

# When is a pressure ulcer not a pressure ulcer? Complexities associated with identifying aetiology of deep tissue injury (DTI) following trauma

## KEY WORDS

- » Deep tissue injuries
- » Dressing regimen
- » Pressure ulcer
- » Trauma

**Abstract:** Identifying the cause and aetiology of wounds is a complex process that requires an in-depth knowledge of wound evolution and holistic aspects of a patient's history (Black et al, 2015). This paper focuses on the complexities of determining whether a deep tissue injury (DTI) is caused by pressure or trauma in order to ensure appropriate care is provided and investigations are in the patient's best interests (Bruce et al, 2015). It is well documented that a pressure ulcer (PU) occurs when sustained, unrelieved pressure is applied over an area with a bony prominence causing the tissues to compress, become starved of a blood supply and progress to tissue ischaemia. Where shear is also a factor, a distortion of cells occurs causing a break in the cell walls and damaging the underlying tissues, the severity is dependent upon the duration and intensity of the pressure and shear forces (Hoogendoorn et al, 2017). While pressure damage occurs over time; when a person is involved in high intensity, short duration shear forces as a result of trauma similar injuries are seen and often confused with pressure damage as a DTI often has a delayed visible appearance on the surface of the skin (Dodward et al, 2015). The case studies described demonstrate the challenges faced by ward level staff in recognising and accurately documenting the aetiology of these wounds. In conclusion, having an in-depth understanding of the forces involved in high velocity trauma can help practitioners to recognise the potential injuries which may become apparent in days following admission to hospital and enable accurate assessment and care planning.

It is all too easy to quickly decide a suspected deep tissue injury (sDTI) over a bony prominence is a pressure ulcer (PU), but there can be other reasons for this wound appearance. Black et al (2015) in their paper described the differential diagnosis of sDTI. The following evidence review and case studies will show the complexities of diagnosing aetiology, particularly where trauma has occurred to the patient.

The NHSi (2018) definition of a PU is:

*"localised damage to the skin and/or underlying tissue, usually over a bony prominence (or*

*related to a medical or other device), resulting from sustained pressure (including pressure associated with shear). The damage can be present as intact or an open ulcer and may be painful"*.

PU's are categorised based on the depth of tissue damage, sDTI is not always immediately visible as it develops deep in the tissues at bone/muscle level and ischaemia of the surrounding tissues discolours the skin sometime later (Black et al, 2015).

Locally, the role of validating PU reports has moved away from the tissue viability team and

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handed to the ward managers and matrons to take accountability. However, these clinicians often report difficulties or a lack of confidence in accurately categorising, especially when it comes to sDTI. This is evident in the incident reports when they are reviewed by the TVN as part of a quality assurance plan, requiring much editing and re-categorising to validate data before external reporting. Inconsistencies in categorising among nurses of differing experience and knowledge have been reported for many years, it is generally agreed that accuracy is increased with experience of the reviewer (Bruce et al, 2012).

To accurately validate a PU report, the case studies discussed show how a holistic review is required, and this can take time to achieve. An experienced TVN will review a patient history to establish the nature of the wound reported and the origin of the tissue damage. In our experience, there are occasions when a wound is reported as a PU but by investigating the patient history and events leading to the tissue damage it is possible to establish that a wound may not be a PU at all. For the inexperienced generalist, alternative causes of wounds may not be easily recognised. This is supported by Brienza et al (2015) in their examination of the differences between shear related PUs and friction injuries, where they describe a deeper understanding of the forces at work are required to accurately identify the true nature of the injury or ulcer.

Why is it important to know? It's not just about getting the data right, but it is in the patients' best interests to understand the underlying aetiology or cause of any wound in order to ensure appropriate care and implementation of any required prevention strategies or diagnostics that may be needed (Bruce et al, 2015).

#### **Prolonged pressure versus rapid shear**

The key event for pressure ulceration to occur is sustained pressure due to a period of immobility with or without shear, pressure ulcers occur over time, the severity is dependent on the duration and intensity of the pressure and shear forces exerted on the tissue (Hoogendoorn et al, 2017). sDTI PUs are particularly a concern when someone has experienced a prolonged duration lie on a hard surface such as a floor or theatre table (Black et al, 2015).

Kosiak (1959 in Peart, 2016) identified high intensity of pressure over a short period of time could also cause similar cellular damage. Therefore, the intensity of pressure exerted in a rapid impact such as blunt force trauma, such as can be seen in slow-motion replays in impact sports such as boxing can also cause compression and ischaemia of tissues at the point of impact. Thus, a severe DTI can also occur with high intensity low duration pressure (*Case studies 1 and 2*).

Additionally, shear forces to tissues can also occur rapidly, for example during a road traffic collision, the vehicle decelerates rapidly, exerting intense shear forces over the body in contact with the vehicle seat over a very short space of time (*Case studies 3 and 4*). This has been demonstrated in crash test dummy experiments over many years and more recently measured by Kim et al (2017) in their quest to study the varying shear forces during acceleration, deceleration and changing direction. They identified that when a vehicle is accelerating, the shear forces to the back and buttocks are in the opposite direction to the vehicle and push the body down and back towards the seat; whereas if the vehicle is decelerating, the body continues to move forward and lifts from the seat, before landing heavily at an angle. Kim et al (a, 2017) were in the business of designing more comfortable car seats, but the information gleaned helps us to understand how trauma patients can present with what appears to be a DTI pressure ulcer a few days into their stay in hospital, but is actually a traumatic shear injury.

#### **Traumatic deep tissue injury**

Like DTI pressure ulcers, traumatic DTIs occur deep in the tissues, over the bone or between the muscle fascia and subcutaneous tissue. These traumatic injuries are sometimes known as a Morel-Lavellée lesion or a closed degloving injury, occurring when shear forces act between the muscle fascia and the subcutaneous layer (Kim et al, 2018). This causes plasma or blood to leak into the space between these layers and can lead to skin necrosis if the fluid is not identified and drained early (Dodwad et al, 2015). Dodwad et al (2015) report these lesions are often identified late due to their nature being hidden in deep tissue and are incidentally identified either during MRI/CT



**Case 1. A 21-year-old man who fell from height (high intensity, low duration pressure).**

scanning or during surgical procedures to fix a sacro-pelvic junction injury.

In addition to the initial rapid shear force at the time of injury, Xiao et al (2014) describes the impact of reperfusion on deep tissue ulcers; for example, when a person is extricated from entrapment within a crashed vehicle. In their modelling experiment, they identified that reperfusion when the load (shear/pressure) is removed causes greater tissue surface injury than the initial local ischaemia caused by loading. They measured the amount of injury over time and found it could take up to 48 hours before the injury was visible at the skin surface, and like Dodward et al (2015) also noted the risk of these extensive injuries going unnoticed until they are visible on the skin. This delayed appearance is also reported by Black et al (2015) who note a lapse of 24–72 hours can occur between the pressure/ shear event and the onset of purple or maroon skin discolouration with full manifestation to a full thickness wound taking up to 10 days.

With such a delay in becoming visible it is little

wonder then that these injuries are often reported as PUs, by the time they are visible, the patient has likely been in a hospital bed for a few days. So how should we differentiate from pressure?

Things to consider when investigating:

- ▶ Location of wound on the body
- ▶ History of sustained pressure/ shear forces
- ▶ History of trauma, high impact
- ▶ Underlying conditions: dermatological, vascular, autoimmune, malignancy, medications

### Case study 1

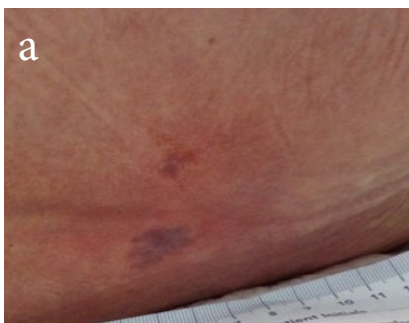
A 21-year-old male, fell from height (high intensity, low duration pressure). He was admitted to the regional trauma ICU after falling from a mezzanine balcony in a local club while intoxicated, he was witnessed to have landed briefly on his feet onto a crockery cabinet before falling a further 2–3 metres to the floor. During daily skin checks, staff noted the appearance of a suspected DTI to the sole of his heel and reported it as a PU incident. However, there was no evidence of pressure being exerted during his stay as his feet had been offloaded throughout.

On review by the TVN, the patient was asked about his accident and he recalled quite clearly remembering hitting his foot on something hard before reaching the ground. On examination the sDTI was under the sole of his heel rather than the posterior where pressure would be expected. Review of X-rays revealed a very small calcaneum fracture directly aligned to the area of sDTI.

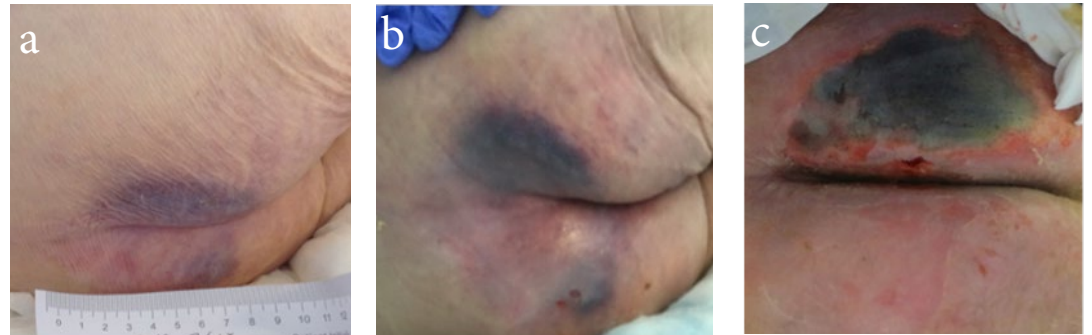
The shape of the sDTI was irregular and indicative of traumatic leakage of blood into the soft tissue. Other than his injuries, he was in good health with no underlying comorbidities; his sDTI fully reabsorbed with no loss of tissue.

### Case 2

A 68-year-old female, jumped from height (high intensity, low duration pressure). She had experienced severe depression since the death her husband 18 months previously, she had left a suicide note at her house and thrown herself off a motorway bridge, landing heavily with great velocity onto her lower limbs and sacrum. Sustaining major fractures to her right leg and sacral bone, the impact also caused a tear to her sacral artery. An MRI scan revealed a large



**Case 2. A 68-year-old female, jumped from height. High intensity, low duration pressure. a) Day 2 after admission. b) The change in colour from pale mauve to deep purple before necrosing, revealing a cavity at the site of the haematoma**



**Case 3.** A 53-year-old moving static vehicle impact (high velocity deceleration impact). a) Day 2, b) day 5 and c) 1 month

haematoma (Morel-Lavellee lesion) extending from her sacral bone towards the skin and tissue viability were asked to observe as she was not fit enough for surgical drainage. Photograph (a) was taken on day 2 of admission, showing a very faint discolouration over the sacrum; this area continued to change in colour from pale mauve to deep purple before necrosing, revealing a cavity at the site of the haematoma (*Case study 2b*).

When she was transferred to her local hospital, despite a full handover being sent, the receiving trust reported a safeguarding incident regarding a hospital-acquired category III PU. This suggests a lack of experienced trauma insight at the tertiary trust to understand the impact of a fall from height landing on the sacrum, causing a fracture and internal haematoma, in turn leading to tissue necrosis due to ischaemia of the underlying tissues.

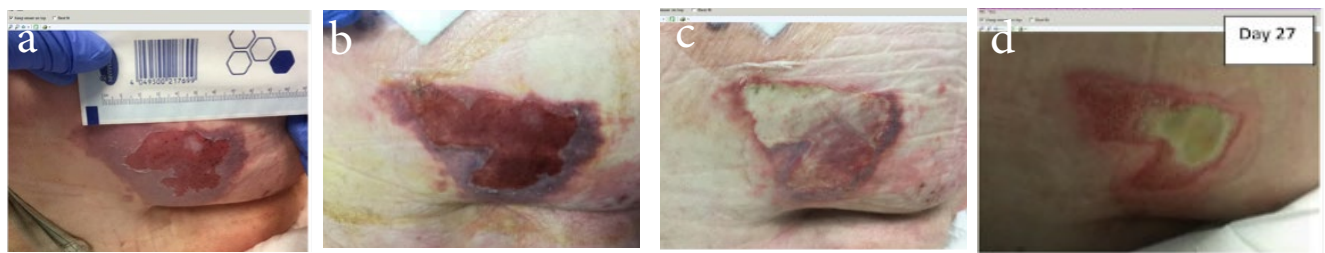
**Case 3**

A 53-year-old male involved in a moving versus static vehicle impact. The patient was obese and suffered from sleep apnea, and fell asleep at the wheel of his car while travelling approximately 30 mph, hitting a stationary vehicle and thus

decelerating rapidly. He was found by paramedics wedged between the steering wheel and the edge of his seat in the foot well, requiring fire services assistance to extricate. The patient was admitted to the ICU, ventilated and on inotropes to maintain his blood pressure. During daily skin checks, a mild discolouration was noted to his buttocks and the duty physician recognised this may be a significant DTI emerging so catalogued a series of photographs (*Case 3*). Due to the high-speed rapid deceleration he had experienced intense shear forces to his buttock tissue and over the course of the next month this became evident as his whole buttock necrosed and eventually required plastic surgical debridement and reconstruction.

**Case 4**

A 46-year-old lorry driver, moving vehicle versus object (high velocity deceleration impact). The patient skidded in his articulated lorry, leaving a major dual carriageway and hitting the barriers. The wound to his buttock was originally reported by staff as a moisture associated skin damage (MASD) as it appeared to be over the soft tissue of the buttock and was erythematous with overlying



**Case 4** A 46-year-old lorry driver, moving vehicle versus object (high velocity deceleration impact). a) Day 1 b) day 2 c) and day 4 and d) day 27



**Case 5. A 23-year-old female involved in a moving vehicle versus spin versus static object (high velocity sideways acceleration force followed by high velocity deceleration)**

superficial skin peeling (*Case 4*). However, he had been catheterised on admission due to his major trauma and had not experienced any faecal incontinence or excessive sweating to account for moisture damage.

It was suspected that the wound was related to shearing forces during his accident and photographs were taken to monitor. The area went on to become necrotic, much like the previous case study but with less depth. The wound was managed without the need for surgical intervention and went on to heal.

#### Case 5

A 23-year-old female involved in a moving vehicle versus spin versus static object (high velocity sideways acceleration force followed by high velocity deceleration). The patient lost control of her car on a wet road, her vehicle is believed to have spun several times before impacting a tree coming to a rapid deceleration. She was not wearing a seatbelt and the shear forces from a spinning vehicle are likely to have pushed her sideways against the frame of the vehicle before the impact caused her to be thrown from the vehicle. TVN received a referral immediately on her arrival to critical care to advise on a large PU to her flank. Bearing in mind she had only just been admitted and was previously well it was highly unlikely that the wound referred was going to be a PU. On examination the TVN noted a deep purple discolouration with some blistering, alongside an area in the skin fold that appeared white and avascular (*Case 5*). Only by examining the ambulance records of how the patient was found at the scene and evidence of skid marks demonstrating the vehicle had spun, was the

TVN able to suggest this wound was a DTI due to traumatic shear forces. With an interruption to her vascular supply to the skin, this wound deteriorated rapidly over the course of a few hours and required extensive plastic surgical intervention.

#### CONCLUSION

Previous studies have shown the potential for misdiagnosis of DTI as pressure related due to both the delayed nature of their appearance (Dodward et al, 2015; Black et al, 2015) and the lack of understanding by clinicians of the forces involved in tissue deformation (Brienza et al, 2015).

These cases demonstrate that careful examination of the whole history before the wound becoming visible and a good understanding of the duration and intensity of shearing (Kosiak, 1959 in Peart, 2016) is essential to establish the aetiology of these complex injuries. Each of these wounds as images alone could easily be misreported as PUs given their position and appearance. As each became visible while an inpatient in hospital significant time could have been spent validating and investigating, with nursing staff questioning if they had not given the best PU prevention care they could have. Duty of Candour conversations would have left these patients believing they had developed PUs, while the true nature of ischaemic underlying tissue may not have been explored and appropriately managed as demonstrated by Dodward et al (2015) when discussing Morel-Lavellée lesions.

By gaining a good understanding of the biomechanics of shear during trauma (Brienza et al, 2015) we can ensure evidence of deep tissue injury is checked for during trauma surveys and

monitored for rapid deterioration or compromise to tissues which could be a sign of continued bleeding in the case of case study 2 and 5 (Dodward et al, 2015). Accurate information from those at the scene of the incident is essential, receiving acute care staff need to familiarise themselves with terminology used by emergency services to describe direction and velocity of travel in road traffic accidents, witness accounts are incredibly useful when someone has fallen/jumped from height to understand how they left the high surface to how they landed as these can shed light on soft tissue impacts. As Kim et al (2017) demonstrated; the direction and velocity of a travelling vehicle has a direct impact on the velocity and direction of impact on the body and the likely points of injury sustained.

These patients all experienced major trauma and an episode in critical care, they are also at extremely high risk for pressure ulceration and all risk assessments and preventative measures must be in place. Any tissue that has undergone a shear or blunt force trauma is going to be weakened and susceptible to any additional forces due to pressure and shear whilst immobilised in hospital (Brienza et al, 2015). Essentially, regardless of the nature of the DTI, these patients require fundamental

nursing care to prevent deterioration of their already compromised skin due to additional pressure. **WUK**

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