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DEFINING PATTERNS OF GENITAL INJURY FROM SEXUAL ASSAULT:

A Review

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Abstract

The forensic examination following rape has two primary purposes: to provide health care and to collect evidence. Physical injuries need treatment so that they heal without adverse consequences. The pattern of injuries also has a forensic significance in that injuries are linked to the outcome of legal proceedings. This literature review investigates the variables related to genital injury prevalence and location that are reported in a series of retrospective reviews of medical records. The author builds the case that the prevalence and location of genital injury provide only a partial description of the nature of genital trauma associated with sexual assault and suggests a multidimensional definition of *genital injury pattern*. Several of the cited studies indicate that new avenues of investigation, such as refined measurement strategies for injury severity and skin color, may lead to advancements in health care, forensic, and criminal justice science.

Keywords

forensic examination; patterns of genital injury; sexual assault

An estimated 876,064 rapes are perpetrated against women each year in the United States (Tjaden & Thoennes, 2000). Among injured female victims of sexual assault, one half of those in which the violence was reported received some type of treatment from a health care provider (Rennison, 2002). The prevalence of genital injury resulting from sexual assault has been an area of interest to the scientific and health care community since the 1970s (Hayman, Lanza, Fuentes, & Algor, 1972; Massey, Garcia, & Emich, 1971; Soules, Stewart, Brown, & Pollard, 1978). Investigators have, over the years, typically reported the prevalence and location of injuries that occur most commonly; however, less is known about other more subtle aspects of injury, such as the type, severity, and extent of the wounds.

The purpose of this review is to critique the existing science that describes genital injury prevalence resulting from sexual assault. In addition, the review builds the case that the prevalence and location of genital injury provide only a partial description of the nature of genital trauma associated with sexual assault and suggests a multidimensional definition of genital injury pattern. Finally, I critique the extant literature, discuss the role of injury in the criminal justice system, and build a case for the scientific work that needs to be accomplished in the future to better understand patterns of genital injury after sexual assault.

GENITAL INJURY PREVALENCE

Genital injury prevalence, which is calculated from injury frequency, can be described as the proportion of females with an occurrence of any injury at an anogenital location following sexual assault. Anogenital injury location can be classified as external (labia majora, labia minora, periurethral area, perineum, and posterior fourchette), internal (fossa navicularis, hymen, vagina, cervix), and anal (anus and rectum) (Sommers et al., 2006).

The prevalence of genital injury resulting from sexual assault varies by examination type and ranges from 5% on direct visualization (Massey et al., 1971) to 87% with colposcopic technique (Slaughter & Brown, 1992). Three primary strategies exist for genital examination: (a) direct visualization with the unaided eye; (b) staining techniques (Gentian violet, Lugol's solution, toluidine blue, fluorescein, or a combination of these staining techniques), which are applied topically to highlight injuries and make them more visible to the eye; and (c) colposcopy (use of a magnifying instrument [colposcope] with a light source and digital imaging and/or photographic capability).

Injury Prevalence With Visual Inspection

Prior to 1995, investigators using direct visualization during the sexual assault exam found the prevalence of genital injury to be less than 40% in series composed of women, adolescents, and children (Cartwright, 1986; Everett & Jimerson, 1977; Goodyear-Smith, 1989; Hayman et al., 1972; Massey et al., 1971). In one of the first-reported investigations of a series of rape victims, Massey et al. (1971) studied 480 females and found detectable gynecologic injuries in 5.2% of the sample. Other investigators reported a prevalence in the range of 20% to 40% in series with sample sizes of more than 100. For example, in 1,223 women and children, 20 victims had severe vaginal and vaginoperineal lacerations, and 199 had minor genital injuries (Hayman et al., 1972). Cartwright (1986) reported an adjusted frequency rate of 0.2% of females ($N = 440$) with genital injury requiring treatment and 16.1% with no treatment needed.

Some investigators reported differences in injury prevalence in children as compared to adults, while others reported differences in prevalence based on severity. In her study of 190 women and primarily female children after sexual assault, Goodyear-Smith (1989) found that 19.5% of children and 40% of adults had genital trauma (bruising, inflammation, tenderness, abrasions, or lacerations), and 3.5% of children and 6% of adults had anal injury. Everett and Jimerson (1977) studied women and children ($N = 117$) who had a rape exam and found that 19% had minor lacerations and abrasions in the genital region and 7% had major vaginal or perineal lacerations.

In more recent years, injury prevalence was documented with visual inspection between 50% to 60% in a sample of women ($N = 1,076$) seen in an emergency department (Riggs, Houry, Long, Markovchick, & Feldhaus, 2000) and in 801 sexual assault survivors (Gray-Eurom, Seaberg, & Wears, 2002), although some authors reported lower prevalence rates depending on injury classification (Sugar, Fine, & Eckert, 2004). One study had lack of control over the examination and little detail on injury classification procedures and therefore was not included in this review (Crane, 2006).

Injury Prevalence With Staining Techniques

A staining technique using toluidine blue contrast was described in 1963 as a mechanism to highlight cervical neoplasms (Richart, 1963). It has been used to identify injury during the forensic examination because toluidine blue adheres to areas of abraded skin and microlacerations, where squamulae in the deeper layers of the epidermis are nucleated (Crowley, 1999). Investigators studying small numbers of participants ($N = 24$ to 44) and using toluidine blue to identify injury have found a 40% to 58% prevalence of genital injury after sexual assault (Lauber & Souma, 1982; McCauley, Guzinski, Welch, Gorman, & Osmer, 1987). Lauber and Souma (1982) chose a high standard of injury, however, by defining injury as laceration only. It is interesting to note that Jones and colleagues found that when using toluidine blue before and after a standard forensic examination 1 of 27 female patients demonstrated a new genital injury from speculum insertion (Jones, Dunnuck, Rossman, Wynn, & Nelson-Horan, 2004), a finding that may have confounded the results of

studies cited above. Since publication of the Jones et al. (2004) study, protocols have been changed nationally to ensure that injuries from the speculum are not counted in the forensic examination (Department of Justice, 2004).

Injury Prevalence With Colposcopy Technique

The colposcope is a binocular system of magnifying lenses connected to an internal light source and may be used with a camera to provide digital or film images (Hobbs & Wynne, 1996). The first description of a forensic examination using a colposcope in adult sexual assault cases ($N = 500$) appeared in 1981 in a report by a Brazilian physician (Teixeira, 1981). With a colposcope, he was able to identify 11.8% more cases of sexual assault than were found by conventional examination. Other investigators found that colposcopic technique was better than direct visualization and toluidine blue contrast to detect injury in children (Muram & Elias, 1989; Woodling & Heger, 1986). Lenahan and colleagues (Lenahan, Ernst, & Johnson, 1998) studied 17 sexual assault survivors and compared findings from the colposcopic technique to gross visualization alone. They found that the colposcope documented trauma in 9 of 17 cases (53%) whereas gross visualization documented trauma in 1 case (6%).

Colposcopic technique with digital image or photographic capture has become the standard of care in the sexual assault forensic examination in the United States (Department of Justice, 2004). Its use is generally associated with documenting a higher injury prevalence than other techniques, particularly when combined with staining preparations such as toluidine blue, Gentian violet, and/or fluorescein. For instance, examiners using colposcopy technique and staining found an injury prevalence of 83% in adolescents and 64% in women ($N = 209$) (Jones, Rossman, Wynn, Dunnuck, & Schwartz, 2003), whereas Sachs and Chu (2002) reported an injury prevalence of 81% in 209 sexual assault survivors. Slaughter and Brown (1992) found a genital injury prevalence of 87% in 131 sexual assault survivors, and the same investigative team later found a localized pattern of genital trauma in 68% of the victims reporting sexual assault (Slaughter, Brown, Crowley, & Peck, 1997).

Injury Prevalence Overview

Development of the science and practice of the forensic examination has led to documentation of an increased prevalence of genital injury over time. The combination of colposcopy and staining techniques resulted in the detection of injuries in the largest number of victims described in the published literature.

LOCATION OF GENITAL INJURY

The most common locations for genital injury in female teenagers and women are the posterior fourchette (tense band of tissue that connects the two labia minora), labia minora (two thin inner folds of skin within the vestibule of the vulva), hymen (thin membrane composed of connective tissue that overlies the vaginal opening), and fossa navicularis (shallow depression located on the lower portion of the vestibule and inferior to the vaginal opening) (Grossin et al., 2003; Jones et al., 2003; Lauber & Souma, 1982; Slaughter & Brown, 1992; Slaughter et al., 1997; Sommers, Schafer, Zink, Hutson, & Hillard, 2001). Slaughter et al. (1997) found the prevalence of genital injury in order by location was posterior fourchette (70% of those with genital injury), labia minora (53% of those with genital injury), hymen (29% of those with genital injury), and fossa navicularis (25% of those with genital injury). Jones et al. (2003) reported similar findings in 766 women and pubertal girls younger than age 18 years. They found that 78% had injuries at one of the four locations mentioned above, although adult women experienced less injury to the hymen and greater injury to the perianal area as compared to girls.

Using a somewhat different classification, Grossin et al. (2003) found that in 161 female sexual assault victims examined in the emergency department (within 72 hours of the assault), 20% had vulvo-vaginal injuries (injuries of the external female genitalia, including the labia, clitoris, and vaginal opening and vaginal injuries), 11% had hymeneal injuries, and 7% had anal injuries. In contrast, adult rape victims in Nigeria had a low detection of genital injury, with only 14 of 171 adult victims having a report of injury to the vulva, 18 with vaginal injury, and 10 with injuries of the hymen (Olusanya, Ogbemi, Unuigbo, & Oronsaye, 1986), and the findings were similar to those from a small series of victims in Northern England (Bowyer & Dalton, 1997). In short, the majority of the evidence in large series of sexual assault cases indicates that the posterior fourchette and labia minora are the most common locations of genital injury in adult females.

IS INJURY PREVALENCE FOLLOWING CONSENSUAL SEXUAL INTERCOURSE RELEVANT?

For as long as investigators have been studying genital injury following rape and sexual assault, others have reported on injuries following consensual sexual intercourse. In an early series of women with vaginal injuries and that mixed women ($n = 7$) who were raped with women who reportedly had consensual coital injuries ($n = 24$), the most common presenting sign was vaginal bleeding (Wilson & Swartz, 1972). In two reviews of sexually related trauma, the authors noted that minor trauma to the vagina commonly accompanied vaginal intercourse and was often accompanied by tears in the lower part of the hymen and posterior fourchette (Elam & Ray, 1986; Geist, 1988). They also noted that the most common injuries during a female's first intercourse are hymenal lacerations and tears. During the same time period that both reviews were written, a prospective study with a small sample ($N = 18$) demonstrated that following consensual intercourse 61.1% of the participants had positive colposcopic and contrast medium findings. Injuries included increased vascularity of the vaginal mucosa with vascular enlargement (telangiectasia), broken capillaries, and microabrasions (Norvell, Benrubi, & Thompson, 1984).

Injury prevalence reported in the literature following consensual sexual intercourse is generally reported at approximately 10%. In a study of 48 women who had voluntary sexual intercourse within 48 hours of the exam, investigators found a 10% injury rate, and all participants with injuries gave a history of dry or painful intercourse. This proportion of injury is similar to those found by other investigators in the consensual sex population (Lauber & Souma, 1982; Slaughter et al., 1997). Fraser and colleagues followed 107 sexually active women, age 18 to 35 years, over a 6-month period to look for changes in vaginal and cervical appearance (Fraser et al., 1999). In 3.5% of the 314 inspections, investigators found a total of 11 abnormalities: 3 ulcerations, 2 ecchymoses, 5 abrasions, and 1 tear. The prevalence of injury was highest when exams followed intercourse in the previous 24 hours or after tampon use.

Injured controls ($n = 8$) in the Slaughter et al. (1997) study had trauma limited to a single site as compared to their nonconsensual counterparts. Four participants experienced ecchymosis and 4 a single tear or abrasion. Five of the injuries were on the posterior fourchette and three on the hymen. Several methodological issues, however, existed with this investigation. The consensual group was examined in the first 24 hours following intercourse, whereas the nonconsensual group was seen from 0 to more than 72 hours after sexual assault. Of the 227 participants with penile penetration in the nonconsensual group, 69 were seen 72 hours or more after the rape, which may have led to underreported injury prevalence because of injury healing. The nature of the control population also raises serious questions about the study findings. The majority of the participants in the consensual group (48 of 75) were seen initially because of reported sexual assault but recanted and stated that

consensual sex had occurred. Investigator bias was another methodological issue. The investigators performed the exams and evaluated the data rather than using blinded experts to classify injury location, number, and type. The rating procedure was not specified, including number of raters and the rating system employed. No effort was made to control for degree of lubrication, condom use, partner size, duration of the encounter, and other variables in the consensual group.

In contrast to other work, in a recent study the investigators reported that 30.4% of consensual participants ($n = 46$) and a surprisingly low 32.1% of nonconsensual participants ($n = 56$) had genital injury (Anderson, McClain, & Riviello, 2006). Although the study had significant methodological problems such as small sample size; heterogeneity of groups with regard to age, history, and time to examination; and lack of adequate matching procedures, the study raises interesting questions about the low injury prevalence in the consensual population reported previously. Clearly, further work is needed with methodologically rigorous studies with large sample sizes to understand injury prevalence following consensual sexual intercourse, and how those injuries compare to the injuries that follow rape and sexual assault.

THE CASE FOR THE DOCUMENTATION OF INJURY PREVALENCE AND LOCATION

Research has consistently shown that injury plays a significant role at multiple decision-making points during criminal justice proceedings such as the decision to report, file, prosecute, and convict (Sommers, Fisher, & Karjane, 2005). The importance of the documentation of injury cannot be overlooked, especially given that an important reason for not reporting to the police is the “lack of proof that an incident happened” (Fisher, Cullen, & Turner, 2000). Forensic evidence documenting the existence of injury following sexual assault can be used as part of a larger constellation of factors of evidence to enhance the government’s case in allegations of sexual assault and allows the jury or judge to make an informed decision to convict or not.

Although in recent years, the role of nongenital and genital injuries together in criminal justice proceeding in sexual assault cases has become clearer, the role of genital injury alone is less clear. Two early studies using retrospective review of medical records in the 1970s and 1980s found no correlation between judicial outcome and the severity of all injuries (genital and nongenital) (Penttila & Karhunen, 1990; Tintinalli & Hoelzer, 1985). Penttila and Karhunen (1990), however, reported that in cases with imprisonment, there were significantly more victims with severe injuries than in other categories.

Given current knowledge about the forensic examination, several limitations are apparent in these early studies. Although examination protocols were not explicated in both investigations, they apparently included visual inspection only, reducing the likelihood that all injuries were detected. Although injury frequency was tabulated separately for genital and nongenital injury, injury prevalence was calculated based on any injury type. The definitions of severe or major injury were also open to interpretation. *Severe injuries* were defined as skeletal fractures or trauma that required major operative repair in one study and numerous bruising, scratches, abrasions, and lacerations in the other study. Thus, one study excluded any genital injury from the severe category (Tintinalli & Hoelzer, 1985), and the other had a broad definition of *major injury* that included minor conditions such as scratches and abrasions (Penttila & Karhunen, 1990).

Several more recent studies also do not differentiate specifically between genital and nongenital injuries, making generalizations problematic. McGregor and colleagues

developed a clinical injury scoring system by using physicians' ratings and a multirater kappa scoring strategy. The score had a range of 0 (*no injury*) to 3 (*severe injury*) and a combined multirater kappa score of 0.87; however, genital and nongenital injuries were included in the scoring, and only nongenital injuries fit the criteria for "severe" (McGregor, Le, Marion, & Wiebe, 1999). In a series of 114 cases of sexual assault, these investigators found that the odds ratio (OR) for filing charges associated with moderate or severe injury was 3.33 (95% confidence interval [CI] 1.06 to 10.42); however, genital injury per se was not associated with the filing of charges. The investigators replicated their study with 462 cases of sexual assault and found a gradient association for injury severity and filing of charges in the following categories: mild injury (OR = 2.85, 95% CI = 1.09 to 7.45); moderate injury (OR = 4.00, 95% CI = 1.63 to 9.84); severe injury (OR = 12.29, 95% CI = 3.04 to 49.65). Severe injury was the only variable associated with conviction, and genital injury alone was not associated with either filing of charges or conviction (McGregor, Du Mont, & Myhr, 2002). In neither of the McGregor studies did the investigators explain their forensic examination protocol in detail. If colposcopy and staining were not used, underreporting of injury prevalence most likely occurred. They also did not report the time from the assault to the examination, raising the issue that in some victims a degree of wound healing may have occurred, thus confounding their findings.

Studies Demonstrating an Association Between Criminal Justice Outcomes and Injury

Rambow and colleagues reported on 182 sexual assault cases, 53 of which had the potential for successful prosecution with a victim willing to testify and an identified assailant. They found that 34% of these cases resulted in a successful prosecution, and evidence of genital or nongenital injury were associated with a successful legal outcome ($p < .01$) (Rambow, Adkinson, Frost, & Peterson, 1992). The examiners used visual inspection and photography to document the injuries, and 96% of the victims were seen within 24 hours of the assault. Analyses were not completed separately for genital and nongenital injury.

In the most elegantly designed protocol, investigators studying the role of injury in legal outcomes used a population-based, retrospective review of forensic evidence in 801 forensic examinations (Gray-Eurom et al., 2002). Although colposcopy was not used in the examinations, all examiners used a standard protocol, underwent initial training, and maintained monthly peer review during the study period. They found evidence of injury in 57% of the forensic examinations. Victims younger than age 18 years (OR = 2.23, 95% CI = 1.2 to 4.16), the presence of trauma (OR = 1.93, 95% CI = 1.08 to 3.43), and weapon use by the assailant (OR = 2.00, 95% CI = 1.05 to 3.81) were all significantly associated with successful prosecution. Injury was treated as a dichotomous variable, and no attempt was made to differentiate between genital and nongenital injury, nor to grade injury severity.

Tintinalli and Hoelzer (1985), who found no statistically significant correlation between the presence of sperm, the occurrence of injury, and legal outcome in sexual assault cases, stated, "we believe pelvic examination is not medically indicated as a routine in sexual assault evaluation" (p. 450). Since this statement in 1985, there have been many changes in the criminal justice system and in the techniques used for the forensic examination. To date, the role of genital injury in the filing of charges and conviction has yet to be fully explicated. No investigators using state-of-the-art examination techniques and a rigorous classification system for genital injury severity have studied the criminal justice outcomes following sexual assault. Until such a time as studies with rigorous methods are available to guide forensic practice, the literature supports the continued refinement of the forensic sexual assault examination with detailed documentation of genital injuries.

THE CASE FOR A COMMON DEFINITION OF GENITAL INJURY PATTERN

Although some authors have used the term *injury pattern* to describe genital injury (Olusanya et al., 1986; Slaughter et al., 1997), they primarily are defining *injury pattern* as prevalence and location. I propose a definition of *injury pattern* that is much broader and includes genital injury prevalence, frequency, location, severity, and type. To further explicate the definition of *genital injury pattern*, *genital injury prevalence* is defined as the proportion of women with an occurrence of injury as calculated from injury frequency. *Genital injury frequency* is defined as the number of injuries counted by examiner during each aspect of the examination: visual inspection, colposcopy, and contrast medium application. *Genital injury location* is defined as the anatomic site of injury and includes the external genitalia (labia majora, labia minora, periurethral area, perineum, posterior fourchette, and fossa navicularis), internal genitalia (hymen, vagina, cervix), and anus (rectum). *Genital injury severity* is defined as the area and degree of injury.

Finally, genital injury types are described as tears, ecchymoses, abrasions, redness and swelling, or TEARS (Slaughter et al., 1997; Sommers et al., 2001). *Tears* are defined as any breaks in tissue integrity, including fissures, cracks, lacerations, cuts, gashes, or rips. *Ecchymoses* are defined as skin or mucous membrane discolorations, known as “bruising” or “black and blue” areas because of the damage of small blood vessels beneath the skin or mucous membrane surface. *Abrasions* are defined as skin excoriations caused by the removal of the epidermal layer and with a defined edge. *Redness* is erythemous skin that is abnormally inflamed because of irritation or injury without a defined edge or border. *Swelling* is edematous or transient engorgement of tissues. Other authors have reported injury classification systems. One group of investigators proposed a different injury typology (nonperforating soft-tissue injury, lacerations, or current bleeding) (Biggs, Stermac, & Divinsky, 1998); however, the TEARS classification is the most commonly used and at this point is the classification most likely to provide comparable data across studies.

Why a common definition? A common definition for *genital injury pattern* has the potential to guide research methods so that all investigators begin to measure genital injury using the same parameters. Thus, studies across consensual and nonconsensual populations will become comparable, and injury science will advance. Measurement strategies are available for injury prevalence, frequency, location, and type. Although further work needs to be done on injury severity, several authors have attempted to classify injury severity (Penttila & Karhunen, 1990; Tintinalli & Hoelzer, 1985), and our investigative team (Sommers et al., 2006) is working on a rigorous quantification of injury severity.

THE UNEXPLORED AREA OF SKIN COLOR AND COLOR AWARENESS

In an article in the *Archives of Pediatric Adolescent Medicine* on the use of the terms *race* and *ethnicity*, the authors noted that the terms can be troublesome because of the impreciseness of the definitions, the historical implications of the words, and the lack of scientific basis for their meanings (Rivara & Finberg, 2001). On the other hand, there are times that investigators explore differences across marginalized, vulnerable, or underrepresented populations to narrow the gap of health disparities and create culturally sensitive interventions.

Little is known about the role of race and ethnicity in genital injury following rape and sexual assault. A careful reading of several series demonstrates subtle indications that racial and/or ethnic differences may be present in the prevalence of genital injury resulting from rape or sexual assault. For example, the obstetric literature reflects differences in genital injury following vaginal births, with Blacks less likely than Whites to have third- and fourth-degree perineal lacerations and tears (Howard, Davies, DeLancey, & Small, 2000;

Robinson, Norwitz, Cohen, McElrath, & Lieberman, 1999). Several authors of large series of sexual assault cases have also found racial differences in their sample populations. They reported that White females have significantly more genital injury as compared to Black females (Cartwright, 1987; Coker, Walls, & Johnson, 1998). Cartwright and the Sexual Assault Study Group (1987) found in a retrospective review of medical records that White women of all ages had almost twice as frequent genital injuries as Black women. Coker et al. (1998) studied male and female sexual assault victims and found among males that the victims' race (being White) was significantly associated with traumatic physical injury when adjusting for other correlates (OR = 1.6, 95% CI = 1.1 to 2.4). Among women, injury was not significantly associated with race (OR = 1.1, 95% CI = .9 to 1.3). In contrast, Sachs and Chu (2002) found no significant differences in genital injury by race.

No definitive trends in the current scientific literature exist that demonstrate differences in genital injury prevalence based on race. In an intriguing recent report, however, Sommers et al. (2006) found significant association between race (Black vs. White) and genital injury (adjusted OR = 4.30, 95% CI = 1.09 to 25.98, $p = .03$), indicating that Whites were more than 4 times as likely as Blacks to have genital injury. The authors made the case that differences in skin pigmentation may have altered the ability of the examiners to observe injury regardless of the technique employed. They note that although White and Black participants have a continuum of skin color that is not bound by race and has a wide variation, anthropological studies do indicate that Blacks have a darker mean skin color than do Whites (Shriver & Parra, 2000). The findings of this study suggested that individuals with darker skin may be at a disadvantage for injury identification with the current examination strategies (direct visualization, contrast media, colposcopy), and color awareness may be an important component of the sexual assault forensic examination.

CONCLUSIONS

As technology and examination techniques have improved, the literature reflects a growing ability by examiners to detect genital injury following rape and sexual assault. In particular, the combination of colposcopy with digital image capture and staining with contrast media such as toluidine blue, Gentian violet, fluorescein, and/or Lugol's solution has led to reports of genital injury prevalence approaching 90% following nonconsensual sexual intercourse. Several replication studies demonstrated the same four locations that are the most common sites for genital injury: posterior fourchette, labia minora, hymen, and fossa navicularis. In addition to relatively well established data for injury prevalence and location, the role of genital injury in criminal justice proceedings is clear. The forensic evidence documenting the existence of injury following rape can aid the victim, police, prosecutor, and jury in their respective roles in the decision-making processes. Because the examination is based on scientific evidence, it may influence victims to report their experiences to police, encourage police to file a complaint, and persuade prosecutors to file rape charges and pursue a conviction (Sommers et al., 2005).

Additional work is needed, however, to understand the multiple dimensions of the pattern of genital injuries after rape and sexual assault. By expanding the definition of *genital injury pattern* to a multidimensional model including genital injury prevalence, frequency, location, severity and type, scientists may be able to further explicate the differences between injury patterns in the consensual and nonconsensual populations. Measurement strategies with validity and reliability testing are not yet available for all the dimensions of genital injury pattern; however, with further scientific work, the use of a comprehensive model of injury pattern will inform the health care science in critical ways and will provide representative evidence in criminal justice proceedings.

Findings in the Sommers et al. (2006) study are intriguing and open new avenues for research. Two ready explanations are available to explain findings that White and Black women have a statistically significant difference in injury prevalence. Differences in skin pigmentation may alter the ability of the examiners to observe injury regardless of the technique employed, although White and Black individuals have a continuum of skin color that is not bound by race and has a wide variation. Sommers et al.'s findings suggest that individuals with darker skin may be at a disadvantage for injury identification with the current examination strategies (direct visualization, contrast media, colposcopy). On the other hand, work studying women after vaginal deliveries indicates that women with dark skin may have a protective factor against injury that is not present in lighter skin, although bias may have confounded the results of those investigations (Howard et al., 2000; Robinson et al., 1999). Although skin color is a socially charged issue, it is critical that further exploration occurs across the continuum of skin pigments to ensure that those with darker skin color are not placed at a disadvantage during the forensic examination. With advanced measurement strategies that reflect a multidimensional definition of injury pattern, the health care and criminal justice practices will have a stronger scientific basis for decision making, and the most rigorous techniques can be employed to benefit all sexual assault victims.

IMPLICATIONS FOR PRACTICE, POLICY, AND RESEARCH

Practice

- Forensic examiners need to document injury pattern with consideration of injury prevalence, frequency, location, and type. When appropriate strategies to quantify injury severity are developed, injury severity also needs to be reported.
- Use of direct visualization only for the forensic examination does not provide adequate strategies to detect all injury; staining and colposcopy are indicated at this time.

Policy

- if females with dark skin have fewer injuries detected than those with light skin, they are at a disadvantage in the criminal justice system. Health disparities need to be remedied through research.
- The role of injury pattern and prosecution/conviction rates needs to be more completely elucidated so that law enforcement officials and health care providers provide the best evidence possible for prosecution.

Research

- Advances are needed to improve the measurement strategies for injury prevalence, frequency, location, and type; advances are needed to develop a measurement strategy for genital injury severity.
- Large-scale trials are needed to determine the role of skin color in genital injury detection.

SUGGESTED FUTURE READING

Citation	Explanation
Teixeira (1981)	First investigation of genital injury outcomes in adult women with the use of the colposcopic technique

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Citation	Explanation
Slaughter, Brown, Crowley, & Peck (1997)	Classic work that compared genital injury in the consensual and nonconsensual population and used the tears, ecchymoses, abrasions, redness and swelling (TEARS) classification
McGregor, Du Mont, & Myhr (2002)	Found that severe injury was the only variable associated with conviction in criminal justice proceedings
Sommers et al. (2006)	Introduced the possibility of inherent health disparities in the forensic examination may exist because of differences in skin color

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Biography

Marilyn (Lynn) Sawyer Sommers is the Lillian S. Brunner Professor of Nursing at the School of Nursing, University of Pennsylvania. She received a bachelors of science in nursing from the University of Pennsylvania, a masters of arts in nursing education from New York University, and a PhD in nursing science from The Ohio State University. She has been involved in research in the area of injury and violence for more than 15 years. She has also been active in research developing and testing interventions to reduce violence against women. She has published her research findings and synthesis of research in prestigious journals such as the *Journal of Trauma*; *Nursing Research*; *Alcoholism: Clinical and Experimental Research*; *Trauma, Violence, & Abuse*; and the *American Journal of Critical Care*.

KEY POINTS OF THE RESEARCH REVIEW

- Incidence of genital injury after rape and sexual assault in recent series ranges from approximately 50% to 90%.
- Considering the current technology available for the examination, forensic protocols should include visual inspection, staining, and colposcopy with digital image capture.
- Posterior fourchette is the most common location for genital injury following sexual assault.
- Severity of genital and nongenital injury is associated with filing of charges and conviction.
- A widely-accepted definition of *injury pattern* that guides the forensic examination would improve consistency in research and practice. The definition of *genital injury pattern* is a model that includes genital injury prevalence, frequency, location, severity, and type.

TABLE 1

Summary of Critical Findings

Category	Critical Findings	Supporting Citations
Injury prevalence following sexual assault	1 Visual inspection prior to 1995: 5% to 40%	1 Cartwright (1986); Goodyear-Smith (1989); Massey, Garcia, & Emich (1971)
	2 Visual inspection after 1995: 40% to 60%	2 Gray-Eurom, Seaberg, & Wears (2002); Riggs, Houry, Long, Markovchick, & Feldhaus (2000)
	3 Toluidine blue contrast: 40% to 58%	3 Lauber & Souma (1982); McCauley, Guzinski, Welch, Gorman, & Osmers (1987)
	4 Colposcopy (alone or in combination with staining): 64% to 87%	4 Jones, Rossman, Wynn, Dunnuck, & Schwartz (2003); Sachs & Chu (2002); Slaughter & Brown (1992); Slaughter, Brown, Crowley, & Peck (1997)
Injury location following sexual assault	1 Posterior fourchette (70% of those with genital injury)	Slaughter et al. (1997)
	2 Labia minora (53% of those with genital injury)	
	3 Hymen (29% of those with genital injury)	
	4 Fossa navicularis (25% of those with genital injury)	
Injury prevalence following consensual intercourse	10% to 30%	Anderson, McClain, & Riviello (2006); Fraser et al. (1999); Slaughter et al. (1997)
Definition for genital injury pattern	Genital injury prevalence, frequency, location, severity, and type	Slaughter et al. (1997); Sommers, Schafer, Zink, Hutson, & Hillard (2001)