

Physical Therapy After Pelvic Injuries, Vertebral Column Injury

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Pelvic Fractures

Introduction

- Mechanism typically high energy blunt trauma
- Mortality rate 15-25% for closed fractures, as much as 50% for open fractures
- Associated injuries
 - chest injury in up to 63%
 - long bone fractures in 50%
 - sexual dysfunction up to 50%
 - head and abdominal injury in 40%
 - spine fractures in 25%
- Prognosis
 - high prevalence of poor functional outcome and chronic pain

Tile Classification

- **A: stable**
 - A1: fracture not involving the ring (avulsion or iliac wing fracture)
 - A2: stable or minimally displaced fracture of the ring
 - A3: transverse sacral fracture
- **B - rotationally unstable, vertically stable**
 - B1: open book injury (external rotation)
 - B2: lateral compression injury (internal rotation)
 - B2-1: with anterior ring rotation/displacement through ipsilateral rami
 - B2-2-with anterior ring rotation/displacement through contralateral rami (bucket-handle injury)
 - B3: bilateral
- **C - rotationally and vertically unstable**
 - **C1: unilateral**
 - C1-1: iliac fracture
 - C1-2: sacroiliac fracture-dislocation
 - C1-3: sacral fracture
 - C2: bilateral with one side type B and one side type C
 - C3: bilateral with both sides type C

Young-Burgess Classification

- The Young-Burgess classification system is based on mechanism of injury: anteroposterior compression type I, II and III, lateral compression types I, II and III, and vertical shear, or a combination of forces.
- Lateral compression (LC) fractures involve transverse fractures of the pubic rami, either ipsilateral or contralateral to a posterior injury.
- Grade I – Associated sacral compression on side of impact
- Grade II – Associated posterior iliac ("crescent") fracture on side of impact
- Grade III – Associated contralateral sacroiliac joint injury

Stable Fractures

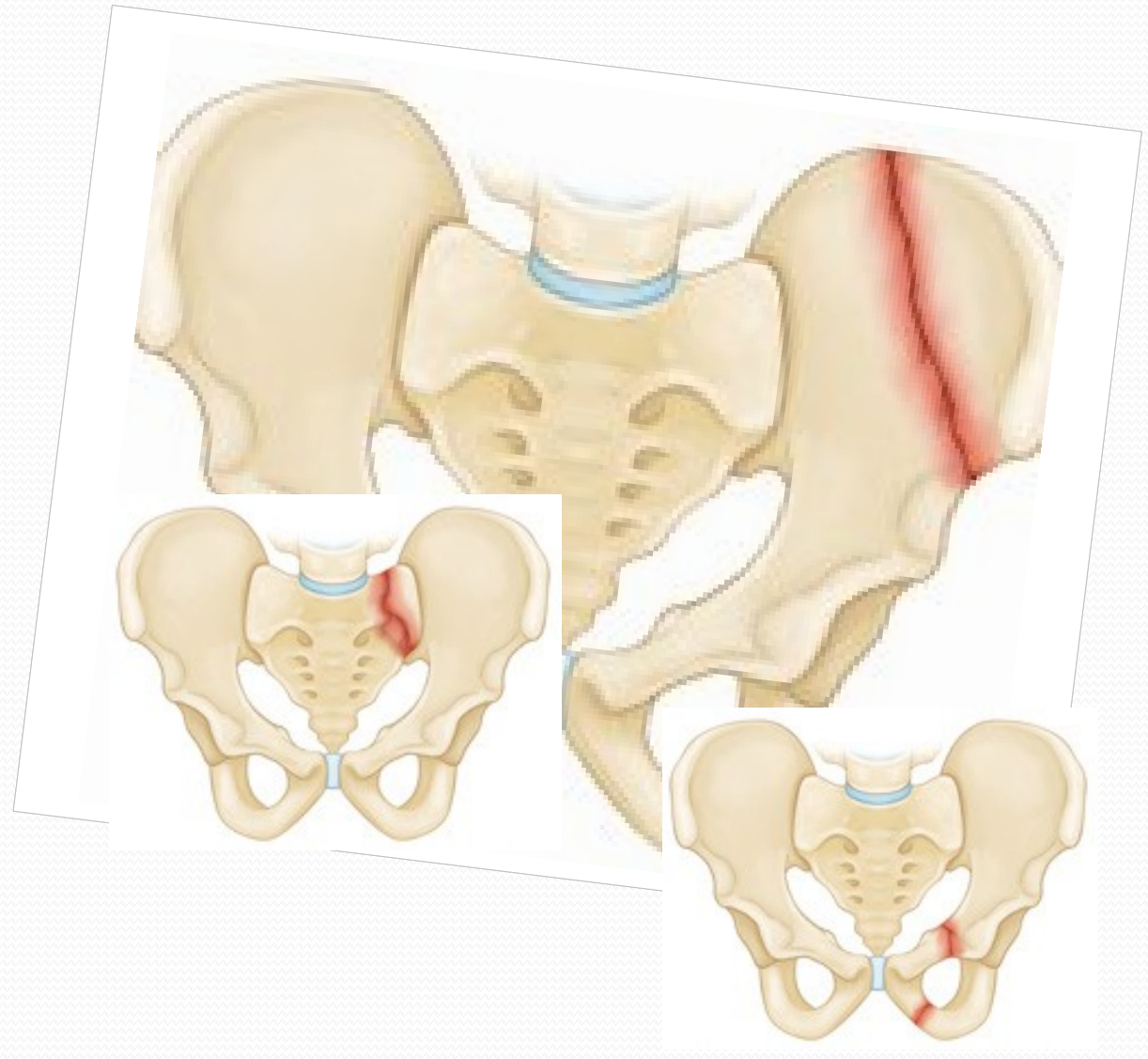
- There is often only one break in the pelvic ring and the broken ends of the bones line up adequately
- Low-energy fractures are often stable fractures
- Stable pelvic fracture patterns include: Iliac wing fracture, Sacrum fracture, Superior and inferior pubic ramus fracture

Stable Fractures

Iliac wing fracture

Sacrum fracture

Superior and inferior pubic ramus fracture



Unstable Fractures

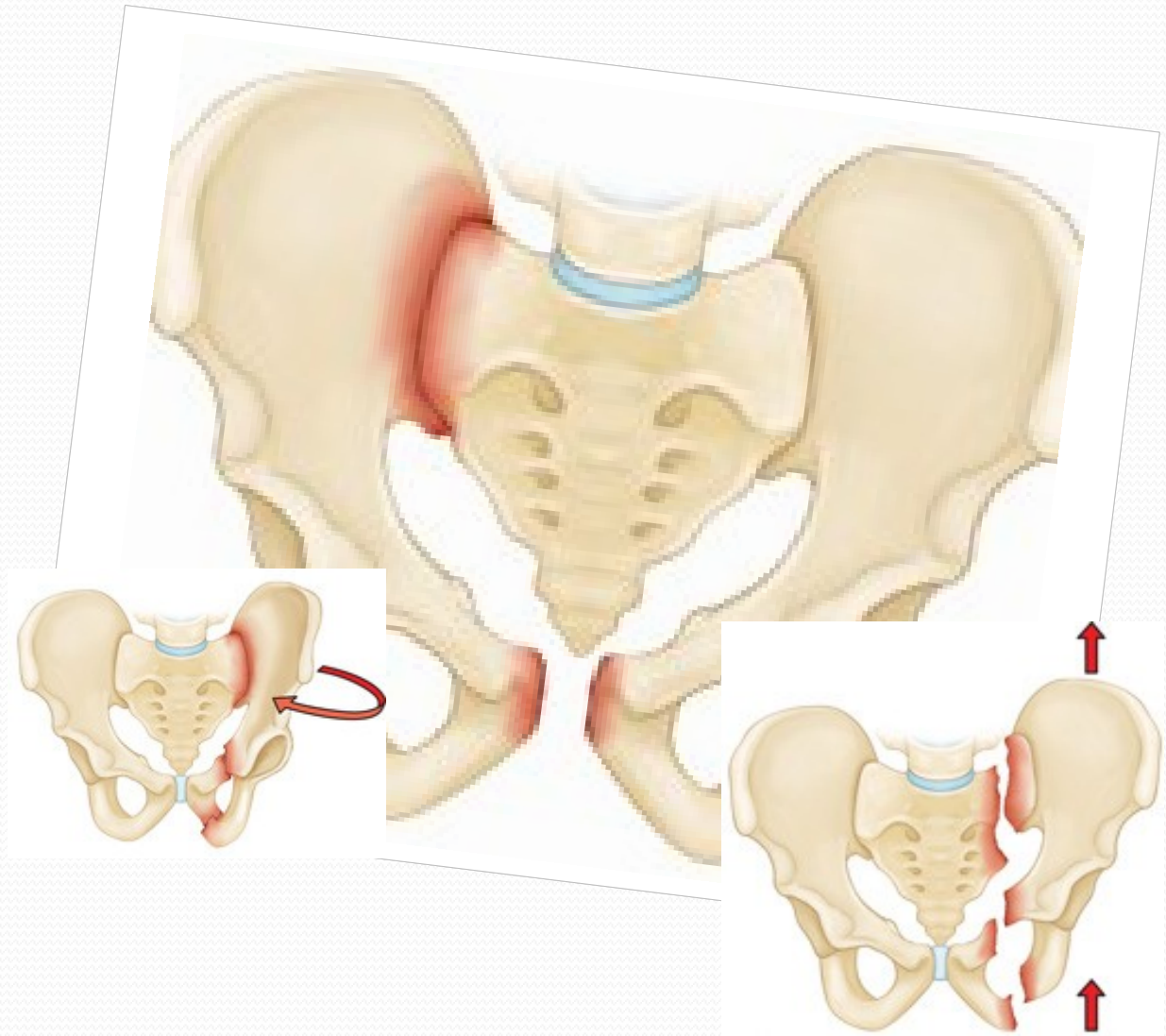
- There are usually two or more breaks in the pelvic ring and the ends of the broken bones do not line up correctly (displacement)
- This type of fracture is more likely to occur due to a high-energy event
- Unstable pelvic fracture patterns include: Anterior-posterior compression fracture, Lateral compression fracture, Vertical shear fracture

Unstable Fractures

Anterior-posterior compression fracture

Lateral compression fracture - in this fracture, the pelvis is pushed inward

Vertical shear fracture - in this fracture, one half of the pelvis shifts upward



Pelvic Fractures, Classification

- Both stable and unstable pelvic fractures can also be divided into:
- **Open fractures** - the bone fragments stick out through the skin, risk of infection
- **Closed fractures** - the skin is not broken

Mechanism of Pelvic Fractures

High-Energy Trauma

- Car or motorcycle collision
- Crush accident
- Fall from a significant height

Bone Insufficiency

- A pelvic fracture may also occur due to weak or insufficient bone
- Most common in older people whose bones have become weakened by osteoporosis
- In these patients, a fracture may occur even during a fall from standing or a routine activity such as getting out of the bathtub or descending stairs
- These injuries are typically stable fractures that do not damage the structural integrity of the pelvic ring, but may fracture an individual bone

Treatment

Treatment is based on a number of factors, including:

- The specific pattern of the fracture
- How much the bones are displaced
- Patient's overall condition and associated injuries

- **CONSERVATIVE** treatment – stable fractures without displacement or minimally displaced, pelvic binder
- **SURGICAL** treatment – unstable pelvic fractures

Surgical Treatment

- **External fixation** - to stabilize the pelvic area, metal pins or screws are inserted into the bones through small incisions into the skin and muscle. The pins and screws project out of the skin on both sides of the pelvis where they are attached to carbon fiber bars outside the skin. The external fixator acts as a stabilizing frame to hold the broken bones in proper position
- In some cases, an external fixator is used to stabilize the bones until healing is complete
- In some cases, it is converted to internal fixation

Surgical Treatment

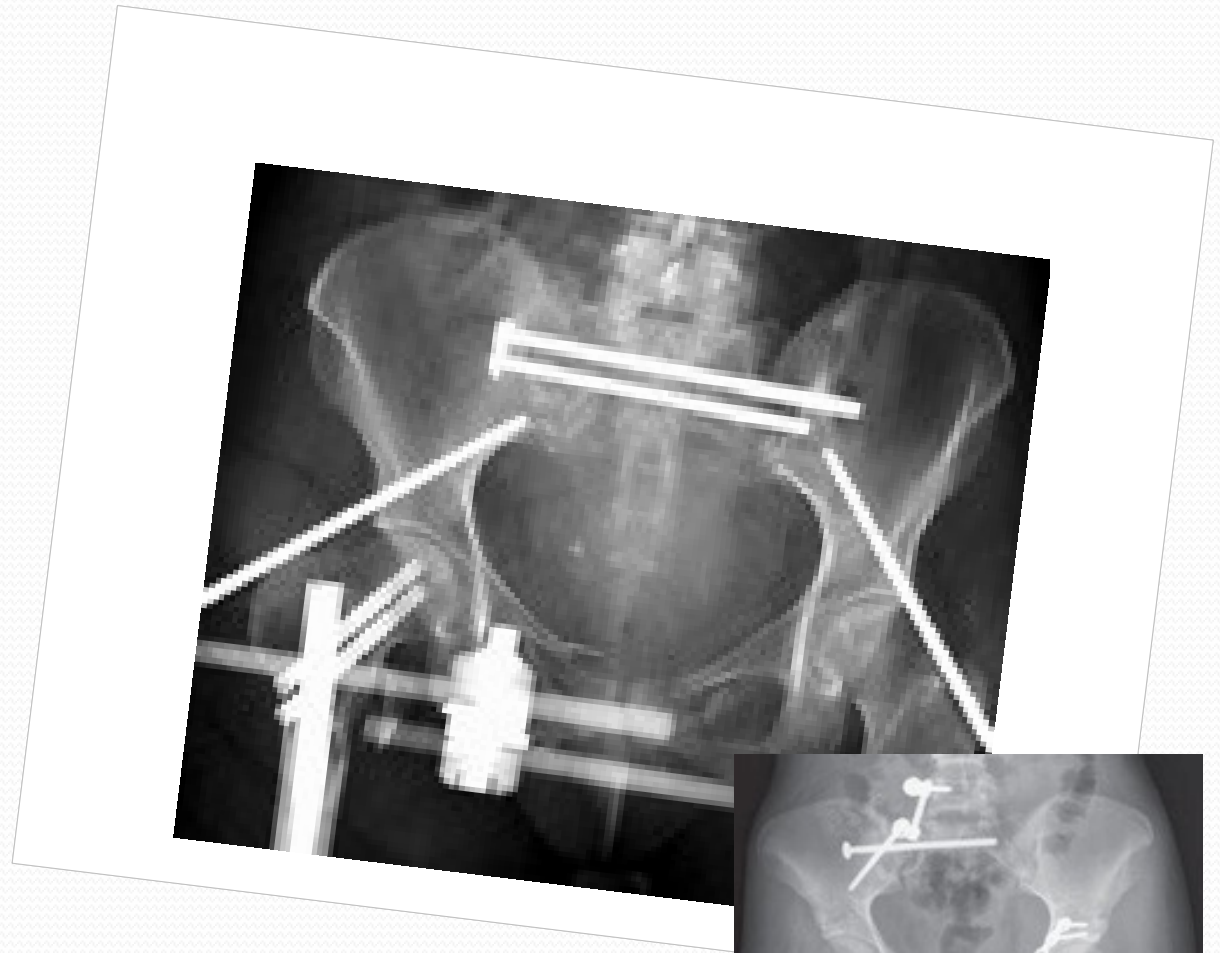
- **Open reduction and internal fixation** - during this operation, the displaced bone fragments are first reduced into their normal alignment. They are then held together with screws or metal plates attached to the outer surface of the bone
- Unstable pelvic fractures and dislocations are complex and potentially devastating injuries
- Early surgical realignment and stabilization of pelvic fractures decreases related bleeding, provides patient comfort and facilitates patient mobility

Surgical Treatment

External fixator

ORIF

<https://www.youtube.com/watch?v=Ty4eibxA G3U>



Rehabilitation


- Rehabilitation is initiated as soon as possible in acute phase during period of bed rest
- Physical therapy may also help a fracture heal more quickly than immobilization alone. Exercise increases blood flow, which delivers more oxygen and nutrients to injured parts of the bone, aiding in healing
- Restoration of leg motion while maintain pelvic fractures stability is the goal of rehabilitation treatment
- The treatment has to respect the time needed to heal the tissues and the physician's decision regarding the permitted loading of the affected side
- Following conservative or surgical treatment, patients follow the decreased weight-bearing status for three to four months


Goals of rehabilitation

- Prevent post-operative complications (pneumonia, deep vein thrombosis)
- Prevent decubitus
- Prevent joint stiffness and muscle contractions or weakness
- Prevent deconditioning
- Improve bed mobility
- Gradually training of sitting, stability in sitting position
- Gait training with assistive devices such as walker, underarm or forearm crutches

Physical Therapy Approaches

- Cryotherapy (application of ice reduces swelling), limb elevation, balling free parts
- Circulatory exercises (ankle pumps)
- Respiratory rehabilitation
- Repositioning (semisupine, supine position)
- Active range of motion exercise and resistance exercise upper extremities
- Isometric exercises lower extremities
- Gentle ROM exercises - PROM or AAROM exercise lower extremities
- Continuous passive motion machine CPM

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- Functional mobility training – includes bed mobility and transfer training such as rolling to an unaffected side, moving up or down the bed - scooting, transitions from lying to sitting in bed or on the edge of bed (when no risk of displacement)
 - Gait training with assistive devices such as walker, underarm or forearm crutches – it depends on patient condition
 - More severe pelvic fractures (bilateral fractures) require a wheelchair – training transfers from bed to wheelchair

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- Weight bearing on leg of the affected side is recommended by physician – non WB (toe-touch WB) with progression to PWB and gradually to FWB within 3 to 4 months
 - ADL training
 - Prepare patient to hospital discharge

Following Rehabilitation


- Self-sufficient patients are discharged from hospital and follow rehabilitation in physiotherapy clinic
- Patients who require 24-hours nurse care, follow therapy and practicing independence in rehabilitation setting

Goals of Following Rehabilitation

- Relieve pain
- Improve ROM
- Improve muscle strength
- Improve or maintain physical fitness
- Improve balance, improve coordination
- Enable ambulation
- Patient's return to their normal activities

Physical Therapy Approaches

- Modalities – magnet therapy (promotes fracture healing), hydrotherapy – whirlpool (reduces swelling and relieves pain)
- Soft tissues mobilization (PIR, balling) – to release contracted muscles, tendons and fascia (lumbal area, pelvic area, hip joints)
- Joint mobilization – to restore joint play
- Scare care
- AAROM, AROM exercise
- Resistance exersice to improve muscle strength (overball, theraband, weights)

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- Sensorimotor training – to improve balance skills and joint stability (includes simple exercises such as toe-standing, standing hip flexion, standing side leg raise following modifications doing exercise with eyes closed; balance training aids such as balance discs, unstable platform)
 - Gait training without assistive devices, gait pattern correction
 - Posture correction
 - Aquatic exercises

Vertebral Column Injury

- Vertebral column injury without spinal cord injury
(Whiplash injury, vertebral fractures)
- Vertebral column injury with spinal cord injury

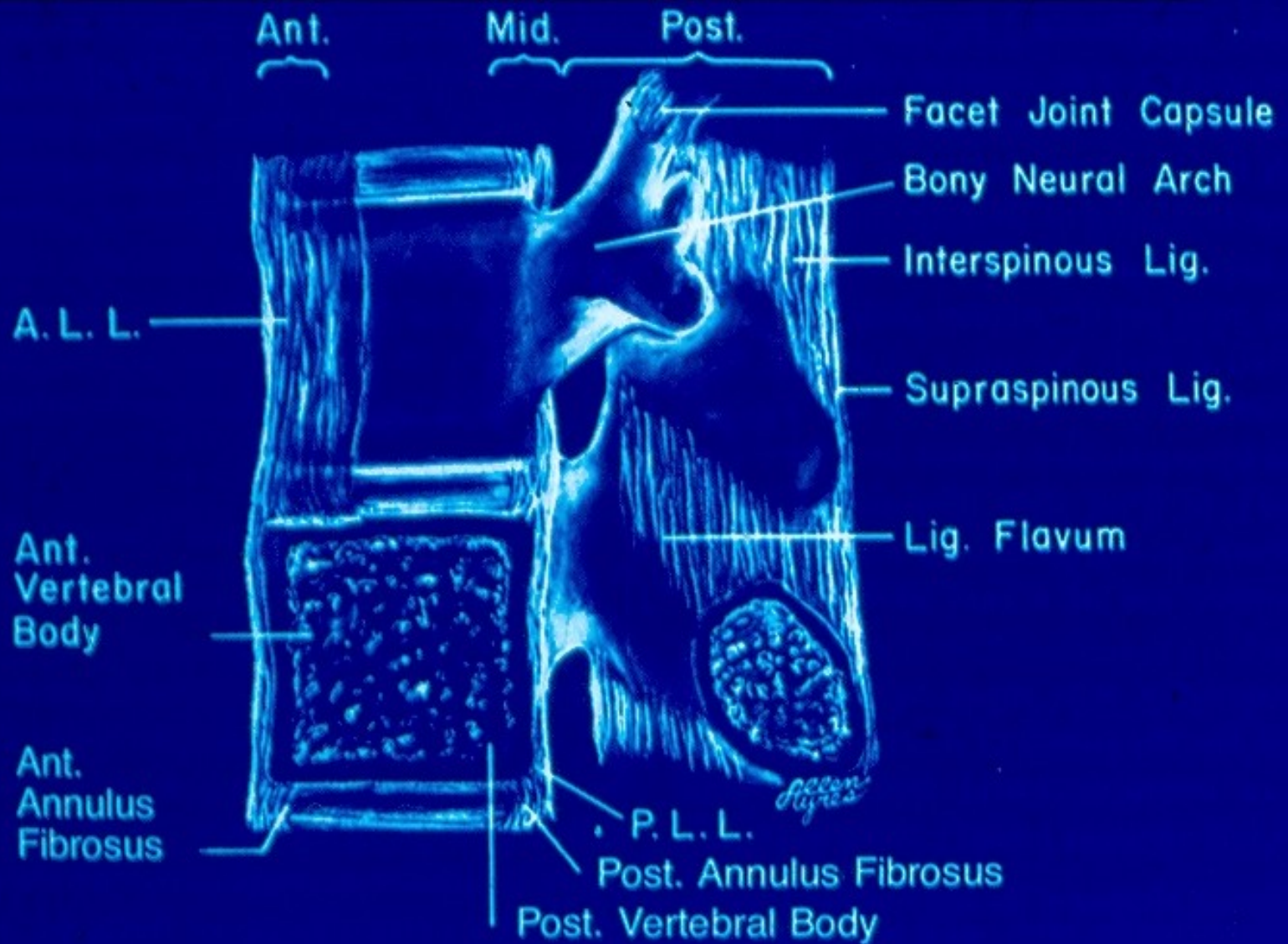


FIG. 1

Whiplash injury

- Neck strain or neck sprain
- Car accidents, any impact or blow that causes the head to jerk forward or backward
- The sudden force stretches (neck strain) and tears (neck sprain) the muscles, tendons and ligaments in the neck
- Symptoms - Pain, decreased range of motion, and tightness in the neck, the muscles may feel hard, tenderness, headache, dizziness
- Treatment - cryotherapy to reduce pain and swelling as soon as possible after the injury for 2 days, painkillers, neck brace, later (3rd day) heat application
- Rehabilitation – when acute symptoms subside to initiate balling, gentle soft tissues techniques, PIR, training of deep postural stabilization of the spine, modalities such as ultrasound and heat application

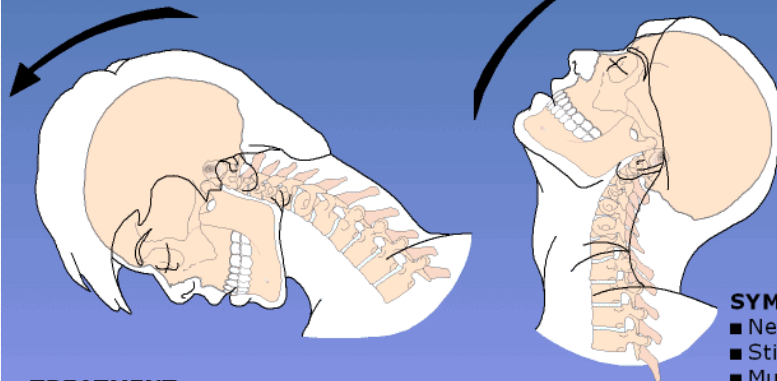
WHIPLASH INJURIES - HEAD & NECK

Whiplash, or neck strain, is caused when injury to the soft tissue of the neck occurs. The damage occurs following sudden extension and flexion of the neck and can include intervertebral joint damage, damage to disks and ligaments, cervical muscles and nerve root damage.

CAUSES

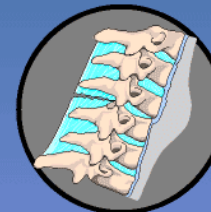
- Automobile accidents
- Contact sports injuries/skiing
- Repetitive stress
- Blow to the head from a fall or punch
- Child abuse (shaking)

Most injuries are to soft tissues such as the disks, muscles and ligaments and cannot be seen on standard X-rays. Specialized tests, such as computed tomography scans or magnetic resonance imaging (MRI) may be necessary.

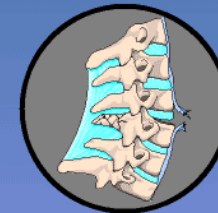


TREATMENT

- Pain medications
- Nonsteroidal anti-inflammatory drugs (NSAIDs)
- Antidepressants
- Muscle relaxants
- Cervical collar (usually worn for 2 to 3 weeks)
- Range of motion exercises
- Physical therapy
- Cervical traction
- Supplemental heat application



Lateral view of vertebral column showing injury caused by hyperextension.



Lateral view of vertebral column showing injury caused by hyperflexion.

CERVICAL HYPEREXTENSION/ HYPERFLEXION INJURIES

SYMPTOMS

- Neck pain
- Stiff neck
- Muscle and ligament damage (myofascial damage)
- Headaches
- Dizziness
- Burning or prickling sensations
- Difficulty with concentration and memory
- Neck pain and stiffness
- Pain in the shoulder or between the shoulder blades
- Low back pain
- Pain or numbness in the arm and/or hand
- Ringing in the ears or blurred vision
- Irritability, sleep disturbances, fatigue

Vertebral Compression Fractures

- When the vertebrae collapse (most commonly in the thoracic and lumbar spine)
- Causes - fall from a tall height in which the person lands on his or her feet or buttocks, car accidents, pathologic fractures and people with osteoporosis (little or no trauma)
- Treatment – **CONSERVATIVE** - pain medications, decreasing activity, orthosis, physical therapy
 - **SURGICAL (internal fixation, spondyloplasty)** – to stabilize the fractured vertebra in case of sudden and serious instability of the spine (if the fracture leads to a loss of 50% of the vertebral body's height)

Jewett Brace

- The orthosis supports the back and restricts movement such as bending forward and rotation
- It holds the spine in straightening, than normal
- This takes most of the pressure off the fractured vertebral body, and allows the vertebrae to heal
- It also protects the vertebra and stops further collapse of the bone



Rehabilitation

- **Goals**

- Prevent complications such as pneumonia, deep vein thrombosis
- Prevent decubitus
- Prevent joint stiffness and muscle contractions or weakness
- Prevent deconditioning
- Improve bed mobility
- Gradually training of sitting and standing with orthosis
- Gait training (with walker if needed in case of bad stability)

Rehabilitation


- **Acute phase** – during relative bed rest
- Respiratory physical therapy
- Circular exercises
- Repositioning
- Functional mobility training – includes bed mobility and transfer training such as bridging, rolling to the sides, log-rolling, moving up or down the bed - scooting
- Active range of motion exercise and resistance exercise of upper and lower extremities
- Isometric exercises
- Training of deep postural stabilization of the spine
- Precautions – restricted movements (bending forward, rotation)
- Application of orthosis (for 3 months)

Rehabilitation

- **Subacute phase**
- Continue with physical therapy in bed
- Training of sitting and standing with orthosis
- Gait training with orthosis (if needed with walker at the beginning)
- Sensorimotor training – to improve balance skills and joint stability (includes simple exercises such as toe-standing, standing hip flexion, standing side leg raise following modifications doing exercise with eyes closed; balance training aids such as balance discs, unstable platform)
- Back school
- ADL training

Spinal Cord Injury

- Spinal cord injury is one of the most devastating health injuries
- Loss of mobility or sensation in the trunk and extremities
- Autonomic nervous system dysfunctions, including urinary and bowel deficits, sexual function deficits and other possible complications
- Spinal cord damage is most often caused by an injury involving a compromise of the spinal canal by a subluxated vertebra or bone fragments
- Spinal injuries involving the spinal cord are mainly caused by car accidents, falls from a significant height and sport injuries
- The average age of such injured patients is usually between 30-35 years
- **Paraplegia** develops with a lesion distal to the T2 level
- **Quadriplegia** with a lesion at T1 and above
- **Pentaplegia** - includes simultaneous involvement of the diaphragm, hence a lesion above the C4 level

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- Complete spinal cord discontinuity - it is a complete transverse spinal cord lesion
 - Incomplete transverse spinal cord lesion - preservation of partial movement or sensation below the level of the lesion
 - The neurological progression of a spinal cord injury involves a period of **spinal shock**, which begins immediately following the spinal cord lesion and lasts most often around 6 weeks
 - During spinal shock - complete atonia, areflexia and anesthesia
 - Not uncommon, after the spinal shock subsides, sensitivity or movement can be renewed to a certain extent

Systematic Approach to Treatment

- **Spondylosurgical facility** - patients with a spinal cord injury caused by a trauma are urgently transported to their regional spondylosurgical facility where they undergo surgery
- The surgery consists of two parts - **spinal decompression** or spinal cord release by repositioning the dislocated vertebra and removing bone fragments.
 - **spinal stabilization** - this is significant so that the injured segments can be loaded, intensive and comprehensive rehabilitation can begin
- Specific medications - anti-inflammatories, anti-depressants, analgesics and antithrombotics
- Intensive rehabilitation is already initiated at the spondylosurgical department or even in the intensive care unit (ICU)
- **Spinal cord injury unit** – stable patient (cardiac and pulmonary) are transferred to a spinal cord injury unit providing comprehensive nursing, medical, rehabilitation and psychological care
- **Rehabilitation facility** (in the Czech Republic: Kladruby, Luze-Kosumberk, Hrabyne) providing intensive rehabilitation for another 5-6 months. After that, the patient is provided with assistive devices and aids and is discharged to a home setting or an Institute of Social Care

Medical Consequences of SCL and Complications

- Autonomic dysreflexia
- Orthostatic hypotension
- Deep vein thrombosis
- Urinary dysfunction
- Bowel dysfunction
- Sexual dysfunction
- Skin complications and pressure sores
- Painful conditions
- Septic conditions
- Spasticity
- Para-articular ossification
- Osteoporosis

Rehabilitation

- Physical therapy and occupational therapy dominate in the treatment of patients with a spinal cord injury
- Patient's health and the level of the spinal lesion play the main role in the selection of an appropriate physical therapy technique
- In the spinal cord unit, the patient should undergo individual physical therapy twice a day during work days in addition to exercising on equipment, verticalization, modalities and occupational therapy
- Respirator y physical therapy
- Passive movements
- Active movements
- Soft tissues techniques and mobilization
- Verticalization
- Modalities
- Occupational therapy
- Social rehabilitation

Respiratory Physical Therapy

- Patients with a spinal cord injury always show changes in breathing mechanics
- In patients with a cervical spinal cord injury, expectoration is affected
- In patients with a thoracic spinal cord lesion, an injury to the thorax and the lungs often occurs simultaneously and some patients undergo artificial pulmonary ventilation or have a tracheostomy cannula
- All patients are prone to an increased risk of atelectasis or bronchial pneumonia
- Respiratory pathway hygiene is one of the main goals of therapy
- Pulmonary physical therapy utilizes passive and active techniques
- **Passive techniques** include positional drainage, relaxation of the thorax, manual vibration during expiration, massage of the intercostal spaces and passive respiratory gymnastics
- **Active techniques** include mainly the practice of expiration against resistance, self-drainage and deep breathing with reflex stimulation developed by Vojta. Tools used in pulmonary physical therapy that utilize resistance during expiration and vibration include Flutter and Acapella

Passive Movements

- Prevent contractures and maintain movement in individual joints
- Intervention is especially necessary for patients with quadriplegia who are at greater risk for upper extremity contractures and frequent shoulder joint pain
- Movements must be slow and smooth and, in the acute phase, should not exceed two thirds of physiological range to decrease the risk of soft tissue injury and the development of periarticular ossifications
- Decrease spasticity
- The centration of joints, particularly the shoulder and hip joints involving continuous pressure of the extremity in the direction of its axis into the joint socket. This causes stimulation of pressure receptors located within the joint socket and sends afferent impulses to the area of the spinal cord disruption with a potential for repair
- MotoMed is used to exercise cyclic passive extremity movements. This equipment also allows for active exercise with an option to assess muscle strength. MotoMed can be used in sitting or in bed. Repeated passive movement significantly improves blood circulation in the extremities and increases the stimulation of muscle and joint receptors that send afferent impulses to the spinal cord

Active Movements

- During active movements, physical therapy focuses on the muscles and muscle groups that show completely or partially preserved function
- Renewal of muscle strength, activation of muscles within correct muscle patterns and gradual control of certain positions
- Various physical therapy methods and concepts are utilized, such as Vojtas method, PNF, the neurodevelopmental treatment (Bobath), sling exercise therapy (S-E-T) approach (exercising in slings with RedCord equipment formerly known as the TerapiMaster)
- Most commonly used physical therapy tools include resistance bands, balls, rolls and balance boards

Vertikalization

- As soon as the patient's overall condition allows, verticalization into sitting and standing is initiated following the injury
- Various types of verticalization beds, verticalization tables and stands can be used
- Transfer skills such as moving from bed to wheelchair, from wheelchair to toilet or tub, from floor to wheelchair
- Lokomat machine - is a new and modern piece of medical equipment that serves as a method of manually assisted gait training utilizing a moving belt (treadmill). The equipment consists of a suspension system, treadmill and robotic orthoses. Synchronization is controlled by a computer and the orthoses contain sensors that scan the actual movement activity of the lower extremities. The equipment can be set to individual specifications for each patient with respect to their demands and gait pattern. For patients with a spinal cord injury, intense and specific locomotor training increases the potential for supraspinal plasticity of the CNS motor centers linked to locomotor functions. Lokomat is used mainly by patients with an incomplete spinal cord lesion



RedCord



MotoMed



Lokomat



Modalities

- Treatment neuromuscular pain, tenosynovitis, arthropathies, and to improve skin defects and scars
- Electrotherapy, ultrasound, magnetic therapy, biolamp, distance electrotherapy treatments are the most commonly used modalities
- Various forms of aquatic therapy are also appropriate. If the patient is relatively continent, mobility exercises can be performed in the pool

Occupational Therapy

- Occupational therapy occurs daily in coordination with physical therapy
- Occupational therapy focuses on the practice of independent and common daily activities (dressing, transfers, personal hygiene, food intake, etc.)
- Functional grasp training for patients
- Appropriate selection of assistive devices for the patient to use in a home setting, such as a wheelchair, cushion, positioning bed, tools for personal hygiene and other compensatory aids
- Consultations in regards to home, car driving and work station modifications for handicapped patients

Social Rehabilitation

- Social rehabilitation already occurs during hospitalization in the spinal cord injury unit and later during one's stay in a rehabilitation hospital
- The goal is to prepare the patient for life with a handicap while surrounded by family and strangers
- An important factor is cooperation of the patient's family, which should serve as a strong support system for the patient
- Options are explored to address the patient's home, modifications or changes in occupation, worksite modifications and patient's transfers or transportation with minimal dependence on others
- The patient should not be limited in social activities. The patient can become involved with various non-profit organizations that deal with their disability such as, in the Czech Republic, Centrum Paraple
- Following discharge from a rehabilitation hospital, each patient should seek to be integrated into work and social activities as soon as possible

Resume

- The patients should also develop long-term individual rehabilitation goals aimed at maintaining their physical condition and preventing contractures, edema, osteoporosis, etc.
- However, a patient should not expect to continue an intensive (multiple hours per day) rehabilitation program for several years even though some patients expect they will. In general, improvement in mobility or sensation can be achieved during the initial year after the injury.