

Isolated Perivesicular Hematoma After Military Parachuting

Timothy P. Plackett; David C. Lynn; Bradley R. Zagol; Bryan A. Malone; John F. Detoro; Jason M. Seery; Peter G. Deveau; Elizabeth M. Sawyer; Richard W. Ellison

- BACKGROUND:** Isolated perivesicular hematomas are uncommonly described and not an injury typically reported in the literature after parachuting or skydiving.
- CASE REPORT:** Herein, we described a series of three patients with isolated perivesicular hematomas sustained after military parachuting. All three patients were managed nonoperatively after a somewhat prolonged hospital course. Despite the lack of orthopedic injuries, all required physical therapy consultation and required an assisting device to aide with ambulation at the time of discharge. For all three individuals, follow-up imaging months after the injury demonstrated a continued presence of the hematoma. Clinically, the patients continued to have ambulatory and urological difficulties for several months after their injury.
- DISCUSSION:** This injury pattern is uncommonly reported in the literature. An appropriate index of suspicion must be maintained or there may be a delay in diagnosis. Management of these injuries requires coordinated care between the trauma service, urology, and physical therapy.
- KEYWORDS:** military, occupational health, parachuting, hematoma, injury, urinary bladder.

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Military parachuting has historically served an important role in facilitating the rapid insertion of troops into an area that might otherwise be difficult to reach at that time. Although not risk free, it does have a relatively low injury rate. Most series over the past 20 yr found an injury incidence of 25–105 injuries per 10,000 military jumps.^{2,6,7} In contrast, sport parachuting is associated with an even lower injury incidence of 4.8–17 injuries per 10,000 jumps.^{1,11} This disparity is largely attributed to the unique difference between the two activities. In particular, there are differences in parachute design, presence of additional equipment, and number of participants that can influence the injury rate.⁶

Injuries to the lower extremity, axial spine, and head are the predominate injury patterns and are somewhat predictable given the nature of the activity and design of parachutes.^{2,6} Injuries to the torso are much less common and intracavitary injury in the absence of an associated fracture is among the rarest of reported injury patterns. In Bricknell's seminal review of 11 studies encompassing 9531 military jumps over 60 yr, there were no reported cases of isolated intracavitary injuries.² Herein we describe three cases of isolated hematomas

in the perivesicular space of Retzius that occurred with military parachuting. We offer our thoughts on why these injuries develop and suggestions on management strategies.

CASE REPORTS

Patient #1

The patient was a 40-yr-old man involved in a daytime jump at 800 ft (243.8 m) using a T10D parachute and wearing a full combat load. Weather conditions at the time of the jump included a clear sky with winds of 9–15 kn. He had a hard

From the Womack Army Medical Center, 240th Forward Surgical Team, Task Force Bragg, Fort Bragg, NC, and the University of Louisville, Louisville, KY.

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Address correspondence to: Timothy P. Plackett, D.O., FACS, Department of Surgery, Loyola University Medical Center, 2160 S. First Ave., Maywood, IL 60153; tplacke78@gmail.com.

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landing with immediate onset of left-sided pubic and lower extremity pain. He was transported from the drop zone to the emergency department by ambulance. There he was found to have normal vital signs. His physical examination was remarkable for tenderness to palpation of the left lower quadrant of the abdomen and left pelvis. He was also noted to have decreased range of motion of the left shoulder and left lower extremity. Laboratory analysis was normal and a computed tomography (CT) scan of the abdomen and pelvis demonstrated an 8 x 6 x 5 cm perivesicular, extraperitoneal hematoma without extravasation of contrast (**Fig. 1**). He was admitted to the hospital for observation and pain control. He had significant pain with ambulation, but by postinjury day 10 he was able to ambulate with a walker enough to be discharged to home. He continues to have significant pain with ambulation, difficulty with urination, and pain with ejaculation 4 mo after his injury. Urodynamic studies have been normal, but a 4 x 3 x 3 cm hematoma remains on magnetic resonance imaging.

Patient #2

The patient was a 32-yr-old man involved in a daytime jump at 800 ft (243.8 m) using a T10 parachute and wearing a full combat load. Weather conditions at the time of the jump included a clear sky with winds of 12-19 kn. He had a hard landing and fell onto his right hip. He was unable to bear weight on the right leg and was brought to the emergency department by a private vehicle. In the emergency department he was found to have normal vitals. His physical exam was remarkable for tenderness to palpation of the suprapubic region, right pelvis, and right hip. Laboratory analysis was notable for a white blood cell count of 15.2×10^9 cells/L, but was otherwise normal. A pelvic X-ray showed a 6-mm pubic diastasis and orthopedic surgery was consulted. He was found to be stable for discharge from the emergency department with crutches, pain medication, and follow-up in the orthopedic surgery clinic.

He returned to the emergency department the next day with worsening suprapubic pain with ambulation and pain with urination. His vital signs were normal and physical exam was

remarkable for periumbilical and suprapubic tenderness to palpation. Laboratory analysis was now normal. A CT scan of the abdomen and pelvis demonstrated a 9 x 7 x 6 cm perivesicular extraperitoneal hematoma without extravasation of contrast (**Fig. 2**). He was admitted to the hospital for observation and pain control. He had an uneventful hospital course and was discharged to home on postinjury day 4 with a four-wheeled walker to assist with ambulation. He underwent continued outpatient physical therapy for over a year after the injury, but was unable to regain a full range of motion with the right hip. He continues to have chronic pain and difficulty with ambulation 18 mo after the injury.

Patient #3

The patient was a 41-yr-old man involved in a daytime jump at 800 ft (243.8 m) using a MC1-1B parachute and wearing a full combat load. Weather conditions at the time of the jump included a clear sky with winds of < 10 kn. He had a hard landing, but was able to walk off the drop zone on his own. Following the jump he went home and was asymptomatic until 5 h after the jump. At that point he had a sudden onset of bilateral abdominal pain, nausea, and difficulty with ambulation. He presented to the emergency department via ambulance. In the emergency department his vital signs were remarkable for a pulse of 69 bpm and a blood pressure of 97/60 mmHg. The hypotension resolved with volume resuscitation. His physical exam was remarkable for a white blood cell count of 16.7×10^9 cells/L and creatinine of $1.5 \text{ mg} \cdot \text{dl}^{-1}$, but otherwise normal. A CT scan of the abdomen and pelvis demonstrated a 13 x 10 x 11 cm perivesicular, extraperitoneal hematoma. He was admitted to the hospital for pain control and continued resuscitation. His initial hemoglobin of $14.1 \text{ g} \cdot \text{dl}^{-1}$ reached a nadir of $6.7 \text{ g} \cdot \text{dl}^{-1}$ with the resuscitation and he was transfused with three units of packed red blood cells. A CT cystogram was obtained which demonstrated no injury to the bladder. He was eventually discharged from the hospital on postinjury day 7.



Fig. 1. CT scan with IV contrast of patient #1 demonstrating a large perivesicular hematoma (*) with displacement of the bladder (◆).



Fig. 2. CT scan with IV contrast of patient #2 demonstrating a large perivesicular hematoma (*) with displacement of the bladder (◆).

A subsequent CT scan obtained 5 mo after his injury demonstrated that the hematoma was resolving, but still showed that it was 6 x 3 x 6 cm (**Fig. 3**). However, the patient reported resolution of symptoms by 6 mo after his injury.

DISCUSSION

While perivesicular hematomas are a well-described injury in conjunction with other pelvic traumatic injuries, their occurrence in the absence of concomitant pelvic or abdominal injuries is infrequently described. The majority of prior reports of isolated hematomas of the perivesicular retropubic space have focused on iatrogenic surgical injury (predominantly during bladder suspension procedures),^{8,9} although there are a few reports related to mechanical bull riding.^{4,10} These latter reports consisted of a series of individuals thrown from a mechanical bull and sustaining hematomas of the perivesicular retropubic space (although generally with injuries to the pelvis or urethra). Like our patients, the clinical course of those injured during mechanical bull riding involved a prolonged hospital stay. There is also a single case report of an isolated perivesicular hematoma after parachuting.¹² Similar to our patients, this occurred during military parachuting activities, was associated with no other injuries, and had significant urology symptoms. Additionally, there was a delay in diagnosis by 2 d, highlighting the need to have an appropriate index of suspicion on initial presentation.

Given the extreme paucity of literature on this injury pattern, it is difficult to offer a definitive mechanism through which these hematomas occur. However, we hypothesize that development of this injury requires an uneven landing and the presence of a distended bladder. Impact with the ground converts gravitational energy into a kinetic injury, which becomes distributed over a much smaller surface area during an uneven landing. As the force is dissipated through the body, any region where the force travels will experience this high energy force. During the uneven landing, rather than equally spread the kinetic energy across both limbs and eventually the hemipelvises, a greater force will differentially travel along the side that

first makes contact with the ground. Much like motor vehicle collisions, the distribution of forces across a smaller location are more likely to result in injury to the associated tissues.¹³ This importance of balanced distribution of energy on landing and needing to appreciate the dissipation of these forces has also been cited by Healy as a potential reason for many of the common lower extremity orthopedic injuries seen after parachuting.¹⁴

The second factor is the presence of a distended bladder. The expanded bladder and its associated mass places additional traction on its suspensory structures. Although the vascular system is not traditionally thought of as being a suspensory structure, under these higher forces it might act as such. The tunica media of veins does contain collagen, elastin, and smooth muscle. This combination does provide some structural support and may portend some suspensory-like function when the bladder is fully distended, helping anchor the bladder to the retropubic space. Under the strain of these higher forces the venous bridges become overstretched and tear, leading to hematoma formation. We can offer no definitive evidence to support this assumption; however, we believe that this makes theoretical and anatomical sense. Warnings about the risks associated with a full bladder during high impact are not unique to our hypothesis. Others have also warned about the risk of traumatic bladder rupture³ and, in experimental studies of pigs, it has been demonstrated that the burst strength of the bladder is capable of being exceeded when dropped while full.⁵ By extension, it would seem reasonable to assume that if a more robust and stout structure such as the bladder can rupture, its suspensory attachments should also be subject to similar forces and outcomes. In fact, the vasculature has less tensile strength than the bladder and may suggest that less significant forces are required to produce a perivascular hematoma than are necessary for bladder rupture.

The fact that this has not been reported in sport skydiving might also lend further credence to our hypothesis that a full bladder is key to the injury mechanism. With military parachuting there often can be prolonged delays between when a soldier is secured in the parachute harness, inspected by the Jump Master, and the jump finally occurs. During this time the soldier is generally not offered an opportunity to use the bathroom and empty their bladder. In fact, several hour delays are extremely common during training jumps with large groups (as occurred with all three of the patients presented). In contrast, with sport skydiving this time period tends to be shorter, suggesting that these individuals are less likely to be jumping with a full bladder.

A second reason that could explain the absence of this injury having been described with sport skydiving is differences in the equipment loads between sport skydiving and military parachuting. In all three of these cases, as well as that of Cunningham,¹² the patients were wearing full combat loads. This can provide a significant increase in the overall weight, which is expected to increase the rate of descent.¹² Considering that kinetic energy is proportional to weight and the square of velocity, increased weight magnifies the kinetic energy experienced upon landing. This, in turn, is known to increase the rate of



Fig. 3. CT scan demonstrating a resolving hematoma (*) 5 mo after injury.

injuries in general.¹⁵ Our hypothesis on the generation of these perivesicular hematomas is based upon kinetic energy distribution exceeding the burst strength of the bridging veins (as opposed to the direct lacerations that can occur with pelvic fractures). Therefore, the influence of a higher kinetic injury with parachuting while wearing full combat loads needs to be considered.

The clinical course of the three individuals suggests that this is not a benign injury and that it can be easily overlooked. In one of the cases, the patient was even discharged from the emergency department without having been diagnosed with a perivesicular hematoma. In order to facilitate the diagnosis, the evaluating provider needs to have a low threshold for obtaining computed tomography of the pelvis when the mechanism is appropriate for this type of injury. Once the diagnosis is made, we recommend consultation with a trauma surgeon if they are not already involved in the patient's care. Additionally, our experience suggests that early consultation from urology and physical therapy is needed. All three of the patients experienced ongoing problems with both urologic function and ambulation 6 mo after their injury. However, further studies are needed in order to determine how to best manage these patients beyond this recommendation.

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Authors and affiliations: Timothy P. Plackett, D.O., David C. Lynn, M.D., Bradley R. Zagol, M.D., Jason M. Seery, M.D., Elizabeth M. Sawyer, M.D., and Richard W. Ellison, M.D., Department of Surgery, Womack Army Medical Center, Bryan A. Malone, B.S., 240th Forward Surgical Team, John F. Detro, PA-C, Task Force Bragg, Fort Bragg, NC; and Peter G. Deveaux, M.D., Department of Surgery, University of Louisville, Louisville, KY.

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