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Water-Related Vaginal and Anorectal Injuries in Personal Watercraft (Jet Ski): Two Case Reports and Literature Review

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Abstract

The use of Personal Watercrafts (PWC) has increased in popularity, size and power engine over time. Water-related injuries when the passenger falls into water and the pelvic floor is directly hurt by the water jet remain rarely reported in literature but potentially lethal. Perineal, gynecological and recto sigmoid regions present significant point of anatomical weakness to the force vector of water. Biomechanical aspects on water-associated injuries on PWC may include disruption of the perineal soft tissues, inefficient anal sphincter and hydrodynamic insufflation by the focused water stream. We describe the management of a 19-year-old rear PWC passenger treated by a Hartmann's procedure for complex perforation of the rectum and the recto sigmoid junction and a 20-year-old PWC passenger with a laceration of the posterior vaginal fornix treated by exploratory laparoscopy and vaginal suturing. The literature review performed on Pubmed reported twenty five patients with major perineal, gynecological and/or digestive injuries due to water-related PWC traumas. Major risk factors were female gender (86%, 21/25), young age (26.92 yo+/-SD 10.36), being a rear passenger and wearing a standard swimsuit (100%, 25/25). Pelvic and lower abdominal traumas can be extremely difficult to diagnose so the multidisciplinary surgical management must include a vaginal and anal exploration under general anaesthesia and an exploratory surgery. It may be completed by a rectosigmoidoscopy in 45.45% (10/22), a vaginal repair (40%, 10/28), a transanal and anal sphincter repair (92%, 23/25), a sigmoidostomy (64%, 16/25) and the restoration of intestinal integrity (88.89%, 8/9). In conclusion, PWC-related hydrostatic injuries are still rare but associated with a global mortality rate of 8% (2/25) and 33.33% (2/6) in case of initial instability. Expert guidelines such as adding an automated engine shutoff switch for the rear passenger and wearing a protective and safety clothing should be more widely respected.

Keywords

Jet skiing • Personal watercraft • Water-related injuries • Anorectal injuries • Hydrostatic trauma • Barotraumatism • Vaginal injuries

Introduction

Introduced in the 1970s, the use of personal watercrafts (PWC) defined as water jet propulsion crafts or jet-skis have increased in popularity over time and especially in the past 20 years. In the United States for example, the number of registered PWC raised from 241,500 in 1990 to 1,300,000 nowadays. With frequency and severity of water accidents rising, PWC riders are currently 8.5 times more likely to traumatic injuries than motor boat riders. Main trauma mechanisms include direct collisions, perineal straddle a lesion, axial loading which can be associated with skeletal injuries, falls from PWC and direct hydrostatic jet nozzle injuries. Global jet-skiing traumas remain barely reported with about 1,000 case reports in literature and water-related traumas are still exceptional [1]. Such PWC accidents occur when the passenger falls on his/her back into water and the pelvic floor with his/her legs spread is directly hurt by the water jet stream, causing perineal, gynaecological and rectosigmoid injuries. Biomechanical characteristics as well as clinical and surgical management of water-related jet-skiing traumas are still unclear. We describe below two case reports managed between 2016 and 2020 in our university hospital in Nice, France, followed by a literature review on PWC water-related vaginal and anorectal injuries.

Case Representation

On September 2016, a 19-year-old patient with only past medical history of humeral fracture was sitting as a rear PWC passenger and fell off of the back of the watercraft. Wearing a standard 2-piece swimsuit and a life jacket, she experienced severe perineal and diffuse abdominal pain with vomiting. The victim was quickly taken to

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the Emergency Room where she remained haemodynamically stable. The clinical examination found a 5-centimeter wound of the anus with sphincter injury and rigidity of the external abdomen. An abdominal computed-tomography scan confirmed major intraperitoneal effusion and free air associated with intraperitoneal faeces in pelvic region and two spleen parenchymal lacerations AAST grade 3. Diagnosis of rectal or rectosigmoid perforation was strongly mentioned. The rectoscopy notice posterior lacerations of the internal and external anal sphincter, superficial rectal lacerations and complex perforation of the rectosigmoid junction [2]. Exploratory laparoscopies then a conversion to laparotomy were urgently performed. The 4L haematic effusion with multiple water debris and the localized fecal peritonitis were treated by peritoneal lavage. No laceration was noticed on the spleen. The patient underwent a Hartmann's procedure with loop colostomy, drainage and transanal sphincter repair. Antibiotics by Amoxicillin and clavulanic acid were then administrated and a wound infection treated by opening and incision packing. The patient was discharged on postoperative day 12. Five months later, colostomy takedown and reanastomosis were performed without difficulty. Normal bowel function has returned so far without any continence issue (Figure 1).

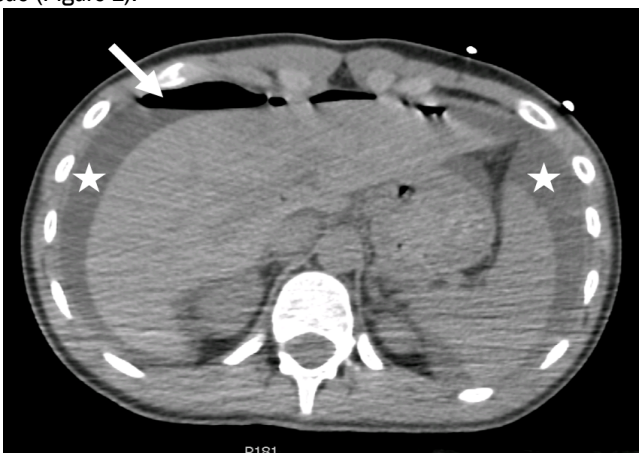

Figure 1: Perineal and diffuse abdominal.

On July 2020, a 20-year-old patient without any past medical and surgical history was thrown off during PWC riding. She was wearing a 2-piece swimsuit and a life jacket as a rear passenger. She was transferred to a primary health centre in a stable condition with perineal bleeding and excruciating vaginal pain. No physical examination was performed in the Emergency Room due to pain symptomatology. The abdominal computed tomography scan noticed an interstitial haemorrhagic change and emphysema in the left periadnexal and perirectal space indicating disruption of the vagina and some evidence of intraperitoneal perihepatic free air and fluid. A perineal examination under general anaesthesia mentioned a disruption of the vaginal fornix associated with multiple clots and externalization of small bowel which was reintegrated with a vaginal packing before referral to our tertiary health centre for combined gynaecological and digestive management. The exploratory laparoscopy was urgently performed in our university hospital but did not bring out any small bowel and colonic perforation. After peritoneal lavage on minimal haematic effusion, an intraperitoneal disruption of posterior vaginal fornix was diagnosed in front of recto-uterine pouch [3]. Vaginal suturing with 3/0 Vicryl was performed and the vaginal closure and rectal integrity were checked on a second-look laparoscopy. Intravenous Cefotaxime and Metronidazole were administrated and the patient was discharged on postoperative day 2. Twenty five patients with major perineal, gynaecological and/or digestive injuries due to water-related traumas on PWC have been reported since 1990 (Figure 2).

Figure 2: Tomography scan noticed an interstitial haemorrhagic.

Major risk factors such as female gender (86%, 21/25), young age with a range from 14 to 52 years old (26.92 yo +/-SD 10.36), being a rear passenger (100%) and wearing a standard swimsuit (100%) were confirmed. 63.16% (12/19) of patients were haemodynamically stable in the Emergency Room. No imaging was performed for 9.09%of patients (2/22) whereas FAST and standard computed tomography scan were performed for 18.18% (4/22) and 54.54% (12/22) of patients. Exploratory surgery was completed by rectosigmoidoscopy in 45.45% (10/22). Surgical management included a vaginal repair (40%, 10/28), a transanal and anal sphincter repair (92%, 23/25), a sigmoidostomy (64%, 16/25) and finally the restoration of intestinal integrity (88.89%, 8/9) 3.81 months later. Early and late complication rate were 12% (3/25). At least, global mortality rate was 8% (2/25) and 33.33% (2/6) in case of initial instability. Both previous case reports present two different types of water-related lesions after PWC trauma requiring a complex surgical management. Besides, the article highlights the most complete and interdisciplinary literature review on this rare and potentially lethal hydrostatic trauma.

Water-related perineal, vaginal and anorectal injuries due to rider's ejection back from PWC remain relatively rare, poorly reported in literature but potentially severe and lethal. The stream of water directed against the perineal region or into the exposed hollow organs such as the vagina or the rectum, a phenomenon studied as vaginal or anorectal "douche", results in a sudden inflation of cavities and disruption of the soft tissues. The posterior vaginal fornix, the rectum and especially the rectosigmoid junction present significant points of anatomical weakness to the force vector of water in water-related sports traumas (Figure 3).

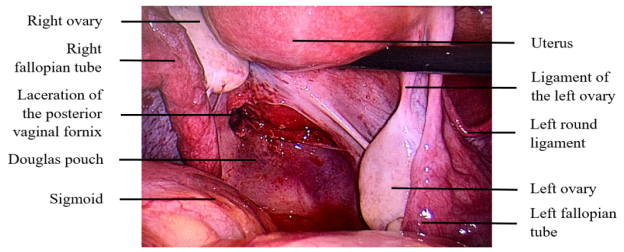

Figure 3: Biomechanical phenomena in water-related PWC.

Perineal "douche" and its consequences on hollow organs are well studied since the 1970s in water-skiing injuries. Gynaecological

lacerations are more common in literature than digestive hazards, only reported as intrarectal tears without any serious lacerations. Biomechanical phenomena in water-related PWC accidents can be considered as derived from water-skiing. The jet nozzle used by watercrafts results in higher and more concentrated pressure on the perineal region. Not only the victim presents traumatic lacerations caused by the surface water with a high-speed PWC, similar to water-skiing injuries, but also direct and severe pelvic injuries due to the jet stream. As found in the literature review, water-related PWC accidents expose differently to gynaecological (52%) and anorectal (84%) injuries with an initial haemodynamic instability rate of 36.84%and a global mortality rate of 8% [4]. Studied biomechanical aspects on water-associated injuries on PWC. Using a simplified modelling, a focused jet-ski nozzle with a typical volumetric flow rate of 1,800 gal/min (6,813 L/min), only 5 msec were sufficient to reach the ultimate tensile strength of the rectum and vagina. In comparison, a fall while water-skiing would cause the cavities' rupture in 12 msec at 20 mph (32 km/h) in such hydrodynamic insufflation. It is reported than PWC ejection is 2.4 times more likely to internal pelvic injuries than the water-skiing group (Figure 4).

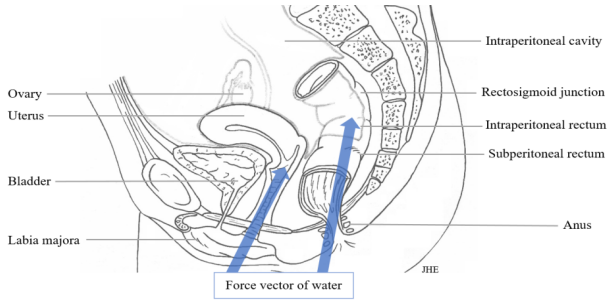

Figure 4: Presents traumatic lacerations.

So the anal sphincter does not seem efficient enough to resist to water-related high pressure on the perineal region contrary to water-skiing traumas. Besides experimental studies found out that hydrostatic perforations occurred more easily on the large intestine at an average pressure of 2.3 pounds per square (psi) or 120 mmHg than on the vagina with an average pressure of 10 psi or 517 mmHg. Management of water-related gynaecological and digestive injuries is not well-standardized in literature. In all traumas, appropriate resuscitation is performed first. Fast and rectoscopy must be part of the minimal initial imaging to stage lesions severity. An abdominal computed tomography scan may be performed on haemodynamically stable patients but indications for rectal contrast are not well-defined. The surgical approach has to be multidisciplinary due to potentially combined gynaecological and digestive injuries and must include perineal and abdominal examination. A vaginal and anal examination under general anaesthesia is compulsory for first evaluation. Tears of the posterior fourchette are common due to the water jet stream, as presented by the two patients reported above. Water-related PWC injuries are considered as penetrating traumas. A laparotomy approach is preferred for instable patients to control haemostasis in case of damage control surgery. For stable patients, an explorative laparoscopy is recommended.

For lacerations of the intraperitoneal rectum, suturing with or without a defunctioning loop sigmoidostomy can be performed depending on laceration complexity. Major rectal or sigmoid injuries may need resection and a Hartmann's procedure with an end sigmoidostomy. If no intra peritoneal digestive tract injury is found, a transanal approach for injuries of the subperitoneal rectum to drain locally any posterior rectal lesion and perform an anorectal repair for sphincteric and ultra-low injury. Suturing the posterior vaginal fornix with a transanal approach, special attention is to be paid to avoiding suturing the intraperitoneal rectum. Perineal repair after excision of necrosed tissues and vaginal repair in layers to reapproximate the anatomic planes can complete the surgical management depending on patients. Lastly, prophylactic antibiotics based on water source and intestinal microbiota must be considered. Guidelines to prevent such PWC-associated injuries do exist and are widely reported for about twenty years. Nevertheless, none of the recommendations below has proved their significant effectiveness in published studies.

PWC speed limit of 65 mph (105 km/h) imposed by the industry automated engine shutoff switch, also known "deadman" switch, for the rider but also for the rear passenger to immediately cut the throttle when passengers are ejected from PWC [5]. Highly visible warnings to indicate potentially life-threatening PWC-associated injuries as recommended minimum age requirement of 16 years old to operate a PWC according protective and safety clothing such as half or full wet suit, ideally made of nylon-reinforced neoprene rubber, life jacket for unconsciousness or even helmets. Ideally, transportation safety board recommend a safe boating certificate to avoid operator inexperience, inadequate supervision or reckless behaviour water-related injuries may be erroneously benign. Pelvic and lower abdominal PWC traumas can be extremely difficult to diagnose. Rare but potentially lethal injuries on gynaecological and/or digestive organs need a standardized and interdisciplinary management. Manufacturers and PWC users should respect the reported guidelines to decrease the rate of such easily preventable water-associated traumas.

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