

Penile Trauma Burden and Aetiology in the Paediatric and Adult Population: A Scoping Review and Critical Analysis of the Literature

Abstract

Penile trauma is rare. It is associated with the impairment of physiological functions and deterioration in patients' quality of life. Currently, the relevance of age demographics in the occurrence of this debilitating injury has not been well discussed. The objective of this study was to provide a scoping review of penile trauma within the lens of the legal age of maturity. A search of the PubMed, Scopus and Web of Science databases was conducted, and then, the identified publications were used to conduct this scoping review focussing on the study aim. The results identified were categorised into five themes. This included publication information (author, year, country, study duration); demographic information (age of presentation, number of patients, relative burden); penile trauma clinical pattern (type, severity, associated injury), risk factors and clinical consequences. While mobile and active young adults were at risk of outdoor trauma, the report on penile trauma in the paediatric population is rare and usually focussed on sexual trauma. Penetrating trauma has been more extensively studied in comparison to blunt penile trauma despite the significance of the latter in the paediatric population. Injury severity classification is not available for most studies limiting their usefulness in the universal comparison of trauma severity and injury prognostication. There is a diversity in the burden and presentation of penile trauma. Available research studies are limited in the paediatric population, mostly focussed on penile fracture in adults and generally devoid of a standardised penile trauma severity description. Additional studies with a specific focus on penile trauma are required to characterise aetiological risks and injury severity across the legal age of maturity.

Keywords: *Age factors, injury, penis*

Introduction

Trauma to the penis is not common.^[1] Although it is also not life-threatening, it is usually associated with significant morbidities.^[2] The broad focus of the sparse literature that is available on this topic; however, blunts discussion on the importance of this injury and limits the application of available evidence during policymaking. Moreover, the relevance of age demographics on the causes and mechanisms of penile trauma has not been well discussed. The aim of this scoping review is to critically appraise the available publications on penile trauma and discuss its demographic and clinical pattern within the lens of the legal age of maturity. It will then identify contextually relevant gaps in evidence in this domain in Nigeria and globally.

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Materials and Methods

Search strategy

Literature search was conducted using the PubMed, Scopus, and Web of Science online databases. The search threads used to capture the published information were (trauma* OR injur*) AND (peni*) AND (peni* OR genital* OR scrot* OR testis or testes OR testicle OR testicles OR urethr*). The boolean operators (AND, OR) were used as conjunctions to connect these terms to combine these terms and narrow the search results. Truncations were used to search for variant spellings of the terms. Restrictions were applied to limit the search to publications on human and male, written or translated to the English language from January 1, 2013, to June 17, 2023.

Study selection

Retrieved titles and abstracts were uploaded and managed through the

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Mendeley reference management software. During title and abstract screening, priority was given to exclude duplications, case reports and descriptive studies with sample size less than 10, non-English manuscripts or articles with irrelevant content. During the full-length text screening, only full-length manuscripts with at least content on the age and aetiology specifically focussed on penile trauma were included. The selection process is presented in Figure 1.

Data collection

The full-length article was retrieved and then appraised on five cross-cutting themes for a critical review of evidence on the subject. The data on the following 12 parameters were extracted: publication information (author, year, country, study duration); demographic information (age of presentation, number of patients/relative burden); penile trauma clinical pattern (type, severity, associated injury),

risk factors and clinical consequences and mapped into cells in a Microsoft Excel sheet.

Results

The final selection consisted of 40 articles. With the exception of year 2022, there were penile trauma-related manuscripts retrieved across the 10-year publication period. The majority of the publications originated from the United States of America, 20% ($n = 8$) and India, 20% ($n = 8$). There were only 12.5% ($n = 5$) of the studies from Africa, including one multi-country research from south and east African countries. Regarding sample size, 42.5% ($n = 17$) of the articles had sample size between 10 and 30, whereas 35.0% ($n = 14$) and 22.5% ($n = 9$) had sample size between 30–99 and 100 and above, respectively.

A high proportion of the studies were focussed on penile fracture, 65.0% ($n = 26$) or different specific aetiologies,

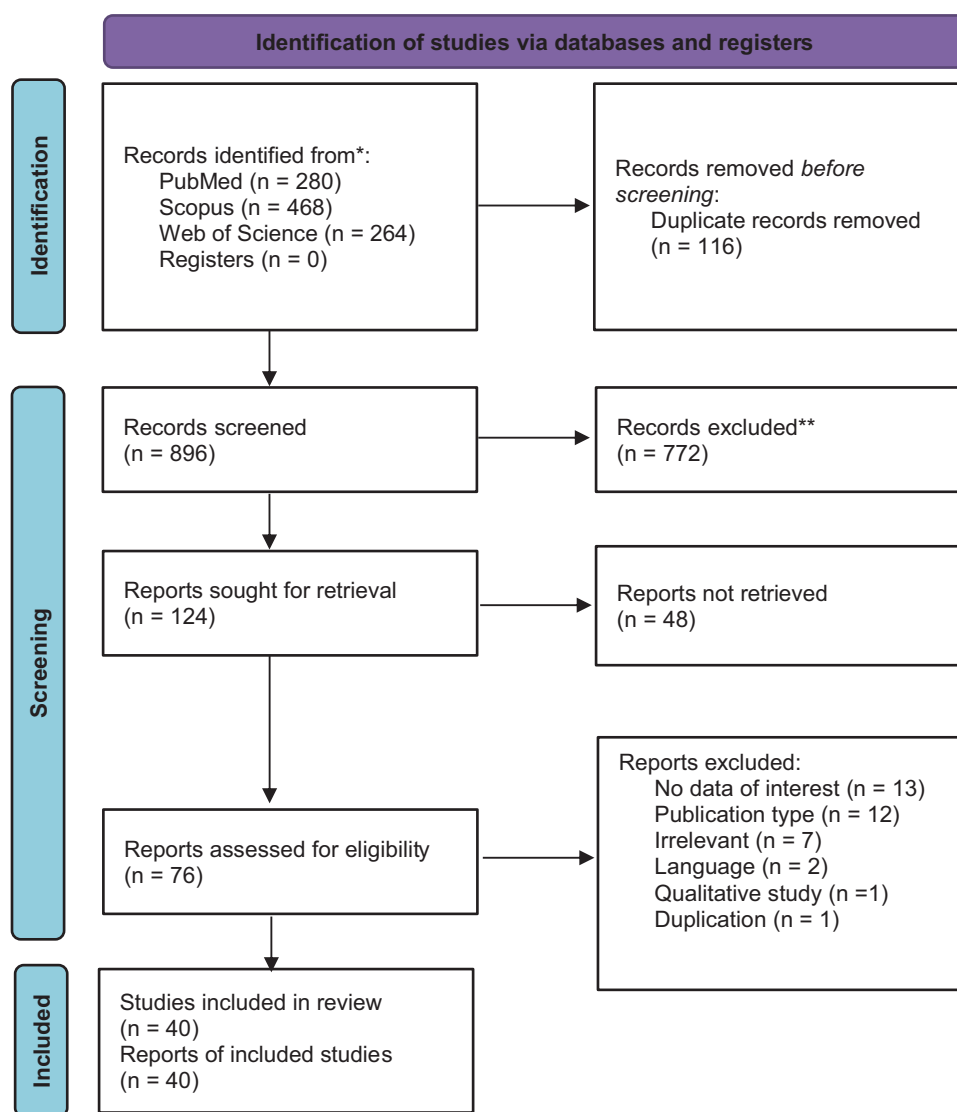


Figure 1: Preferred reporting items for systematic review and meta-analyses (PRISMA) 2020 flow diagram. Reproduced from: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, *et al.* The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

22.5% ($n = 9$) of penile trauma. However, 12.5% ($n = 5$) were broadly directed to mixed causes of penile trauma. The paediatric age group were predominantly reported to be affected by the trauma in 17.5% ($n = 7$) of the studies. Severity of penile trauma was not reported in 77.5% ($n = 31$). Details of the result data are presented in Tables 1 and 2.

Discussion

Epidemiology

The burden of genital injury in the genitourinary trauma spectrum

The rate of involvement of the external genitalia in traumatic injury to the genitourinary system appears to be variable. A 10-year retrospective study by Zou and Fu^[3] in Shanghai observed that it constituted 22.1% of the genitourinary trauma. Ofoha *et al.*^[4], however, reported a rate of 34.0% in their single-centre prospective study. This is within the range of 27.8%–68.1% of genitourinary trauma documented by an earlier publication,^[5] although the latter was a narrative review without a documented methodology. Nevertheless, the figure is also in line with a recent systematic review by Cassell and Manobah,^[6] which documented a wider rate of 8.8%–67.7% of the trauma in the genitourinary region based on literature from the African population. A higher proportion of involvement is, however, seen in the combat or non-battle military zones as Janak *et al.*^[7] reported that external genitalia injury accounted for 73.2% of the total number of injuries to the genitourinary area.

Penile trauma rate and its relation to injury at other sites of the external genitalia

Eight to ten percent of genitourinary injuries occur in the penis.^[8] Looking at penile trauma in comparison to scrotal and testicular trauma, it appears that injury to the penis is less common in adults in civilian and military settings.^[5] McCormick *et al.*,^[9] in a pool of 118 patients with trauma to the external genitalia from a level one trauma centre in the United States, indicated that the proportion of those who present with penile trauma (38.0%) in this genital trauma population is far lower than the proportion of those who present with scrotal injury (71.0%) but slightly higher than the proportion of those who present with testicular trauma (34%). Janak *et al.*, in a larger pool of 1366 external genitalia trauma sustained in the military setting, further documented that proportion of scrotal trauma (55.6%) was about 1.8 and 1.7 times more common than penile trauma (31.0%) and testicular trauma (33%), respectively.^[7] This pattern might also hold for children as Cengiz and Abuzer^[10] reported that penile trauma was a less common form of genital injury than scrotal injury with the earlier accounting for 7.5% of the 254 children that sustained genitourinary trauma and just over one-quarter (27.5%) of the cases of male genital injury.

Another study has, however, reported penile trauma to be responsible for 52.2% of the genital trauma in comparison to the scrotum and testis, which accounted for 30.4% and 17.4%, respectively.^[3] Similar to this observation, Ofoha *et al.*^[11] observed that the rate of occurrence of penile trauma (47.6%) is around 1.7 times higher than that of scrotal injuries (28.6%). The lower rate of blunt trauma in these latter studies could account for a reverse in the burden of scrotal trauma in comparison to penile trauma.

Risk factors

Anatomical factors

The external location of the penis increases its risk of trauma from an external force.^[12] It is, however, a highly mobile structure, which has a relatively small percentage of surface area in the body.^[9] It is further shielded by the anatomy of the bone and muscles of the pelvis and upper thigh.^[13] These protect the penile and other external genital organs in males from blunt and penetrating trauma.^[14]

Penile turgidity

The penis in its flaccid state is pendulous and has the potential to absorb a large amount of kinetic energy from external forces.^[15,16] The erect penis, due to the associated thinning of the tunica albuginea from about 2.0 to 0.25 mm, is, however, more prone to trauma.^[17] Despite the presence of high intracavernosal pressure of around 100 mmHg during erection, an abrupt increase in the pressure, up to a level of above 1500 mmHg, could overcome this tensile strength to cause sudden rupture or transverse laceration of the corpora cavernosum.^[18] This state could occur following sudden or abnormal bending of the penis.^[16]

Seasonal variation

Environmental factors may further play a role in the pathogenesis of this male genital trauma. A study by Phillips *et al.*^[19] in Boston demonstrated a higher risk of penile fracture during the winter. The cold nature of the season creates an ambient environment for more frequent coitus, which could increase the potential for sexual trauma. Another publication from the United States, however, found a higher risk of accidental non-sexual genital trauma during the summer.^[9] This latter reflects an increase in the rate of industrial work and outdoor recreational activities as well as a higher tendency for road traffic accidents during the peak activities of the summer season.

Specific setting: Military versus civilian setting

History suggests that reports of injury to the external genitalia are more common in the military population.^[2] Janak *et al.*^[7] observed that the most commonly affected region in genitourinary injury in this setting are organs of the external genitalia. It has been further documented that the penis accounts for 18.5% of trauma to the genitourinary system in the military setting.^[17] Reddy *et al.*,^[13] however,

Table 1: Summary of the publication and demographic information of the included studies on penile trauma

S. No.	Type of trauma	Publication information				Demographic information		
		Author	Year	Country	Study duration	Age ^a	Sample size	Relative burden ^b
1	Penile fracture	Al Ansari <i>et al.</i> ^[30]	2013	Qatar	2005–2012	30 (18–74) ^c	109	–
2	Zipper	Bagga <i>et al.</i> ^[31]	2013	USA	2002–2010	18 ^c (0–18): 51.4% (≥19): 48.6%	523	Fraction of overall penile trauma (21.6%)
3	Penile trauma (penetrating)	Bjurlin <i>et al.</i> ^[24]	2013	USA	2004–2011	28 (14–66)	45	Incidence (0.16%)
4	Toilet and toilet seat-related penile trauma	Glass <i>et al.</i> ^[32]	2013	USA	2002–2010	3.9 (crush) 29.4 (non-crush)	10,983	Fraction of all toilet seat-related injuries (83.3%)
5	Penile fracture	Khan <i>et al.</i> ^[33]	2013	Pakistan	2008–2011	(18–45): 81.3%	16	–
6	Penile fracture	Nason <i>et al.</i> ^[34]	2013	Ireland	2000–2012	33.1 (19–63)	21	–
7	Penile fracture	Ozorak <i>et al.</i> ^[35]	2013	Turkey	2002–2012	32 (23–47)	31	–
8	Penile fracture	Yamacake <i>et al.</i> ^[36]	2013	Brazil	2004–2012	33.8 (21–61)	42	–
9	Penile fracture	Alami <i>et al.</i> ^[37]	2014	Morocco	2000–2008	38.7 (23–51)	32	–
10	Missile	Al-Azzawi <i>et al.</i> ^[20]	2014	Iraq	2004–2008	29 (14–55)	24	Civilian population (79.0%)
11	Male grooming penile trauma	Gaither <i>et al.</i> ^[38]	2015	USA	2013	42.5	1652	Fraction of male grooming injury (27.1%)
12	Penile fracture	Omisanjo <i>et al.</i> ^[39]	2015	Nigeria	2008–2013	35.2 (23–56)	15	–
13	Penile trauma	Phillips <i>et al.</i> ^[19]	2015	USA	2004–2013	39.4 (19–87)	32	–
14	Hair coil	AbouZeid <i>et al.</i> ^[40]	2016	Egypt	2010–2016	4.8 (2–17)	16	–
15	Circumcision	Appiah <i>et al.</i> ^[41]	2016	Ghana	2012–2014	(2 days–11) ^c (0–2 weeks): 87%	72	–
16	Penile fracture	Barros <i>et al.</i> ^[42]	2017	Brazil	2006–2016	39 (18–66)	95	–
17	Penile fracture	Bolat <i>et al.</i> ^[43]	2017	Turkey	1999–2016	35.7 (17–64)	64	–
18	Penile Fracture	Tamhankar <i>et al.</i> ^[44]	2017	India	2011–2016	32 (20–48)	21	–
19	Penile fracture	Bozzini <i>et al.</i> ^[45]	2018	Italy, Spain, Austria, Belgium, Switzerland	1996–2013	34.5 (28.0–46.5) ^b	137	–
20	Penile trauma	Etabbal <i>et al.</i> ^[14]	2018	Libya	2011–2017	31.3 (16–62)	29	–
21	Penile fracture	Kumar <i>et al.</i> ^[46]	2018	India	2014–2017	37.7 (20–60)	20	–
22	Penile fracture	Majhi <i>et al.</i> ^[47]	2018	India	2014–2016	37 (28–46)	13	–
23	Penile fracture	Naouar <i>et al.</i> ^[48]	2018	Tunisia	2000–2015	44.6 (22–70)	42	–
24	Penile trauma	Djordjevic <i>et al.</i> ^[25]	2019	Serbia	2007–2016	16 (4–29)	13	–

Table 1: Continued

S. No.	Type of trauma	Publication information				Demographic information		
		Author	Year	Country	Study duration	Age ^a	Sample size	Relative burden ^b
25	Penile fracture	Kasaraneni <i>et al.</i> ^[49]	2019	India	2000–2016	31.5 (25–36)	12	–
26	Penile fracture	Kumar <i>et al.</i> ^[50]	2019	India	2014–2018	39.7 (22–60)	17	–
27	Penile fracture	Ortac <i>et al.</i> ^[51]	2019	Turkey	2014–2018	41.7 (19–64)	26	–
28	Penile fracture	Patil <i>et al.</i> ^[52]	2019	India	2014–2018	28.9	18	–
29	Penile fracture	Barros <i>et al.</i> ^[53]	2020	Brazil	1997–2017	38.2 (18–69)	285	–
30	Penile fracture	Dias-Filho <i>et al.</i> ^[54]	2020	Brazil	2008–2017	38 (31.8–42.2) ^b	56	–
31	Penile trauma	Lucas <i>et al.</i> ^[55]	2020	South Africa, Kenya, Zimbabwe, Malawi, Mozambique, Namibia, Botswana, Tanzania, Zambia	2015–2018	(0–14)	36	0.43–0.87 per 100,000 circumcisions
32	Penile strangulation	Qamar <i>et al.</i> ^[56]	2020	Pakistan	1999–2018	5.8 (6 months–11)	15	–
33	Penile fracture	Sharma <i>et al.</i> ^[57]	2020	India	2002–2019	37 (23–72) ^c	43	–
34	Penile fracture	Panella <i>et al.</i> ^[58]	2020	Italy	2010–2020	40.2 (21–65) ^c	20	–
35	Penile fracture	Bulbul <i>et al.</i> ^[59]	2021	Turkey	2007–2019	42 (34–51) ^b	31	–
36	Penile fracture	Christian-Miller <i>et al.</i> ^[60]	2021	USA	2005–2016	38.7	5802	1.0–1.8 per 100,000 hospitalisations
37	Penile foreign bodies	Fischer <i>et al.</i> ^[61]	2021	USA	2008–2017	13.1 (0–12); 3270 (46%)	7138	Fraction of all austere foreign bodies (26.0%)
38	Penile Fracture	Sarikaya <i>et al.</i> ^[62]	2021	Turkey	2010–2020	35 (20–65) ^c	42	–
39	Penile fracture	Shimpi <i>et al.</i> ^[63]	2021	India	2016–2019	33 (23–46)	14	–
40	Penile foreign body	Pandher <i>et al.</i> ^[64]	2023	USA	2011–2020	0–18: 69 (69%) per 100 foreign body genital trauma 19–64: 158 (64.8%) per 100 foreign body genital trauma	241	Fraction of all foreign body genital trauma (65.9%)

^aMost age is expressed as mean and/or upper and lower ranges (in parenthesis). The predominant age group is further expressed as the age range (in parenthesis) followed by the percentage occurrence.

^bAge is expressed as median with interquartile ranges (in parenthesis).

^cAge is expressed as median and/or upper and lower ranges (in parenthesis)

opined that under-reporting by patients contributes to the epidemiological picture in the civilian population.

Comparing injuries in the two settings, there is a greater tendency for use of improvised explosive devices and high-velocity missiles on the battlefield.^[15] Improvised

explosive device has a propensity not just to cause injury to multiple regions of the body but to also result in greater severity of the injury.^[20] There is therefore a greater potential for tissue damage in the military setting.^[15] Etabbal *et al.*^[14] in their study in Libya, however, found out that 69.0% of the trauma to the penis that was sustained during the war

Table 2: Summary of the clinical information of the included studies on penile trauma

S. No.	Author	Type of trauma	Clinical information, <i>n</i> (%) ^a			
			Predominant severity type	Associated trauma site	Predominant risk factor	Predominant complication
1	Al Ansari <i>et al.</i> ^[30]	Penile fracture	–	–	Manual penis bending (54.0)	Post-op erectile dysfunction, 2 (18.0)
2	Bagga <i>et al.</i> ^[31]	Zipper	–	–	Trouser zipper (not reported)	Penile cellulitis, 11 (2.1)
3	Bjurlin <i>et al.</i> ^[24]	Penile trauma (penetrating)	–	Urethra, 21 (47.0)	Gunshot, ^b 150 (93.0)	–
4	Glass <i>et al.</i> ^[32]	Toilet and toilet seat-related penile trauma	Contusion (61.3)	–	Toilet seat crush (68.4)	–
5	Khan <i>et al.</i> ^[33]	Penile fracture	–	–	Sexual activity (not reported)	Penile curvature, 3 (18.6)
6	Nason <i>et al.</i> ^[34]	Penile fracture	–	Urethra (2/21)	Sexual intercourse (20/21)	Voiding difficulty, 2 (9.5) Erectile dysfunction (2/21)
7	Ozorak <i>et al.</i> ^[35]	Penile fracture	–	–	Sexual intercourse, 27 (87.0)	Post-op penile curvature, 2 (11.5) Post-op ED, 2 (34.6)
8	Yamacake <i>et al.</i> ^[36]	Penile fracture	–	Urethra 5 (14.2)	Sexual intercourse, 34 (80.9)	Penile deviation on erection (7/42)
9	Alami <i>et al.</i> ^[37]	Penile fracture	–	Urethral (6.3)	Coital faux pas (66.0)	Post-op sexual discomfort, 12 (37.0)
10	Al-Azzawi <i>et al.</i> ^[20]	Missile	Predominantly grade III penetrating injury (79.0)	Urethra, 7 (29.2) Scrotum (92.0)	Improvised explosives (67.0)	Death (17.0)
11	Gaither <i>et al.</i> ^[38]	Male grooming penile trauma	Laceration with blood (68.3)	–	Non-electrical blade (52.0)	–
12	Omisanojo <i>et al.</i> ^[39]	Penile fracture	–	Urethra, 4 (26.7)	Vigorous coitus, 10 (66.7)	Post-op penile curvature, 2 (13.3)
13	Phillips <i>et al.</i> ^[19]	Penile trauma	–	Urethra, 4 (13.0)	Coitus, 25 (78.0)	New-onset erectile dysfunction (2/32)
14	AbouZeid <i>et al.</i> ^[40]	Hair coil trauma	Near total glans amputation, 1 (6.3)	Urethra, 15 (93.8)	Accidental circumferential constriction	–
15	Appiah <i>et al.</i> ^[41]	Circumcision injury	Partial amputation (2.8) Complete amputation (4.1)	–	Nurse-delivered (77.8)	Urethrocutaneous fistula (77.8)
16	Barros <i>et al.</i> ^[42]	Penile fracture	–	–	Sexual trauma (76.5)	Urethral bleeding (10.1)
17	Bolat <i>et al.</i> ^[43]	Penile fracture	–	Urethra, 3 (4.7)	Sexual intercourse, 44 (68.8)	Post-op erectile dysfunction, 5 (7.8)
18	Tamhankar <i>et al.</i> ^[44]	Penile fracture	–	Urethra (2/21)	Sexual intercourse, 18 (85.7)	Urinary retention (2/21)
19	Bozzini <i>et al.</i> ^[45]	Penile fracture	–	Urethra, 16 (11.7)	Sexual intercourse, 113 (82.5)	Post-op penile curvature, 5 (3.6)
20	Etabbal <i>et al.</i> ^[14]	Penile trauma	Grade III, 11 (37.) Grade II, 8 (27.6)	Urethra, 10 (34.5) Scrotum, 14 (48.3) Testis, 9 (31.0)	War with gunshot, 18 (62.0)	Urethral stricture, 8 (27.5)

Table 2: Continued

S. No.	Author	Type of trauma	Clinical information, n (%) ^a			
			Predominant severity type	Associated trauma site	Predominant risk factor	Predominant complication
21	Kumar et al. ^[46]	Penile fracture	–	Urethra (3/20)	Coitus (18/20)	–
22	Majhi et al. ^[47]	Penile fracture	–	Urethra (3/13)	Sexual intercourse (100.0)	–
23	Naouar et al. ^[48]	Penile fracture	–	Urethra (1/42)	Masturbation (66.6)	Penile curvature (7/42)
24	Djordjevic et al. ^[25]	Penile trauma	Penile amputation Grade IV (6/13) Grade V (7/13)	–	Iatrogenic, 8 (61.0) Self-mutilation and partner assault causing Grade V, 3 (23.1)	Urethral fistula in Grade V trauma (2/7)
25	Kasaraneni et al. ^[49]	Penile fracture	–	Urethra (100.0)	Sexual intercourse, 9 (75.0)	Acute urinary retention, 3 (25.0)
26	Kumar et al. ^[50]	Penile fracture	–	–	Sexual intercourse, 16 (94.1)	Erectile dysfunction, 3 (75.0) ^c
27	Ortac et al. ^[51]	Penile fracture	–	Urethra, 3 (11.5)	Sexual intercourse, 16 (61.5)	Post-op erectile dysfunction, 9 (34.6)
28	Patil et al. ^[52]	Penile fracture	–	Urethra (1/18)	Coitus, 12 (66.7)	Erectile dysfunction, 8 (44.4)
29	Barros et al. ^[53]	Penile fracture	–	Urethra, partial (13.5) complete (5.2)	Sexual trauma (88.5)	Erectile dysfunction (14.7)
30	Dias-Filho et al. ^[54]	Penile fracture	–	–	Sexual intercourse, 44 (78.6)	–
31	Lucas et al. ^[55]	Penile trauma	Glans amputations, 23 (64.0)	–	Voluntary male medical circumcision (100.0)	–
32	Qamar et al. ^[56]	Penile strangulation	Partial division of corpus cavernosum, 9/15	–	Cotton/polyester thread (11/15)	Urethrocutaneous fistula (1/15)
33	Sharma et al. ^[57]	Penile fracture	–	Urethra (4/43)	Sexual intercourse, 33 (76.7)	Mild erectile dysfunction (8/14) ^d
34	Panella et al. ^[58]	Penile fracture	–	Urethra, ^e 2 (13.3)	Sexual intercourse (16/20)	–
35	Bulbul et al. ^[59]	Penile fracture	–	Urethra, 4 (12.9)	Sexual intercourse, 20 (64.4)	Erectile dysfunction, 5 (16.1)
36	Christian-Miller et al. ^[60]	Penile fracture	–	–	Substance abuse (26.4)	Urinary retention, 139 (2.4)
37	Fischer et al. ^[61]	Penile foreign bodies	–	–	Day wear clothing, 1625 (23.0)	–
38	Sarikaya et al. ^[62]	Penile fracture	–	–	Sexual intercourse, 30 (71.4)	Skin infection, 3 (7.1)
39	Shimpi et al. ^[63]	Penile fracture	–	Urethra (1/14)	Coitus, 8 (57.1)	Erectile dysfunction (1/14)
40	Pandher et al. ^[64]	Penile foreign objects	–	–	0–18: Swimming apparel (23/53) ^f 19–64: Ring (74/146) ^f	–

^aAll values are expressed as frequency and/or percentage (in parenthesis) or ratio, x/y (in parenthesis).

^bBased on the denominator of the total count of patients with penetrating genital trauma.

^cBased on the denominator of the total count of patients on conservative management.

^dBased on the denominator of the total count of patients who are sexually active.

^eBased on the denominator of the total count of patients who had explorations.

^fBased on the denominator of the total count of those with foreign body implicated

was from various gunshots whereas explosions accounted for only 31.0% of the injuries. Al-Azzawi and Koraitim^[20] in Iraq also provided supporting evidence that about two-thirds of the penile trauma in their civilian setting was from the use of improvised explosive devices. It is, therefore, important to critically appraise the context of the use of arms whereas discussing this injury in the civilian and military setting.

Specific population: Age groups

Although traumatic penile trauma can occur in all age groups, young adults are particularly at high risk.^[4] This could be explained by the active and mobile role of this young class in the overall activity of the population.^[1] This age group further stands as the peak time for sexual function and reproductive activity.^[7] A study in India documented an age range of 22–52 years for adults with varying degrees of penile trauma.^[13] Another study based on the trauma databank of the American College of Surgeons in the United States further observed that the majority of the 2257 patients (71.0%) with penile trauma were below 35 years even though 23.0% were 18 years and below.^[12] Despite the fact that both studies were retrospective, the large population of patients in the penile trauma database strengthens the ability to use the latter data in a wider setting.

Even though only 1 in 20 trauma cases occurs in those less than the age of 10 years, the paediatric age group still represents a specific population at risk.^[11] Most of the genital trauma (65.9%) in this younger age group occurs in the indoor setting.^[21] Casey *et al.*^[21] observed that the age group in legal minors (less than the age of 18 years) with the highest occurrence (37.1%) of genital trauma was 5–8 years. In the other age groups of 0–4, 9–12, and 13–18 years, genital trauma occurred in 31.9%, 17.6%, and 13.4%, respectively.^[21] Nevertheless, the report on trauma to the external genitalia in the paediatric group is sporadic and that of penile trauma is even rarer.^[22] Moreover, it usually dwells on those related to sexual abuse and is less focussed on the role of accidental injury on genital trauma in this patient population.^[21]

Psychiatric illness

Another risk factor for penile trauma is patients with psychiatric illnesses.^[16] Around 9 in 10 (87%) of self-inflicted penile trauma is associated with a psychotic episode, with schizophrenia and depression being the commonly associated disorders.^[15]

Mechanisms of penile trauma

External forces leading to the occurrence of penile trauma are variable.^[4] However, these can be broadly grouped as blunt or penetrating mechanisms of trauma.^[23] This is significant as the mechanism affects its subsequent management.^[15]

Regarding penetrating trauma, a systematic review indicated that about 40%–60% of these type of injury to the genitourinary region involves the external genitalia.^[6] Penile trauma however accounts for only around one-third (34.0%) of the penetrating injury to the external genitalia.^[24] Specifically, its incidence has been documented to be 0.16% of the total cases of trauma and 0.56% of all the patients with penetrating trauma in a descriptive study of a large population of 28,489 trauma patients.^[24] It, however, appears that penetrating injury to this genitourinary region is higher during battles and wars as more than three-quarters (75.2%) of the injuries sustained to this region during this event had a penetrating mechanism.^[7] It is also known that this mechanism of injury could occur in the civilian population especially those with psychiatric disorders.^[13]

It appears as though blunt penile trauma has not been as extensively studied as penetrating trauma. Nevertheless, Cengiz and Abuzer^[10] observed that this is the most common mechanism for genital trauma in children (90.0%). This is not to say that blunt trauma does not occur in adult age groups but McCormick *et al.*^[9] noted that those with this type of trauma were significantly older than those who had the penetrating genital injury (40.6 vs. 34.1 years, $P = 0.012$). However, these two studies were not specific to patients with penile trauma.

Causes of penile trauma

In general, penile trauma can be accidental or intentional.^[18] The earlier aetiological group includes iatrogenic causes like circumcision, which is said to be frequently reported accounting for 63.0% of penile trauma in boys.^[22] Non-iatrogenic causes like sexual trauma from penile fracture, and non-sexual trauma from road traffic accidents, industrial and agricultural machinery accidents, gunshot wounds, animal bites, strangulation and zipper injury can also occur.^[13,18,25] On the other hand, intentional injuries usually result from either self-mutilation, direct assault, physical abuse, and civil violence.^[8,25]

Bicycles (14.7%), bathtubs (5.8%), daywear (5.6%), monkey bars (5.4%), and toilets (4.0%) are the most commonly associated consumer product with genital injury in children.^[21] There, however, appears to be an age-related variation in the aetiology of penile trauma with circumcision-related trauma more common in neonates, toilet seat and zipper injury in toddlers, and sport- and other outdoor-related injuries in the school age.^[26] A source of concern in the vulnerable age group of children is the ability to distinguish between intentional and accidental trauma. While this might be difficult, inconsistency in the history of the caregiver and a pattern of concurrent injury might be indicators to differentiate the potential causes.^[10]

Conveyor belt injury

This arises from blunt traumatic injury to the tissues in a penis in a flaccid state.^[17] It follows the entrapment of

free-flowing clothes in the pulley belt of either a moving industrial machinery or a powered community grinding machine.^[15] This results in the transfer of an extensive amount of kinetic energy leading to a wide spectrum of injuries including avulsion injuries and amputation of the penis.^[15] Ofoha *et al.*^[11] stated that this cause of injury is rare, noting that only three of the ten cases of penile trauma in their study were sustained from injuries in a grinding machine.

Zou and Fu^[3] emphasised that the rising economic growth led to an increase in industrial-related accidents. However, it is said that the incidence of this type of penile trauma has reduced with the institution of better occupational safety measures.^[15] It is however not clear if the enforcement of safety measures translates into the depth of communities where various high-grade non-mobile grinding machine driven by a pulley system exists in some countries.

Penile fracture

In this form of blunt trauma, there is a forceful bending of the penis in an erect state leading to a tunica albuginea defect and bleeding from the corporal body.^[2] The defect is usually transverse in orientation, proximally located and sited on one of the corporal bodies. However, in 6%–26%, the defect could be located distally and in 5%–14% could involve both corporal cavernosa.^[17]

Sex-related activities such as accidental thrust against the pubic bone or perineum during intercourse, masturbation or the practice of forcing down the erect penis to quickly achieve detumescence (taghaandan) are commonly implicated.^[5] The predominant sex-related cause however appears to vary in different parts of the world.^[17] Penile fracture could also arise from non-sexual causes like rolling over the penis in bed or falling off the bed.^[13,18]

There is a suggestion of epidemiological disparity in penile fracture between North Africa/Middle East and the rest of the world due to the large volume of publications on this subject in the earlier region.^[17] Based on data from a North American population, the estimated rate of occurrence of penile fracture is about 0.29–1.36 per 100,000 people.^[19] The possibility of under-reporting due to cultural issues in different parts of the world could limit the generalisation of this computed data.^[18]

Missile injury

This penetrating trauma could occur as a result of the use of individual firearms and improvised explosive devices.^[20] The anatomical protection of the flaccid penis could account for the rarity of gunshot injury to this organ in comparison to other parts of the body.^[14]

Maxwell *et al.*^[8] in a cohort study observed that penile gunshot wounds accounted for 1.7% of patients with

wounds from gunshot injury but the lack of granular data was a limitation of this observational study. Further exploring the burden of penile gunshot wounds on a more narrow level, it represents 50%–90% of penetrating injuries to the external genitalia.^[27] The occurrence of intentional penile trauma from gunshot (90.7%) is over nine times the frequency of accidental penile trauma from this type of missile injury (9.3%).^[8]

Road traffic accident

This could occur following the collision of cars, bicycles or motorcycles. It commonly results in the degloving injury of the penis.^[15]

Animal bite

The cause of this penetrating injury is commonly a dog bite.^[18] The degree of penile trauma sustained depends on the severity of the bite but it is said that it is usually not severe.^[18] The significance of animal bite is indicated not just by the physical injury inflicted on the penis, but also because of the risk of infection complications including tetanus and rabies as well as the potential for poor functional outcome.^[1] Fortunately, it is one of the rare causes of penile trauma.^[17] However, the paediatric age group are particularly more vulnerable to this type of injury.^[18]

Iatrogenic injury

This injury mostly results from circumcision, especially in settings where it is not performed by trained professionals.^[18] It is unique because it occurs in the early years of the life of the patient in some regions as it was documented to occur in 63.0% of penile trauma in the paediatric population.^[18]

Strangulation injury

This form of penile trauma is caused by metallic materials (such as heavy metal rings or sprockets) and non-metallic objects (like the plastic bottleneck or plumbing cuff) during its use for sexual satisfaction.^[18] It causes circumferential compression of the penis resulting in vascular compromise, oedema and subsequent gangrene of the penis.^[18] In other instances, the object could penetrate through overlying tissues to involve the corpora cavernosum.^[18] Strangulation injury to the penis is, however, uncommon.^[18]

Assault

This type of injury could be an accidental or intentional injury. The latter is commonly associated with assault by the partner as a manifestation of anger.^[16] However, it could also be self-inflicted on the penis by the patient as a feature of Klingsor syndrome.^[28] It usually results in the laceration or amputation of the penis.^[13] In addition to the above burden, there is the risk of life-threatening haemorrhage from self-inflicted injuries.^[18] Although stab wounds to the penis are said to account for 10%–18% of penetrating traumatic genital injuries, this figure is largely based on

data from large-volume trauma centres and might not be reflective of rates in smaller institutions.^[17]

Penile zipper injury

This is known to occur in uncircumcised boys, especially those with phimosis.^[18] In this injury, the foreskin is trapped within the zipper during the process of dressing leading to injury to the soft tissue.^[16]

Clinicosocial consequence of penile trauma

Even though a wide spectrum of injuries can be sustained, penile trauma, especially the isolated type, is not usually life-threatening.^[2] This might however have significant functional and cosmetic costs. Regarding functional problems, post-trauma sequelae of loss of length from a severe injury could compromise vaginal penetration.^[25] Other sexual functional problems include long-term erectile dysfunction following injury to the corpora cavernosa, which is documented to occur in 10%–25% of patients.^[27] However, this figure might be lower for patients with penile fracture as Furr and Culkin^[2] documented a high potency rate of 87%–100% with optimal management. There could also be the development of pain during intercourse.^[13] These clinical consequences might be more significant in relatively younger patients who are at the stage of development of their sexual identity.^[7]

Voiding function could be further affected by a stricture or fistula, following urethral injury.^[9] A disfigured aesthetic appearance from potential penile scarring, curvature and devastating deformity could further affect the perception of manly quality and physical balance of the patient.^[25,29]

Different domains in the health-related quality of life of these trauma patients may also be affected.^[11,14] Looking at the psychological state of the patient, the occurrence of penile trauma or its morbidities could have a negative effect on the social and emotional relationship of the patient or intimacy with his partner.^[6]

Etabbal *et al.*,^[14] however, observed that only 37.9% patients developed complications following penile trauma but this was based on injuries in a war-related setting. McCormick *et al.*,^[9] however, documented a 15% complication rate but this outcome might only be replicable in a highly specialised trauma centre.

Prevention of penile trauma

Indeed, the devastating outcomes of penile trauma call for the prevention of penile trauma at different applicable levels. A well-known approach in adults is the use of personal protective equipment to protect the external genitalia from low and high-energy missile injury in the military setting.^[7]

Conclusion

Penile trauma is not common. Despite the diversity in its burden, risk factors and clinical pattern across different population settings, majority of research studies on this condition are focussed on penile fracture and are mostly devoid of a standard

description of penile trauma severity. There is also a dearth in publications of large multi-country series and limited reports of penile trauma in the paediatric population.

Additional studies are required on the severity of penile trauma from specific aetiologies across the legal age of maturity. This is important to identify trends and provide evidence that could help shape contextually relevant policy on child welfare and occupational safety in communities.

Conflict of interest

There are no conflicts of interest.

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