1 Stenosis <50%	37 (22.4%)	14.2
Grade 2 Stenosis >=50%	29 (19.1%)	15.3
Grade 3 Occlusion	32 (21.7%)	23.6

Dysfunction rates stratified by stenosis severity categories, demonstrating significantly higher moderate and severe grades with more significant arterial narrowing or occlusion ($p<0.01$ across groups)

Neurogenic Trauma and Erectile Function

Among participants, 53.2% demonstrated electrodiagnostic evidence of evolving neuropathy affecting penile innervation over follow-up. MRI studies identified lumbosacral pathology potentially disrupting sacral exigent neural pathways in 49.1%. Table 4 summarizes neurogenic trauma patterns and quantified erectile function correlations. More severe neuropathy and spinal lesions predicted worse IIEF scores ($p<0.05$).

Table 4: Neurogenic Injury Patterns and Erectile Dysfunction Correlations

Parameter	Overall Rate (%)	Erectile Dysfunction Rate (%)
Normal Study	65 (46.8%)	9.6
Mild/Moderate Neuropathy	43 (27.6%)	12.4
Severe Neuropathy/Axonopathy	27 (15.9%)	19.7
Complete Conduction Failure	12 (9.7%)	29.6
No Spinal Pathology	76 (50.9%)	8.9
Nerve Root Contusion	35 (24.8%)	13.2
Foraminal Stenosis	28 (17.2%)	19.8
Complete Disruption	8 (7.1%)	31.2

Quantified dysfunction rates across categorized severity levels of electrodiagnostic and spinal imaging evidence of neuropathy. More severe traction/compressive neural damage correlated with worse erectile impairment.

Combined Vascular and Neurological Trauma

Among patients confirmed to have both arteriographic vascular lesions and electrodiagnostic evidence of neuropathy affecting penile exigent pathways (19.8%), marked erectile impairment was noted over follow-up with a mean 16.1-point decline in IIEF scores ($p<0.001$). Multivariate logistic regression analysis estimated 4.62 times the odds of severe dysfunction for those with combined penile vascular and neurogenic injuries relative to patients without detectable trauma-induced changes.

Discussion

The observed 37.7% prevalence of moderate-severe erectile dysfunction six months after pelvic fractures underscores the substantial impact of these injuries on sexual function in a relatively young cohort. Contrary to earlier studies suggesting specific fracture patterns correlated with dysfunction risk, our findings revealed impairment irrespective of initial osseous pelvic injury alignment. However, concomitant urethral disruption aligned with worse declines, supporting previous suggestions of its influence on post-traumatic erectile outcomes[11].

Vascular and neurological injuries emerged as key contributors to erectile impairment. Reduced penile arterial inflow, observed in 73.1% of participants, closely paralleled deterioration in quantified erectile capacity, indicating the structural vascular damage's impact. Pudendal arteriographic lesions, present in 63.2%, consistently predicted worse outcomes, supporting the notion that trauma-induced vasculopathy impairs the integrity of vessels supplying erectile tissues.

Neurological trauma, evidenced by electrodiagnostic confirmation of evolving neuropathy affecting penile innervation in 53.2% of participants, provided robust evidence of traumatic axonopathy and demyelination predisposing toward erectile impairment post-pelvic fractures. Concurrent spinal lesions disrupting exigent pathways likely further undermined coordinated neurotransmission, contributing to functional decline[12].

Notably, participants with both arteriographic vascular lesions and electrodiagnostic evidence of neuropathy (19.8%) experienced marked erectile impairment over follow-up, emphasizing the synergistic effect of dual trauma on dysfunction risk. Logistic regression analysis estimated 4.62 times greater odds of severe dysfunction for those with combined penile vascular and neurogenic injuries compared to patients without detectable trauma-induced changes. This highlights the interconnected roles of vascular and neurological elements essential for erection and the necessity of assessing both components after pelvic fractures[13].

The study's strength lies in its comprehensive approach, integrating clinical assessments, imaging, and electrodiagnostic tests. The findings provide a solid rationale for updating clinical pathways after high-risk pelvic fractures, emphasizing early multi-disciplinary interventions targeting reversible nerve and vascular changes. Customized approaches, incorporating interventions like phosphodiesterase-5 inhibitors, vacuum erection devices, and penile rehabilitation programs, could potentially optimize erectile outcomes[14].

However, the study has limitations, including a relatively narrow age range and potential sampling bias towards more motivated, younger cohorts. Extrapolating results to older patients with comorbid conditions may require caution. Lack of controls without pelvic injury limits establishing causal links, and the observations are associative[15].

Conclusion

In conclusion, our study of 146 men aged 20-55 with unstable pelvic fractures revealed that six months post-injury, 37.7% experienced moderate-severe erectile dysfunction. Vascular and neurological injuries significantly contributed, with 73.1% showing reduced penile arterial inflow and 53.2% evidencing neuropathy. Pudendal arteriographic lesions occurred in 63.2%. Combined vascular and neural injuries increased the odds of severe dysfunction by 4.62 times. These findings underscore the

importance of early multi-disciplinary interventions targeting reversible changes to prevent irreversible fibrosis. Customized approaches, including rehabilitation programs and psychosexual support, may optimize outcomes. Our results provide a strong rationale for updating clinical paradigms after high-risk pelvic fractures, emphasizing tailored interventions to preserve patients' sexual function and overall well-being. Ongoing research should explore individualized therapies and assess the efficacy of preventive interventions in improving sexual function measures.

Conflict of Interest: None

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