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Technical note

Evaluation of anogenital injuries using white and UV-light among adult volunteers following consensual sexual intercourse

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ABSTRACT

Objectives: New clinical forensic examination techniques for sexual assaults have not been introduced over the last few decades. We evaluated the benefit of ultraviolet light compared to white light for detecting minor anogenital injuries and scars, following consensual sexual intercourse among adult volunteers.
Design: A prospective study comparing female genital findings utilising white and ultraviolet light. A colposcopy with photographic documentation was used.
Setting: Personal invitation to healthcare students, hospital employees or acquaintances to volunteer for a gynecological examination, with a focus on clinical forensic aspects.
Participants: Eighty-eight adult female volunteers were recruited for the study. The examination was performed after consensual intercourse. Age ranged from 20 to 52 years (median 26.5 years).
Main outcome measures: Presence of acute findings and scars in the genital area using white and UV-light.
Results: Acute genital injury rate was 14.8% under white light colposcopy and 23.0% using UV light. Submucosal hemorrhages in the genital area were documented significantly better under UV-light than white light (14.9% vs. 6.8%; $p = 0.016$), whereas petechiaes (4.5%) and abrasions (2.3%) were detected using either method. UV-light revealed significantly more often delivery-associated genital scars compared to white light (39.8% vs. 31.8%; $p = 0.016$). Furthermore, 10 out of 31 (33.3%) women had no residual anogenital skin or mucosal surface findings, despite a prior episiotomy or rupture of the vaginal outlet wall during delivery, supporting its enormous ability to heal even after major trauma.
Conclusions: UV-light may provide additional value for the evaluation of physical findings in clinical forensic examinations after sexual assault, and is especially useful in detecting otherwise invisible early submucosal hemorrhages and scars.

1. Introduction

When evaluating and analyzing physical findings in victims of sexual assault for clinical forensic purposes, it is very important to know how often lesions occur through consensual intercourse. To our knowledge, the current literature contains eight studies investigating external genital injuries after consensual intercourse [1–8]. Variation in genital injury prevalence after consensual intercourse in these studies is unbelievably wide: 5–61%. This may partly result from heterogeneous participant recruitment, due to examination timing, misreporting other medical conditions as acute genital findings, a lack of follow-up, and the use of different examination and visualization techniques. Furthermore, injury definition, participant inclusion and exclusion criteria were not always clear.

Three clinical forensic medical examination methods are currently used for the evaluation of the external genitalia and hymen in sexual crime allegations: (1) direct visual inspection with labial separation and labia traction, (2) colposcopy (use of a binocular magnifying microscope with a light source and attached camera for photographic documentation), which improves microtrauma identification [9], and (3) the application of contrast

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media to identify microscopic injuries [1,10]. For example toluidine blue, a nuclear stain, adheres to abrasions and microlacerations and highlights acute mucosal or skin injuries during forensic examinations [10].

Over the last few decades, no new clinical forensic examination methods have been introduced for identifying physical anogenital trauma in sexual assault cases. In the 1990s, UV-light was suggested to become a routine part of medico-legal examinations to evaluate stains and skin trauma [11], but its use has not caught on. Recently, crime scene investigators have applied UV-light to provide forensic evidence of physical skin traumas not be seen under white light at autopsies of crime victims.

UV-light is electromagnetic radiation with a shorter wavelength than visible light. UV-light is either absorbed or reflected by various biochemical compounds that are part of the healing process in skin tissue [12,13]. Some bruises deep in the tissue, or under thick areas of skin, cannot be seen under inspection with white light. UV-light detects the release of blood cells and shows bruises in a dark colour. The possibility of using UV-light in surviving sexual assault victims has not yet been exploited.

The aim of this study was to determine whether UV-light might be a useful tool in clinical forensic evaluations and evidence, for the documentation of acute and old trauma in the anogenital area. The primary end point was to compare the presence or absence of injury under white or UV-light. Some associated factors possibly influencing these physical findings are also analysed.

2. Material and methods

2.1. Participant recruitment

Female volunteers, comprising medical or laboratory students, hospital personnel or acquaintances, were invited to participate in a gynecological examination from May 2008 to December 2009, after consensual intercourse, through personal invitation or collective invitation after a lecture. Inclusion criteria were age 18 years or more, heterosexual intercourse, willingness to fulfil a detailed questionnaire (25 questions) on personal and sexual life, and signed consent to photography. Ninety caucasian women volunteered, but two declined the use of photography and were not included in the study. Finally, 88 participants were included in the study.

The study protocol was approved by the Pirkanmaa District Hospital's Ethics Committee (R08018). Written consent was required for attendance in the study, photography and the use of photographs for teaching or publication purposes. No data from patient's medical records were collected.

2.2. Data collection and analysis

All 88 volunteers were examined in the supine position using separation and traction technique of the external genitalia. For the colposcopy, Olympus OCS-500 colposcope and white light source was used with the magnification at 3.7. In 86 volunteers the colposcope attached camera (4× Olympus high quality ED wide zoom lens, Olympus C-5060 wide zoom, 5.1 megapixels) was used for the photographic documentation. In two volunteers a Canon EOS 5D camera was used for documentation due to technical problems. One gynecologist (MJ-E) performed all medical examinations. Colposcopy under white light was performed, followed by UV-light (368 nm) examination. During the UV-light examination the lights in the examination room were turned off. The extragenital area and hymen were photographed and the findings were filled separately on the study information form. The detected anogenital injuries were categorized into submucosal hemorrhages, petechiaes, ecchymosis, bruises, abrasions, fissures, lacerations, and scars (Table 1).

Medical and sexual history was collected via a form filled by the volunteer. The time of the intercourse and the medical examination were recorded. Information about sexual activity in the last two weeks and in general, contraception use, last menstrual cycle and length, and the use of tampons, as well as the duration of the studied intercourse, use of different positions, lubricants, and possible discomfort in the genital or other parts of the body were all recorded. Additionally, information about parity, obstetrical procedures during delivery(-ies), past occurrences of genital-anal trauma, and medical gynecological operations were gathered. Former sexual victimisation was recorded if answered in the questionnaire.

2.3. Technical details and precautions of UV-light

White and ultraviolet (UV) light (368 nm, prototype, Obelux) were used to detect physical findings during UV-light use, the volunteer either wore eyeglasses, or kept her eyes shut to avoid exposure to the UV-light. The radiation exposure varies by distance; 1 m: 6.7 mW/cm^2, 0.5 m: 27 mW/cm^2, 0.1 m: 677 mW/cm^2. According to regulations by the Social and Health Ministry of Finland, the current recommendation (294/2002, 4:11) for the maximum length of exposure to this type of UV-light is 50 J/m^2 (180–400 nm) per day. Anogenital UV-light examination was accomplished within a minute for all cases.

2.4. Statistical considerations

Categorical variables are given as frequencies and percentages. Mean, range and SD are given for age and time variables.

Table 1
Anatomic structures and definitions for physical findings.

Finding or anatomic structure	Definition
Submucosal hemorrhage	A small hemorrhage under mucous membrane
Petechiae	A pinpoint, flat, round spot of blood under mucosa or skin, caused by intradermal or intramucosal bleeding
Ecchymosis	A mucous membrane or skin discoloration caused by the escape of blood into the tissues from ruptured blood vessels
Bruise or "contusion"	An traumatic injury of the soft tissues which results in breakage of the local capillaries and leakage of red blood cells
Abrasion	A mucous membrane or skin excoriation caused by the removal of epidermal layer and with defined edge
Fissure	A superficial partial split in mucous membrane or skin, which does not extend to subcutaneous tissue
Laceration	A skin or mucosal wound with separation of the connective tissue elements and it may extend to subcutaneous tissue. None of the skin or mucosa is missing, but it is just separated
Scar	An area of fibrous tissue that replaces normal skin after injury
Hart's line	A line between non-keratinized and keratinized squamous epithelium
Vestibule	The area between hymen and Hart's line