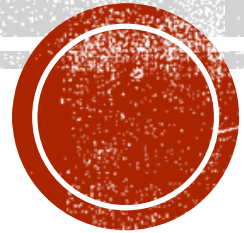
A BRACE, ONE OF THOSE THINGS WILL DO.

Timothy Burke - cPO



Acknowledgement

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Basics
Classifications
Clinical Considerations
Putting into practice

The Basics

- **Main aims for spinal orthoses**

- Prevent uncontrolled movement
  - Control gross flexion
  - Maintain or prompt extension
  - Limit rotation
  - Prevent further fracture loss of height (LOS)

(Chang and Holly 2014)

The Basics

- **Main aims for spinal orthoses**

- Prevent uncontrolled movement
  - Control gross flexion
  - Maintain or prompt extension
  - Limit rotation
  - Prevent further fracture loss of height (LOS)

- Influence Pain

- Prevent further loss of condition / function

- Enable function
  - Global mobility
  - Bed mobility
  - Compensate for weakness

(Chang and Holly 2014)

The Basics

There multiple answers to the same question and no single correct answer

Evidence based practice

- Paucity of evidence
- Conflicted findings

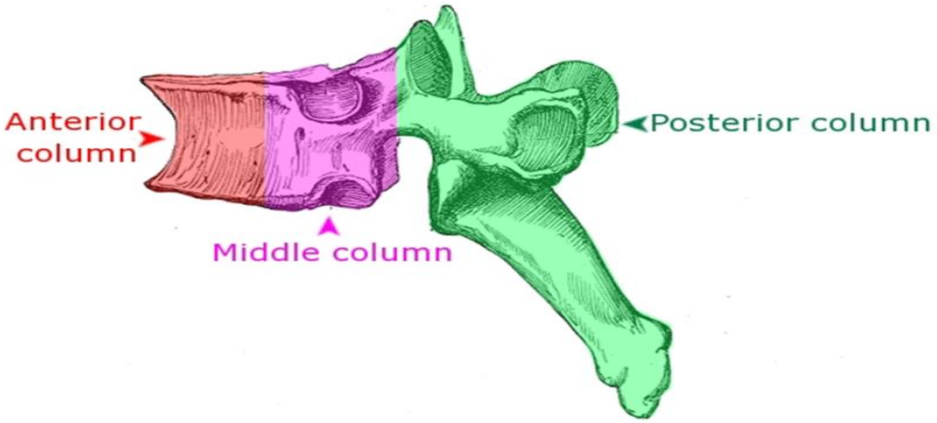
The Evidence Gap for Assistive Devices

- Multiple known challenges to knowledge development and mobilisation (knowledge translation)
- Lemaire, E. D. (2016). "Mobilizing knowledge: The evidence gap for assistive devices." Technology Innovation Management Review **6**(9).

The Basics – Denis Classification

Spinal Columns

- Three main columns of the spine
- Anterior, Middle and Posterior



Compression Fractures

- Mechanism of injury determines the presentation
  - Eg: Anterior or lateral flexion
  - Failure of anterior column with middle column acting as hinge.

Stability it dependent upon

- Number of columns involved
  - 1 column = minor injury
  - 3 column = significant injury
- Involvement of ligaments
- Loss of height and bony fragments

The Basics – Denis Classification

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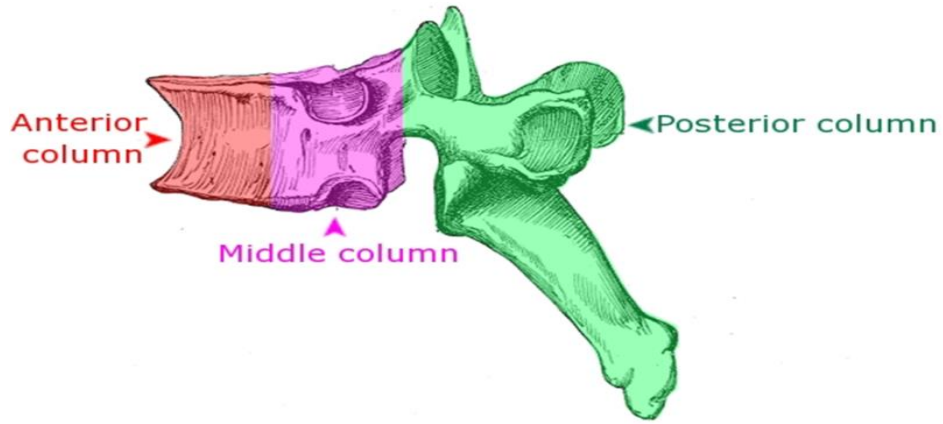

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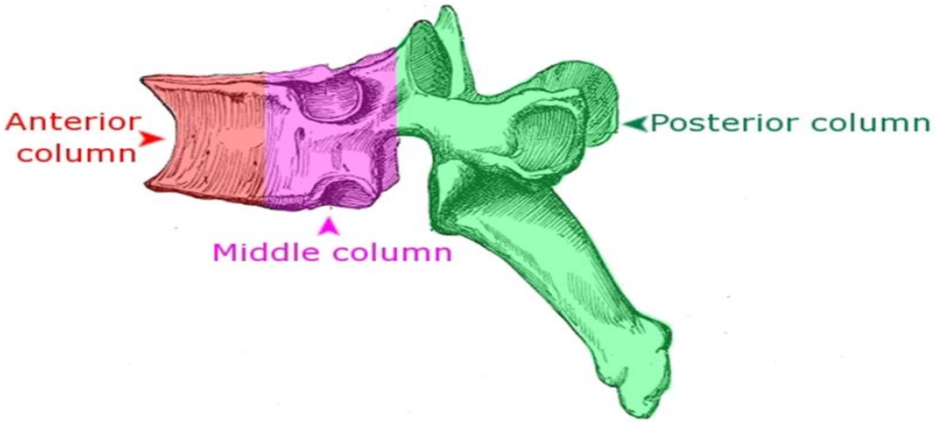

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Compression Fractures

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The Basics – Denis Classification

Stable Fractures without neurology

- Conservative management
- Pain management
- No management

The Basics – Denis Classification

Stable Fractures without neurology

- Conservative management
- Pain management
- No management

Unstable Fractures with neurology

- Surgical management and internal fixation

The Basics – Denis Classification

Stable Fractures without neurology

- Conservative management
- Pain management
- No management

Stable Fractures / Unstable Fractures without neurology

- Surgical management
  - Involvement of 2/3 vertebral columns
  - >50% LOS
  - Angulation at thoraco-lumbar junction >20°
  - Multi-adjacent compression fractures
- Conservative management

Unstable Fractures with neurology

- Surgical management and internal fixation

Controversies in Spinal Trauma

Controversies in Spinal Trauma and Evolution of Care FREE

James S. Harrop, MD, George N. Rymarczuk, MD, Alexander R. Vaccaro, MD, PhD, Michael P. Steinmetz, MD, Lindsay A. Tetreault, HBSc, Michael G. Fehlings, MD, PhD

Neurosurgery, Volume 80, Issue 3S, March 2017, Pages S23–S32,
https://doi.org/10.1093/neuros/nyw076
Published: 21 February 2017 **Article history** ▾

Controversies in Spinal Trauma

1. corticosteroid therapy in acute spinal trauma,
2. odontoid fractures,
3. timing of surgery in central cord syndrome,
4. thoracolumbar burst fracture treatment,
5. thoracolumbar vertebral compression fractures (VCFs),
6. timing of surgery in spinal trauma,
7. blood pressure management goal,
8. timing of magnetic resonance imaging (MRI) in spinal trauma,
9. hypothermia in spinal trauma,
10. effect of global sagittal balance on clinical outcomes,
11. lumbar subarachnoid drainage,
12. minimally invasive surgery (MIS) strategies for thoracolumbar trauma,
13. diffusion MRI,
14. classification schemes in spinal trauma.

(Harrop, Rymarczuk et al. 2017)

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14. classification schemes in spinal trauma.

(Harrop, Rymarczuk et al. 2017)

AO Spine Classification Systems

AO SPINE

www.aospine.aofoundation.org

- Upper Cervical Injury Classification System
- Subaxial Injury Classification System
- Thoracolumbar Injury Classification System
- Sacral Injury Classification System

Further information:
www.aospine.org/classification

AO Spine Classification Systems

- **AO classification of spinal injuries**
  - Three separate components to every fracture are considered, with only the first fully assessable on imaging alone.
    1. morphology of the fracture
    2. presence of neurological signs
    3. presence of ligamentous injuries or co-morbid conditions (referred to as modifiers)

Further information:
www.aospine.org/classification

AO Spine Classification Systems

- **Morphology (A, B or C)**
  - Injuries are broadly categorized into three groups:
    A. compression injuries
    B. distraction injuries
    C. displacement or dislocation

Further information:
www.aospine.org/classification

AO Spine Classification Systems

- **Neurology (N0 – Nx / +)**
  - Neurology is divided into 7 categories

    N0. Neurological intact

    N1. Transcient neurologic deficit

    N2. Radicular symptoms

    N3. Incomplete spinal cord injury or any degree of cauda equina injury

    N4. Complete spinal cord injury

    Nx. Cannot be examined

    +. Continued spinal cord compression

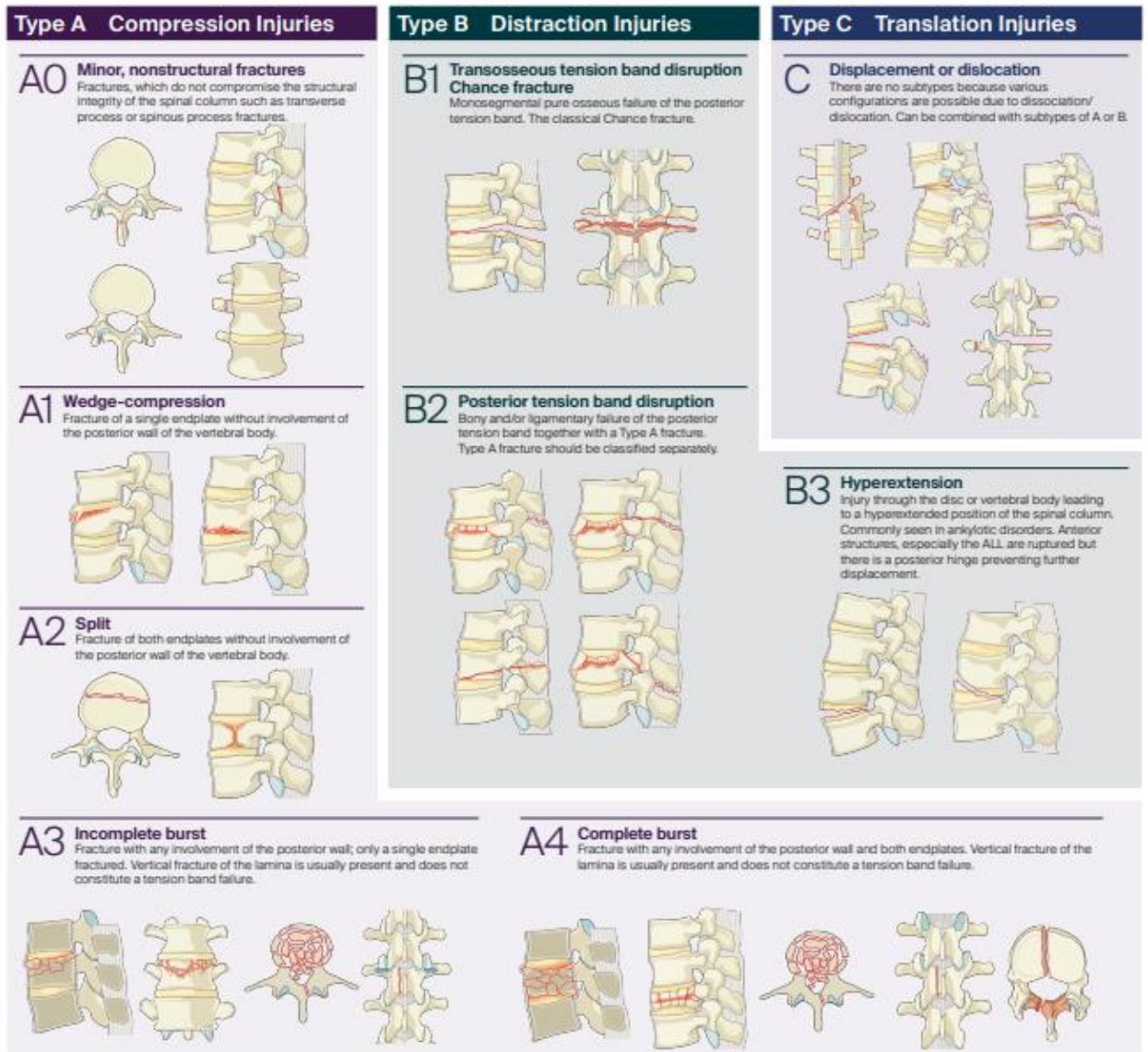
Further information:
www.aospine.org/classification

AO Spine Classification Systems

- **Modifers (M1 –M4)**
  - Modifiers are spinal region specific
    - Cervical
      - M4. Vascular Injury
    - Thoracic
      - M2. Patient specific comorbidity (ankylosing spondylitis

Further information:
www.aospine.org/classification

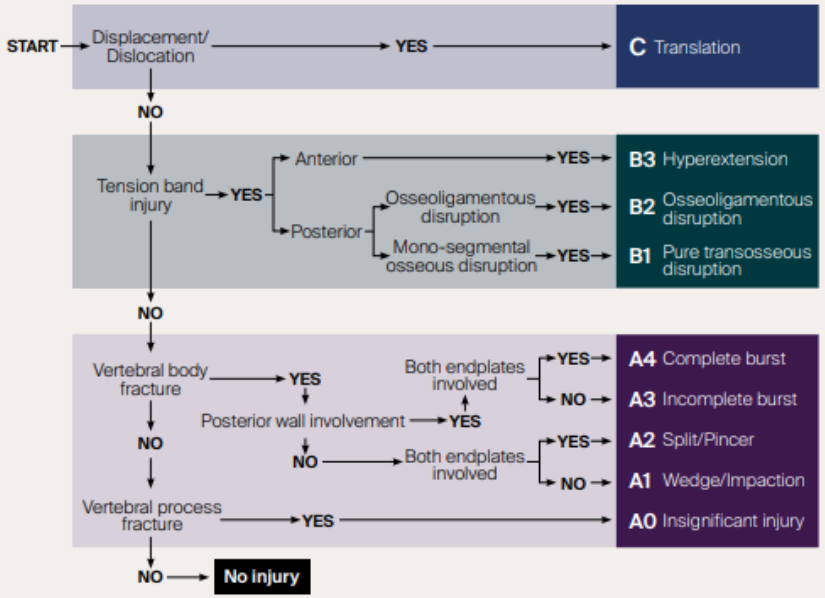
AO Spine Thoracolumbar Injury Classification System



Further information:
www.aospine.org/classification

AO Spine Thoracolumbar Injury Classification System

Algorithm for morphologic classification



Neurology

Type	Neurological
N0	Neurology intact
N1	Transient neurologic deficit
N2	Radicular symptoms
N3	Incomplete spinal cord injury or any degree of cauda equina injury
N4	Complete spinal cord injury
NX	Cannot be examined
+	Continued spinal cord compression

Modifiers

Type	Description
M1	This modifier is used to designate fractures with an indeterminate injury to the tension band based on spinal imaging with or without MRI. This modifier is important for designating those injuries with stable injuries from a bony standpoint for which ligamentous insufficiency may help determine whether operative stabilization is a consideration.
M2	Is used to designate a patient-specific comorbidity, which might argue either for or against surgery for patients with relative surgical indications. Examples of an M2 modifier include ankylosing spondylitis or burns affecting the skin overlying the injured spine.

Classification Nomenclature

Displacement injury of the segment T 8/9 with an incomplete burst fracture of T9, incomplete spinal cord injury, ankylosing spondylitis

Complete burst fracture of L1, neurologically intact, PLC status unclear

T8-T9: C ← Primary injury → **L1: A4**

Secondary injury: **(T9: A3; N3; M2)**

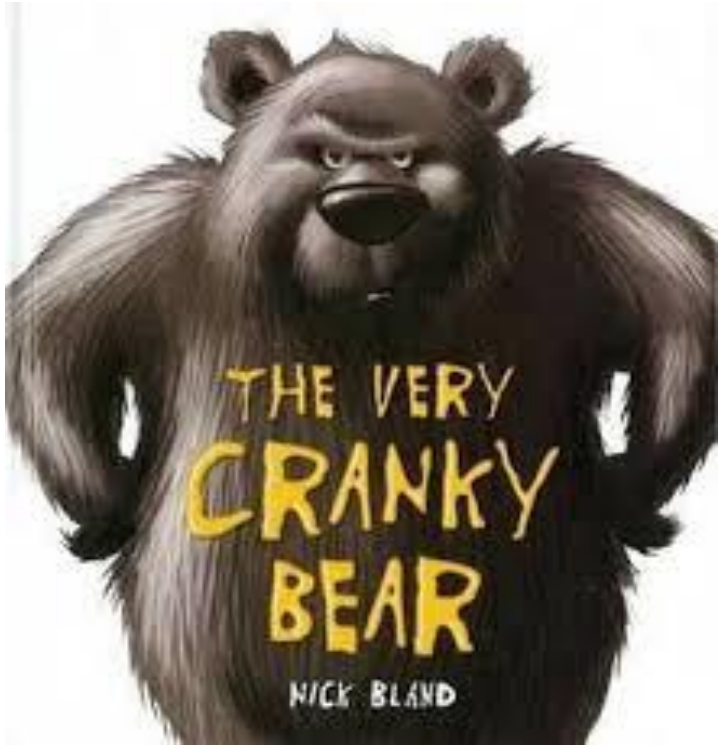
Neurologic status and modifiers: **(N0; M1)**

1. Vaccaro, A. R., C. Oner, C. K. Kepler, M. Dvorak, K. Schnake, C. Bellabarba, M. Reinhold, B. Aarabi, F. Kandziora, J. Chapman, R. Shanmuganathan, M. Fehlings, L. Vialle, A. O. S. C. Injury and F. Trauma Knowledge (2013). "AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers." Spine (Phila Pa 1976) **38**(23): 2028-2037.

2. Kepler, C. K., A. R. Vaccaro, J. D. Koerner, M. F. Dvorak, F. Kandziora, S. Rajasekaran, B. Aarabi, L. R. Vialle, M. G. Fehlings, G. D. Schroeder, M. Reinhold, K. J. Schnake, C. Bellabarba and F. Cumhur Oner (2015). "Reliability analysis of the AOSpine thoracolumbar spine injury classification system by a worldwide group of naive spinal surgeons." Eur Spine J. *(e-pub)*

Further information:
www.aospine.org/classification

Know Your Goal



Bland, N., et al. (2009). The very cranky bear, Hodder Children's.

Prescription matrix

“Clinicians need to know the best type of [orthoses] to prescribe, for whom they should be prescribed, the optimal time to prescribe one, how long they should be used, the adverse effects, and the factors influencing acceptability and adherence to their use.” (Tyson and Kent 2013)

	Collar	CTO	HALO	Antiflexion	TLSO
Flex / Extension	Mild - Mod	Mod - Sig	Sig	Mild - Mod	Mod - Sig
Rotation	Mild	Mild - Mod	Sig	N/A - Sig	Mod - Sig
Skin Care	Mild	Mod	Sig	N/A - Mild	Sig
Trache Care	Mod	Mod	Mild	N/A	N/A
Unique bits	Occian backs	Ability to add / subtract sections	Captain Complex	Captain Dependable	Custom vs Prefab

N/A - Not applicable, Mild - Mild, Mod - moderate, Sig - Significant.

Location, Location

- Who decides on prescription and how much say do they have?
  - O&P Department, Physiotherapy Department, Nursing etc…
  - Surgeons (Neurosurgeon vs Orthopaedic Surgeon)

- Historical prescription trends
  - Confidence and knowledge in products OR Cost?

- Facility priorities
  - Length of Stay (LOS), Pressure Injury prevention and Complex Care

Location, Location

- How much support does the facility have and for which aspect of care?
  - Acute vs Subacute / Rehab
  - Post Discharge vs Outpatient
- Is the facility linked to another organisation?
  - Officially / Non-officially
- Governance
  - Internal vs External oversight
  - Clinical guidelines

Clinical Guidelines

- **Organisation Specific Guidelines**
  - Organisations specific guidelines around spinal management, depending on the size and specialty of the service
  - These can cover device indications, timelines for management and clinical expectations

- **Product Guidelines**
  - Internal Ossur ‘guidance’ documents that indicated what fracture types / levels devices are appropriate for

Cervical Spine Immobilisation

Orthoses	Use	Timeframe
Patriot Extrication	Emergency Immobilisation	< 6/24
Philadelphia Collar	Short term Immobilisation	< 3/7
Miami J / Miami J Select	Medium / Long term Immobilisation	+/- 12/52

Additional considerations:

- Ongoing investigations
- Progression of immobilisation
- Education and carer support
- Skin care

Cervico-Thoraic Spine Immobilisation

Orthoses	Use	Timeframe
Miami JTO / Minerva	Long term Immobilisation	+/- 12/52
Halo Thoracic Orthosis	Long term Immobilisation	+/- 12/52
CTLSO	Long term Immobilisation	+/- 12/52

- **Additional considerations:**
  - Long term care options and follow up
  - Education and carer support
  - Skin care
  - Pressure injury risk level

Thoraco-Lumbar Spine Immobilisation

Orthoses	Use	Timeframe
Anti-flexion: Jewett/Cash	Single Anterior Column Fractures	+/- 12/52
Boston Overlap Brace*	Multiple Column Fractures	+/- 12/52
Miami LSO / TLSO*	Multiple Column Fractures	+/- 12/52

Additional considerations:

- Ability to don/doff independently
- Education and carer support
- Skin care and pressure injury risk level
- Burden of care and discharge destination

*think about the shower

Personal Care

Clarify showering restriction at the outset, on for showering or sit to fit / off for showering*

Cervical Collars:

- Shower daily to 2nd/3rd daily activity dependent
- Change liners following shower
- Shave following shower with patient supine and head held
- Clean/wash liners daily but they must be dry before being re-used

Halo's and CTO:

- Shower and liner change during Orthotic review only (fortnightly)
- Very tiring for patients, so consider dry liner change if patients do not have necessary physical endurance.

Personal Care

Clarify showering restriction at the outset, on for showering or sit to fit / off for showering*

TLSO / LSO:

- Shower daily to 2nd/3rd daily
- Typically will not have liners and can be donned directly on skin of showers
- Aim to shower in the evening to enable the straps to dry overnight
- Consider provision of second device for showering

Education

- **To Who, When, How**
  - Education is a core part of spinal management
  - Things that seem straight forward, might not also be
    - The arrow points up

- **Discharge**
  - Where is the patient going? Who we be there?
  - Who else needs to know?
    - Secondary discharge

Education

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Education

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    - The arrow points UP!

Image source: Netflix (2018). *New Amsterdam*

Education

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- **Discharge**
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Image source: https://www.hartmann.info/en-cn/-/media/

Complications

Image source: https://www.hartmann.info/en-cn/-/media/

Complications

“Was it that colour before?”

Complications

“The room smelt funny and we couldn’t figure out why…”

Complications – when things aren't right

Pain

- Un-resolving pain
- Pain 'spiking' to an abnormal level during mobility

Neurology

- Previously documented?
- Previously investigated?
- Changing neurology

What to do?

- Escalate to treating team
- Liaise with treating spinal team

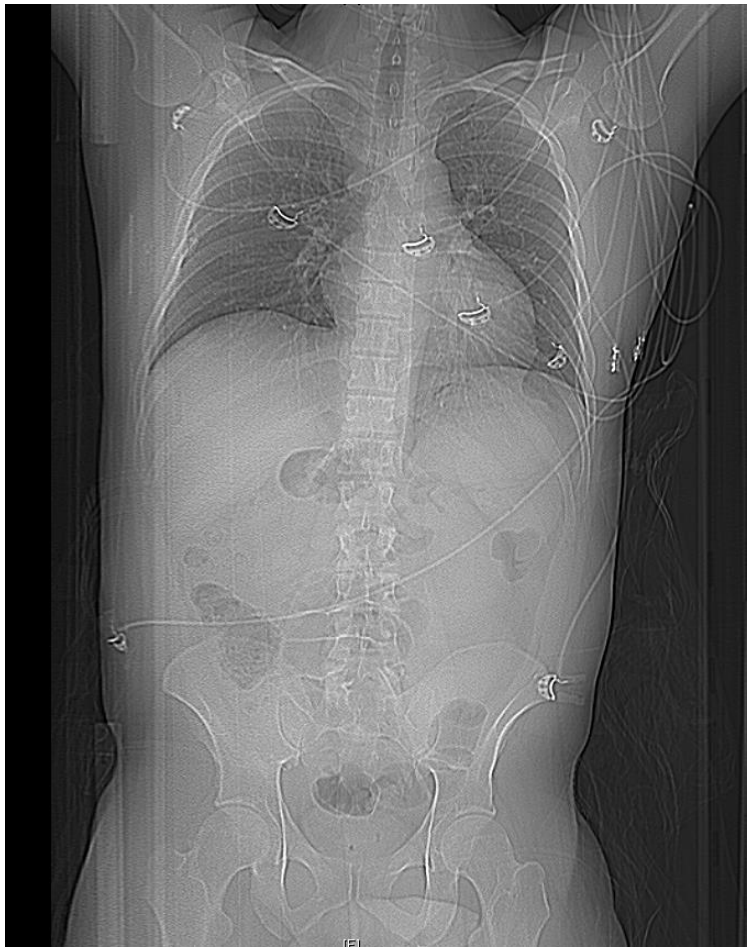
(Shen, Xu et al. 2015)

Case Study 1 - 34yo Male, 76kg

Reason for admission:

- Patient painting 2nd storey of house, ladder slipped (propped against house from carport), patient fell in gap. Estimated fall 3-5 meters.

Case Study 1 - 34yo Male, 76kg



CT - AP Scout

CT - Sagittal View

Case Study 1 - 34yo Male, 76kg

XR - Left Knee AP

Case Study 1 - 34yo Male, 76kg

Reason for admission:

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Injury:

- Fracture L1, Superior End Plate (SEP) - AO: L1 - A1, N0
- Open Left fracture proximal tibia / fibular

Subjective:

- Prolonged NWB Left L/L.

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Injury:

- Fracture L1, Superior End Plate (SEP) - AO: L1 - A1, (N0)
- Open Left fracture proximal tibia / fibular

Management:

- TLSO - Antiflexion, Jewett

https://www.ossur.com.au

Case Study 2 - 74yo Male, 101kg

Reason for admission:

- Pt sitting on stool (two step) and fell onto floor. Direct axial load and radicular pain for last 3/7. Presented to ED due to pain and reduced mobility.

Case Study 2 - 74yo Male, 101kg

CT - AP View

CT - Sagittal View

Case Study 2 - 74yo Male, 101kg

Reason for admission:

- Pt sitting on stool (two step) and fell onto floor. Direct axial load and radicular pain for last 3/7. Presented to ED due to pain and reduced mobility.

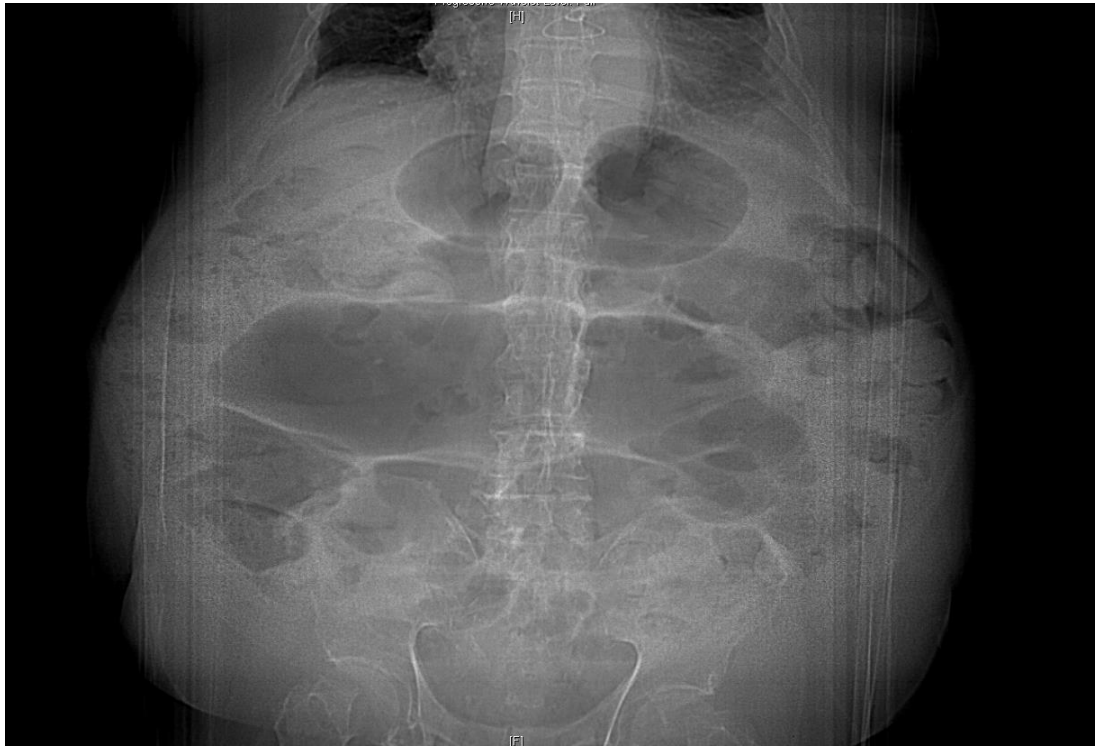
Injury:

- Acute/subacute Fracture T10 vertebral body with widening and gas within fracture defect - AO: T10 - A3 (N0; M2)
- Multiple additional subacute rib fractures

Subjective / Objective:

- Third hospital admission in 6 months, previous presentations for decreasing mobility, SOB and poor glycemic control (BSL 2.7 on past admission)
- Previously home alone

Case Study 2 - 74yo Male, 101kg



CT - AP Scout

CT - Sagittal Scout

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Injury:

- Acute/subacute Fracture T10 vertebral body with widening and gas within fracture defect - AO: T10 - A3 (N0; M2)
- Multiple additional subacute rib fractures
- Large body habitus

Management:

- Modified Bi-valved BOB with custom anterior section.
- 3-4 x assist to don = Subacute / Slow Stream Rehab given de-conditioning and poor base line.

Case Study 2 - 74yo Male, 101kg

Anterior Section

Midline Overlap

Case Study 3 - 75yo Female, 76kg

Reason for referral:

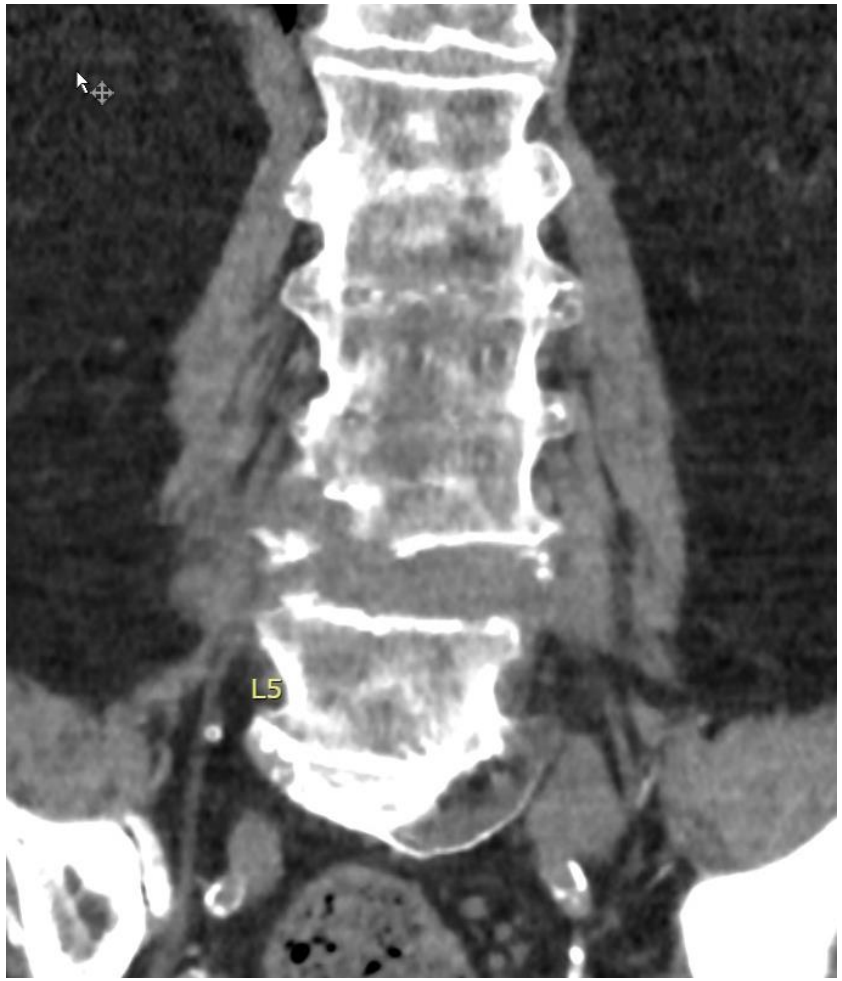
- Previous admission for acute fracture L4 / L5 intervertebral disc following fall from step ladder. Fell while vacuuming her walls at home. Re-referred 6 months later for long term pain management.

Injury:

- Fracture L4/L5 - 3 column - AO: L4-L5 - B3 (L4: A0; N0; M1)
- Intervertebral disc fracture with associated pars fracture.

Case Study 3 - 75yo Female, 76kg

CT - Sagittal View



CT - AP View

Case Study 3 - 75yo Female, 76kg

Reason for referral:

- Previous admission for acute fracture L4 / L5 intervertebral disc following fall from step ladder. Fell while vacuuming her walls at home. Re-referred 6 months later for long term pain management.

Injury:

- Fracture L4/L5 - 3 column
- Intervertebral disc fracture with associated pars fracture.
- Large body habitus

Management:

- Previous managed in BOB, moderate compliance but requesting something less rigid.
- Primary request for pain relief

Case Study 3 - 75yo Female, 76kg

Reason for referral:

- Previous admission for acute fracture L4 / L5 intervertebral disc following fall from step ladder. Fell while vacuuming her walls at home. Re-referred 6 months later for long term pain management.

Injury:

- Fracture L4/L5 - 3 column
- Intervertebral disc fracture with associated pars fracture.
- Large body habitus

Management:

- Miami Lumbar - posterior panel +/- anterior panel
- ? No management

https://www.ossur.com.au

(Urquhart, Alrehaili et al. 2017)

References

Ackland, H. M., et al. (2007). "Factors predicting cervical collar-related decubitus ulceration in major trauma patients." Spine **32**(4): 423-428.

Ackland, H. M., et al. (2016). "Danger at every rung: epidemiology and outcomes of ICU-admitted ladder-related trauma." Injury **47**(5): 1109-1117.

Al-Khalifa, F. K., et al. (2005). "Patterns of collapse in thoracolumbar burst fractures." Clinical Spine Surgery **18**(5): 410-412.

Bakhsheshian, J., et al. (2014). "Evidence-based management of traumatic thoracolumbar burst fractures: a systematic review of nonoperative management." Neurosurgical focus **37**(1): E1.

Cassell, E. and A. Clapperton (2006). "Consumer product-related injury (3): Injury related to the use of ladders." Hazard, Edition **63**: 4.

Chang, V. and L. T. Holly (2014). "Bracing for thoracolumbar fractures." Neurosurgical focus **37(1): E3.**

Faergemann, C. and L. B. Larsen (2000). "Non-occupational ladder and scaffold fall injuries." Accident Analysis & Prevention **32**(6): 745-750.

Harrop, J. S., et al. (2017). "Controversies in spinal trauma and evolution of care." Neurosurgery **80(3S): S23-S32.**

Hayward, G. (1996). "Risk of injury per hour of exposure to consumer products." Accident Analysis & Prevention **28**(1): 115-121.

Lemaire, E. D. (2016). "Mobilizing knowledge: The evidence gap for assistive devices." Technology Innovation Management Review **6**(9)

Kortebein, P. (2009). "Rehabilitation for hospital-associated deconditioning." American Journal of Physical Medicine & Rehabilitation **88**(1): 66-77.

Newman, M., et al. (2016). "Spinal orthoses for vertebral osteoporosis and osteoporotic vertebral fracture: a systematic review." Archives of physical medicine and rehabilitation **97**(6): 1013-1025.

Rubery, P. T., et al. (2013). "Stabilization of 2-column thoracolumbar fractures with orthoses: a cadaver model." Spine **38**(5): E270-E275.

Shen, J., et al. (2015). "Risk factors for the failure of spinal burst fractures treated conservatively according to the Thoracolumbar Injury Classification and Severity Score (TLICS): a retrospective cohort trial." PloS one **10(8): e0135735.**

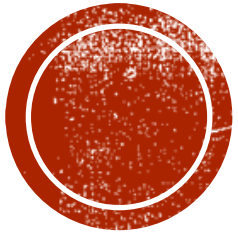
Skoch, J., et al. (2016). "Bracing after surgical stabilization of thoracolumbar fractures: a systematic review of evidence, indications, and practices." World neurosurgery **93**: 221-228.

Takasaki, H. and T. Miki (2017). "The impact of continuous use of lumbosacral orthoses on trunk motor performance: a systematic review with meta-analysis." The Spine Journal **17**(6): 889-900.

Tyson, S. F. and R. M. Kent (2013). "Effects of an ankle-foot orthosis on balance and walking after stroke: a systematic review and pooled meta-analysis." Archives of physical medicine and rehabilitation **94**(7): 1377-1385.

Urquhart, J. C., et al. (2017). "Treatment of thoracolumbar burst fractures: extended follow-up of a randomized clinical trial comparing orthosis versus no orthosis." Journal of Neurosurgery: Spine **27**(1): 42-47.

Wood, K., et al. (2003). "Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit: a prospective, randomized study." JBJS **85**(5): 773-781.



QUESTIONS?