

Gestione extraospedaliera del traumatizzato spinale: review della letteratura

Matteo Giacomini

S.C.Neuroranimazione-Ospedale Niguarda Cà Granda Milano



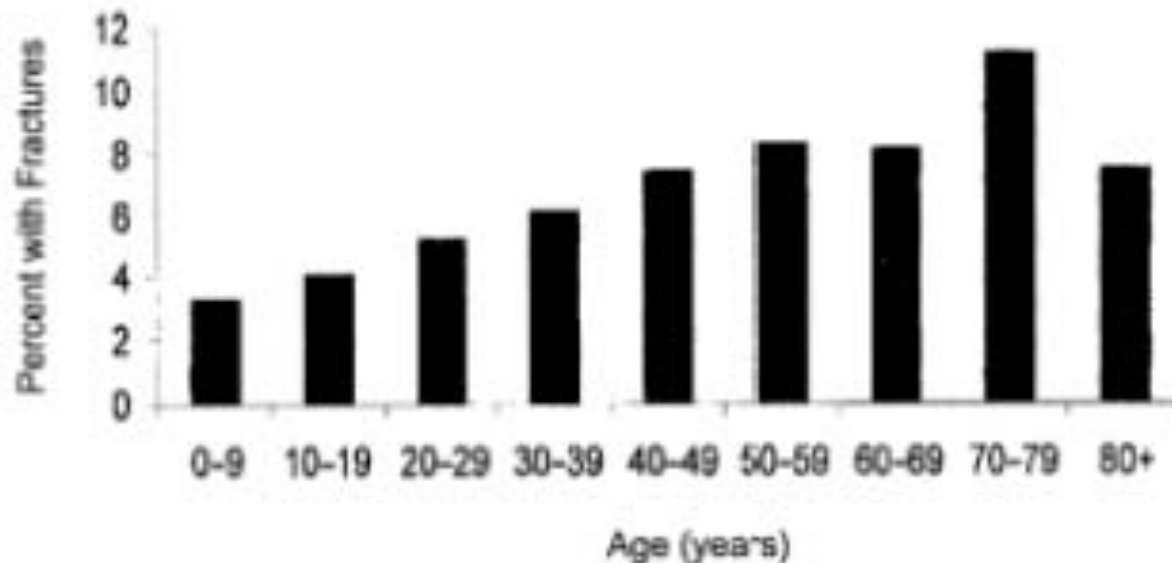
Le dimensioni del problema

- Tra 10 e 83 traumi spinali/1.000.000 abitanti ogni anno **nel mondo** di cui:
 - 1/3 tetraplegici ed il 50% con lesione completa
 - Età media 33 anni rapporto m/f 4:1 (Spinal Cord 2006 Sep;44(9):523-9)
 - Quindi:
 - Età giovane, complicanze “continue”: respiratorie, disautonomiche.
 - Carico sociale: paziente, nucleo affettivo, assistenziale

Le dimensioni del problema

- Dove la lesione? 55% c-spine 20% Toraco-lombare

-
-
-



1/3

Age (years)

Il Danno

Spinal Instability as a Result of Trauma

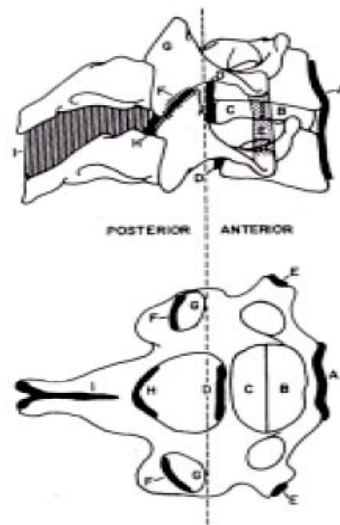
Biomechanically spinal instability can refer to an abnormal response to applied loads and can be characterized by motion in spinal segments beyond the normal constraints. Clinical instability refers to the loss of the spine's ability to maintain the anatomic relationships between spinal elements under physiologic loads, which can lead to subsequent damage or irritation to the spinal cord, its nerve roots, or can cause incapacitating deformity or pain.¹² This clinical definition takes into account neurologic as well as mechanical instability. In practice, spinal fractures associated with neurologic injury are by definition unstable, except for those injuries secondary to penetrating trauma (i.e., gunshot, stabbing).

Feliciano et al-Trauma-McGrow-Hill



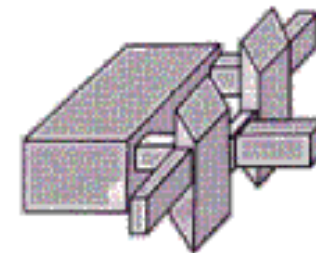
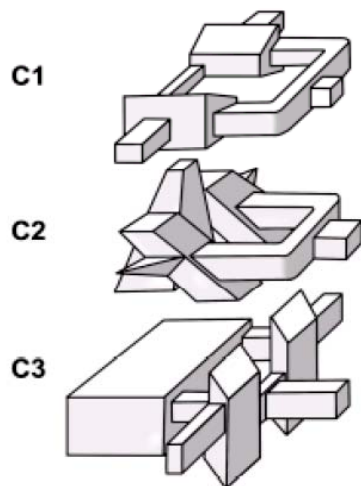
La cinematica...

- Unità di base della colonna sono 2 corpi vertebrali adiacenti e i relativi legamenti e dischi.
- Primo tratto Oc C2 solo legamenti: molto instabile
- C spine: modello a 2 comparti anteriore e posteriore da C2-C7



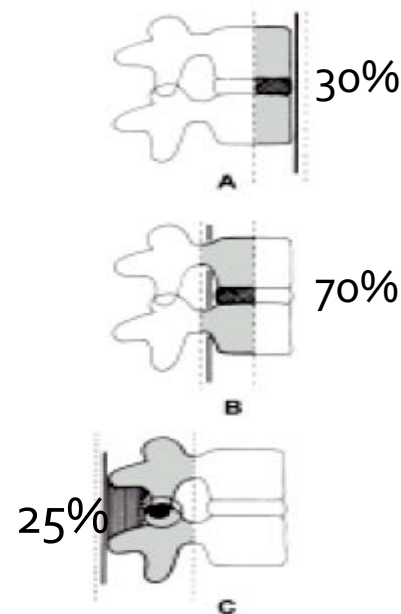
cinematica

- C-spine : da Oc a C2 molto mobile sui due piani saggitale(fle-est) e frontale (rotazione capo)
- C2-C7 principalmente fle-est
- Danno: in rotazione ed in flessione estensione data la relativa scarsità del supporto legamentoso

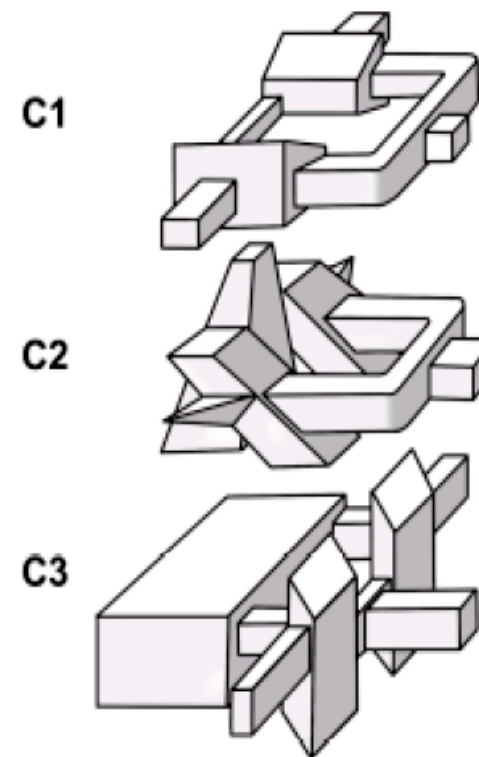
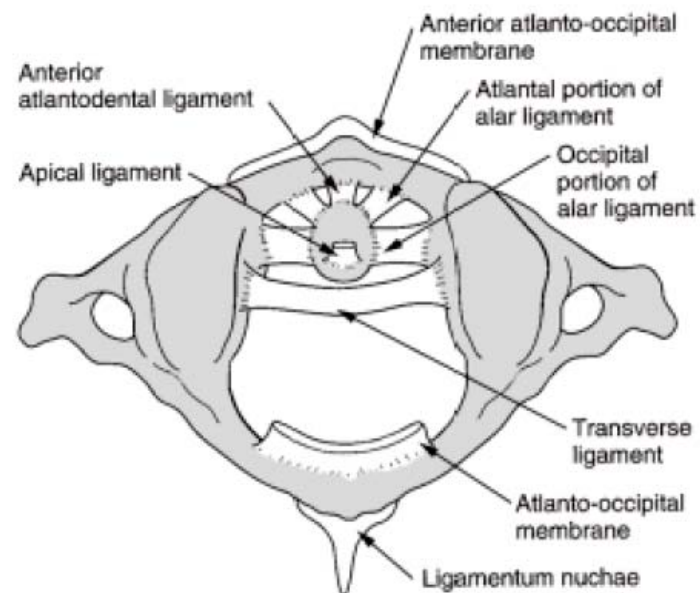


Cinematica

- Tratto toraco-lombare rigido-si articola in alto (c-spine) ed in basso (lombare) con tratti mobili
- modello a 3 compartimenti se danno ad almeno 2 compartimenti:instabilità



Articolazione C1-C3



Meccanismi di danno primario..

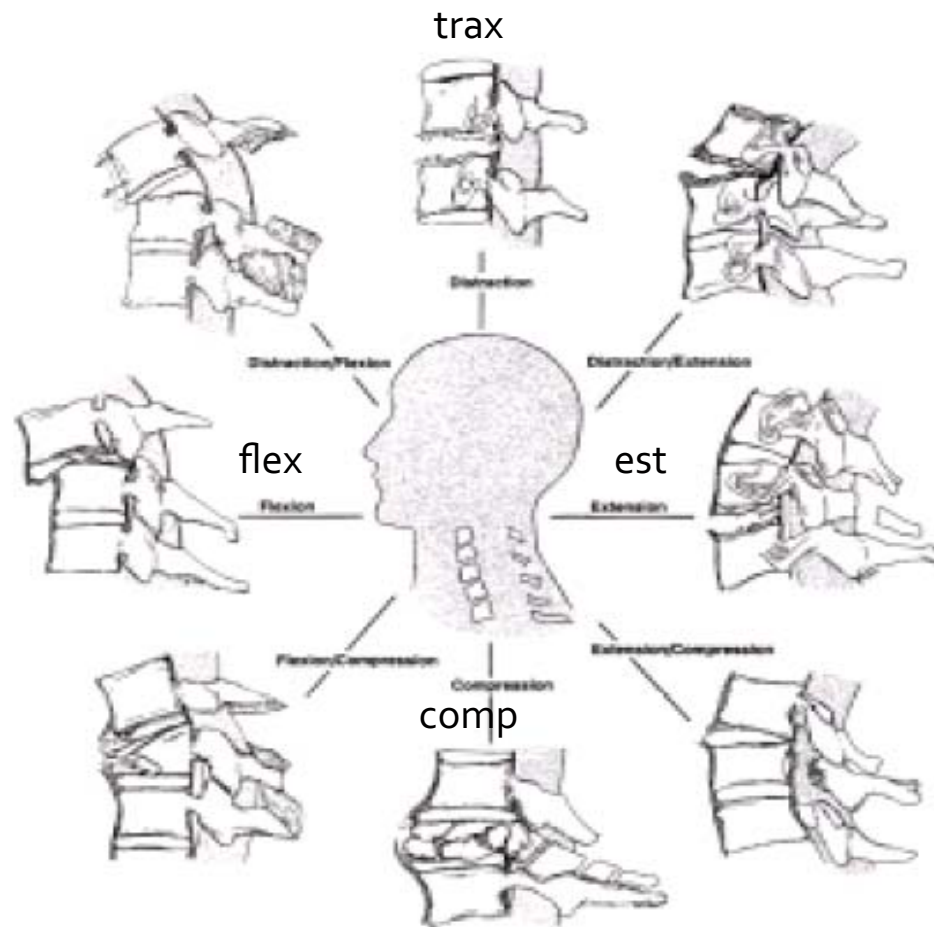
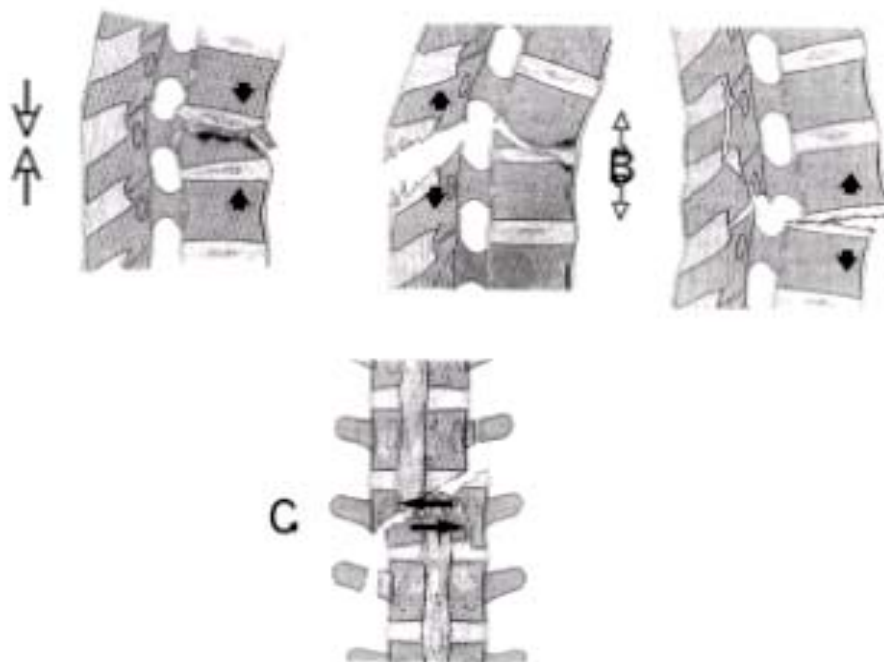


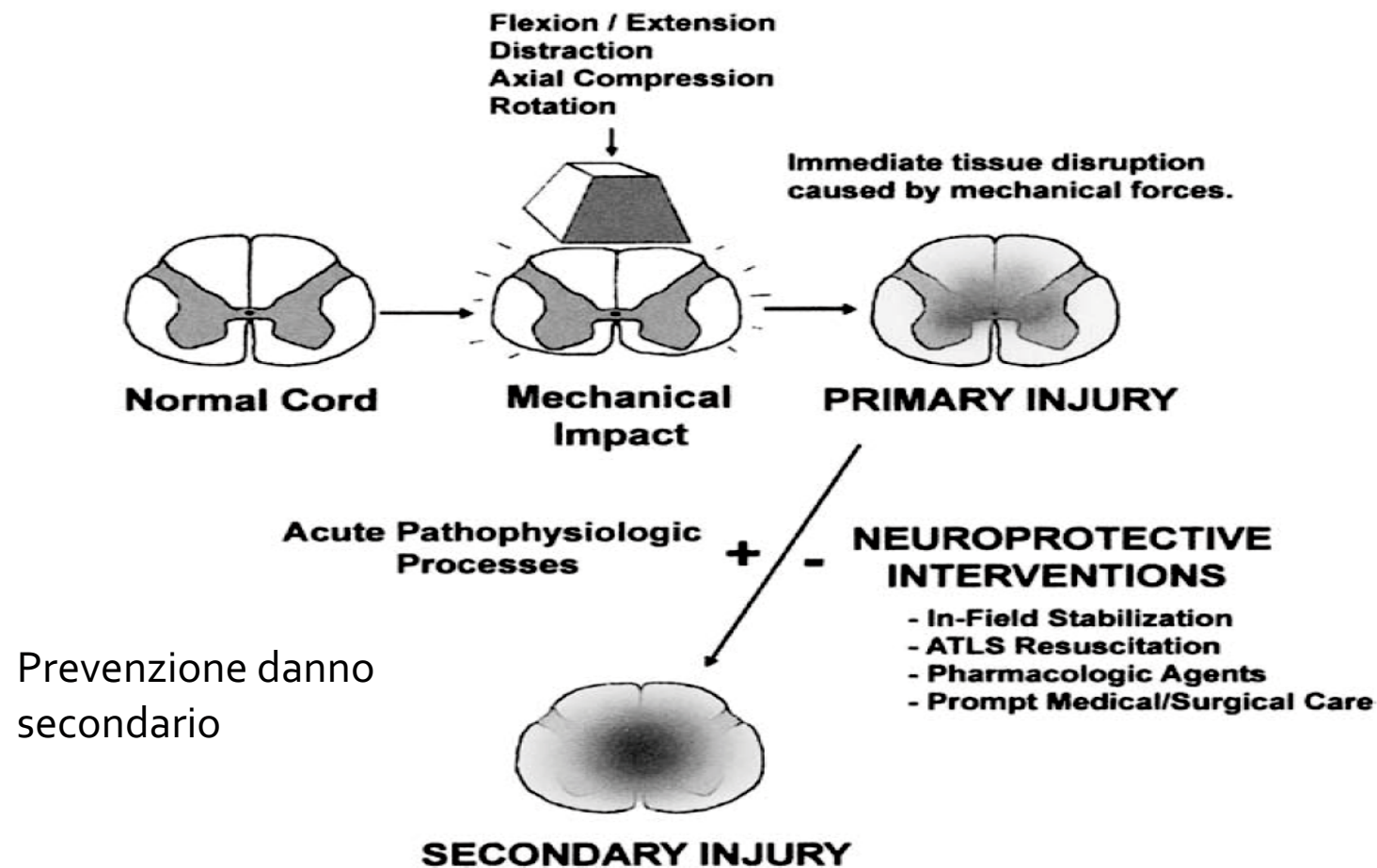
Figure 23-20. Patterns of subaxial cervical spine injury based on the injury mechanism.

...meccanismi di danno primario

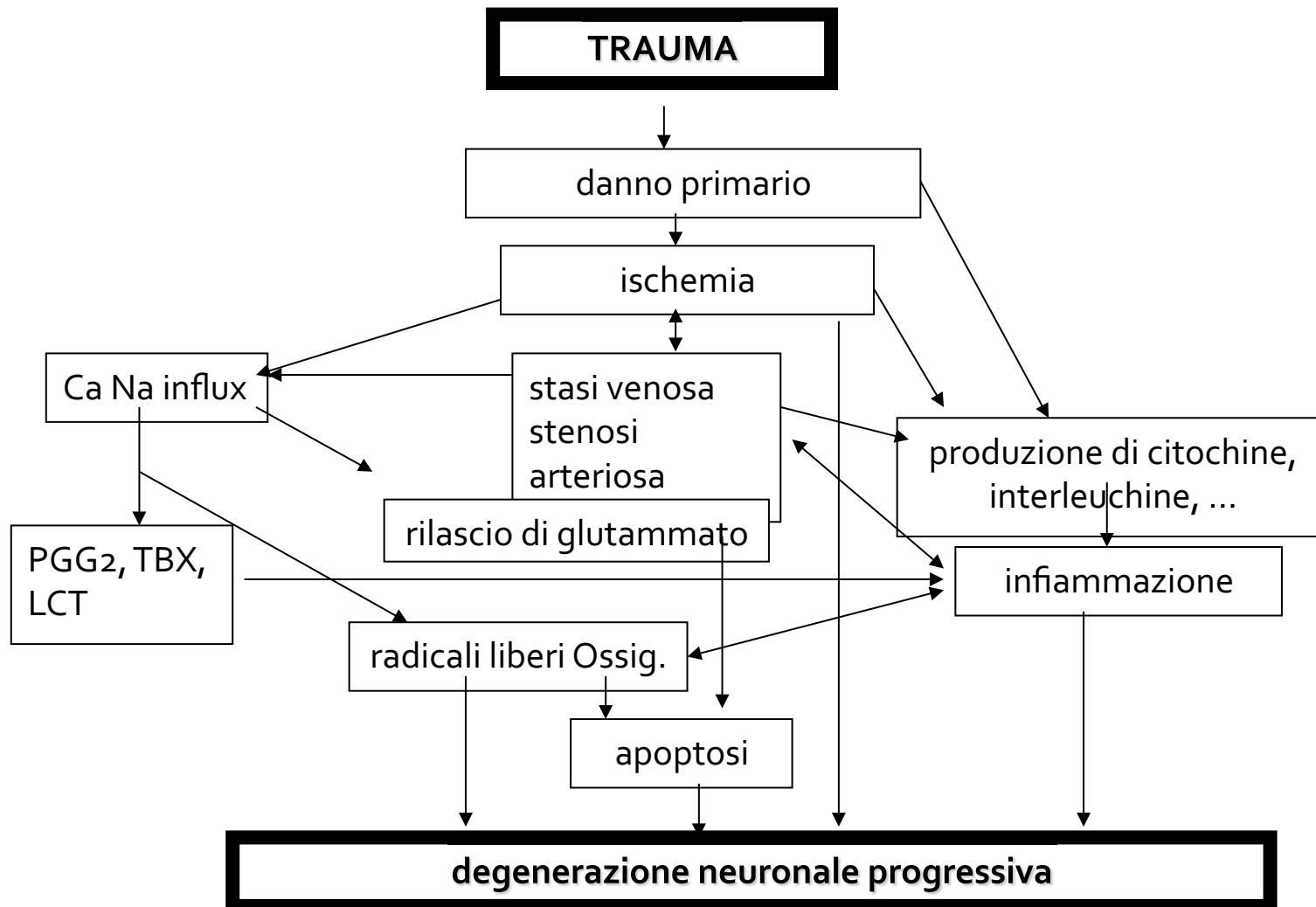
Tratto toraco lombare



..e secondario



Danno



Fase acuta

Immediato danno meccanico a tessuto nervoso ed altri tessuti molli comprese le cellule endoteliali con necrosi prevalente nella sostanza grigia
Entro pochi minuti blocco del potenziale d'azione neuronale
Aumento di concentrazione intracellulare di Na e Ca ed extracellulare di K con shock spinale che rappresenta la crisi della rete neuronale spinale

Emorragia, edema locale, trombosi della microcircolazione, vasospasmo, perdita dell'autoregolazione dei vasi con incremento del danno neuronale

Fase secondaria o subacuta

- Necrosi cellulare ischemica, edema e scompensi elettrolitici proseguono dalla fase acuta
- Lisi cellulare e alterazione del trasporto sinaptico e non-sinaptico provocano concentrazione citotossica extracellulare di glutammato e di altri amminoacidi eccitatori (6-8 volte)
- Perossidazione lipidica
- Produzione di radicali liberi (anioni superossido, ...)
- Apoptosi con gliosi reattiva e proliferazione astrocitaria
- Invasione del midollo di neutrofili e linfociti (24-48 ore)

Fase acuta

Inevitabilmente il tempo di ricovero ospedaliero supera il tempo di inizio del danno secondario quindi:

gli immediati processi della lesione acuta non lasciano margine di intervento utile salvo che i Servizi Sanitari di Emergenza (118) siano adeguati ad un intervento mirato e precoce

Al contrario gli eventi delle fasi subacuta e cronica sono strategicamente un campo di intervento migliore

Valutazione extra ospedaliera: Diagnosi

- **Meccanismo trauma:**
- trauma cranio e mxf → trauma C spine
- Frattura scapolari ,ematomi → Rachide toraco-lombare
- Caduta → lesioni da compressione

C4	Respiro
C5	Ele spalle
C6	Flex gom
C7	Est gom
C8	Flex dita
T1-T12	Interc
L1	Flex cosc

Prevenzione danno secondario:

- Stabilizza → fratture instabili
- Perfondi e ossigena → ischemia
- Trasporta in sicurezza → diagnosi e eventuale trattamento precoce
- Farmaci

Stabilizzazione

- Collare cervicale adeguato associato a tavola spinale E immobilizzazione capo
- Tavola spinale : elevata pressione sacrale (> 200 mmHg) ,tavole imbottite
- (J of Neurotrauma 2010 27: 1-21

Stabilizzazione

TABLE 23-7. COMPARISON OF TOTAL CERVICAL MOTION RESTRICTED BY VARIOUS CERVICAL ORTHOSES

Orthosis	Motion Restricted [%]				
	Combined Flexion-Extension	Flexion	Extension	Lateral Bending	Axial Rotation
CO					
Soft Collar ¹⁻³	26	23	20	8	7
High-Thoracic CTO					
Philadelphia ¹⁻⁵	70	74	59	34	56
Miami J ⁵	73	85	75	51	65
NecLoc ³⁻⁵	80	86	78	60	73
Newport/Aspen ^{5,6}	62	59	64	31	38
Stifneck ^{5,7}	70	73	63	50	57
Malibu ⁸	—	86	82	55	74
Nebraska ⁹	87	74	60	75	91
Low-Thoracic CTO					
SOMI ^{1,2}	72	93	42	34	66
Yale ²	86	—	—	61	76
Four Poster ¹	79	89	82	54	73
Minerva ¹⁰	79	78	78	51	88
LMCO ⁹	83	68	66	50	60
Halo-Vest ²	96	—	—	99	96

CO, cervical orthosis; CTO, cervicothoracic orthosis; LMCO, Lehrman-Minerva cervical orthosis; SOMI, sternal occipital mandibular immobilizer.

Stabilizzazione

Spinal immobilisation for trauma patients (Review)

AUTHORS' CONCLUSIONS

Implications for practice

We found no randomised controlled trial which met our inclusion criteria in this review. The effect of pre-hospital spinal immobilisation on mortality, neurological injury, spinal stability and adverse effects in trauma patients therefore remains uncertain. Because airway obstruction is a major cause of preventable death in trauma patients, and spinal immobilisation (particularly of the cervical spine) can contribute to airway compromise, the possibility that immobilisation may increase mortality and morbidity cannot be excluded.

Airway

- Stabilizzazione manuale in line garantisce il minor movimento flex ext cervicale
- Collare e fermacapo

(J of Neurotrauma 2010 27: 1-21)



Airway

- Video laringo e stabilizzazione manuale:

Table 3 Median changes in the angle between adjacent cervical vertebrae during T2. T2, Time from laryngoscopy to intubation. Data are expressed as median (range). Negative values denote flexion; positive values denote extension. * $P < 0.05$ vs AWS group

	AWS	Macintosh	<i>P</i> -value
Occiput-C1 ($n=12$)	10° (6.0–22.5)	15°* (6.0–21.5)	0.041
C1-C2 ($n=13$)	4.5° (1.0–8.0)	7.0°* (2.0–11.0)	0.0079
C2-C3 ($n=13$)	–0.5° (–14.5 to 8.0)	1.5° (–9.0 to 10.5)	0.075
C3-C4 ($n=12$)	0.5° (–6.0 to 9.5)	3.0°* (–4.5 to 13.5)	0.0050

perfondi

- Shock spinale : vasodilatazione massiva da perdita della funzione regolatoria autonoma al di sotto del livello di lesione :
- Ipotensione ,bradicardia (perdita della tachicardia compensatoria)
- Diagnosi Differenziale: pnx, emorragie
- Espansione volemica

farmaci

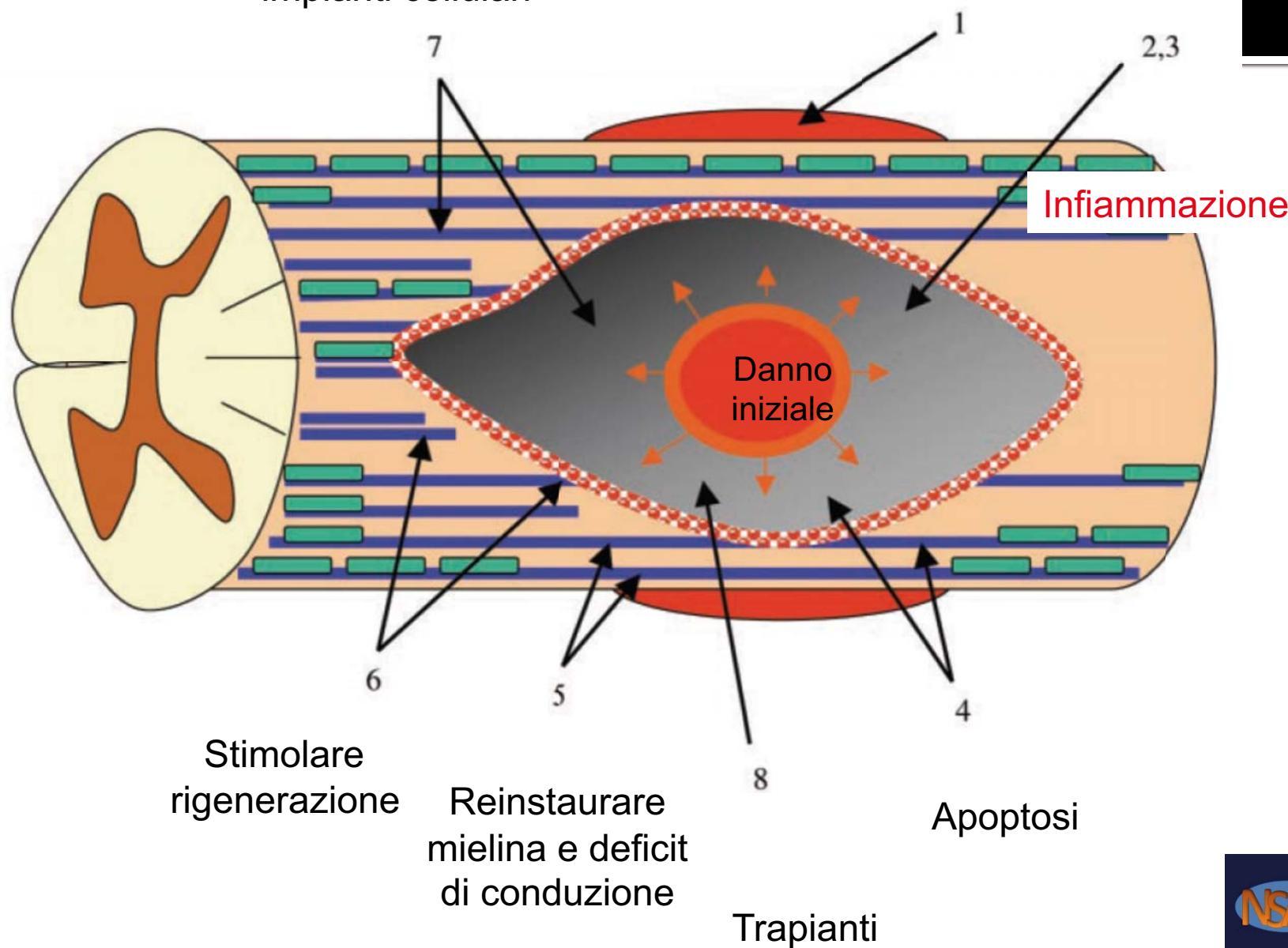
- Corticosteroidi per prevenzione danno secondario
- Attuabile in durante ALS
- Maneggevole , economico, relativamente sicuro?

Possibili interventi terapeutici

Ridurre edema e produzione
di radicali liberi

Terapie con
impianti cellulari

Neurotossicità da GLU



Metilprednisolone MP

- NASCIS 1 1984 MP 100 vs 1000 mg
- NASCIS 2 1990 MP, Naloxone, placebo
- NASCIS 3 1997 MP24, MP48, Tirilazad Mes.

NASCIS 3 : bolo di 30 mg/kg + 5 mg/Kg/h per 24 h se entro 3 ore, per 48 h se entro 8 ore, nulla dopo le 8 ore

NON STUDI IN POPOLAZIONI PEDIATRICHE

- Gli stessi studi prospettici, randomizzati e controllati **NASCIS non evidenziano significative differenze** nel recupero funzionale tra i gruppi trattati ma solo nel punteggio motorio (non ASIA)

- **percentuale di complicanze infettive, di emorragie gastro-intestinali, di pancreatite, della poli-miopatia del paziente critico** Spinal Cord 2005 43 199-203

Metilprednisolone..

Steroids for acute spinal cord injury (Review)

Bracken MB



**THE COCHRANE
COLLABORATION®**

The first NASCIS trial (Bracken 1984/85) did not find any beneficial effect of methylprednisolone given at 1g per day for 10 days.

The second NASCIS trial (Bracken 1990/93) found significantly increased neurologic recovery among patients treated with very-high-dose methylprednisolone within eight hours of injury. This treatment has become a standard therapy in many countries. As

Metilprednisolone..

AUTHORS' CONCLUSIONS

Implications for practice

Methylprednisolone sodium succinate has been shown to enhance sustained neurologic recovery in a phase three randomized trial, and to have been replicated in a second trial. Therapy must be started within eight hours of injury using an initial bolus of 30 mg/kg by IV for 15 minutes followed 45 minutes later by a continuous infusion of 5.4mg/kg/hour for 24 hours. Further improvement in motor function recovery has been shown to occur when the maintenance therapy is extended for 48 hours. This is particularly evident when the initial bolus dose could only be administered three to eight hours after injury.

Implications for research

Methylprednisolone treatment improves neurologic recovery but is unlikely to bring a return to normal function unless there is minimal initial deficit. More research is needed to examine whether different MPSS protocols would achieve even more recovery. It is likely that future trials will be able to examine concurrent pharmacologic therapies (sometimes called drug cocktails) or sequential therapies which operate on different aspects of the secondary injury processes ranging from early neuron protection to nerve regeneration in the chronic patient.



Metilprednisolone..

- Attualmente non spazio nel trattamento extraospedaliero
- Da valutare in accordo con il centro di destinazione se praticarlo precocemente

Suggested Indications for the Use of MP in Acute SCI⁹⁷

For acute non-penetrating SCI (<3 h after injury), MP should be given as per NASCIS II protocol (i.e. 24 hours of treatment)

For acute non-penetrating SCI (>8 h after injury), MP should not be used

For acute non-penetrating SCI (after 3 h, within 8 h), MP should be given as per NASCIS III protocol (i.e., 48 h of treatment)

For acute penetrating SCI, MP is not recommended

Steroide?..



Steroidi?



Bambini...

- Pochi , 1.5% sul totale (national pediatric trauma registry)
- Spinal Cord Injury Without Radiological Abnormalities (SCIWORA) 43%
- Traumi strada causa prevalente nei pre adolescenti
Attività sportive E ORA traumi strada adolescenti
- Miglior outcome motorio sulle lesioni incomplete

... e bambini

- SCIWORA: difficile diagnosi anche con RM
Davis, P.C., Reisner, A., Hudgins, P.A., Davis, W.E., and
O'Brien, M.S. (1993). Spinal injuries in children: role of MR.
AJNR 14, 607-617.

Sospetto in caso di incidenti sportivi

Brown, R.L., Brunn, M.A., and Garcia, V.F. (2001). Cervical spine injuries in children: a review of 103 patients treated consecutively at a level 1 pediatric trauma center. J. Pediatr. Surg. 36, 1107-1114.

Diagnosi clinica: tumefazione e dolore linea cervicale e dinamica incidente

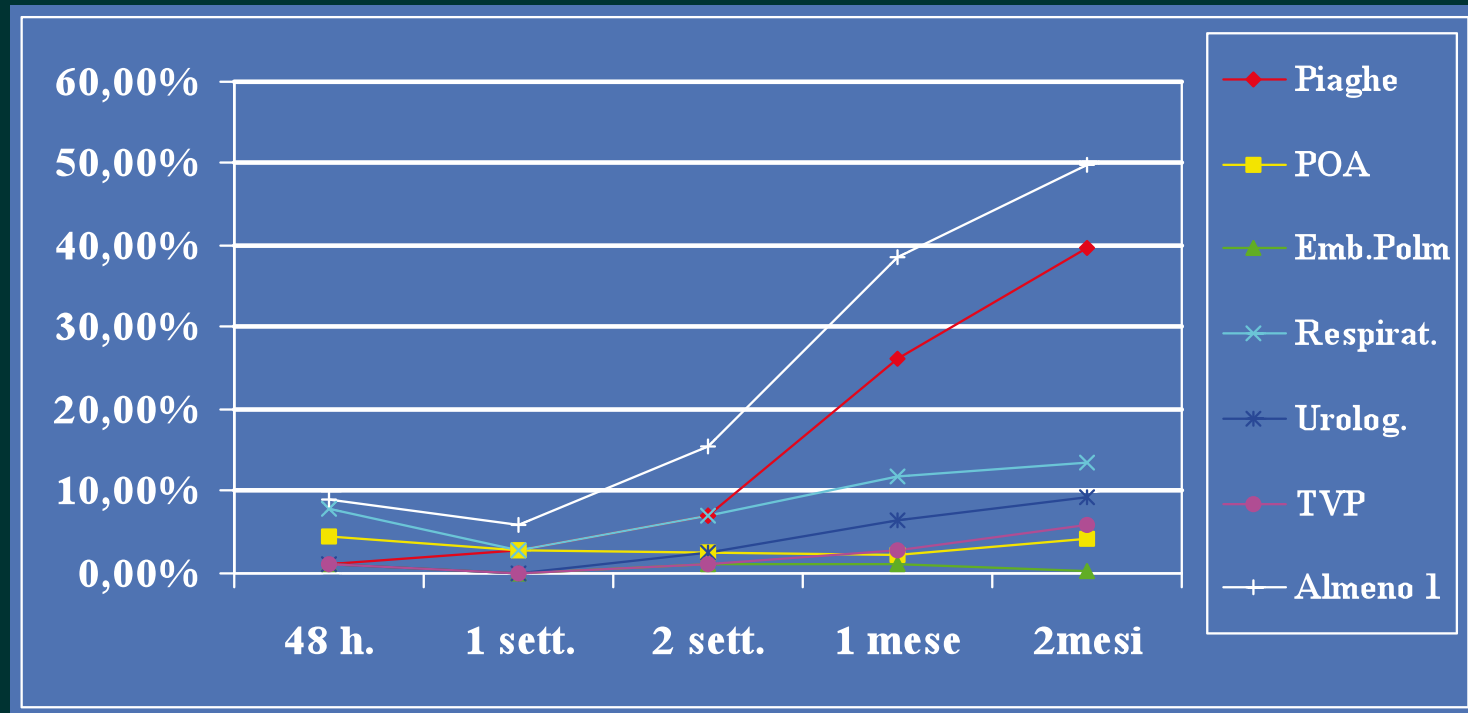
Conclusioni:

- Dinamica del trauma e valutazione del livello di lesione
- Stabilizzazione completa
- Circolo e ossigenazione
- Steroidi: non in extra ospedaliero
- Ospedalizzazione precoce nel centro di riferimento e..

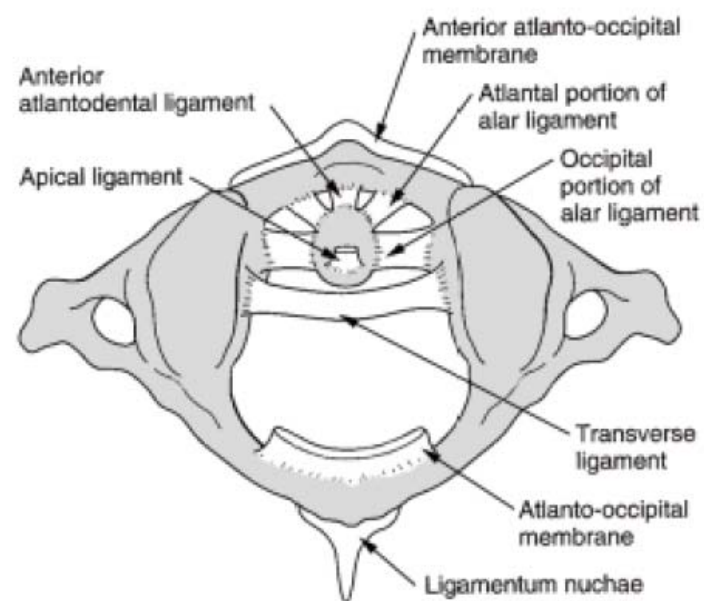
..Conclusioni

- ..creare subito un percorso :
- Triage pre ospedaliero
- Trauma Center definitivo
- Unità spinale
- Riabilitazione e inserimento
- GRAZIE!!!

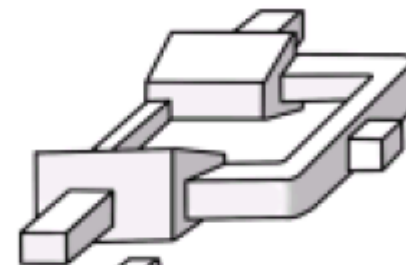
GISEM Study



Correlation between time interval of hospitalization and complications



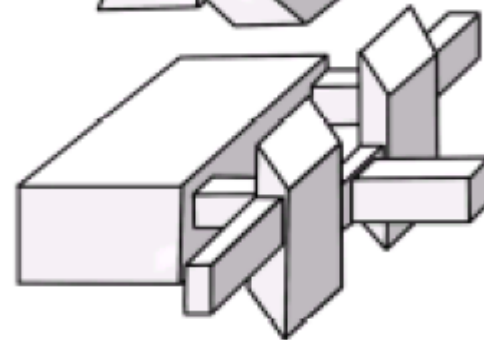
C1



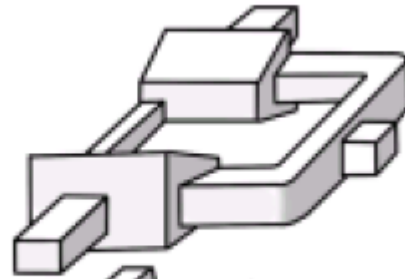
C2



C3



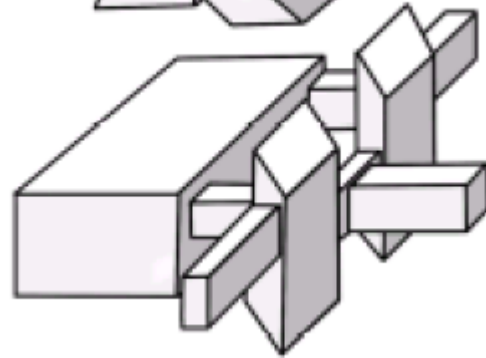
C1



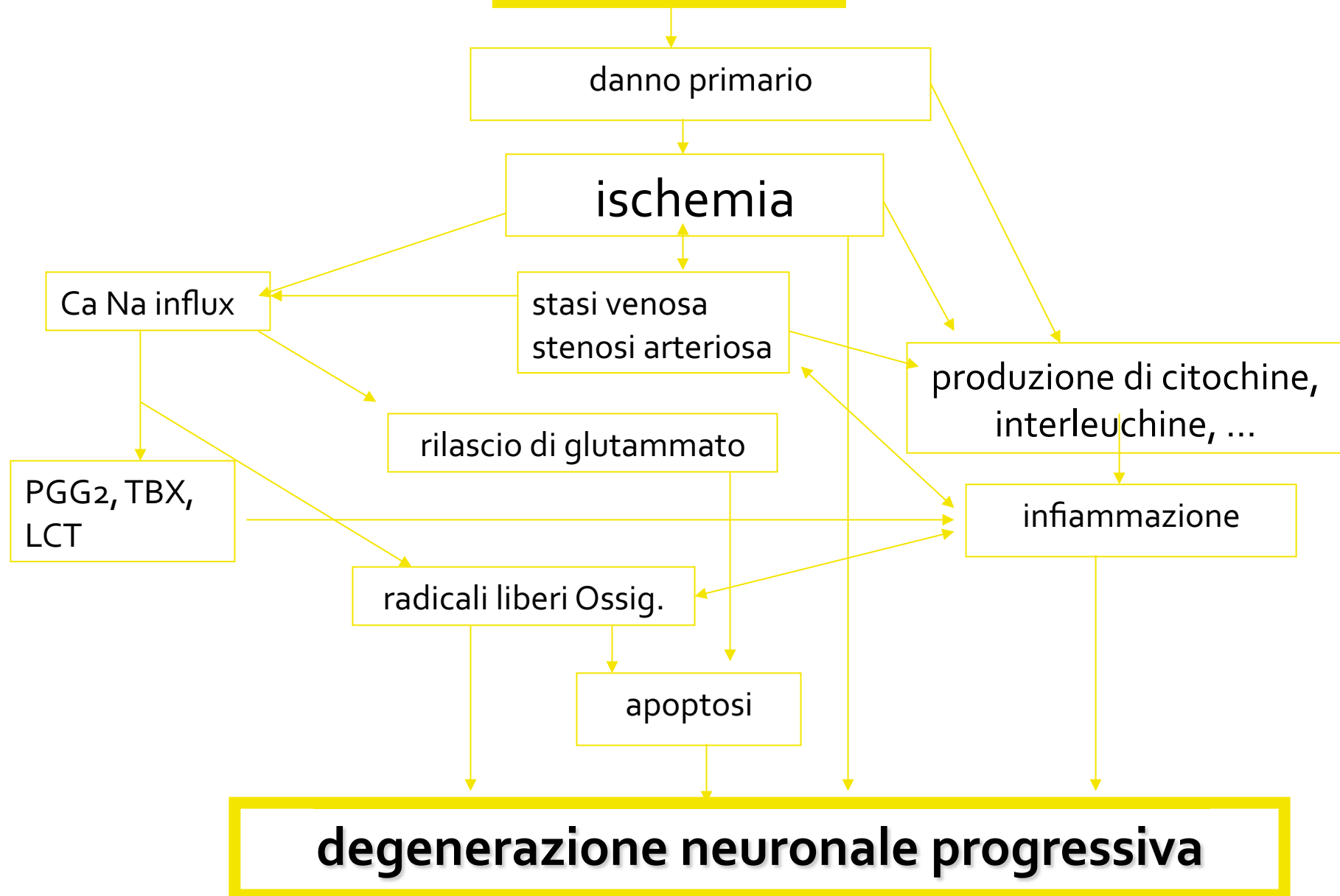
C2

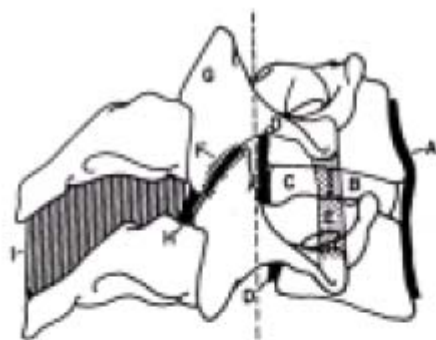


C3

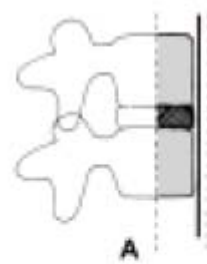
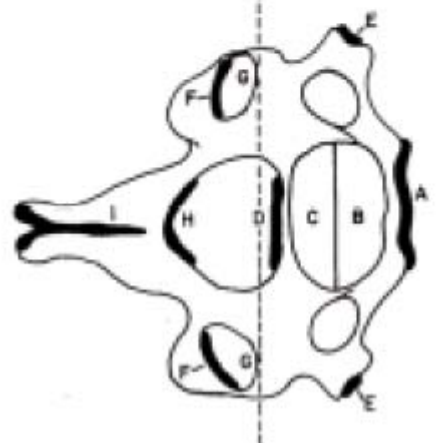


TRAUMA

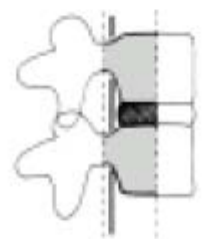




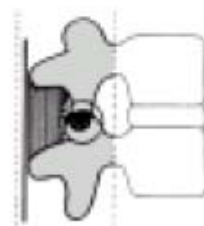
POSTERIOR ANTERIOR



A



B



C

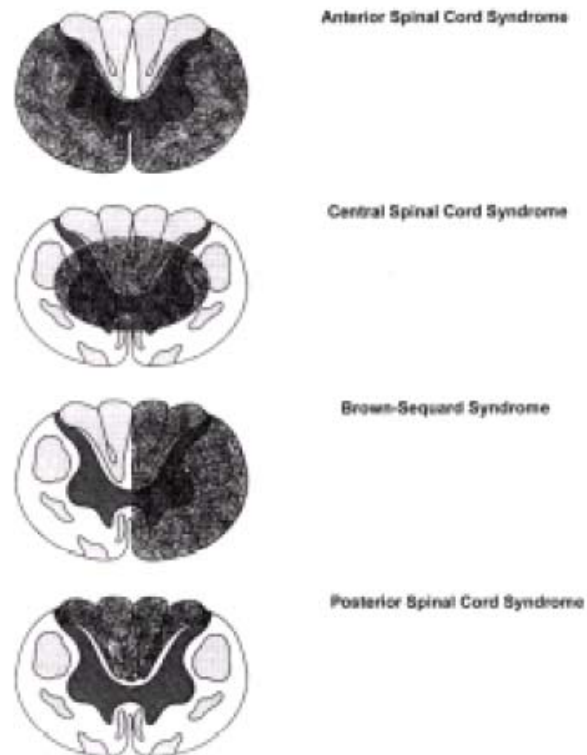
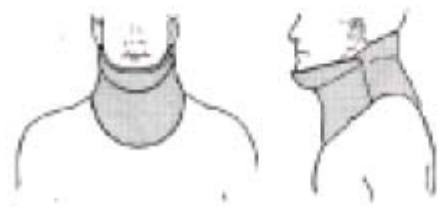


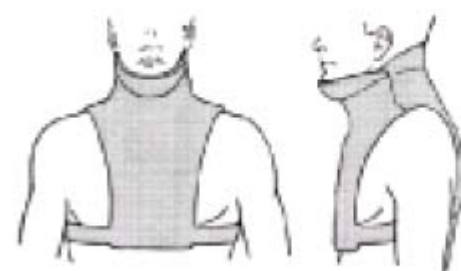
Figure 23-17. The most common patterns of spinal cord injury.



A



B



C

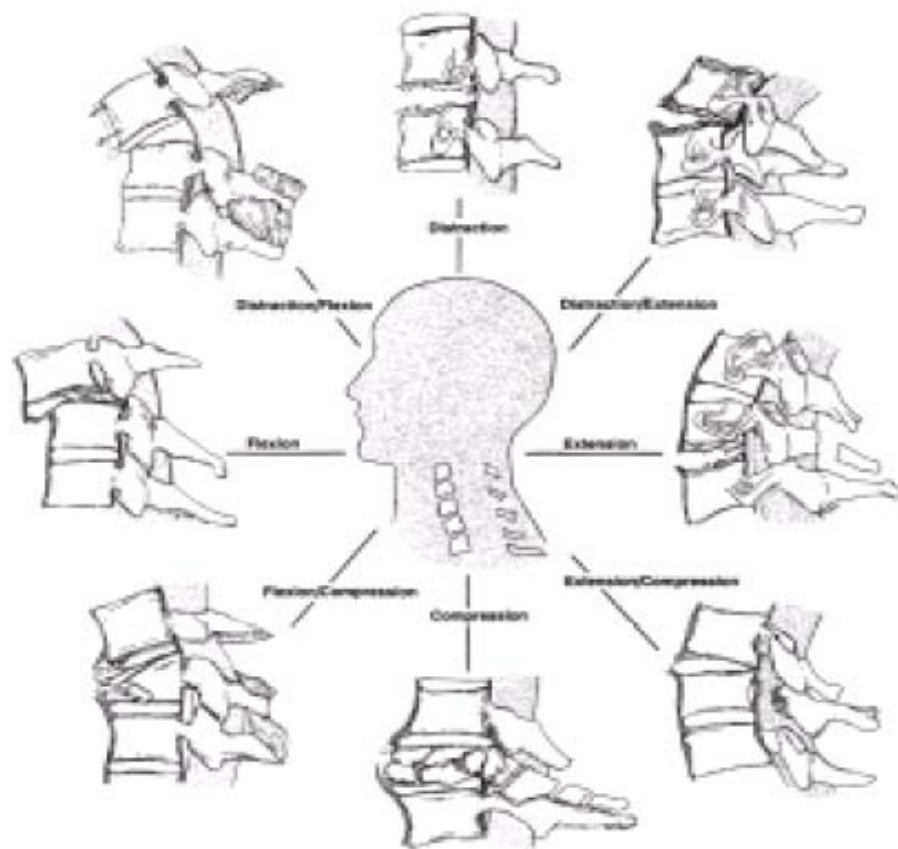


Figure 23-20. Patterns of subaxial cervical spine injury based on the injury mechanism.

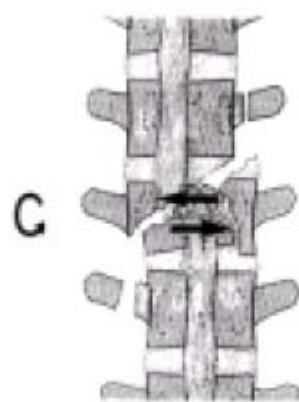
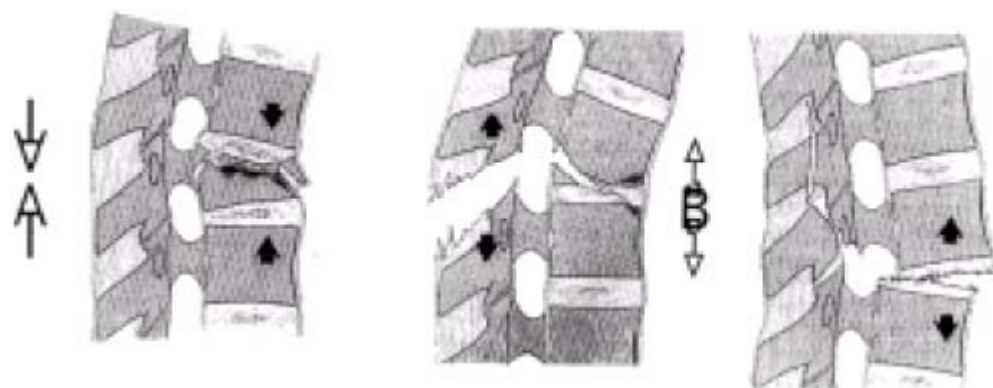


TABLE 23-7. COMPARISON OF TOTAL CERVICAL MOTION RESTRICTED BY VARIOUS CERVICAL ORTHOSES

Orthosis	Motion Restricted [%]				
	Combined Flexion-Extension	Flexion	Extension	Lateral Bending	Axial Rotation
CO					
Soft Collar ¹⁻³	26	23	20	8	7
High-Thoracic CTO					
Philadelphia ¹⁻⁵	70	74	59	34	56
Miami J ⁵	73	85	75	51	65
NecLoc ³⁻⁵	80	86	78	60	73
Newport/Aspen ^{5,6}	62	59	64	31	38
Stifneck ^{5,7}	70	73	63	50	57
Malibu ⁸	—	86	82	55	74
Nebraska ⁹	87	74	60	75	91
Low-Thoracic CTO					
SOMI ^{1,2}	72	93	42	34	66
Yale ²	86	—	—	61	76
Four Poster ¹	79	89	82	54	73
Minerva ¹⁰	79	78	78	51	88
LMCO ⁹	83	68	66	50	60
Halo-Vest²	96	—	—	99	96

CO, cervical orthosis; CTO, cervicothoracic orthosis; LMCO, Lehrman-Minerva cervical orthosis; SOMI, sternal occipital mandibular immobilizer.

1. What is the optimal type and duration of spinal immobilization in patients with acute SCI?
2. During airway manipulation in the pre-hospital setting, what is the ideal method of spinal immobilization?
3. What is the impact of pre-hospital transport time to definitive care on the outcomes of patients with acute SCI?
4. What is the role of pre-hospital care providers in cervical spine clearance and immobilization?

Frein, 2007; Walton et al., 1995; Waninger et al., 2001). Most evidence in the literature was based on biomechanical studies with volunteers. The studies showed that immobilization with a board and collar and head immobilization between towels or foam wedges provided the most stable biomechanical immobilization (Huerta et al., 1987; Perry et al., 1999). The addition of the board to the cervical collar provided statistically significantly more immobilization than a collar by itself (Chandler et al., 1992; Graziano et al., 1987). There were not enough studies to recommend exact types of collars. Certain forms of strapping, if applied appropriately in terms of location and tightness may further reduce lateral thoraco-lumbar spinal movement, but the clinical relevance of this reduction is not known (Mazolewski and Manix, 1994; Peery et al., 2007).

Vie aeree

The available clinical studies evaluating the impact of airway control using in-line cervical stabilization did not find worsening of neurologic status after airway management (Maruyama et al., 2008; Scannell et al., 1993). Anatomical studies of in-line stabilization with a Miller blade showed less cervical movement compared to use of a cervical collar alone (Gerling et al., 2000).

trasporto

Burney and associates reviewed patients with spinal column fractures with SCI (complete or incomplete) to assess whether these patients could undergo safe early transport to an SCI center using basic equipment for spine stabilization. Transportation was achieved both by ground ambulance (41%) , helicopter (54%), and fixed-wing aircraft (5%), and 84% were transferred within 24h of injury. No patients suffered ascending injury levels as a result of transfer. There was no significant difference found in the probability of improvement between ground and air transportation (Burney et al., 1989).

Recommendations

All recommendations were derived from the systematic reviews, statements from the authors, and the Delphi process. The latter was reported using the level of agreement and the comments and suggestions of experts.

Question 1. What is the optimal type and duration of pre-hospital spinal immobilization in patients with acute SCI?

- Immobilization of patients with SCI during the pre-hospital setting should include a cervical collar, head immobilization, and a spinal board.
- Patients should be transferred off the hardboard on admission to a facility as soon as is feasible to minimize time on the hardboard. If patients are awaiting transfer to another institution, they should be taken off the hardboard while awaiting transfer.

- Padded boards or inflatable bean bag boards should be utilized to reduce pressure on the occiput and sacrum.
- These recommendations are intended for adults and children over the age of 12 years.

Question 2. During airway manipulation in the pre-hospital setting, what is the ideal method of spinal immobilization?

- Airway management of acute SCI patients requiring intubation in the pre-hospital setting should include the use of manual in-line cervical spine traction.
- Intubation of patients with acute SCI in the pre-hospital setting should not rely solely on cervical collar neck immobilization.
- Indirect methods of intubation may cause less cervical movement than with direct laryngoscopy with a Miller blade.

Question 3. What is the impact of pre-hospital transport time to definitive care on the outcomes of patients with acute SCI?

- Transport of patients with acute traumatic SCI to the definitive hospital center for care should occur within 24 h of injury.

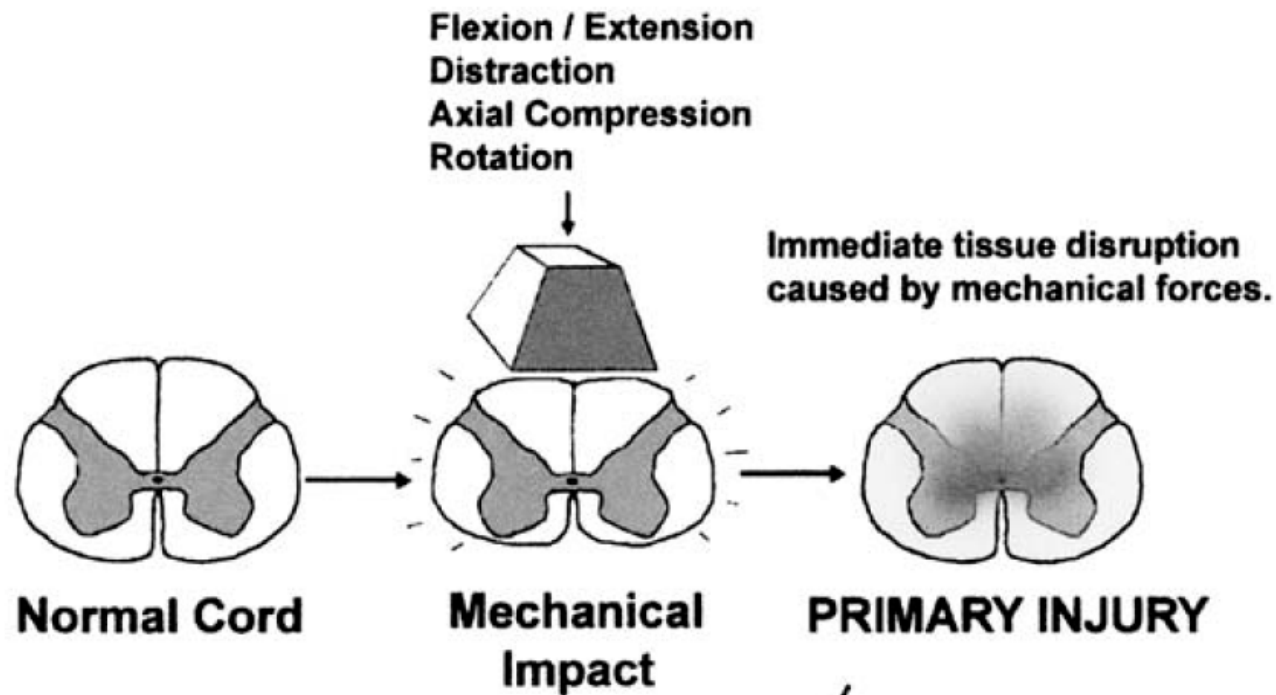
Question 4. What is the role for pre-hospital care providers in cervical spine clearance and immobilization?

- Emergency medical personnel in the pre-hospital setting can be trained to apply criteria to clear patients of cervical spinal injuries and immobilize patients suspected of having a cervical spinal injury.
- The implementation of this recommendation will likely be impacted by regional variations in law and health policy.

There is insufficient evidence to make recommendations for children, and the authors have concerns regarding the applicability of adult recommendations to pediatric patients.

Triage protocols and trauma systems of care:

- Prehospital Triage
- Trauma Centers
- Spinal Cord Injury Centers
- Neuroprotection
- Prognosis for neurological recovery
- Rehabilitation intervention



Acute Pathophysiologic
Processes

**NEUROPROTECTIVE
INTERVENTIONS**

- In-Field Stabilization
- ATLS Resuscitation
- Pharmacologic Agents
- Prompt Medical/Surgical Care

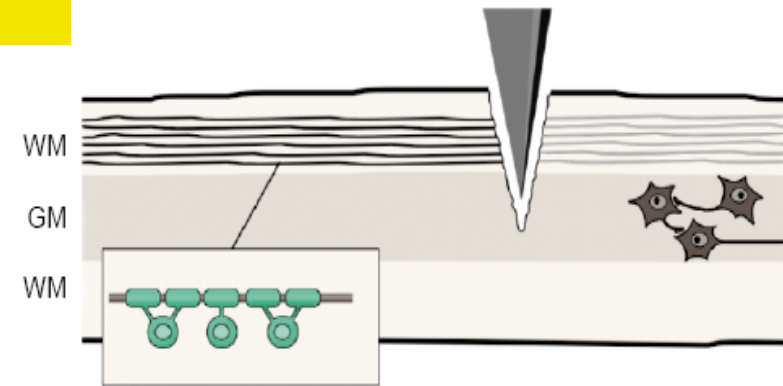
**Therapeutic
window**

SECONDARY INJURY

Evoluzione macroscopica del quadro neuropatologico

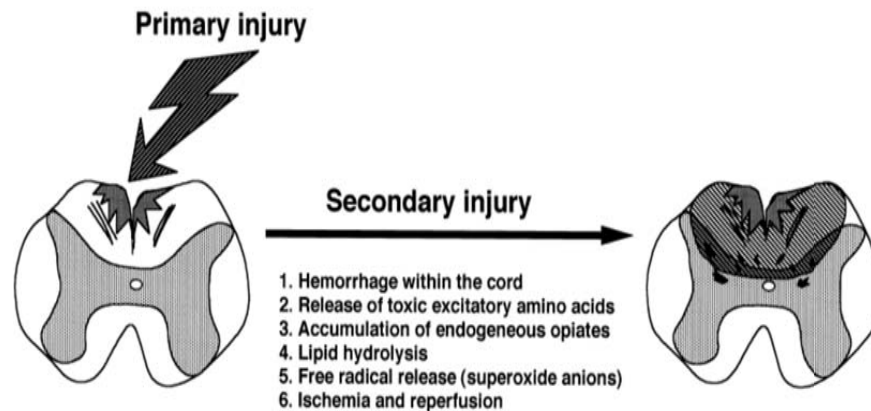
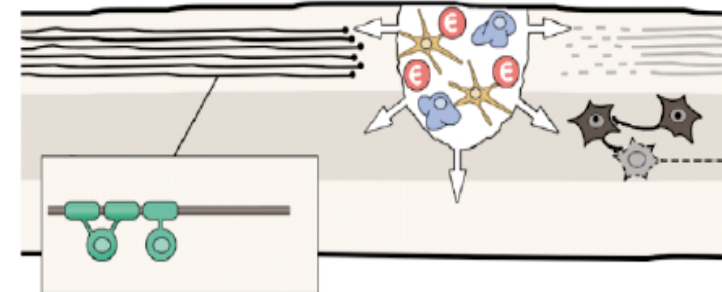
Danno Primario

Acute: from the impact to the first few days after SCI

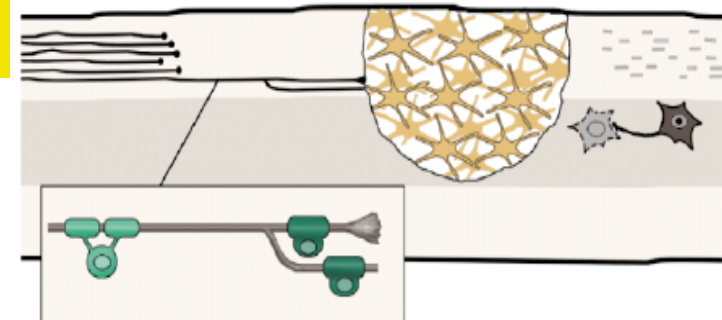


Danno Secondario

Secondary: within minutes to weeks after SCI



(c) Chronic: within days to years after SCI



Stadio Cronico

Possibili interventi terapeutici

Ridurre edema e produzione
di radicali liberi

Neurotossicità da GLU

Terapie con
impianti cellulari

