

CASE REPORT

A Rare Non-penetrant Abdominal Wall Injury Caused by High-pressure Water: A Case Report

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Abstract: Background: High-pressure water jet injuries are an uncommon cause of trauma. High-pressure water injuries are usually seen at the extremities and less often in the thorax and abdominal areas. A review of the literature reveals a few case reports describing intraabdominal injuries due to penetrating trauma. In this paper, we present the radiological findings of a rare case of abdominal wall injury without penetration of peritoneum caused by high-pressure water jet due to the Coanda effect. The Coanda effect is the tendency of a fluid jet to stay attached to a curved.

In our case, the peritoneum also functions as flat and curved surface, causing non-penetrant abdominal wall injury.

Case Report: A 28-year-old male working at a hydroelectric terminal presented to the emergency department with abdominal pain and a two-centimeter cutaneous gap in the left lower quadrant of the abdomen caused by high-pressure water.

The CT findings revealed a small entrance to left lower quadrant of the abdominal wall and extensive subcutaneous injury. There was no internal injury. The cutaneous gap was managed by primary surgical closure. Subcutaneous emphysema was diminished on the follow up physical examination. The patient was recovered without sequelae.

Conclusion: The water jet can cause a wide subcutaneous injury by following the peritoneum even though there is a small entrance. Therefore radiological imaging can help to determine their severity and planning treatment.

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1. INTRODUCTION

High-pressure water jet injuries are an uncommon cause of trauma. High-pressure water injuries are usually seen at the extremities and less often in the thorax and abdominal areas. A review of the literature reveals a few case reports describing intraabdominal injuries due to penetrating trauma [1, 2].

In this paper, we present a rare case of abdominal wall injury without penetration of peritoneum caused by high-pressure water jet. We attributed the abdominal injury occurred as a non penetrant due to a physics principle, the coanda effect.

2. CASE REPORT

A 28-year-old male working at a hydroelectric terminal presented to the emergency department with abdominal pain and a two-centimeter cutaneous gap in the left lower quadrant of the abdomen caused by high-pressure water.

The patient had been using a water jet device for cutting and drilling stones in hydroelectric terminal. When the worker loosed grip of the hose causing a jet of water to strike him in the abdomen. On arrival the patient was haemodynamically stable. He had abdominal pain. On examination there was a 2 cm entry wound located over his left upper quadrant. His abdomen was tender with marked crepitus palpable.

The CT findings revealed a small entrance to left lower quadrant of the abdominal wall and extensive subcutaneous injury. Parts of anterior abdominal muscle were separated by emphysema after water drainage and the subcutaneous fat tissue laceration extended to the lumbar area (Fig. 1).

The patient did not need surgery because of no visceral injury at CT. There was only extensive subcutaneous injury and no internal injury sustained by patient. A single dose of Ampicillin-Sulbactam was administered prophylactically. The cutaneous gap was managed by primary surgical closure. Subcutaneous emphysema was diminished on the follow up physical examination. The patient was recovered without sequelae.

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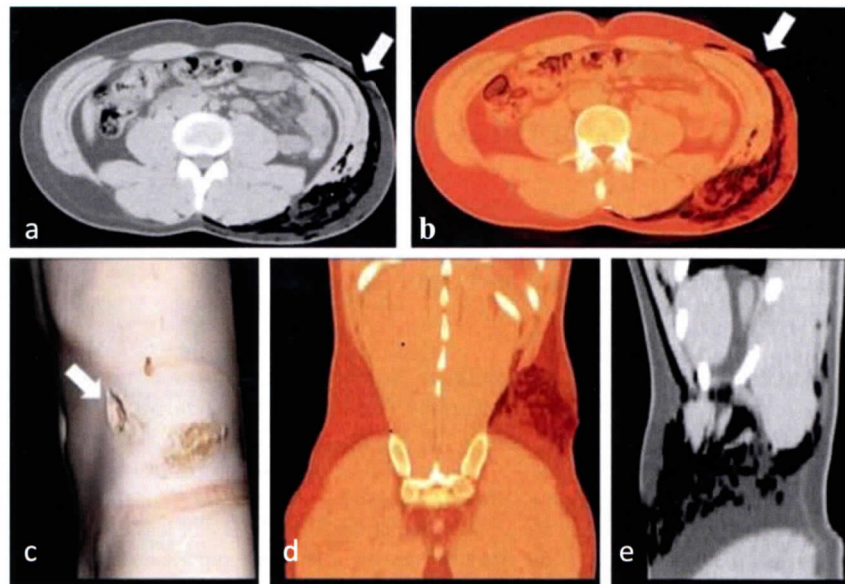


Fig. (1). Axial CT images (a-b), volume rendering image (c) and coronal, sagittal CT images (d-e) shows subcutaneous emphysema. The entry point at the left side of anterior abdominal wall (arrows a-c) is seen with subcutaneous fat tissue laceration and a tract between the abdominal wall muscles. The damaged areas are seen as emphysema after the absorption of water.

3. DISCUSSION

Injuries due to high-pressure injection were first described in the 1930s. Since then, the increasing use of industrial water jet devices has led to an increased number of reported cases of injuries due to this unique mechanism. In the literature, injuries caused by high-pressure water have been mostly reported in the extremities and less commonly in the eye, nose, neck, and vaginal injuries [3-6].

There are only eleven cases of high-pressure water jet injuries to the abdomen reported since 1966 [2, 7-16]. Only three of the eleven patients avoided abdominal visceral injuries. The first patient, described by Gardner, had a non-penetrating abdominal injury. The water jet stream caused edema, emphysema, and abrasion of the abdominal wall [7]. The second patient, described by De Beaux, was underwater. The water stream penetrated the abdominal cavity, but caused only mesenteric bruising and an omental tear [10]. The last one described by Magnuson, had an abdominal injury. This injury was in the lower right anterior abdominal wall lateral to the rectus abdominis muscle and no injury to the viscera was identified. The injury related to the water stream was extending along the abdominal wall avoiding the abdominal viscera [16]. We assumed that in these three cases the injury was limited to the abdominal wall due to Coanda effect too. The other cases were penetrant abdominal injury.

The severity of injuries from high-pressure water devices depends on the affected area and the level of the water pressure [12, 17]. Injuries from these devices are characterized by small entry wounds with extensive internal damage. Physical examination can be deceiving if the cutaneous damage is small.

The Coanda effect is a fluid dynamics term that describes the movement of water jet across the curved surfaces [18]. The discovery was first applied in aerodynamics, the main field of interest for Henri Coanda. He made the observation

that a thin liquid jet, passing through a narrow channel that is followed by a curved surface, deviates according to the surface shape, adhering to it [19].

Because the peritoneum acts as a curved surface, the water jet can cause a wide subcutaneous injury by following the peritoneum due to Coanda effect even though there is a small open wound in our patient. The significance of this type of injury is the unexpectedly greater damage in deep soft tissue compared to the limited damage in the cutaneous tissue.

CONCLUSION

The water jet can cause a wide subcutaneous injury by following the peritoneum even though there is a small entrance. Therefore radiological imaging can help to determine their severity and planning treatment.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by Afyonkarahisar Health Sciences University Clinical Researches Ethics Committee, Turkey (2018/155).

HUMAN AND ANIMAL RIGHTS

No animals were used in this study. The reported experiments on humans were followed in accordance with the ethical standards of the committee responsible for human experimentation (institutional national), and with the Helsinki Declaration of 1975, as revised in 2008 (<http://www.wma.net/>).

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that the data supporting the findings of this study are available within the article.

FUNDING

None.

CONSENT FOR PUBLICATION

Written informed consent was obtained from the patient for this study.

STANDARDS OF REPORTING

CARE guidelines and methodology were followed to conduct the case study.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

REFERENCES

- [1] Go SJ, Sul YH, Ye JB, Choi JH, Kim JS. Intraperitoneal injury due to a high-pressure water jet. *Trauma Monthly* 2016; 22(6): e39700.
- [2] Kessel B, Eilam D, Ashkenazi I, Alfici R. Severe hydroblast intra-abdominal injuries due to high-pressure water jet without penetration of abdominal cavity. *Injury Extra* 2005; 36: 82-3.
- [3] Kwong QT, Khandwala M. Corneal Descemet's membrane rupture in a patient sustaining high-pressure water jet injury. *Can J Ophthalmol* 2015; 50: e35-6.
- [4] Salminen L, Ranta A. Orbital laceration caused by blast of water: report of two cases. *Br J Ophthalmol* 1983; 67(12): 840-1.
- [5] Lacy J, Brennan E, Ornstein M, Allen L. Vaginal laceration from a high-pressure water jet in a prepubescent girl. *Pediatr Emerg Care* 2007; 23(2): 112-4.
- [6] Schoo MJ, Scott FA, Boswick JA. High-pressure injections of the hand. *J Trauma* 1980; 20(3): 229-38.
- [7] Gardner AW. High pressure water injury. *Trans Soc Occup Med.* 1966; 16(1): 30.
- [8] Neill RW, George B. Penetrating intra-abdominal injury caused by highpressure water jet. *Br Med J* 1969; 2: 357-8.
- [9] Dabrowski Z, Nagay B, Szacillo A. Abdominal injury caused by jet of water under pressure. *Pol Przegl Chir* 1974; 46: 167-8.
- [10] De Beaux JL. High-pressure water jet injury. *Br Med J* 1980; 280: 1417-18.
- [11] Estrera AL, Aucar JA, Wall MJ Jr, Granchi TS, Mattox KL. Hydroblast injuries to the small bowel and inferior vena cava. *J Trauma* 1999; 47: 979-81.
- [12] Sharma OP, Oswanski MF. Hydroblast intra-abdominal organ trauma. *J Emerg Med* 2002; 22: 49-53.
- [13] Costello MW, Bolling RP, Gonzalez RP. Intra-abdominal injury as a result of high-pressure water injection. *J Trauma* 2008; 65: 222-4.
- [14] Marks W, Bialko M, Stasiak M, *et al.* Mixed hydroblast and missile injury with abdominal eventration: Case Report. *BMJ Case Rep* 2009; 2009: bcr06.2008.0249.
- [15] Redmond CE, McEvoy SH, Ryan ER, Hoti E. Pancreatic transection as a result of a high-pressure water jet injury. *BMJ Case Rep* 2013; 2013.
- [16] Magneson F. High-pressure Water Jet Injury to the Abdomen: A Case Report and Literature Review. *Occup Med Health Affairs* 2014; 2: 4.
- [17] Radojevic N, Radnic B, Curovic I. Fatal Penetrating Injuries Sustained by High-pressure Water Jet Unit. *J Forens Sci* 2015; 60(6): 1652-53.
- [18] Tritton DJ. *Physical Fluid Dynamics.* Van Nostrand Reinhold, 1977.
- [19] Ginghină C. The Coandă effect in cardiology. *J Cardiovasc Med (Hagerstown)* 2007; 8(6): 411-3.