

## Injuries in jumpers - are there any patterns?

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### Abstract

Suicide as a cause of death, affects every health system, and is a particular problem in heavily urbanised states and low and middle income countries (which account for 75% of suicide deaths). The World Health Organisation records that 800000 commit suicide each year, representing 1.4% of annual global deaths, and that suicide was the second leading cause of death in 15-29

year-olds across the world in 2012. In the United Kingdom, jumping from height accounts for 3%-5% of the 140000 suicide attempts annually is similar incidence to the rest of Europe. The Medline and EMBASE were interrogated for studies examining suicide caused by jumping from height. Manual screening of titles and abstracts was used to identify relevant works before data was extracted and systematically reviewed to identify the characteristics of a patient who jumps from height to commit suicide, delineate their patterns of injury and explore techniques that could be used to limit its occurrence. Emergency departments receiving patients who jump from a height need to have an understanding of the potential pathology that is likely to be encountered in order to deliver multidisciplinary, efficient and timely care in order that the impact of this devastating physical, psychological and social problem could be modified to the benefit of the patients involved.

**Key words:** Polytrauma; Suicide; Fracture

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**Core tip:** This paper examines the incidence of injuries following a deliberate fall from height, and argues that there are predictable patterns of injury following this mechanism.

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### INTRODUCTION

Suicide, as a cause of death, affects every global health system, and is a particular problem in low and middle income countries (which account for 75% of suicide deaths) and in heavily urbanised states<sup>[1-5]</sup>. More than

800000 commit suicide each year. The World Health Organisation records that 1.4% of annual global deaths are caused by suicide, and that suicide was the second leading cause of death in 15-29 year-olds across the world in 2012<sup>[1,6-9]</sup>.

Jumping from height accounts for 3%-15% of the 140000 suicide attempts in the United Kingdom each year, a similar incidence to the rest of Europe but lower than the 26% incidence found in California<sup>[7,9-15]</sup>. Jumping requires no equipment and is easily carried out with little planning, and is likely to be fatal with 55% of patients dying either at the scene within an emergency department<sup>[16-18]</sup>.

Emergency departments that receive patients who jump from a height need to have an understanding of the potential pathology that is likely to be encountered in order to deliver organised and timely care to these patients. The management of these patients requires a multidisciplinary approach and involves the consumption of significant resource<sup>[19]</sup>. When it is considered that patients are most often of working age in low to middle income countries, this becomes particularly relevant as the social and economic consequences as suboptimal management of a patient can be devastating to a family unit.

By identifying the characteristics of a patient who jumps from height for suicidal purposes, delineating their patterns of injury and exploring measures that could be used to limited the incidence of deliberate falls, the impact of this devastating physical, psychological and social problem could be modified to the benefit of the patients involved.

## RESEARCH METHODS

Using the OVID portal (Wolters Kluwer, Alphen aan den Rijn, the Netherlands), both Medline (1950-Present) and EMBASE (1980 to 2015 week 16) were searched for studies examining the subject. The search was conducted using the term suicide (mapped to MeSH headings) in combination with synonyms for jump (jump, leap, fall, autokabales). Abstracts identified were then screened manually for relevance and data extracted.

## THE JUMPER AND THE JUMP

### *The jumper*

Suicide is a desperate conclusion to a psychological problem, one that may have been diagnosed prior to the attempt or may have yet to be found. Several attempts have been made to describe the characteristics of a patient who attempts suicide by jumping from a high place. Gore-Jones *et al.*<sup>[11]</sup> and others have described the jumping patient as a 31-year-old single person with a diagnosis of a psychotic illness or borderline personality disorder, of which 60% will have had contact with mental health services<sup>[20]</sup>. Work from our own unit in the United Kingdom shows that in a series of 41 patients a Caucasian male aged 25-30 years is the most common

patient to present with this mechanism, a picture also seen in the United States<sup>[20,21]</sup>. Other work has shown conflicting descriptors of patients. Chia and several European studies show that jumpers were usually female, young and single whereas many other reports show that jumping is more common in males<sup>[7,9,13,17,20,22-25]</sup>.

Other demographics of the patient group have been identified. Whilst eighty percent of patients show features that the act was impulsive, three in every four patients have made previous suicide attempts<sup>[11]</sup>. Furthermore, Choi *et al.*<sup>[16]</sup> showed that patients who jumped had a lower final grade of education, showing that severe injury following an attempt was associated with having attained a high school diploma rather than a university degree, perhaps indicating the social-economic situation in which the patient finds themselves at the time of their attempt.

Small *et al.*<sup>[26]</sup> showed that inpatient suicide was a unique problem. The group showed that youth and social isolation in common with prolonged admission, a history of assaults and previous suicide attempts were particularly associated with jumping. Work in the inpatient population in the United Kingdom showed that jumping was likely to be the most common method of suicide for inpatients, as their access to alternative methods was likely to be restricted by virtue of sectioning or other controls in their environment<sup>[14]</sup>.

The presence of a psychotic illness in patients who jump is agreed on in all series that examine the phenomenon. Psychosis may be diagnosed either before or after the attempt, but is typically made in association with the presentation. Estimates of pre-existing psychiatric illness, most commonly schizophrenia (which is more severe than that suffered by those who employ other methods of suicide) range from 10%-97%<sup>[3,4,11,19,21,22,24,26-37]</sup>. Nielssen *et al.*<sup>[29]</sup> examined a cohort of survivors of deliberate jumps from height and noted that only 44% of the cohort had a diagnosis of psychotic illness, of which 44% had received no previous treatment, suggesting that they were in their first episode of psychosis. Further exploration of the psychological state of these patients showed that 20% had a robust diagnosis of delusional psychosis, suggesting that the first episode of psychosis is a significant risk factor for suicide attempt<sup>[29]</sup>.

Although schizophrenia is the most often quoted psychotic diagnosis given to this cohort of patients, others diagnoses do feature. Stanford *et al.*<sup>[35]</sup> found a diagnosis of personality disorder in 49%, depression in 25% and mood disorder in 18%. Kennedy *et al.*<sup>[22]</sup> showed depression in 27% of patients, and Kontaxakis *et al.*<sup>[24]</sup> showed affective psychosis-depressive type in several of their 46 patients. In contrast, our own cohort showed an absence of documented psychiatric disease either pre-existing or newly diagnosed during inpatient stay in 44% of patients; however depression features in 23% and psychosis in 13% of cases<sup>[21]</sup>. Organic illness is found within the cohort more than one might expect given the young age of patients. Wong *et al.*<sup>[4]</sup> showed that 44% of patients had physical illness, while others list

“serious somatic illness” as a comorbidity<sup>[24]</sup>. Substance abuse also features in patient backgrounds with Bostman quoting 15% of Finnish patients suffering alcoholism at the time of their jump<sup>[19,21,23,35]</sup>.

The frequency of previous suicide attempt ranges from 23% to 75%<sup>[11,22,38]</sup>. Alongside this, the methods of suicide do seem to change following a failed attempt. Paraschakis found that most patients who failed to commit suicide with self-poisoning, self-inflicted wrist laceration or jumping switched method to jumping on their subsequent attempts<sup>[38]</sup>. Stanford reports a cohort of 55 patients with an 84% follow-up at a mean of 8 years, four had gone on to successful suicide<sup>[35]</sup>.

### The jump

Unfortunately, 55% of deliberate falls cause death, a figure influenced by the height of the jump and the physical and psychological comorbidities<sup>[16,17,39,40]</sup>. Dickinson *et al*<sup>[17]</sup> examined a cohort of 117 patients attended by the London's Helicopter Air Ambulance Service who had fallen from height either accidentally or deliberately, and found that those who jumped rather than fell were more likely to die and that if head and chest injuries occurred, the height fall required for 50% of patients to die was found to be 11 m. If these injuries did not occur, the height fall required for 50% of patients to die increased to 22 m<sup>[17]</sup>. Further study by Türk *et al*<sup>[39]</sup> showed that suicidal falls occurred from a mean height of 23 m compared to 11 m for accidental falls, and that 79% of suicidal jumps were from a height greater than 16 m, whereas Copeland showed most suicidal falls were from 7 storeys (21 m) or higher<sup>[23]</sup>.

Deliberate jumps occur from a range of structures, including residential buildings in 63%-83% of cases, bridges and hotels<sup>[4,14,25,32,36,40-44]</sup>. The prevention of suicide from bridges by the installation of barriers or other protections reduces the incidence of suicide from that site, an effect seen in both Europe and the United States<sup>[8,9,14,25,36,42,43,45]</sup>.

The surface that the patient lands on influences both injuries and survival. Whilst jumping from buildings is likely to end with a solid surface, jumping from a bridge could lead to landing on water. Gill<sup>[46]</sup> showed that 77 suicides involving a jump into water showed few external signs of injury, suggesting drowning as the mode of death. Simonsen examined 10 cases of suicide with a water landing, and of the 10, drowning was the cause of death in six cases. Injuries, which were restricted to the thorax and spine, due to the fall caused death in four cases<sup>[47]</sup>.

## THE INJURIES

The injury severity score correlates to the height of the jump and position of the patient on landing. It is established that those patients who survive their jump have multiple, severe injuries that usually require extensive treatment and that jumpers usually sustain injuries

to more than one body region<sup>[18,28,48,49]</sup>. Each region of the body has particular injuries associated with it following a jump, each of which may give a clue as to the attitude of the patient on landing and help to guide both investigation and treatment.

### The spine

The spine is the most commonly injured body region following a deliberate fall from height, an association that is magnified if sacral fractures are included into this category<sup>[11,21,35,37,50-53]</sup>. Each group who have examined these injuries has identified a different spinal level as being most vulnerable. It seems that the most mobile spinal segments are particularly at risk particularly the thoracolumbar junction<sup>[28,35]</sup>. Wirbel *et al*<sup>[50]</sup> showed that of 36 patients with spinal injuries due to jumping, 33 had spinal injuries and Hahn *et al*<sup>[51]</sup> showed that 83% of jumpers had fractures of the thoracolumbar spine, usually at the thoracolumbar junction. Li *et al*<sup>[20]</sup> showed an incidence of 19% of neck injuries in their series, and Stanford *et al*<sup>[35]</sup> showed in his series of 55 patients with spinal cord injury as a result of jumping, 23 patients (42%) had a complete cord injury with C5 and L1 being the most commonly injured levels. Our own series shows that 15/41 patients sustained a thoracolumbar fracture (37%) and 5/41 patients a cervical spine injury<sup>[21]</sup>.

### The head

It is reasonable to hypothesise that primary brain injury is responsible for a significant proportion of the 55% of early deaths due to suicide *via* jumping, supported by Richter *et al*<sup>[28]</sup> who showed that half of patients with a head injury fell or jumped from a single storey died<sup>[16]</sup>. Abel *et al*<sup>[41]</sup> showed that 30% of patients seen at their unit sustained craniofacial injuries, a figure in approximate agreement with Richter *et al*<sup>[28]</sup> (27%) and our own series (29%)<sup>[21]</sup>. However, Li *et al*<sup>[20]</sup> showing an incidence of head injury of 70% in their series of 124 lethal falls or jumps, suggesting the conclusion that the head injury is often fatal. Head injury is further explored by Dickinson *et al*<sup>[17]</sup> who showed that at a jump height of 11 m, 50% of those patients sustaining a head or chest injury die. Slightly contradictory to this, Türk *et al*<sup>[39]</sup> showed that patients jumping from heights between 11-25 m, head injuries were less common than when patients jumped from heights outside this range, and that 79% of suicides were from 16 m or higher.

### The pelvis

The only reports of pelvic fractures caused by a deliberate jump have been made by Roy-Camille *et al*<sup>[53]</sup>. They describe an H-shaped transverse sacral fracture with vertical elements through the foramina. H-shaped fractures are now synonymous with the “Jumpers Fracture” are rare, with only 1.2% of pelvic fractures treated in a European trauma centre within a 9-year period being of this type<sup>[52]</sup>. They are however significant injuries, requiring surgery in all displaced fractures, especially

with vertical shear fractures and associated L5 and S1 neurological damage<sup>[52,53]</sup>.

Teh *et al*<sup>[48]</sup> found that their series of 57 jumpers showed a higher rate of pelvic injury in those who jumped from height when compared to fallers, and Richter *et al*<sup>[28]</sup> found a 30% incidence of pelvic fracture amongst 39 jumpers with the incidence of pelvic injury increased significantly once the height of the jump was above 7 m<sup>[48,51]</sup>. Within the cohort in our unit, pelvic fractures were found in 14/41 patients (34%), with jumpers fractures sustained in 4 of these, perhaps refuting a causal link between jumping and jumpers fractures<sup>[21,53]</sup>. Pelvic injuries due to jumping come with poorer long-term results when compared to other causes of pelvic fracture. It is evident that these patients have a lower health related quality of life score than other pelvic fracture patients, and that patients who are younger at the time of injury fare better when compared to more elderly<sup>[54]</sup>.

### The limbs

The limbs are intuitively the most vulnerable to injury with any significant trauma and in jumping<sup>[50]</sup>. However, the degree to which they are injured and the pattern in which those injuries are found is not well described. Jumpers appear to sustain significantly more bilateral limb injuries than fallers which tend to be metaphyseal and epiphyseal<sup>[28,48,49]</sup>. Hahn *et al*<sup>[51]</sup> reported a limb fracture incidence to be 45% with calcaneal and ankle fracture to be the most common extremity injuries seen, with a respective incidence of 65% and 27%. Li *et al*<sup>[20]</sup> showed a 28% incidence of extremity fracture in jumpers, and Katz *et al*<sup>[37]</sup> showed that the lower limbs were the most common skeletal injury. These figures fall short of our own, where we found a 93% incidence of lower limb injury in our series of jump survivors<sup>[21]</sup>. No studies have yet published regarding the relative incidences of open and closed fractures in jumpers, although one would expect a tendency toward a higher incidence of open fractures in this group, due to the higher energy. Only two studies reporting on upper limb injuries. Our own work has shown an incidence of 8/41 upper limb injuries (most often open fractures), and Hahn *et al*<sup>[51]</sup> identified a 25% incidence of upper limb fracture in 39 jumpers<sup>[21]</sup>.

### The thorax and abdomen

Injuries to the thorax are associated with death in the jumper<sup>[17]</sup>. Chest injuries occur in up to 66% of jumpers, with abdominal injuries occurring much less frequently, estimated at being present in 6% of cases<sup>[20,28,41]</sup>. Dickinson details how the presence of a chest injury was associated with a higher risk of death, and that in the absence of chest (and head) injuries reduced the risk<sup>[17]</sup>.

Abdominal injuries are rarely reported with one study reporting an incidence of 48% of abdominal injuries in a series of 139 fatal falls and jumps<sup>[20]</sup>. This figure varies from other published and raw data both of which

give figure of 6% or less<sup>[21,28]</sup>. It may be that abdominal injuries, similar to cervical spine and head injuries, are often fatal in the very early stages (through massive haemorrhage or visceral trauma) and so could be over-represented in the fatalities.

## PATTERNS OF INJURY

Few papers have commented on the patterns of injury sustained by jumpers. As is seen above, every region of the body is affected by the trauma, and the trauma can affect a patient of any background, gender or age, with their concomitant influences on presentation and survival. It is difficult to categorise the injuries sustained to a particular attitude of landing or height of jump.

Richter *et al*<sup>[28]</sup> has stated that no significant differences exist in the pattern of traumatic injuries caused by either accidental falling or deliberate jumping. Dickinson *et al*<sup>[17]</sup> showed that jumpers have a higher injury severity score and mortality than fallers and Abel *et al*<sup>[41]</sup> showed that 56% of patients who jump from bridges died from polytrauma rather than drowning or accompanying substance ingestion.

## CONCLUSION

By recognising the common injury patterns of suicide attempts from jumping, the treating clinician can target investigation and treatment to severe and easily missed injury, the Jumpers fracture being the most obvious example. Outcomes are difficult to report in this patient population, but they almost all require multidisciplinary management. Patients presenting after jumping from a height should undergo routine screening of their head, chest, abdomen, pelvis and spine, and it is of course mandatory to address the psychological issues which lead to the suicide attempt.

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