

Update on Deep Tissue Injury

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Fatal DTI due to placement on a bedpan

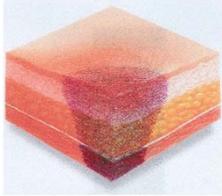


History of Deep Tissue Injury

- Ulcers could erupt from intact skin (Paget, 1874)
- May be purple or yellow from extravasation of blood. The deeper tissues die, muscles, bones. Sloughing follows in the skin and fat and the place is empty (Paget, 1874)
- Ulcers that started in muscle were malignant (Groth, 1942)
- Closed pressure ulcers (Shea, 1975)
- Clinical records of "purple" pressure ulcers, bruises over intact skin, cauterly burns, evolving full-thickness ulcer

Deep Tissue Injury Definition

- Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear.



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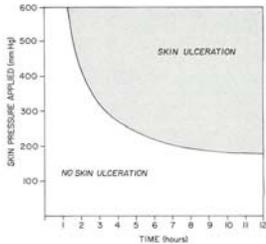
Deep Tissue Injury Description

- The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue.
- Deep tissue injury may be difficult to detect in individuals with dark skin tones.
- Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar.
- Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

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Time to Develop Pressure Ulcers

- Koziak's model shows ulcers developing in 2 hours at 600 mmHg pressure
- And ulcers developing after 10 hours at 200 mg Hg pressure
- Are these ulcers different?



Pathogenesis: An inside out pressure ulcer?

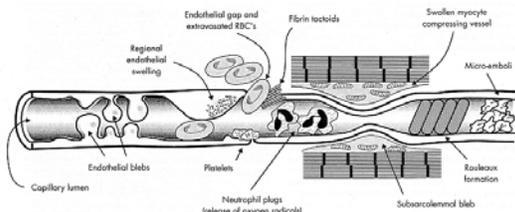
- Is the progression of a stage II ulcer always potentially a stage IV?
- Or are there 3 distinct possibilities?
 - Superficial pressure and/or microclimate leading to stage I and II
 - Ischemia leading to stage I to IV
 - Deep pressure with muscle cell damage leading to stage III and IV

Zones of infarct, ischemia and injury?

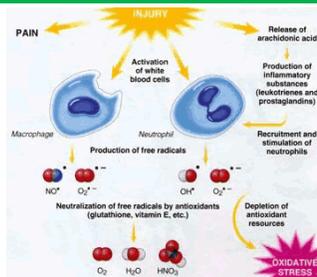
- Area sustaining highest pressures is infarcted
- Surrounded by rings of ischemic and injured tissue that is rescuable



Reperfusion Injury: No Flow-Flow



Cellular Changes with Tissue Injury



Cellular injury initiates a cascade of inflammatory responses including free radical production. Normally "mopped up" with antioxidants. This process is likely overwhelmed in large injuries.

Background

- Epidemiology (Vangilder N = 10,728)
- sDTI's are likely to be facility acquired
 - 9.5% of all ulcers identified are sDTI's
 - 13.4% of FA ulcers are sDTI's
- sDTI's are more common in high acuity settings
 - ICU (14% of all ulcers & 20% of FA ulcers)
 - LTAC (10% of all ulcers & 18% of FA ulcers)

DTI Incidence

- Increasing reported incidence to 9% of observed ulcers
 - Increased education
 - More prevalent than stage III and IV ulcers
 - Anatomic locations
 - Heel = 41%
 - Sacrum = 19%
 - Buttocks = 13%
- Vangilder, 2010

Natural history of purple pressure ulcers

- 82 cases of patients who sued over severe pressure ulcers that began as purple skin
 - Period of “confinement” to a hard surface or limited turning on a support surface preceded purple skin by around 48 hours
 - Purple skin on buttocks and heels developed thin blisters about 24-48 hours later, then became necrotic or blood blistered
 - Population at risk
 - Wide variation in age (ages 24-98)
 - 70% emergent admissions to hospital Black, unpublished

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Natural history—prospective—6 NC facilities (Richbourg)

- Patient variables
 - Preatlb 10.9, alb 2.2, Hgb 9.7
 - 83.8% on group 2 surface
 - 65% AC use
- Outcomes
 - 5% of sDTI naturally resolve
 - 68% remained DTI
 - 28% became stage III/IV or unstageable
 - Poorer outcomes with smoking, OR

Natural History of sDTI in Acute Care

- 200 cases of sDTI reported to wound service
 - Wide age range (14-102 years)
 - 70% of sDTI Present on Admission
 - Pneumonia, Failure to Thrive and Sepsis common
 - Anemia common
 - Progression
 - 73.5% intact purple initially
 - 65.5% blistered or denuded at 72 hrs
 - 46% necrotic at day 7

Baharestani, unpublished

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Natural history (Sullivan, 2013)

- Retrospective review of 77 pts with DTI
- Followed from 1 day to 14 weeks
- Patient factors
 - Age range 32-91 years
 - CAD, DM, Immobility, ICU time, incontinence
 - Surgery in past 7 days
- Outcomes
 - 40% sacrum/coccyx, 29% heels, 7% buttocks
 - 90% purple or maroon initially , 24% remained so
 - 9% deteriorated

Photograph of “typical” sDTI

Early presentation of purple-maroon tissue

Blister phase

Necrotic phase

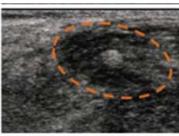


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Diagnosis of DTI

- Usually by inspection
 - Issues with misidentification
- Ultrasound
 - Aoi, PRS, 2009
- Elevated CPK
 - False positives

Heterogeneous hypochoic area (HHA)



Diagnosis of DTI with Biomarkers (Dan Bader)

- Sweat and Tissue CO₂ higher in loaded tissue
 - From Polliack, 1993, 1997; Knight 2001; Bader, 2005
- Cytokines – Interleukin 1 higher in loaded tissue
 - From Cornelissen, 2009
- Collagen breakdown products released in urine in SCI patients
 - From Rodriguez and Claus-Walker, 1988

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Prevention of DTI

- Little published work in prevention of DTI
 - Low Air Loss-Microclimate Management Mattress
 - Preventive Dressings
- Any program of pressure ulcer prevention would decrease DTIs

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Implanted electrodes to target paralyzed muscles (Dan Bader)

- Analyses Interface Pressures and stimulates gluteal muscles
- May provide a method for pressure relief in paraplegics

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Clinical Presentation is Unique

- Location
 - Occur on tissue subjected to pressure
 - not always bony prominences
- Timing
 - Color change is delayed sometimes after pressure is relieved
- Color
 - Purple or maroon, not red
- Rate of deterioration
 - Rapid, becoming full thickness quickly



Time Frame between Injury and Visible Presentation

- An event of confinement always preceded the first notation of purple skin by 48 hours
- Within 48 hours of the identification of purple skin, blisters were noted from epidermal sloughing
 - Thin blisters, not fluid filled
 - Often called "Stage II" pressure ulcers

Determining surface that led to injury

- Examine location of current DTI
 - Buttocks – patient was flat
 - Sacrum – HOB was up
 - Heels – feet were on mattress
 - Bottom of the foot – feet were pressing against something – footboard?
 - Can develop under medical devices

DTI Following 12 Hour Operation



DTI in Septic Patient, Unstable for 48 hours



Delay between injury and visible presentation

- Time delay presents problem when
 - Patient has moved between settings
 - Patient has been in OR, ER, Cath lab
- Difficult to have conclusive root cause analysis

Epidermal loss in black skin

- Epidermal loss with skin slippage
- Red blistered skin visible
- Commonly called a skin tear



Distinguish from Skin Tears

- Skin flap of blistered epidermis mimics skin tear
- Seldom is there a history of trauma in that body area



Photo from Tod Brindle

Distinguish from Ecchymosis

- Bruising with a history of trauma
- Can be difficult to distinguish from deep tissue injury in the same area
- Consider Morel-Lavallee lesions



Photo from Tod Brindle

Distinguish DTI from Hematoma

- History of trauma
- Fractured pelvis with pelvic hematoma
- May lead to purple skin and epidermal slough
- Morel-Lavallee lesions (internal degloving injury) with pelvic trauma



This patient had a history of fall at high rate of speed onto concrete.

Degloving Injury of the Leg



Distinguish from Ischemic (Levophed) tissue changes

- Seen with prolonged hypotension and Levophed use
- Peripheral tissue only, not subjected to pressure



Distinguish from Venous Engorgement

- Patients with poor perfusion may develop purple skin in dependent tissues
- Purple color changes with motion



Distinguish from Kennedy Terminal Ulcer

Rapidly developing ulcer appearing about 48 hours prior to death

Etiology unknown

Low perfusion during which the skin cannot recover from usual pressures?

Skin infarction?
Variant of DTI?



Finding Cases of sDTI

- Look at risk profile
 - Confinement for more than 3 hours
 - OR, cath lab cases
 - History of being down at the scene
 - Unable to turn in ICU
 - Leg immobile
 - Total hip, total knee
 - Fractured hip
 - Leg numb
 - Stroke, DM
- Look at skin in areas subjected to pressure
 - Ask high risk patient about pain in heels, buttocks, tailbone
 - Look for purple or maroon nonblanchable skin

Reporting DTI Cases

- If present on admission, document the evolution of DTI
 - Risk profile of admission
 - Purple skin 48 hours later
 - Blistered skin following
- Coders have been advised to label this wound as unstageable because there is no ICD-9 code for DTI
- Same process with hospital acquired

Recommended Treatment

- Relieve pressure completely from areas likely to have DTI
 - Side to side turning
 - Support surfaces
 - Heels in boots
- Relieve pressure from all purple skin
- Maintain perfusion
- Building evidence for Noncontact Low Freq Ultrasound
 - Honaker Study
 - Hanada research on vibration
- No evidence to support:
 - Xenaderm
 - Early debridement
 - HBO

Improvement of DTI with Noncontact Ultrasound

- Retrospective chart review; March 09 - March 10
 - 127 sDTI's
 - 63 were treated with SoC only
 - 64 with SoC and MIST®
- Inclusion consisted of patients identified with sDTI with in 4-5 days of onset.
 - All patient received standard of care
 - Treatment group received MIST and standard of care

Honaker, 2011

Two Extremes of Koziak's Pressure Time Curve?

The graph plots Skin Pressure (mmHg) on the y-axis (0 to 600) against Time (hours) on the x-axis (0 to 10). A curve separates the 'NO SKIN ULCERATION' region (below) from the 'SKIN ULCERATION' region (above). The curve shows that as pressure increases, the time to reach skin ulceration decreases significantly. Two photographs of skin ulcers are shown: one on the left showing a large, dark ulcer, and one on the right showing a smaller, red ulcer. Arrows indicate the relationship between the graph and the photographs.

Evolution of DTI versus superficial ulcers

The flowchart compares the evolution of DTI (dark grey boxes) versus superficial ulcers (orange boxes). DTI starts with 'DTI' and progresses to 'Stage II with epidermal loss', 'Unstageable with eschar or blister', and 'Stage III or IV'. Superficial ulcers start with '(Classic) Stage I' and progress to 'Fluid-filled blisters' and 'Stage II'. A green arrow points from 'Outside to Inside with Low Pressure' to 'Inside to Outside with High Pressure'.

Consensus Questions with High Levels of Agreement

- Statements on Present on Admission
- A sDTI visible on admission is not a facility/agency acquired pressure ulcer
 - 98% Agree (N = 101/103)
- The beginning of sDTI can precede admission to a health care facility and may not be visible on admission.
 - 97.6% Agree (N = 122/125)

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Consensus on POA and Documentation

- Given that the standard of care was met, the evolution of an sDTI into a full thickness pressure ulcer, which was present on admission, is NOT evidence of inadequate care
 - 95.6% Agree (N = 110/115)
- The electronic medical record should include the ability to document the evolution of sDTI
 - 94.5% Agree (N = 105/111)

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Consensus on Patient Factors

- A history of pressure and/or shear in the injured tissue makes the diagnosis of sDTI more likely
 - 93% Agree (N = 94/101)
- Distinguishing an sDTI from other causes of purple/maroon tissue is a complex process.
 - 93.3% Agree (N = 112/120)

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Consensus on Patient Factors

- Perioperative pressure ulcers classified as sDTI may occur after prolonged exposure to pressure during surgical procedures.
 - 98% Agree (N = 97/100)
- An sDTI can occur under a medical device in contact with the skin.
 - 98.3% Agree (N = 119/121)
 - *This item had the highest level of agreement of all statements.*
 - *Please find a downloadable poster at npuap.org*

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Treatment of DTI Consensus Items

- Support surfaces, higher than Group 1, are recommended for the treatment of sDTI (truncal, pelvic, trochanteric locations) in the home setting.
 - 83.8% Agree (83/99)

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Outcomes of DTI Consensus Item

- Some sDTI can resolve without full thickness tissue loss
 - 82.4% Agree (N = 89/108)
 - *This item had the lowest level of agreement of all statements.*

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Consensus Items without Agreement

- An sDTI that presents in less than ____ hours of the first admission to a health care setting is likely unavoidable.
 - 24 hours (N = 18)
 - 48 hours (N = 31)
 - 72 hours (N = 30)
 - No one knows (N = 36)

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Consensus Items without Agreement

- In persons with dark skin tones, an sDTI presents with a color change in the skin.
 - 62.1 % Agree (N = 51/82)
 - Considerable discussion on this point including photographs of darkly pigmented patients with sDTI



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Consensus Items without Agreement

- The color variation in sDTI (maroon vs purple) predicts the likelihood of recovery.
 - 22.3% Agree (25/112)

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Consensus Items without Agreement

- Deep tissue injury is an etiology of pressure ulcers, not a stage
 - 59% Agree (N = 59/99)
- Deep tissue injury should have its own phases
 - 1 = intact purple skin
 - 2 = blistered
 - 3 = loss of dermis
 - 4 = necrotic (full thickness)
 - 75 % Agree (N = 75/101)

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New Studies in Pressure Ulcer Prevention

- 5 layer dressings prevent sacral pressure ulcers in high risk patients
 - Santamaria RCT
 - Kawoles RCT
- 4 layer dressing prevents heel ulcers in high risk patients
 - Santamaria RCT
- Turning Q 2, 3, 4 in LTCs led to same number of pressure ulcers on viscoelastic foam
 - Bergstrom RTC

Questions?

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