



## Case Report

## Reverse suspension syndrome: First report of a novel mechanism of severe trauma

Awaneesh Katiyar<sup>1</sup>, Neeraj Kherwal<sup>1</sup>, Ajay Kumar<sup>2</sup>, Quamar Azam (Md)<sup>3</sup>,  
Amulya Rattan<sup>2,\*</sup>

Department of Trauma Surgery & Critical Care, Trauma Center, AIIMS Rishikesh, India

## ARTICLE INFO

## Keywords:

Rope injury  
Suspension rope  
Parietal wall transection  
Suspension syndrome  
Suspension trauma

## ABSTRACT

About 48,000 workers die at the workplace in India due to occupational accidents of which 38 fatal accidents take place every day in the construction sector. Indigenous innovative methods (Jugaad) devised to accomplish tasks at work are common in our country. We report the case of an abdominal injury sustained while using rope tied around the torso for suspension, termed as 'Reverse suspension syndrome' by authors due to analogy in mode to Suspension syndrome but exactly opposite kinematics of injury. As described in the report, Reverse suspension syndrome is a dangerous mechanism of trauma involving transmission of major energy and severe visceral injuries. Workup to rule out bowel, ureter, great vessels, spine and cord injuries is recommended. The outcome is good if the patient presents in time. To the best of our knowledge, this mechanism of injury hasn't been described in the literature so far.

## Background

In developing countries like India, preventable deaths at the workplace are not uncommon. An estimate puts around 372 million people at risk of injury/ death from workplace-related accidents [1]. About 48,000 workers die at the workplace in India due to occupational accidents of which 38 fatal accidents take place every day in the construction sector [2]. Construction site accidents are common due to neglect of safety norms for containing costs while employing uneducated labor [3]. Indigenous innovative methods (Jugaad) devised to accomplish tasks at work are common in our country. We report the case of an abdominal injury sustained while using rope tied around the torso for suspension. To the best of our knowledge, this mechanism of injury hasn't been described in the literature so far.

## Case report

Twenty-eight-year man presented to the ED (Emergency Department) with blunt abdominal injury. He had tied a rope around the abdomen to climb down a cliff (for cutting unwanted vegetation) and fixed the other end to the rear of a vehicle for suspension. He sustained sudden pull and drag when the vehicle started and sped off by the unaware driver (Fig. 1).

\* Corresponding author.

E-mail address: [amulya.rattan@gmail.com](mailto:amulya.rattan@gmail.com) (A. Rattan).

<sup>1</sup> Trauma Fellow

<sup>2</sup> Assistant Professor

<sup>3</sup> Professor



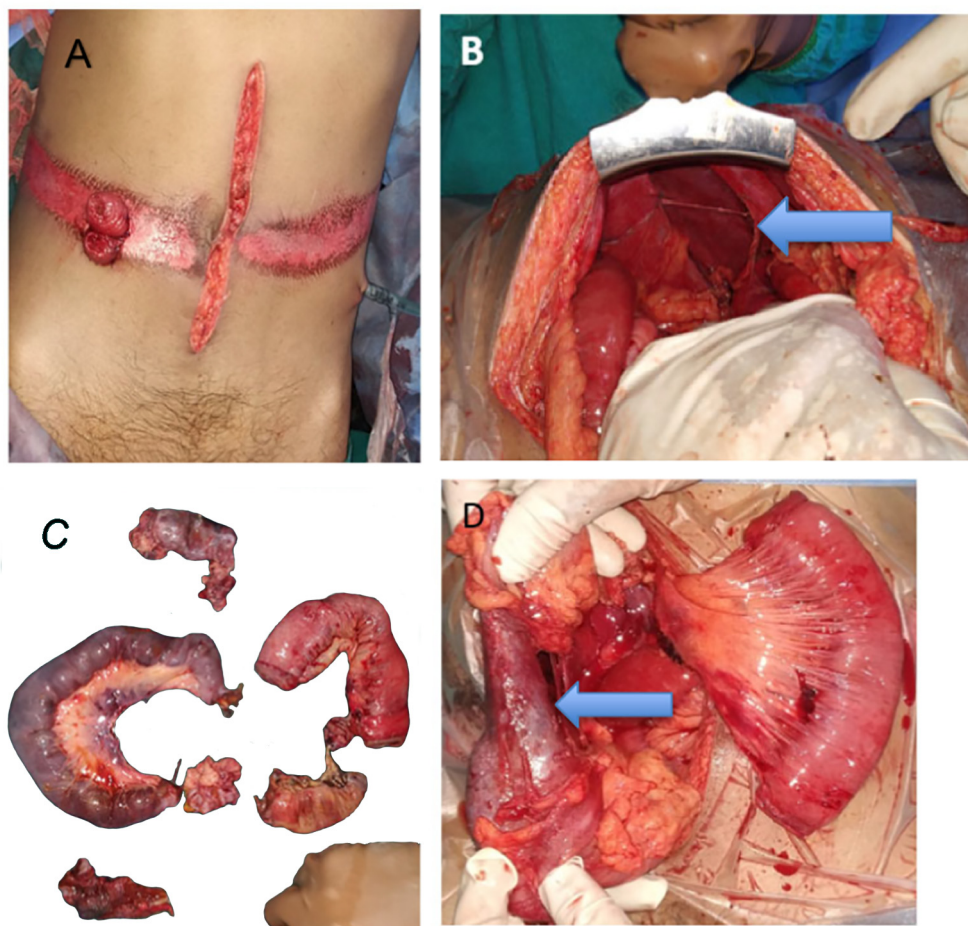
**Fig. 1.** This figure was incidentally taken just before the injury happened. It shows the patient leaning down from a boundary wall to cut unwanted vegetation, supported by a rope tied to his waist. The vehicle used for anchoring is covered by the vehicle in fore of the picture.

The primary survey was normal except for a positive FAST examination. Patterned abrasion of rope injury was present below the umbilicus curving posteriorly and cephalad in bilateral flanks (Fig. 2A). CECT showed pneumo-peritoneum and free fluid. Aorta, inferior vena cava, ureters, and spine were normal. On exploration, the parietal wall was completely transected in the flanks leaving only the skin intact (Fig. 2B). Multiple transections were found in the small bowel (Fig. 2C) and seromuscular layers of ascending and descending colon with contused mucosa at the level of rope mark (Fig. 2D). Parietal wall repair in layers, jejuno-jejunal, and colocolic anastomosis were done with protective ileostomy (Fig. 2A). Post-operatively he developed superficial surgical site infection which required removing skin sutures and was grafted after a period of dressing. Restoration of bowel continuity was done 2 months later.

## Discussion

Suspension of body is required in industrial as well as recreational activities. Suspension syndrome results due to orthostatic hypotension during periods of prolonged suspension and is potentially fatal if the victim isn't rescued in time [4]. Falls from suspension occurs most commonly in the construction industry, leading OSHA to make fall arrest systems compulsory at any site where vertical drop of 6 ft. or more is a possibility [5]. Chains, safety harness, body harness and lock are commonly used personal fall arrest equipment. Industrial rope access is a discipline in itself and much work has been done to promote safety [6].

However, workplace safety is frequently ignored in developing countries [1]. Therefore, workers come up with indigenous ways to ensure personal protection. Suspension using a rope tied around the waist is commonly practiced and can be seen at almost any construction site [3]. Force dissipation over the larger area may not occur in case of sudden pull in such cases and hence, serious injury may occur. Body belts were banned by OSHA in 1998 due to the possibility of serious internal injuries while arresting a fall, presumably due to similar mechanism of force transmission [5]. Magnitude of energy imparted to tissues is exemplified by complete transection of parietal wall and bowel in our case. Injury to other organs placed in the cephalocaudal axis like ureter, great vessels, and spinal cord may also occur. Besides, sudden flexion of the torso when pulled from knot placed at the back may lead to flexion-distraction injury of the spine. Therefore, OSHA recommends attachment of body harness to be located in the center of back, near



**Fig. 2.** A: Patterned abrasion; Protective ileostomy  
 B: Transected parietal wall with intact overlying skin  
 C: Multiple small bowel transections  
 D: Seromuscular tear of Transverse Colon with non-viable mucosa.

shoulder level or above head [5].

We could not find any report of injury sustained due to sudden pull up of suspended worker in English published literature using keywords like “rope suspension injury, blunt abdominal injury, rope related injury, accidental rope injury, accidental abdominal hanging, tie rope injury, injury due to sudden pull while suspension”. Therefore, we believe it to be the first report of such a mechanism of trauma. Due to the paucity of literature, understanding kinematics would require analogy and extrapolation. Such pull-ups may be seen analogous to emergency ejection from aircraft, but due to vast difference in antigravity speeds of pull up, injury constellations can't be extrapolated. Clothesline injury to neck in sudden strangulation is known to disrupt trachea, esophagus, carotid artery and even spine beneath intact skin [7]. However, these injuries largely result due to sudden compression; an element of sudden acceleration as in our case is missing in these neck injuries. Jiang et al. looked at the prevalence of abdominal injuries with seat-belt sign in patients categorized by belt-mark location with respect to anterior superior iliac spine (ASIS). They found that the chances of both vertebral and visceral injuries increased when lap belt sign was above ASIS as compared to below ASIS; injury prevalence in the latter was, in fact, comparable to patients with no seat belt sign [8]. We propose the term ‘reverse suspension trauma’ due to a similar mode but opposite kinematics in this case as compared to the ‘suspension syndrome’ described very well in literature.

Last but not the least, ignorance of trauma in developing countries is highlighted by the fact that the patient didn't even consider to inform the car driver of getting himself suspended from his vehicle.

### Take home message

Reverse suspension syndrome is a dangerous mechanism of trauma involving the transmission of major energy. Workup to rule out bowel, ureter, great vessels, spine and cord injuries is recommended. The outcome is good if the patient presents in time.

## References

- [1] <https://timesofindia.indiatimes.com/business/india-business/48000-die-due-to-occupational-accidents-yearly-study/articleshowprint/61725283> (Accessed on April 12, 2019).
- [2] [Indianexpress.com/article/india/accidents-at-workplaces-in-india-under-reported-38-per-day-in-construction-sector-study-4947079](https://indianexpress.com/article/india/accidents-at-workplaces-in-india-under-reported-38-per-day-in-construction-sector-study-4947079) (Accessed on April 12, 2019).
- [3] <https://www.ndtv.com/india-news/even-after-fatal-accidents-indias-construction-sites-remain-death-traps-for-workers-1734233> (Accessed on May 8, 2019).
- [4] B. Raynovich, F.T. Rwaili, P. Bishop, Dangerous suspension. Understanding suspension syndrome & prehospital treatment for those at risk, *JEMS: a journal of emergency medical services* 34 (8) (2009) 44–51.
- [5] <https://www.osha.gov/SLTC/etools/construction/falls/fallarrest.html> (Accessed on May 8, 2019).
- [6] <https://irata.org/page/about-us> (Accessed on May 8, 2019).
- [7] J. Graham, R. Dick, D. Parnell, M.E. Aitken, Clothesline injury mechanism associated with all-terrain vehicle use by children, *Pediatr. Emerg. Care* 22 (1) (2006) 45–47 Jan 1.
- [8] O. Jiang, S.E. Asha, J. Keady, K. Curtis, Position of the abdominal seat belt sign and its predictive utility for abdominal trauma, *Emergency Medicine Australasia* 31 (1) (2019) 112–116 Feb.