

CÉLIA DUARTE CRUZ

Spinal cord injury and bladder dysfunction

DEFINITION

- Spinal cord injury (SCI) is damage to the spinal cord that results in a loss of function such as mobility or feeling.
- Life expectancy greatly increased since WW II.
 - Clean intermittent catheterization
 - Medications, equipment, etc



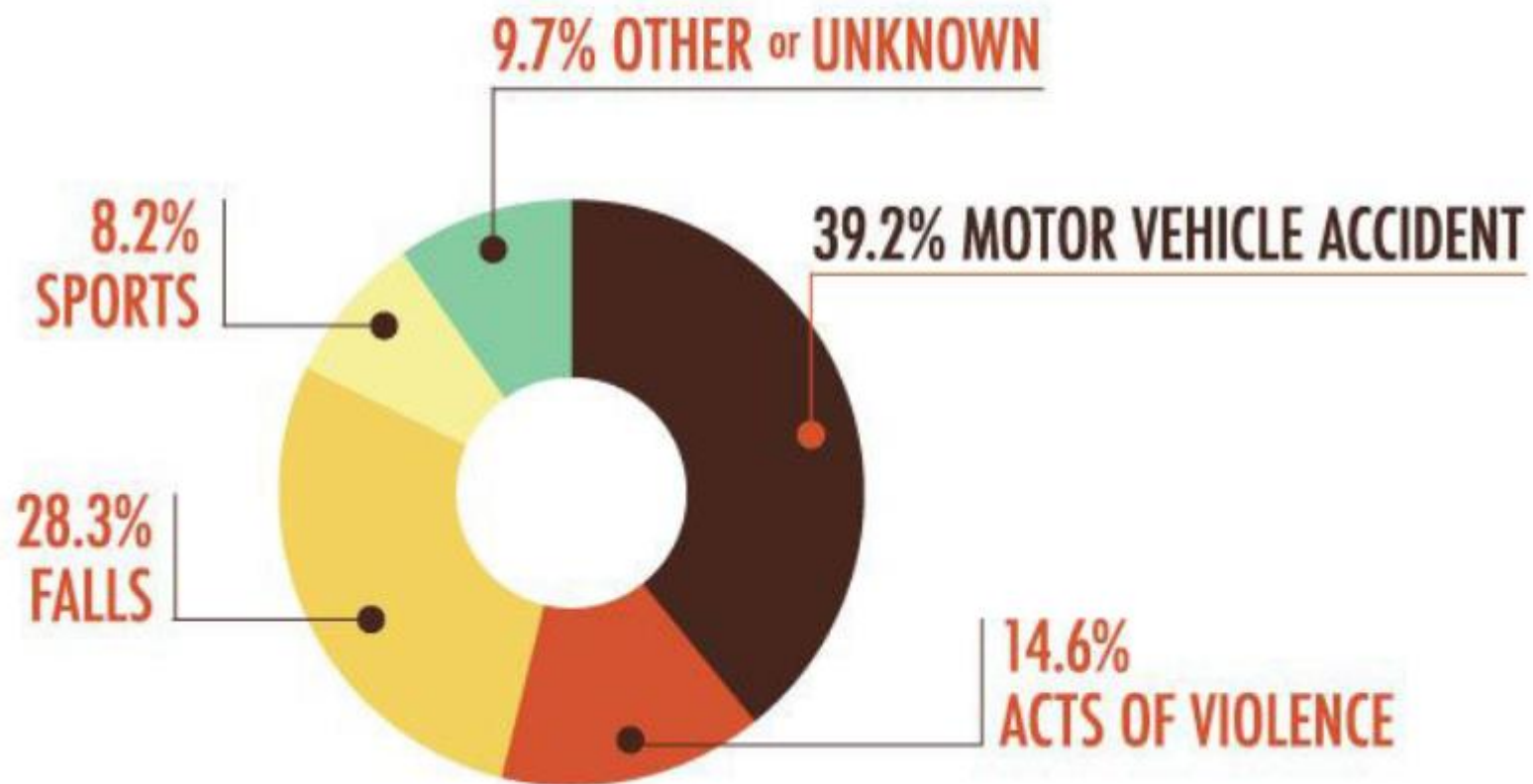
Sir. Ludwig Guttman
German-born British
neurologist



CAUSES OF

SPINAL CORD INJURY

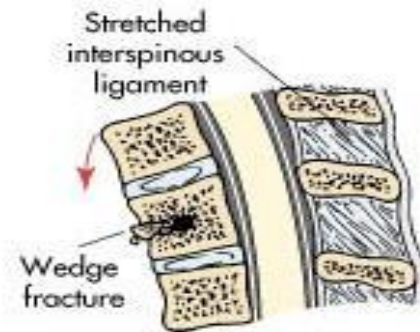
APPROXIMATELY 11,000 NEW INJURIES OCCUR EACH YEAR



Classification of SCI

Mechanism of injury:

- Flexion (bending forward)
- Hyperextension (backward)
- Rotation (either flexion- or extension-rotation)
- Compression (downward motion)

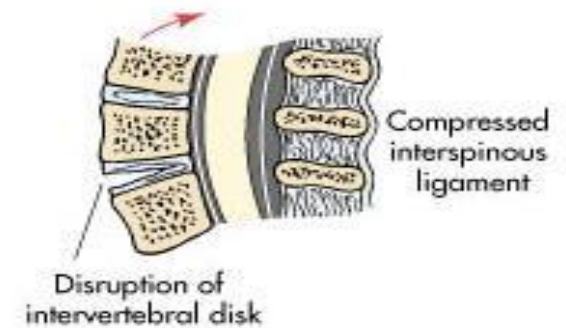


Flexion injury

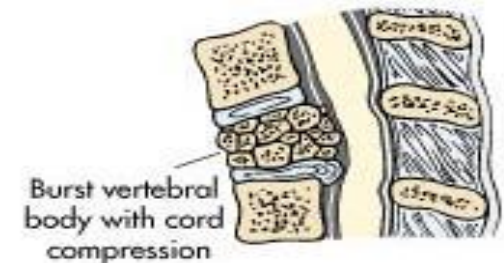
Displacement of vertebrae with fracture of 2 vertebral bodies and 1 disk



Flexion-rotation injury



Extension injury



Compression injury

Classification of SCI

- Level or Injury

- Cervical (C-1 through ??)
- Thoracic (T-1through ??)
- Lumbar (L-1through ??)

- Degree of Injury

- Complete

- Total paralysis and loss of sensory and motor function although arms or rarely completely paralyzed

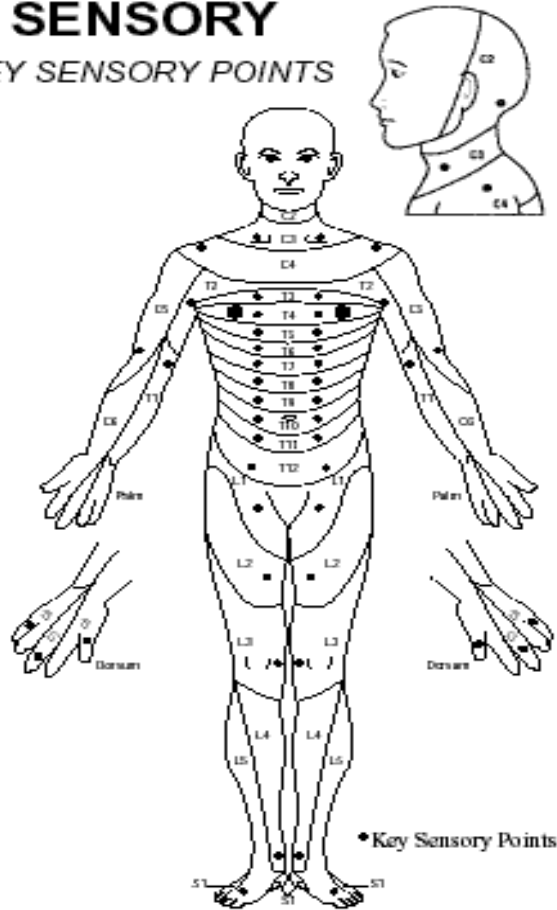
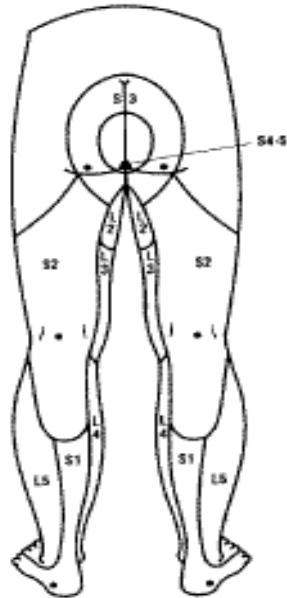
- Incomplete or partial

- Mixed loss of voluntary motor activity and sensation
- Four patterns or syndromes (central cord; anterior cord, posterior cord, Brown-Sequard)

SENSORY

KEY SENSORY POINTS

0 = absent
 1 = impaired
 2 = normal
 NT = not testable



Any anal sensation (Yes/No)

	R	L	KEY MUSCLES
C2	<input type="checkbox"/>	<input type="checkbox"/>	
C3	<input type="checkbox"/>	<input type="checkbox"/>	
C4	<input type="checkbox"/>	<input type="checkbox"/>	
C5	<input type="checkbox"/>	<input type="checkbox"/>	Elbow flexors
C6	<input type="checkbox"/>	<input type="checkbox"/>	Wrist extensors
C7	<input type="checkbox"/>	<input type="checkbox"/>	Elbow extensors
C8	<input type="checkbox"/>	<input type="checkbox"/>	Finger flexors (distal phalanx of middle finger)
T1	<input type="checkbox"/>	<input type="checkbox"/>	Finger abductors (little finger)
T2	<input type="checkbox"/>	<input type="checkbox"/>	
T3	<input type="checkbox"/>	<input type="checkbox"/>	
T4	<input type="checkbox"/>	<input type="checkbox"/>	
T5	<input type="checkbox"/>	<input type="checkbox"/>	
T6	<input type="checkbox"/>	<input type="checkbox"/>	
T7	<input type="checkbox"/>	<input type="checkbox"/>	
T8	<input type="checkbox"/>	<input type="checkbox"/>	
T9	<input type="checkbox"/>	<input type="checkbox"/>	
T10	<input type="checkbox"/>	<input type="checkbox"/>	
T11	<input type="checkbox"/>	<input type="checkbox"/>	
T12	<input type="checkbox"/>	<input type="checkbox"/>	
L1	<input type="checkbox"/>	<input type="checkbox"/>	
L2	<input type="checkbox"/>	<input type="checkbox"/>	Hip flexors
L3	<input type="checkbox"/>	<input type="checkbox"/>	Knee extensors
L4	<input type="checkbox"/>	<input type="checkbox"/>	Ankle dorsiflexors
L5	<input type="checkbox"/>	<input type="checkbox"/>	Long toe extensors
S1	<input type="checkbox"/>	<input type="checkbox"/>	Ankle plantar flexors
S2	<input type="checkbox"/>	<input type="checkbox"/>	
S3	<input type="checkbox"/>	<input type="checkbox"/>	
S4-5	<input type="checkbox"/>	<input type="checkbox"/>	

0 = total paralysis
 1 = palpable or visible contraction
 2 = active movement, gravity eliminated
 3 = active movement, against gravity
 4 = active movement, against some resistance
 5 = active movement, against full resistance
 NT = not testable

Voluntary anal contraction (Yes/No)

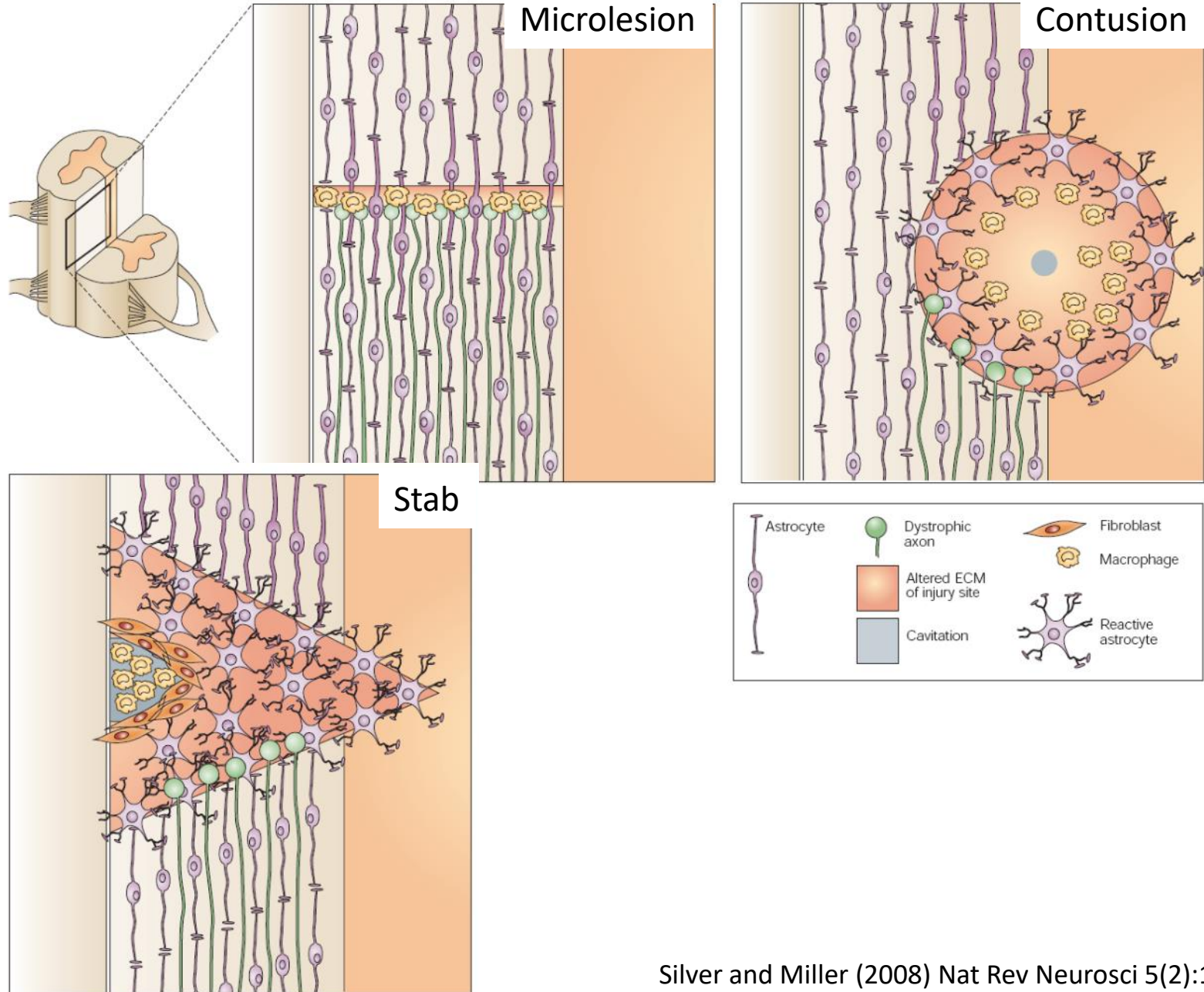
American Spinal Injury Association (ASIA) impairment scale

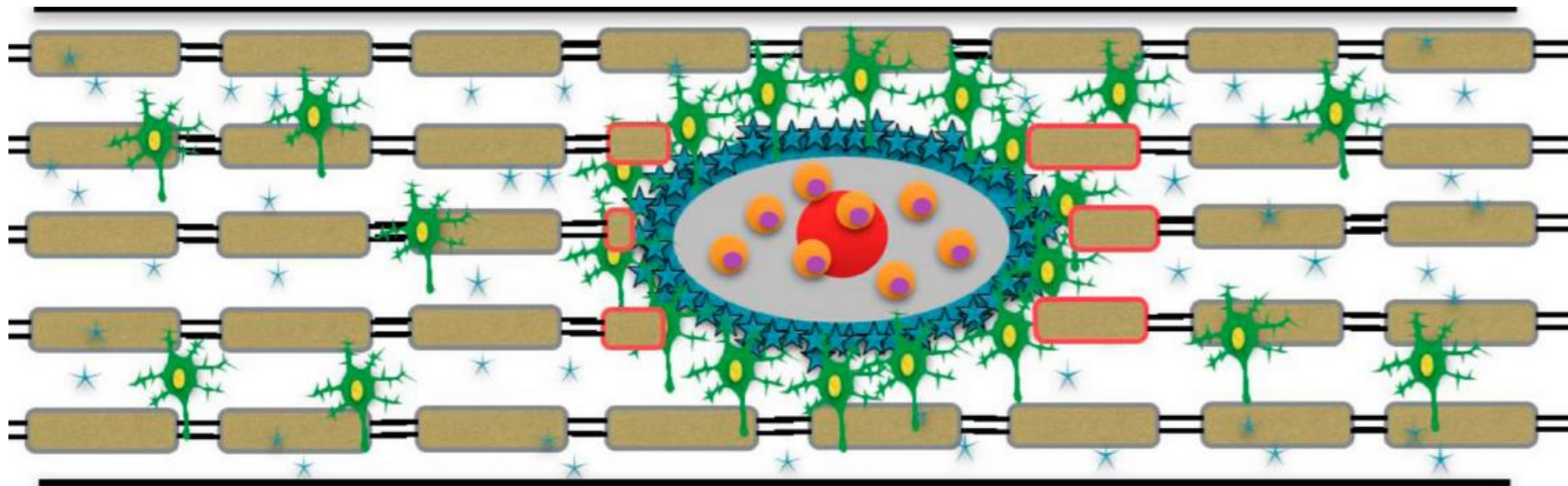
Panel 2: **ASIA impairment scale**

Grade	Description
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A	Complete; no sensory or motor function preserved in the sacral segments S4–S5
B	Incomplete; sensory but not motor function preserved below the neurological level and extending through the sacral segment S4–S5
C	Incomplete; motor function preserved below the neurological level; most key muscles have a grade <3
D	Incomplete; motor function preserved below the neurological level; most key muscles have a grade >3
E	Normal motor and sensory function

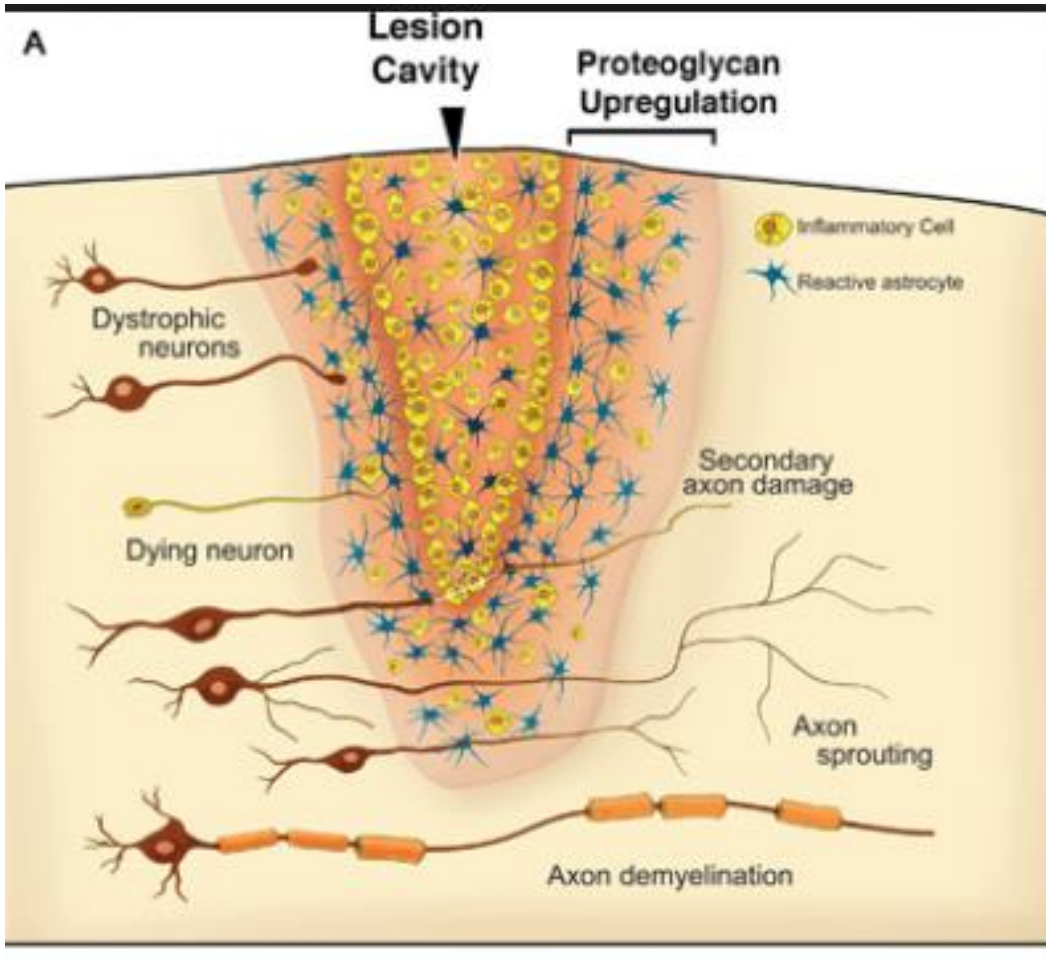
Different types of spinal cord injury





- | | | | |
|---|---------------------------------------|---|--------------------------------|
|  | Primary injury |  | Secondary injury |
|  | Reactive astrocytes formed glial scar |  | Reactive astrocyte |
|  | Normal astrocyte |  | Resident microglia |
|  | Myelin sheath |  | Demyelinated sheath |
| | |  | Bone marrow-derived macrophage |

The glial scar



Prevention of axonal growth and adequate rewiring

Innapropriate rewiring

➤ Myelin-derived inhibitory proteins

- Myelin-associated glycoprotein (MAG)

- Nogo protein

- Oligodendrocyte myelin glycoproteins (OMGs)

➤ Extracellular matrix proteins

- Chondroitin sulphate proteoglycans (CSPGs; ex. neurocan, versican, aggrecan, brevican, phosphocan, N2)

Spinal and Neurogenic Shock

Below site of injury:

- Total lack of function
- Decreased or absent reflexes and flaccid paralysis
- Lasts from a week to several months after onset.
- End of spinal shock signaled by muscular spasticity, reflex bladder emptying, hyperreflexia

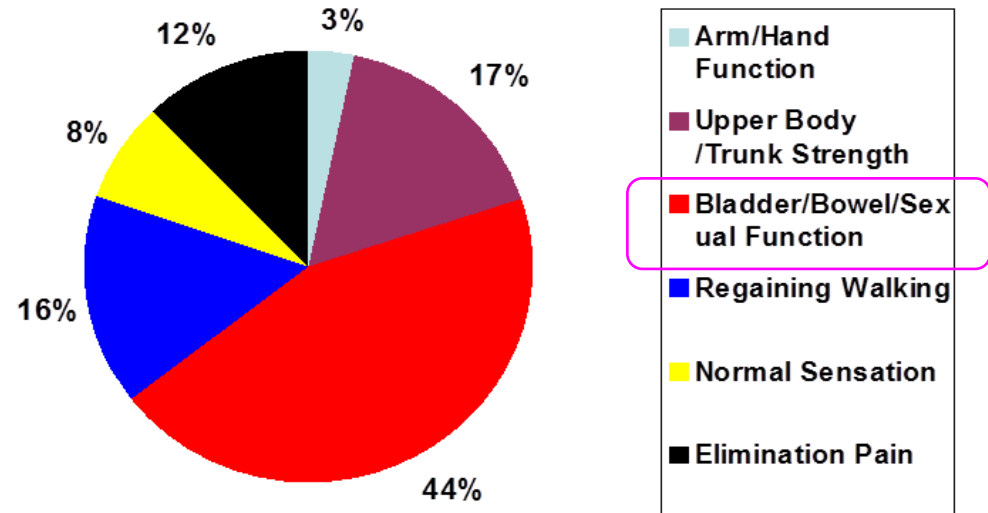
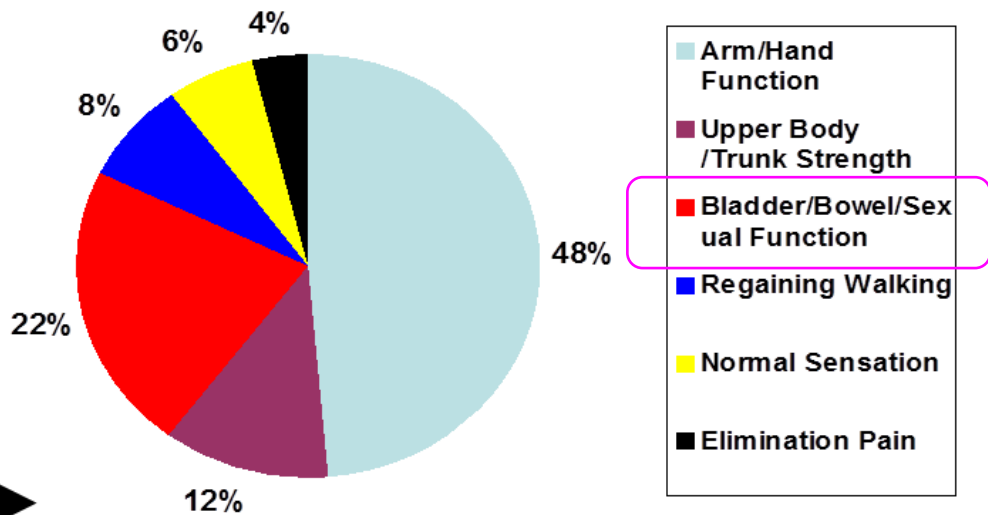
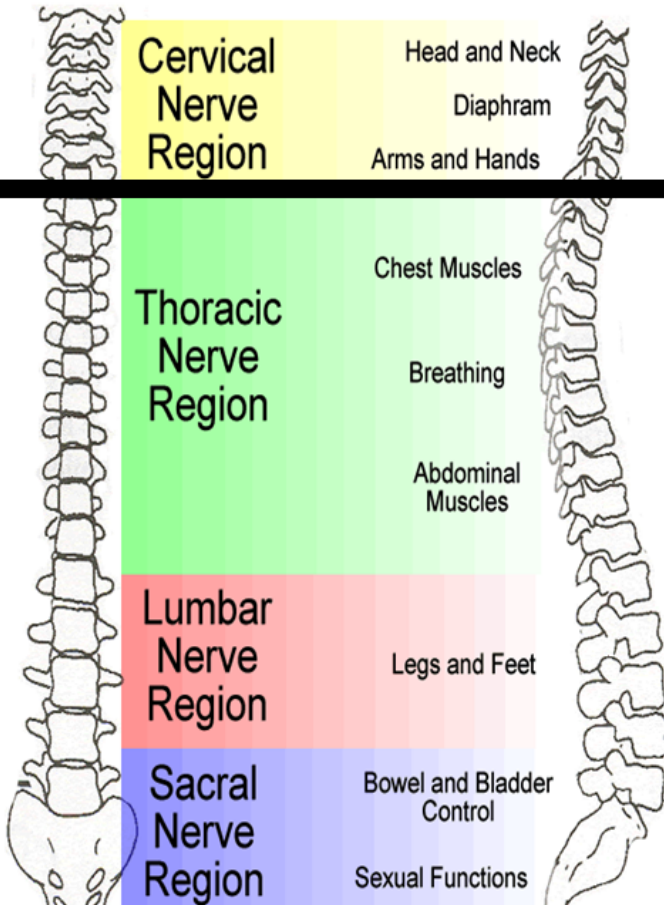
Consequences of SCI

- Inability to sustain spontaneous ventilation
- Sensory changes (loss of function, numbness...)
- Muscle weakness, paralysis
- Impairment of cardiac function
- Impairment of skin integrity
- Spasticity
- Impact on sexual function
- Impaired bladder and bowel function (constipation, neurogenic detrusor overactivity/detrusor-sphincter dyssinergia) -> Autonomic dysreflexia

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Tetraplegic

Paraplegic



[Anderson 2004]
Targeting Recovery: Priorities of
the Spinal Cord-Injured Population



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'I am peeing myself literally non-stop': Woman, 24, who almost died in horrific skydiving accident reveals the reality of her spinal-cord injuries

- Emma Carey, 24, suffered a spinal cord injury after a skydiving accident
- She explained the accident four years ago has resulted in bladder incontinence
- Ms Carey bravely shared a picture of herself after suffering an accident
- Her bladder can only hold 100ml of liquid and admits she pees herself 'non-stop'

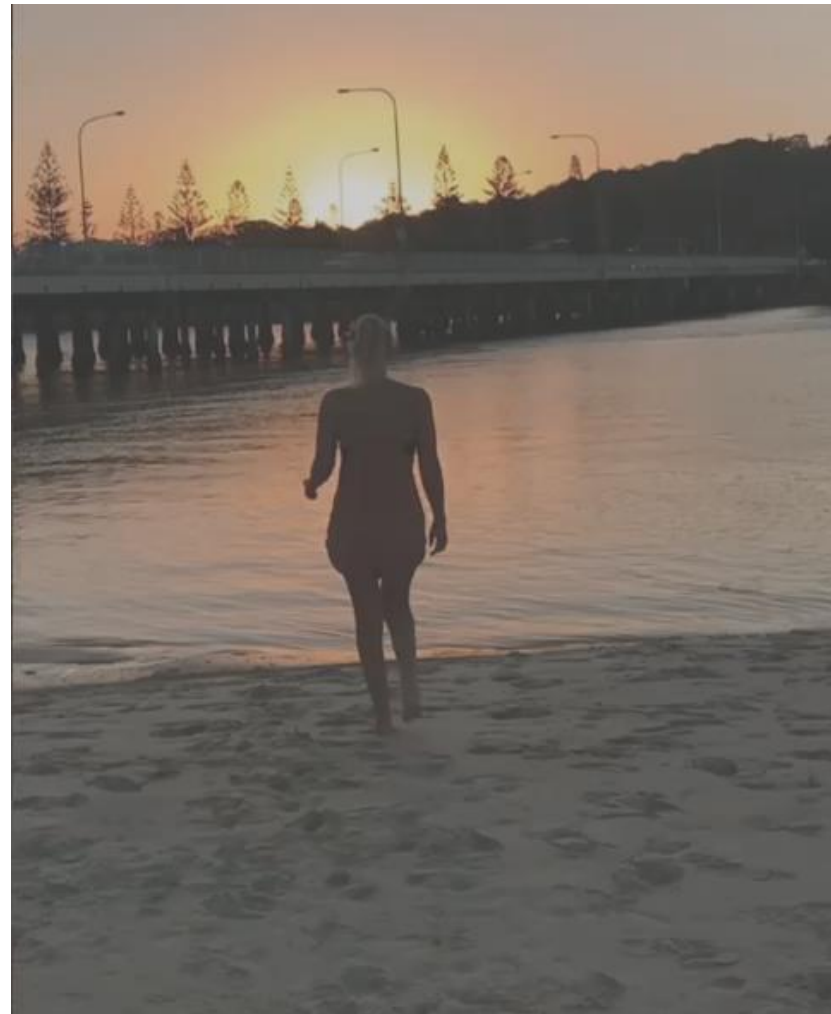
By APRIL GLOVER FOR DAILY MAIL AUSTRALIA

PUBLISHED: 03:42 BST, 20 November 2017 | UPDATED: 12:19 BST, 20 November 2017

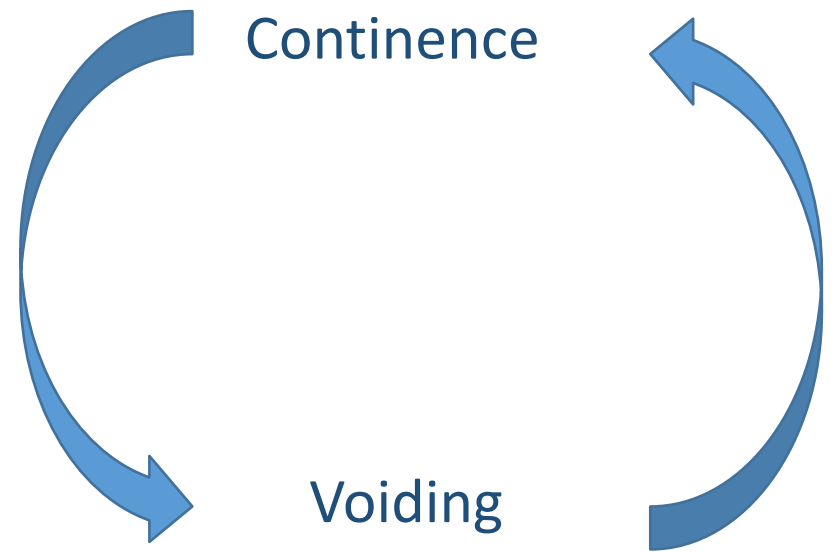


© em_carey / Instagram

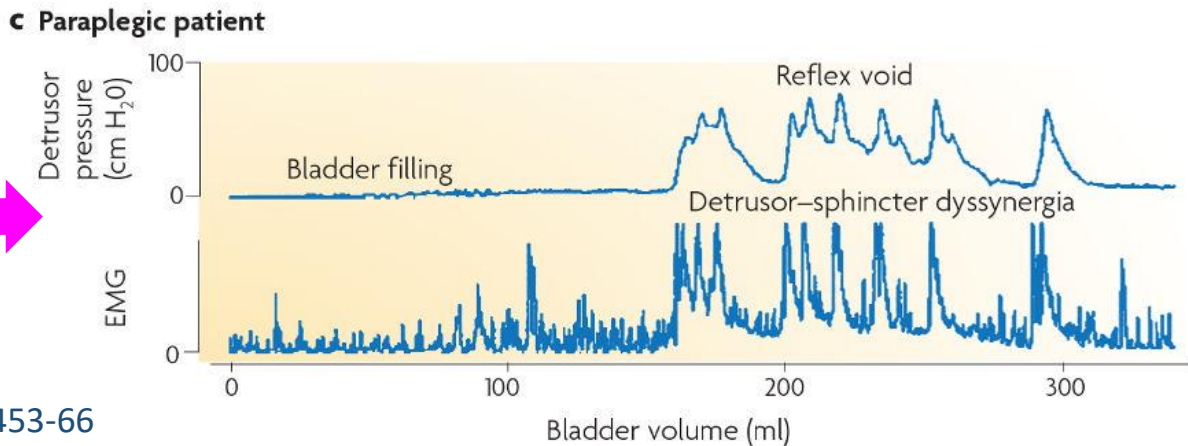
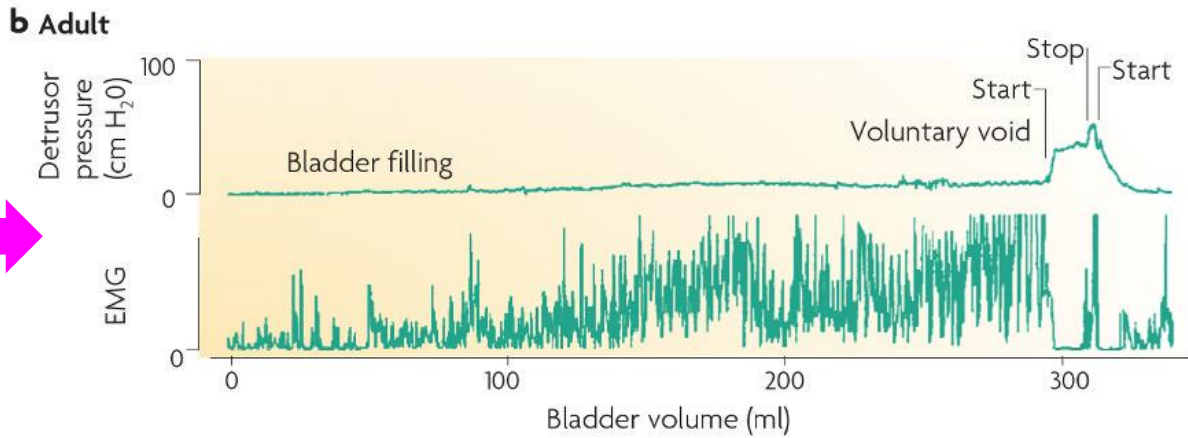
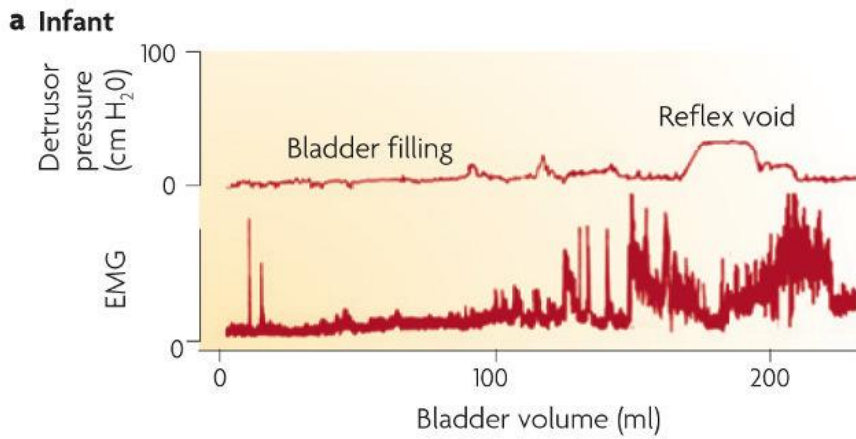
Emma Carey (pictured) has documented her recovery with an unexpected legion of fans and candidly revealed some of the intimate symptoms of her injury, including bladder incontinence



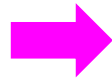
The micturition cycle



Voiding responses in an infant, a healthy adult and a paraplegic patient



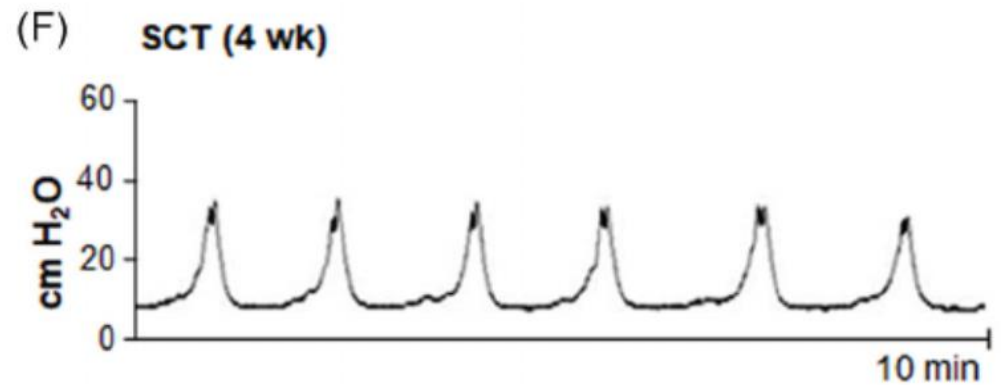
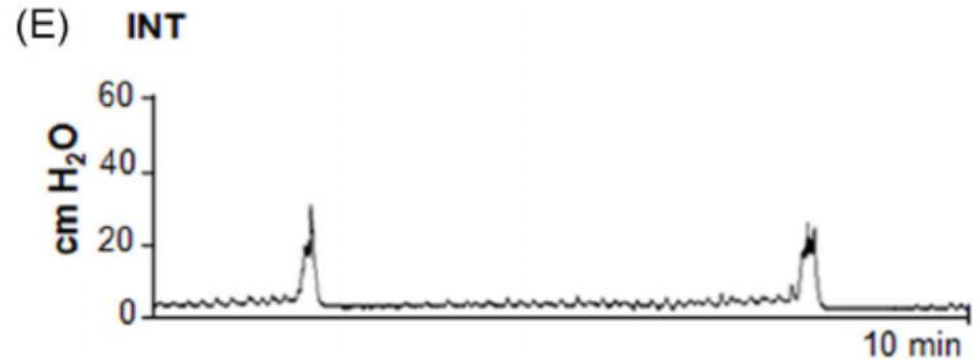
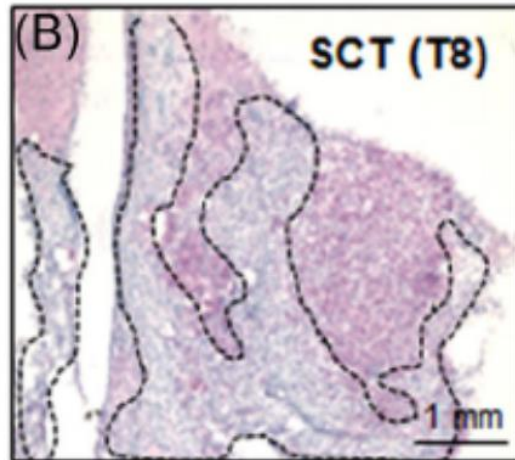
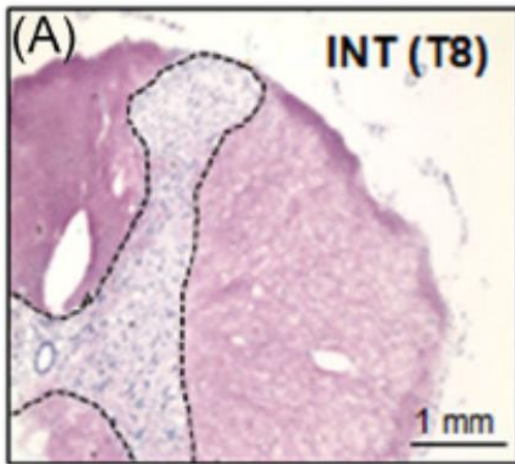
Coordinated activity
detrusor-sphincter

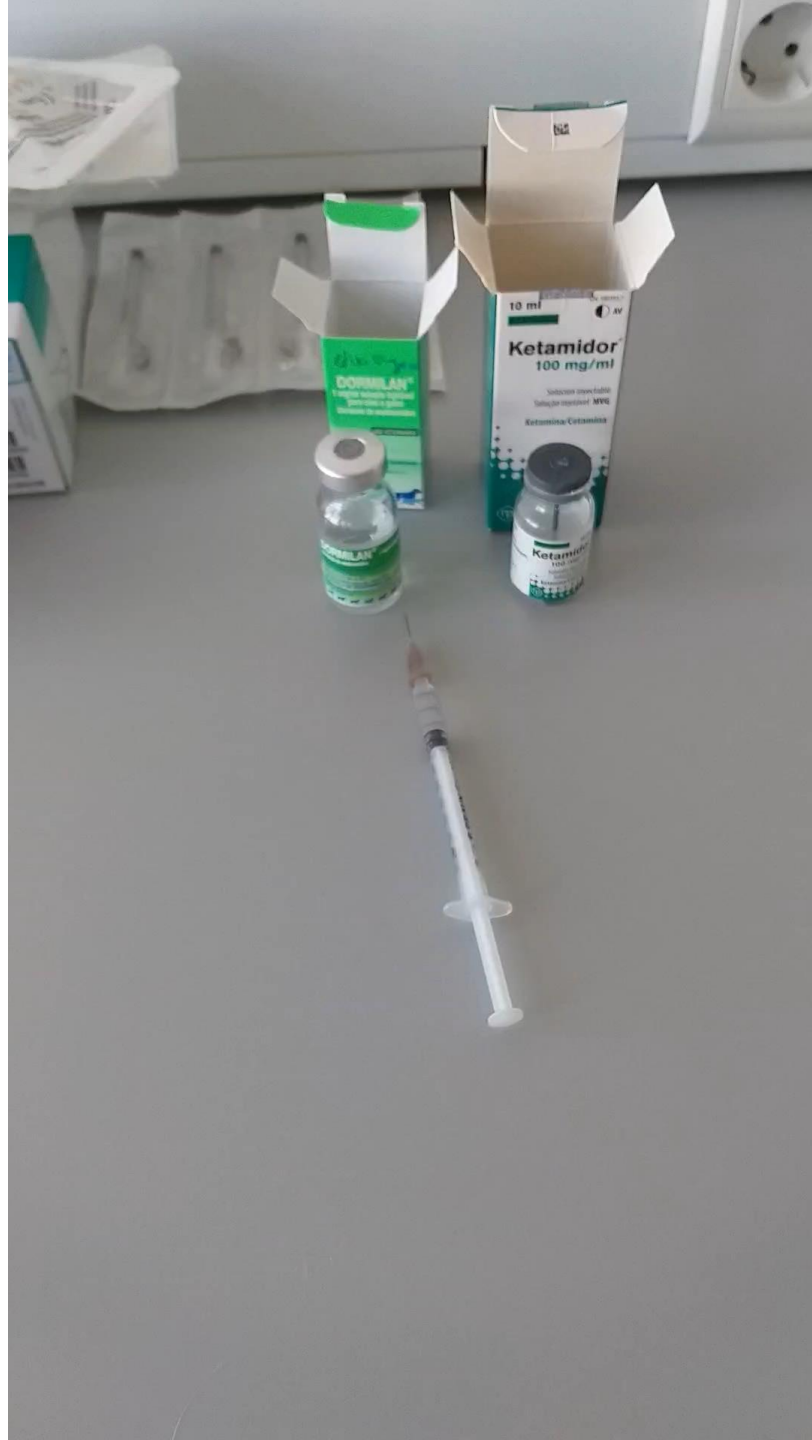


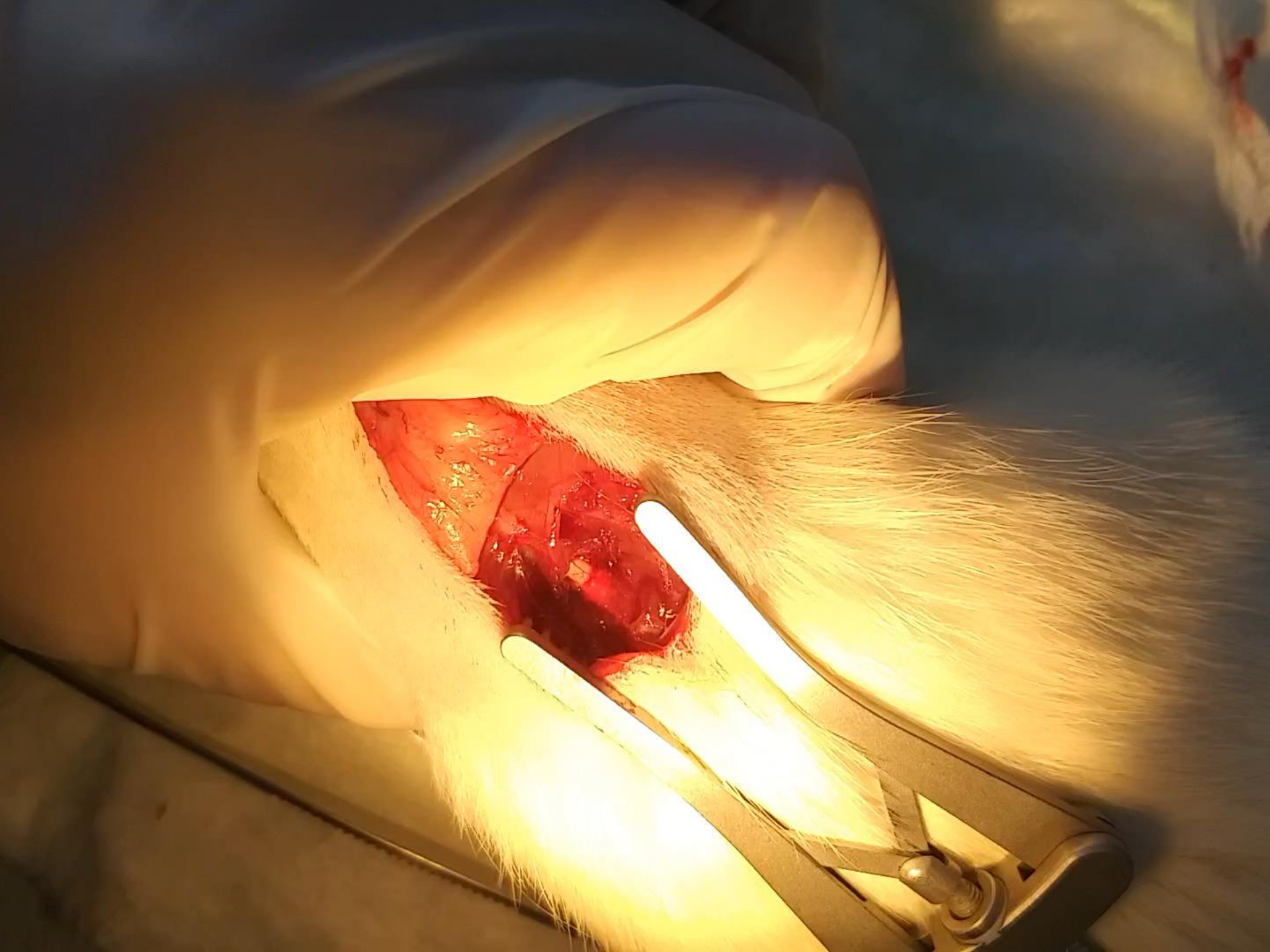
Detrusor-sphincter
dyssynergia



- Bladder dysfunction after SCI







Induction of Complete Transection-Type Spinal Cord Injury in Mice
(video)

A Contusion Model of Severe Spinal Cord Injury in Rats _ Protocol
(video)

Acute and Chronic Tactile Sensory Testing after Spinal Cord Injury in
Rats _ Protocol (video)