SPINAL ORTHOTICS

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Disclosures:

- None

- The views and opinions expressed in this presentation are those of the authors and do not necessarily reflect the official policy or position of any agency of the United States government, including the Department of Veterans Affairs, as well as employers, employee affiliates. It was not prepared as part of official government duties for Dr. Jones

Learning Objectives

- Understanding Terminology
  - How to name an orthotic device
- Understanding the Mechanisms of Action for spinal orthotics
- What considerations are required for use of spinal orthotics?
- How to write a prescription for an orthotic device
- Understand the various devices and their utility

Terminology

- Orthosis: A singular device used to aid or align a weakened body part
- Orthoses: Two or more devices used to aid or align a weakened body part
- Orthotics: The field of study of orthoses and their management
- Orthotic: An adjective used to describe a device
- Orthotist: A person trained in the proper fit and fabrication of orthoses

How do I determine if I have a trained Orthotist?

- An **Orthotist** is a person who is trained to properly fit and fabricate orthoses. The Orthotist is usually credentialed by the American Board for Certification in Prosthetics, Orthotics and Pedorthics (ABC), which was found in 1948. The National Commission on Orthotic and Prosthetics Education (NCOPE) set accreditation standards for entry-level Orthotic and Prosthetic training programs and post-graduate residency training sites.[61]
- The older certification is Board of Certification (BOC)
  - BOCO-(Orthotist)
  - BOCP-(Prosthetist)

Why are spinal orthoses used in clinical care?

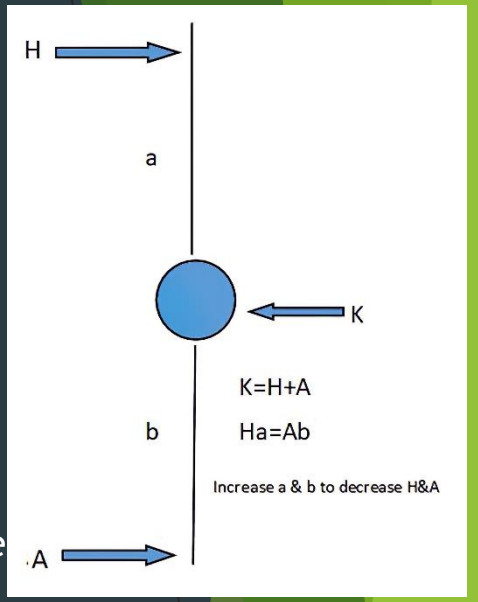
- Stabilization and maintenance of spinal alignment
- Prevention and correction of spinal deformities
  - Promotion of fracture healing
  - May assist with healing of underlying surgical fixation devices
- Relief of pain by limiting motion or weight-bearing
  - The control of the spinal orthosis is based upon the biomechanics of the spine requiring restriction of the sagittal plane, coronal plane, transverse plane of motion or some combination of directional control.
- Reduction of axial loading of the spine
  - Elevated intra-abdominal pressure increased by rigidity of the rib cage and compression of the abdominal muscles reduces the forces on the spine. It reduces the net force applied to spine during the act of lifting a weight from the floor and reduces intradiscal pressure approximately 30% in the lumbar spine.
    - This mechanism of action on abdominal pressure may be questionable
- Improvement of spinal function
  - Unfortunately, there are no demonstrated benefits on proprioception in healthy subjects wearing lumbosacral orthoses.
- Provision of effects such as heat, massage, and kinesthetic feedback [10,31,35,36,46]

Objective of Spinal Orthoses

- Control of Pain
  - limiting motion or weight bearing
  - Provides heat to an area
- Protection against further injury
  - Limit's motion
    - Promotion of healing of fractures
  - Stabilization of vertebral segment
  - Provides stabilization when soft tissue cannot
- Assistance for muscle weakness
- Serves as a kinesthetic reminder

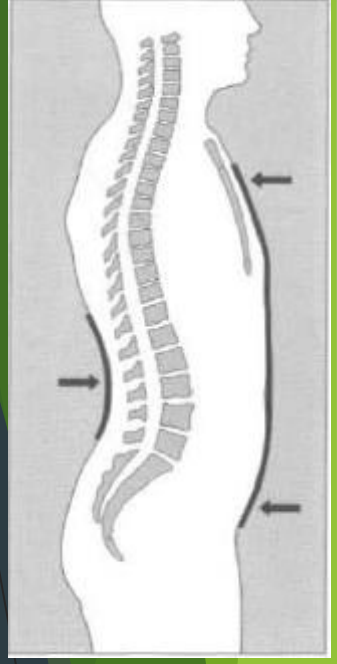
Orthotic Mechanisms of Actions

- Three-point pressure system



- Circumferential support
  - Forms a semirigid cylinder
    - Nachemson (1964) –reduction of intradiscal pressure by 30%
    - Spinal pressure not reduced by increasing intraabdominal pressure
- Irritant
  - Kinesthetic feedback
    - Avoiding discomfort
- Skeletal Fixation
  - True limitation of motion

Purpose of Spinal Orthoses



- Prevention and Correction of Deformities
  - By providing external forces
  - Applying corrective forces to abnormal curvatures
  - 3-point pressure system
- Reduction of Axial Loading
  - Morris,1961 JBJS
    - Elevated intra-abdominal pressure
      - Reduces the net force applied to spine during the act of lifting a weight from the floor
        - May not actually be true
      - Nachemson (1964):Reduces intradiscal pressure approximately 30% in lumbar spine
- Postsurgical Stabilization
  - With or without fracture

John Redford ,PM&R secrets Chapter 96

Ideal Orthosis

- Functional
- Fits well
- Comfortable
- Light in weight
- Easy to use
- Cosmetically acceptable
- Easily maintained/repaired
- Ideally locally manufactured

Different than the “3H’s”predicing failure

Hot, Heavy, Horrible looking

Complications or Side-effects of Spinal Orthotics

- Weakening of axial muscles
- Trapping of moisture with loss of skin integrity
- Development of pressure area
- Pressure on nerves
- Limit some activities of daily living
- Potential osteopenia though misuse or overuse
- Causes discomfort and emotional distress leading to impaired quality of life

What factors require consideration in prescribing the most appropriate orthosis for a specific spinal problem?

- Baseline musculoskeletal and neurological examination
- The pertinent diagnoses, age, bone development, deformity, prognosis
- The patient's body habitus?
- Projected patient requirement of compliance?
- The intended mechanism and results from the orthotic device?
- The regions that need to be controlled?
- What complications or loss of function may be caused by the device?
- What type of control upon the biomechanics of the region is required?
  - Restriction of sagittal plane motion
  - Restriction of coronal/Frontal plane motion
  - Restriction of transverse plane motion

- From Orthotist standpoint
  - The weight of the device
  - What forces or loads are going to be required by the device
  - The material being utilized for the device
  - Can the material utilized hold up to the forces required to control the body part?
  - Cosmetic appearance of the device
  - Cost, availability and ease of care of the device

Prescription:

Prescriptions should include the following items:

- Patient's name, age, and gender, Current date
- Diagnosis
- Functional Goal,
- Orthotic description
  - Area covered
  - Flexible or Rigid device
  - Custom or Off-the-shelf
- Control desired based upon biomechanics of the spine
  - Restriction of sagittal plane motion
  - Restriction of coronal plane motion
  - Restriction of transverse plane motion
- Precautions
- Physician name and unique physician identifier number
- Physician signature, office address, contact phone number.

Custom vs Off-the-shelf

- Tenet of Orthotic classical practice
  - *"Customized orthoses more effectively limit or control motion better than prefabricated or off-the-shelf orthoses"*
    - More intimate fit with custom
    - Better control of Triplanar Motion with custom
    - Better control of lateral flexion and Rotation with custom
    - Unequal panels from OTS that creates flexion or extension components
    - Rotation not controlled in OTS due to not locking down on ASIS or the rib cage
    - Custom better adjustment for pendulous abdomen
    - Custom more comfortable to wear than OTS

Bernardoni: Comparison between custom and noncustom spinal orthoses: PM&R Clinic NA 12(2006)73-89

Nomenclature/Categories

- Name by the body regions that they cross/ Eponyms
  - CO: Cervical Orthosis,HCO: Head cervical orthosis
    - Soft or rigid (Philadelphia, Aspen, Miami, Newport)
  - CTO: Cervicothoracic orthosis
    - Halo, SOMI, Minerva
  - CTLSO: Cervicothoracolumbosacral orthosis
    - Milwaukee
  - TLSO: Thoracolumbosacral orthosis
    - Custom-molded body jacket, CASH, Jewett
  - LSO: Lumbosacral orthosis
    - Chairback, Knight, corsets/binders
  - SO: Sacral orthosis
    - Trochanteric belt, sacral belt, sacral corset
- Rigidity
  - Rigid
  - Semirigid
  - Flexible

Need to understand Spinal Anatomy and Motion

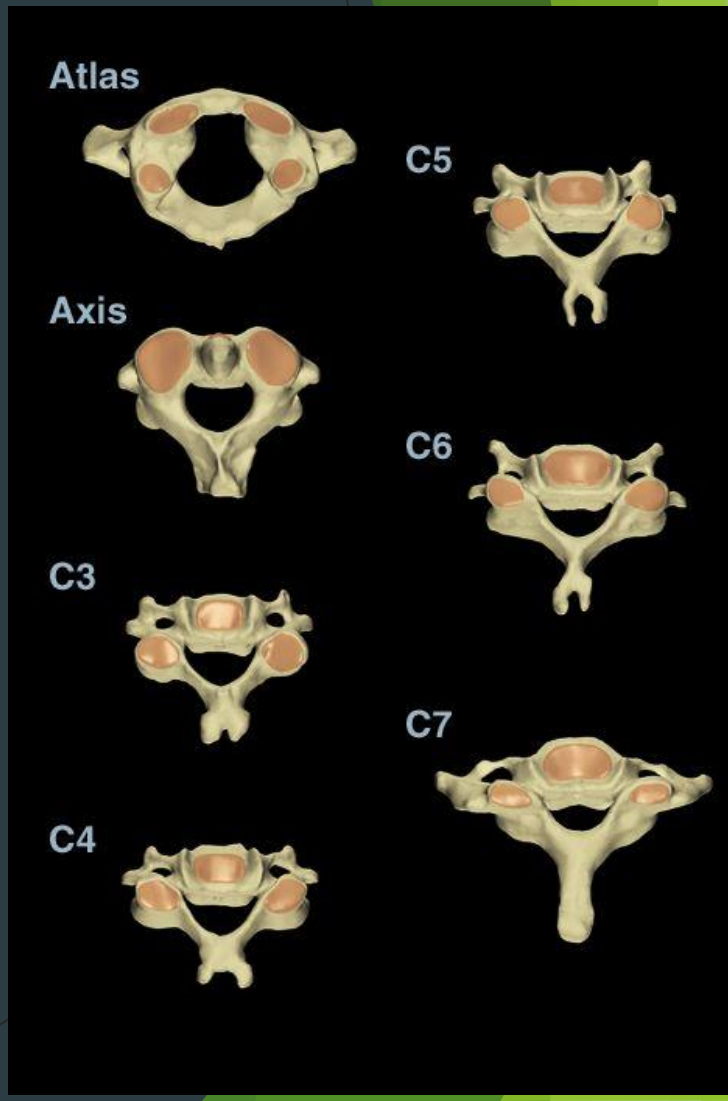
Very limited discussion

List the three principal functions of the vertebral column

- Protect the spinal cord and its nerve roots
- Distribute axial compressive forces
- Provides axis to support the head and translates torque to axis from the limbs.

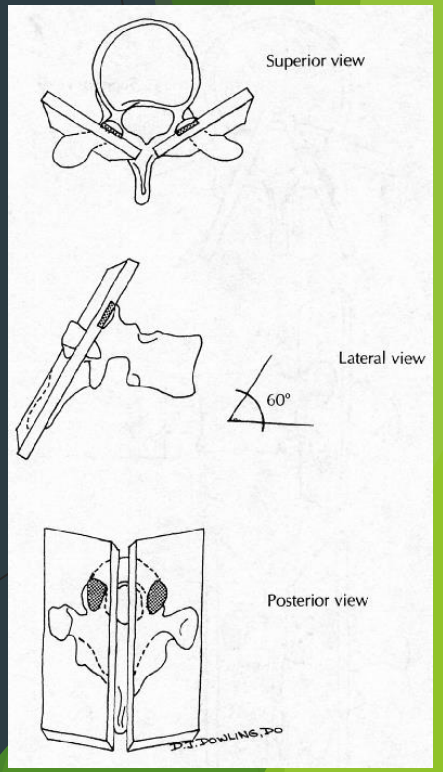
Vertebral Motion-Cervical

- Atypical Cervical Vertebrae
  - Atlas (C1) and Axis (C2)
  - Provides 50% of flexion/extension (OA) (AA) rotation of cervical spine
- Typical Cervical Vertebrae
  - C3-C7
  - Provides 50% of flexion/extension and rotation of cervical spine
  - Maximum flexion/extension C5-6



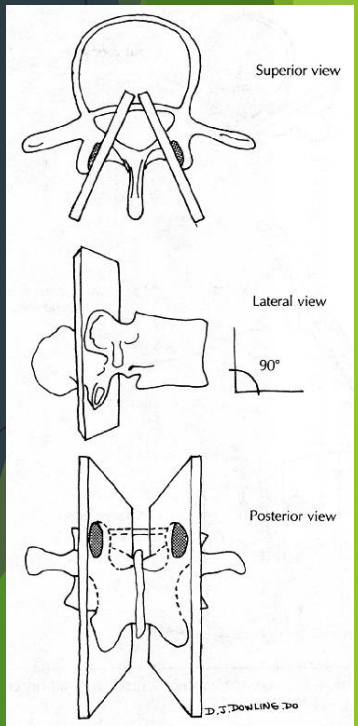
Vertebral Motion-Thoracic

- Thoracic spine
  - All limited by facets and ribs all direct/ Mostly Rotation
  - Upper (T1-4)
    - Rotation> flexion/extension>sidebending
  - Middle (T5-8)
    - Rotation> flexion/extension>sidebending
  - Lower (T9-11)
    - Flexion/extension>sidebending>rotation

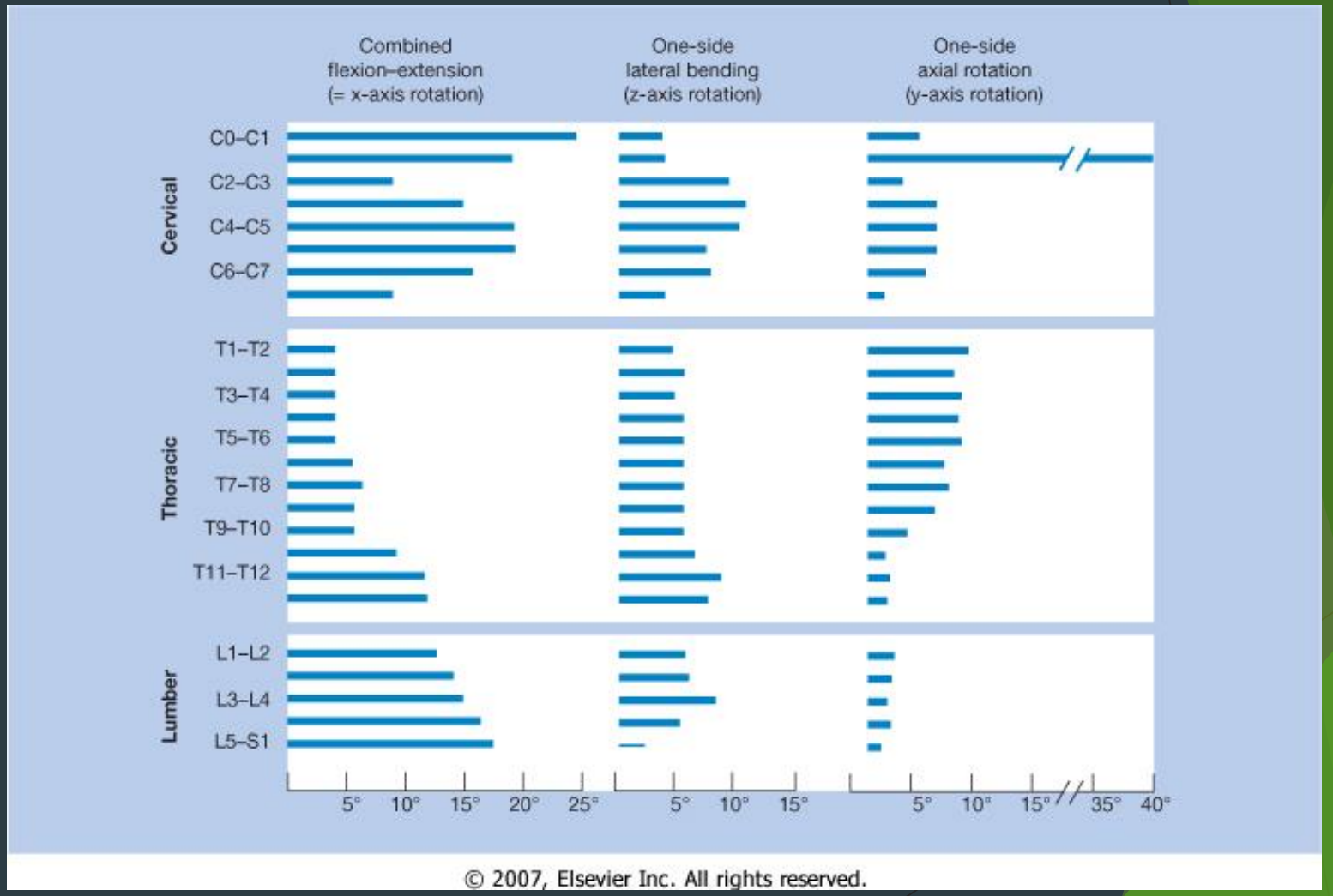


Lumbar Vertebral Motion

- Lumbar spine
  - Major motion is flexion/extension
    - Small degree of sidebending and very little rotation
  - Thoracolumbar Junction (T12-L1)
    - Most mobile section of the spine
  - Midlumbar (L2-4)
  - Lumbosacral Junction (L5-S1)
    - Area more difficult to control



Range of Motion Spinal Area



Braddom 3rd edition

Soft Cervical Collar

Flexion/Ext limited 8-26% Lateral Bending limited 5-10%(8%)
Rotation limited 10-17%

- Foam Rubber
- Benefit
  - Warmth
  - Psychological Reassurance
  - Kinesthetic reminder to limit motion
  - No structural support

May not reduce duration of intensity of pain

Miami J Collar

Flexion/Ext limited 60-76%
Lateral Bending limited 52%
Rotation limited 65-77%

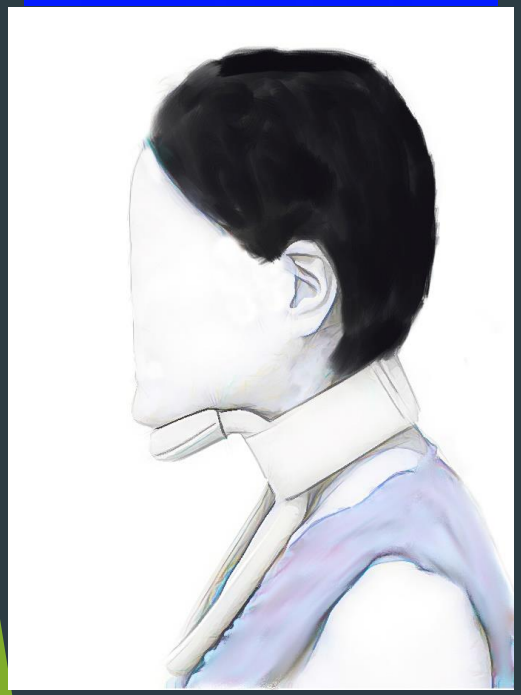
- Polyethylene
  - Has tracheostomy opening
  - Custom adjustment around chin and occiput
  - Lowest level of mandibular and occipital tissue-interface pressure compared to other rigid CO's
  - Lower skin temperature
    - Less sweating
    - Less skin breakdown
- Indications
  - s/p Anterior Cervical fusion
  - Jefferson's Fx (C1)
  - Hangman's fracture
    - Traumatic spondylolisthesis of C2 on C3
  - Dens type I fracture
  - Anterior diskectomy
  - Cervical trauma in unconscious patients
  - Cervical Strain

Malibu Collar

Flexion/Ext limited 55-60%
Lateral Bending limited 60%
Rotation limited 60%

- 2-piece orthosis
  - Anterior opening for tracheostomy
  - Adjustable chin support
  - MRI compatible
  - Heat moldable Kydex
- Indications
  - s/p Anterior Cervical fusion
  - Dens type I fracture
  - Anterior diskectomy
  - Cervical trauma in unconscious patients
  - Cervical Strain


Headmaster control CO



Headmaster control CO

- Light weight and flexible
- Very limited control of motion
- Low profile
- Supports head

- Indications
  - ALS
  - Multiple Sclerosis
  - Dropped Head Syndrome (DHS)
  - Radiation Fibrosis Syndrome
  - Motor Neuron Disease
  - Muscle relaxation due to too much Botoxin

Use of CO for Axial Neck Pain

- No evidence for rigid or soft CO
- Only thing beneficial is therapeutic exercise
- In “whiplash” injury could prolong return to work
  - 34 days vs. 17 days ($p<0.05$)

Crawford, Early Management and outcome following soft tissue injury of the neck: A random controlled trial Injury: 2004;35 (9) 891-895

Philadelphia Collar with Thoracic Extension

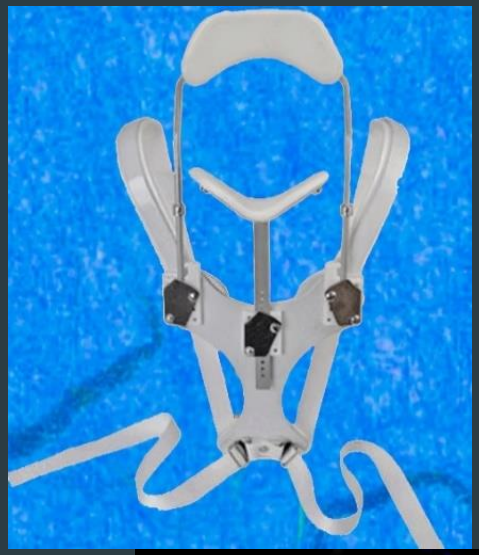
Thoracic support adds restricted motion C6-T2

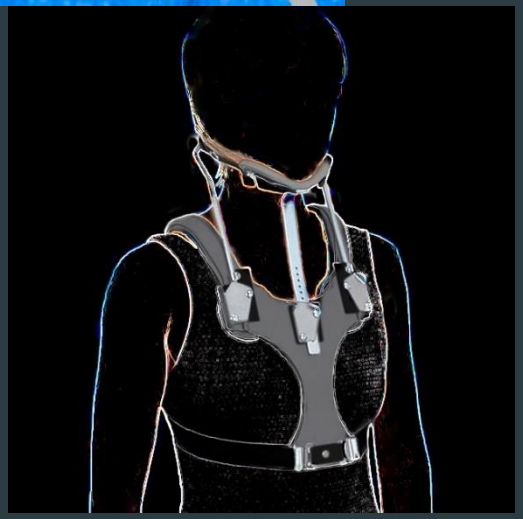
Some say to **T5**

Flexion/Ext limited 65-70%
Lateral Bending limited 30-35%
Rotation limited 60-65%

- 2-piece Plastizote Foam
  - High capillary closing pressure
    - Increase skin temp
    - Increase sweating
    - Increase risk of ulcer
- Indications
  - s/p Anterior Cervical fusion
  - Dens type I fracture
  - Anterior diskectomy
  - Cervical trauma in unconscious patients
  - Cervical Strain

Sternal-occipital-mandibular Orthosis (SOMI)





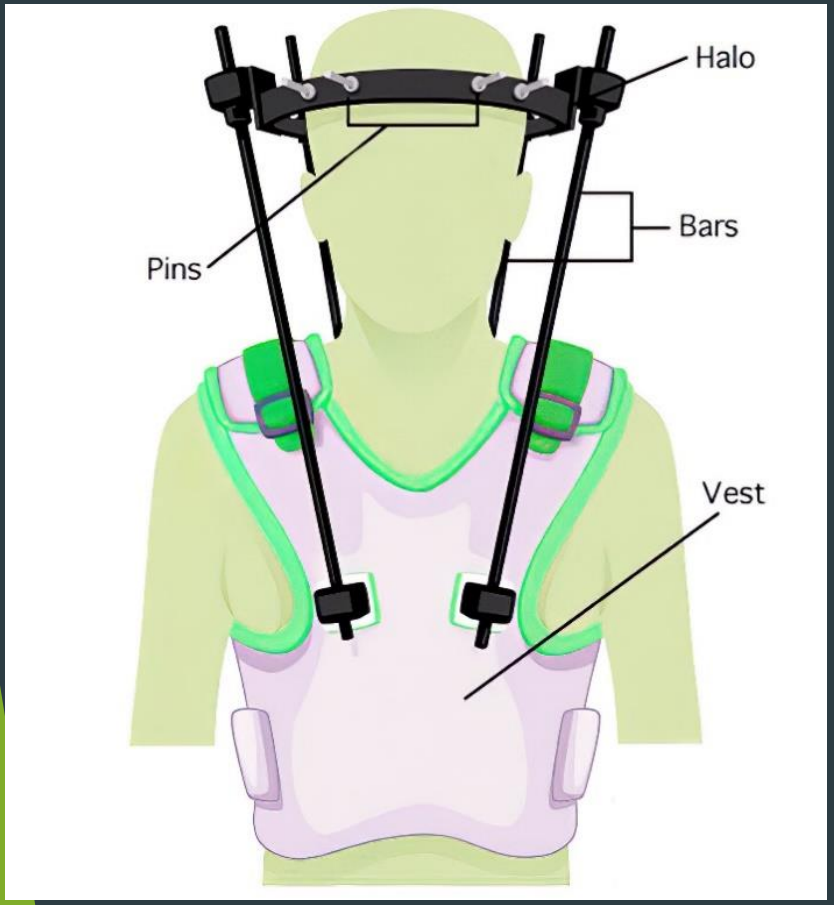
- 3-Poster CTO
  - Ant chest plate to xiphoid process
  - Removable chin strap
- Control of Motion
  - Flexion
    - C1-3
  - Extension
    - Less control than other CO's
- Indications
  - AA instability-RA
  - Neural arch fx C2
    - Due to flexion instability

Flexion/Ext limited 61-72%
Lateral Bending limited 18-34%
Rotation limited 29-66%

CTO

- CTOs provide significantly more restriction of intervertebral flexion and extension than CO's
- Controls motion down to around T5

Halo Device



Flexion/Ext limited 96%
Lateral Bending limited 96%
Rotation limited 99%

- 4-Poster Control
  - Controls down to T3
  - Usually worn 8-12 weeks
  - Good control Occiput to C1
  - Poor control mid-cervical region
  - Indications:
    - Occipital condyle fracture
    - C1 ring fracture
    - C2 facet subluxation
    - Spinal infections

Halo Device Positioning

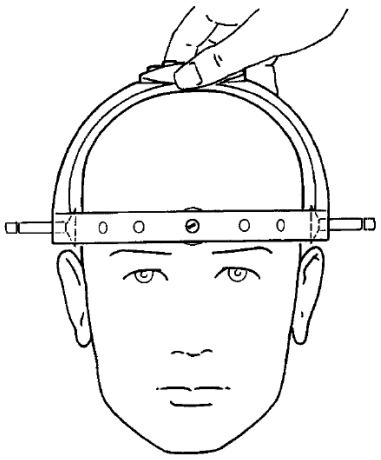


Fig 3. The proper position for the crown is below the equator of the skull but not touching the patient's ears.

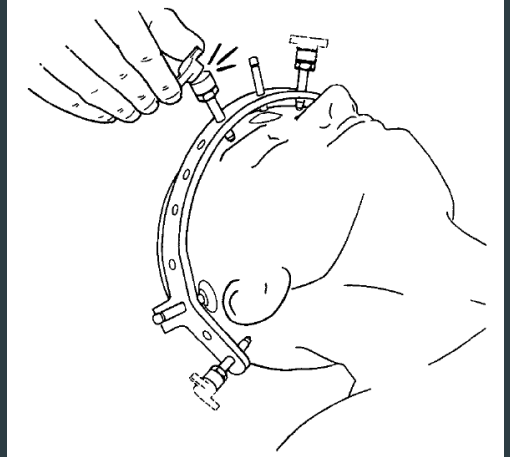


Fig 4. When the crown position is correct and the skin is not under tension, the skin-piercing pins on opposing sides should be tightened until the torque-limiting knobs break off.

- Anteriorly
  - 1cm above orbital rim lateral orbit
- Posteriorly
  - 1 cm above the top of the ear/below largest diameter of skull
- Avoiding
  - Supraorbital nerve-medially
  - Temporal artery-laterally
  - Zygomaticotemporal nerve too lateral

Halo Device

- Problem
  - Intersegmental “snaking”
    - Flexion of one vertebral segment with extension of the adjacent vertebral body
    - Koch + Nichel:31% of normal motion at lower cervical level (C4-5)
    - Lind: 2-17° C2-C6
      - Most OA articulation
  - Complications
    - Pin site infection
    - Scarring
    - Nerve injury
      - Supraorbital nerve/supratrochlear nerve and abducens nerve
    - Dural penetration
    - Intracranial abscess
    - Seizures
    - Dysphagia
- Precautions
  - Avoid Shoulder Abduction ≤90°
  - Avoid Shoulder Shrugging
    - Distraction forces
  - **DO NOT!!!!**
    - Lift, turn, move patient by pulling on vest/rods or superstructure


Fig.1

Halo Device

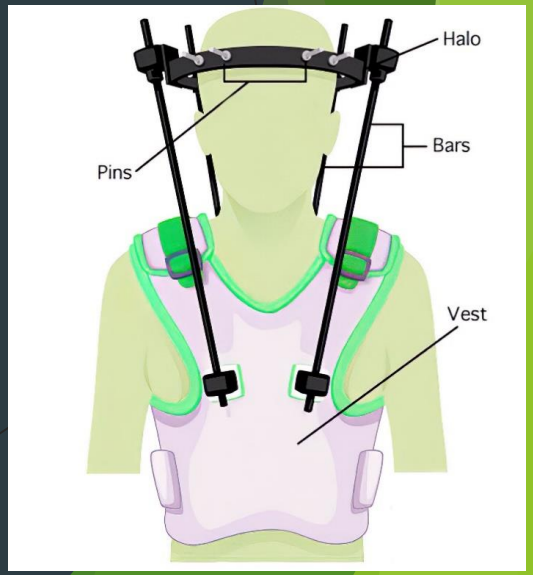
- Pin Care
  - Every 8 hours in hospital
  - Bid after discharge others qd
  - Check for crusting,drainage,redness, swelling
- Pin Cleaning daily
  - Sterile Q-tip
  - Antimicrobial soap and Normal saline
    - Not Betadine, Hydrogen peroxide, or alcohol
      - Pin corrosion
      - Disruption of Healing
- When placed
- Check Lateral X-ray alignment
  - Horizontal position
  - Bed elevated 45 degree
  - Bed elevated 90 degree

Sandra Mangum RN, A comprehensive guide to the halo brace-application,care, patient teaching AORN J Sept 1993,Vol 58,#3

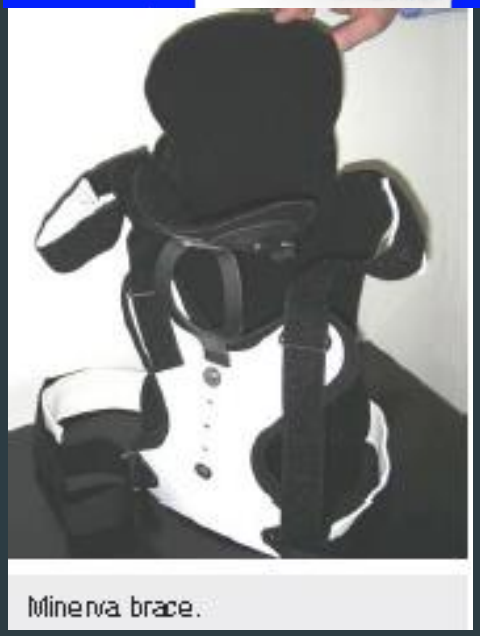
Halo Device Complication

- Pin loosening
  - Clicking/grating/creaking sound
  - Sensation of looseness
  - Pain in pin site
  - Headache
  - Halo vest movement
- Torque Wrench setting
  - Adult
    - 8 inch-pound
  - Children
    - 2-5 inch-pound
- Check pin once a month

- Signs of Brain Abscess
  - Psychosis
  - Scalp pin cellulitis
  - Headache
  - Eye pain
  - Fever
  - Seizure



Minerva Body Jacket


Minerva brace.

- Lighter than halo
  - No pins
  - No risk of infection or slippage
- Less restriction than Halo for OA
- Better control intersegmental than Halo
- Indication
  - Adherent Patient
  - Unstable cervical spine
  - Compliant patient
  - Patient with skull Fx
  - Preschool children
    - Decrease weight
    - Increase comfort
  - C2-T3 stable fractures
  - Cervical muscular and ligamentous injury at or below C2

Flexion/extension limited 78%
Lateral bending limited 51-90%
Rotation limited 84-88%

Alterative to Halo/Minerva

- Lerman noninvasive halo system
  - Use in children
  - Better for C1-2 rotary subluxation
  - Contraindicated
  - unreliable patient/family
  - Unstable cervical spine

Relative percentage restriction of motion by the various CO's [21]

Restriction of Motion % by Orthosis			
Device	Flexion/Extension	Lateral Bending	Rotation
Halo	96	96	99
Minerva	78	51-90	84-88
Four-Post CTO	79-88	54	73
SOMI	61-72	18-34	29-66
Miami J	60-76	52	65-77
Vista -Aspen	69-90	34-48	74
Philadelphia	59-75	12-34	27-56
Soft Collar	8-26	8	10-17

Efficacy of Cervical Orthoses Limited Numbers

Table 1

Studies on the Efficacy of Cervical Orthoses

Study	Motion Tested	Braces Tested	Subjects
Schneider et al[9]	F/E, LB, AR	Philadelphia (Philadelphia Cervical Collar, Thorofare, NJ), Aspen (Aspen Medical Products, Irvine, CA), PMT Halo System (PMT, Chanhassen, MN), Miami J (Össur, Paulsboro, NJ), Minerva, Lerman halo, SOMI	45 volunteers
Gavin et al[8]	F/E	Aspen, Miami J, Aspen 2-post CTO, Aspen 4-post CTO	20 volunteers
Richter et al[10]	F/E, LB, AR	Soft collar, Miami J, Minerva, halo vest	Cadaver specimens, intact and unstable (type 2 odontoid fracture)
Alberts et al[11]	F/E, AR, LB	Nebraska, Philadelphia, SOMI, Lehrman-Minerva brace	14 volunteers
Askins and Eismont[12]	F/E, LB, AR	NecLoc (Össur), Miami J, Philadelphia, Aspen, Stifneck (Laerdal, Armonk, NY)	20 volunteers
Sandler et al[13]	F/E, LB, AR	Soft collar, Philadelphia, Philadelphia with thoracic extension, SOMI	5 volunteers
Rosen et al[14]	F/E, LB, AR	NecLoc, Philadelphia	15 volunteers
McGuire et al[15]	F/E, translation	NecLoc, StiffNeck, Philadelphia	C4-5 destabilized cadaver specimens
Benzel et al[16]	F/E	Minerva, halo vest	10 patients with unstable cervical spine fractures
Kaufman et al[17]	F/E, LB, AR	Soft collar, NecLoc, Philadelphia	10 volunteers
Johnson et al[5]	F/E, AR, LB	Soft collar, Philadelphia, SOMI brace	44 volunteers

AR = axial rotation, CTO = cervicothoracic orthosis, F/E = flexion/extension, LB = lateral bending, SOMI = sternal-occipital-mandibular immobilizer

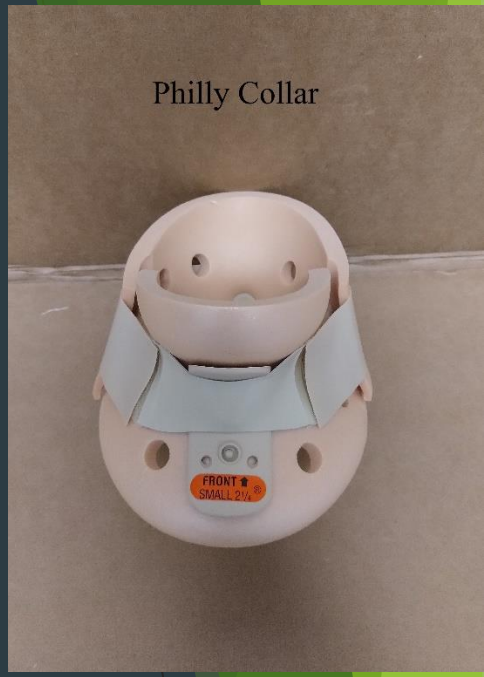
Agabegi: Spinal Orthoses JAAOS, November 2010, Vol 18,#11

Summary Best CO

- All orthoses tend to control flexion better than extension
- Increasing height of the rigid collar more restricted motion
  - May also lead to increase cervical extension (?undesirable)
- The halo is the most effective orthosis for use in controlling flexion and extension at C1-C3, followed by the 4-poster brace and then the CTOs
- CTOs are best for use in controlling flexion and extension at C3-T1, whereas the SOMI is best for use in controlling flexion at C1-C5
- The CTO brace is the second best orthosis for use in controlling rotation and lateral bending in the cervical spine
- The SOMI controls extension less effectively than do other orthoses
- The halo is the best orthosis for use in controlling rotation and lateral bending at C1-C3
- The 4-poster (Halo) brace is slightly better than the CTO brace for use in controlling lateral bending in the cervical spine

Summary Best CO

- Miami J Collar
  - Lowest level of mandibular and occipital tissue-interface pressure compare to other CO's
- Cervical Collars
  - Increase intracranial Pressure in TBI
  - Swallowing effected
    - Narrowing of Pharynx
      - Extension or Hyperextension of C-spine
- Rigid CO
  - Less control
    - Occiput to C2
    - C6-7
  - Good control
    - Mid cervical *(better than Halo)*



- Philadelphia Collar
  - Not well ventilated
    - Increased skin maceration
  - Increased pressure on chin, mandible, occiput
    - Increased risk of tissue ischemia and ulcer

Thoracolumbar Orthosis(TLSO)

- 3-point pressure system
  - Supplies anterior abdominal pressure
    - Increase intracavity pressure
      - Decrease lumbar lordosis
      - Decrease load on the vertebra and disc
  - Restricts trunk and intervertebral motion
    - Control of motion categories
      - Flexion
      - Flexion-extension
      - Flexion-extension-lateral bending
      - Flexion-extension-lateral bending-rotation
  - Supports/aligns spine
  - Most restricted motion cephalad region
    - Least control at L/S junction

Usual Indications and Studies for TLSO's

From Michael Zlowodzki MD,University of MinnesotaDepartment of Orthopaedic Surgery-Spinal Orthotics Lecture

T10-L2 Burst fracture Treatment

- Non-Operative group (n=23):
  - Significantly less disability
  - Significantly lower pain scores
  - Significantly higher physical functioning scores
  - Lower cost ($11k vs. $49k)
- Complications more frequent in Op group
- All patients remained neurologically intact
  - Braces/Casts avoid surgical complications

Operative Compared with Nonoperative Treatment of Thoracolumbar Burst Fracture without Neurologic Deficit: A Prospective, Randomized Study. Wood et al. JBJS Am 2003

T/L Burst Fractures without Neurological Deficit: RCT Operative vs. Brace

- N=80
- Op: Posterior 3-level fixation
  - earlier pain relief and partial kyphosis correction (gradually lost)
  - Earlier pain relief
- Non-op: Hyperextension brace
  - FUNCTIONAL OUTCOME AT 2 YEARS SIMILAR
- Safe treating burst fx with TLSO*

Li-Yang Dai: Conservative Treatment of Thoracolumbar Burst Fracture: Spine Vol 33, No 23 pg 2536-2544 2008*

Nonoperative Treatment vs. Posterior Fixation for Thoracolumbar Junction Burst Fractures without Neurological Deficit. Shen et al. Spine 2001

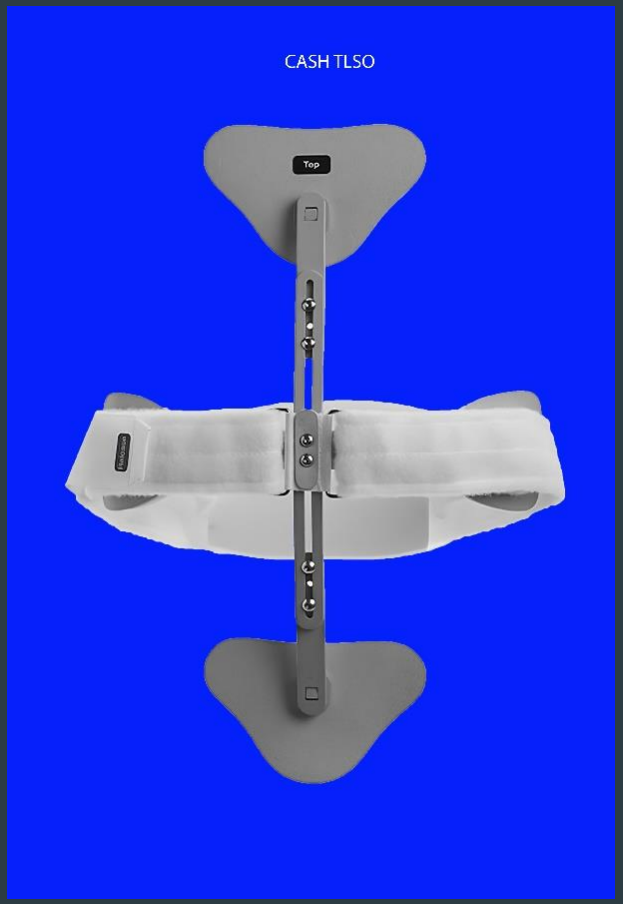
Compression Fractures (<30%): Bracing vs. No external support

- T12-L5; Mostly L1
- One-column fractures of the thoracolumbar spine with <30% compression can be treated with early ambulation and hyperextension exercises

Is there a need for lumbar orthosis in mild compression fractures of the thoracolumbar spine? Ohana et al. J Spinal Disorders 2000

Flexion Control

Cruciform Anterior Spinal Hyperextension Brace (CASH)



Flexion limit T6-L1

- Flexion control
  - Does not limit lateral bending or rotation
  - Easy to donn/doff
- Indications
  - Thoracic/lumbar vertebral body Fx
    - Vertebral height loss >85%
      - Does not prevent progressive deformity
  - Kyphosis reduction/osteoporosis

Contraindication

- Unstable Fracture
- Where extension is prohibited
  - Can cause excessive hyperextension forces of the posterior elements

Jewett Hyperextension Brace

Flexion/ limit T6-L1

- Flexion control
  - Does not limit lateral bending or rotation

Indications(T6-L1)

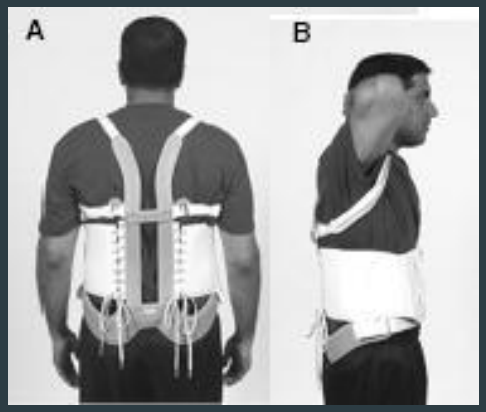
- Thoracic/lumbar vertebral body Fx
- Kyphosis reduction/osteoporosis
- Post op stabilization of TL Fx

Contraindication

- Unstable Fracture
  - 3-column fractures
- Compression Fx above T6
  - Increased motion above pad
- Where extension is prohibited
  - Can cause excessive hyperextension forces of the posterior elements

Flexion-Extension Control

Taylor Brace

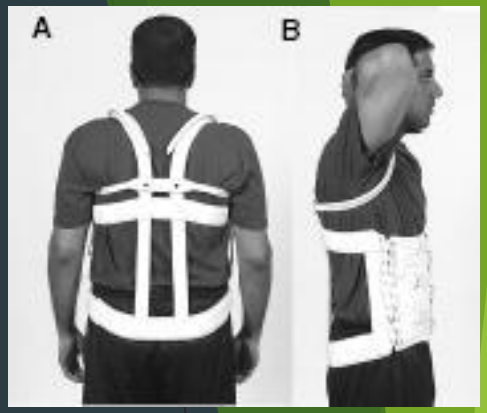


- Limited motion of Mid to lower thoracic to upper lumbar region-? Sacral spine
  - No lateral rigid lateral supports so less lateral control
  - Counteracts kyphosis
    - Produces extension in sagittal plane

Flexion-Extension-lateral Control

Knight Taylor Brace

Controls T6 to L3-4
Possible T4-5 with shoulder straps



Limited motion of Mid to lower thoracic to upper lumbar region

- Increase motion Upper thoracic and lower lumbar & LS junction
- More scapular band than Taylor
- Poor rotary control

Indication

- Anterior compression Fx of Vertebral body
  - Stable Thoracic-Lumbar
- Osteoporosis w Kyphotic curve and trauma
- Spinal extension weakness
- Truncal Paralysis

Flexion-Extension-Lateral-Rotary Control

Custom-Molded Body Jacket

- Polypropylene or Plastic
  - Best control all planes
    - Increases intracavity pressure
    - Diffuse distribution of pressures
      - Ideal for Neurologic Injuries
      - Reduces myoelectric activity of erector spinae muscles
    - T3-L3 areas
  - Anterior shell
    - ½ inch above pubic symphysis to sternal notch
  - Posterior shell
    - Spine of scapula to sacrococygeal junction

Lumbosacral Orthoses

(LSO) Flexible or Rigid

- Elevated intra-abdominal and thoracic pressure reduces net force applied spine during the act of lifting a weight from floor
  - Use of corset decreased the activity of the abdominal muscles

Morris: Role of trunk in stability of the spine. JBJS, 1961;43:327-351

- Tight brace can reduce intradiscal Pressure in lumbar spine by ≈25%

Nachemson, JBJS,1964;46:1077-1092

- Variable Effect on myoelectric activity of abdominal muscles/Extensors of spine

Lantz,Spine Vol(11),No 8 1986 838-842

- No benefit for Low back pain

Consensus statement APTA Guidelines LBP 2012/ACP Guidlelines 2017

Steven Stiens MD, editor PM&R secrets

"With proper prescription, fitting and patient and family education bracing accomplishes pain control, a reduction in anxiety, a dampening of movement to prevent triggered spasm, and an improvement in active function for life activity."

Flexible LSO

- Corsets or binders
  - Indications
    - Pain relief
    - Postural support
    - Vasomotor support
      - SCI
    - Respiratory Support
      - SCI

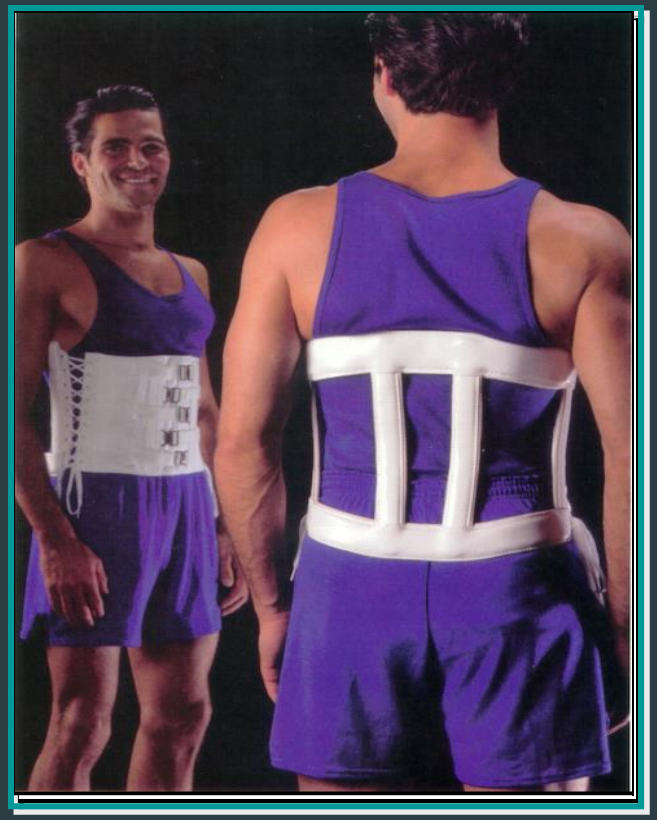
Flexion-Extension Control Sagittal Plane

Chairback

- Limits Flexion-Extension
  - L1-L4
  - Minimal limitation of rotation
  - Lateral bending by 45%
- Unloads intervertebral disc

Knight LSO

Sagittal and Coronal Plane Control



Indications:

Lower back weakness or pain,Arthritis,Need for immobilization of the lumbosacral region

- Components
  - Paraspinal bars
  - Lateral uprights
  - Pelvic band
  - Thoracic band
  - Abdominal support
    - Tightening the abdominal support
      - creates intra-abdominal pressure which effectively reduces lordosis by distending the lumbar spine.

Chairback LSO Sagittal Plane

- Paraspinal bars
- Butterfly pelvic band
  - Sacrococcygeal junction
- Thoracic band
  - Below inferior angle of scapula
- Abdominal support
  - Tightening the abdominal support creates intra-abdominal pressure, which effectively reduces lordosis in the lumbar spine
- Indications
  - Lower back weakness or pain
  - Sacroiliac pain
  - Arthritis
  - s/p Lumbar laminectomy

Extension-Lateral Control

Williams Flexion LSO
Sagittal and Coronal Plane Control

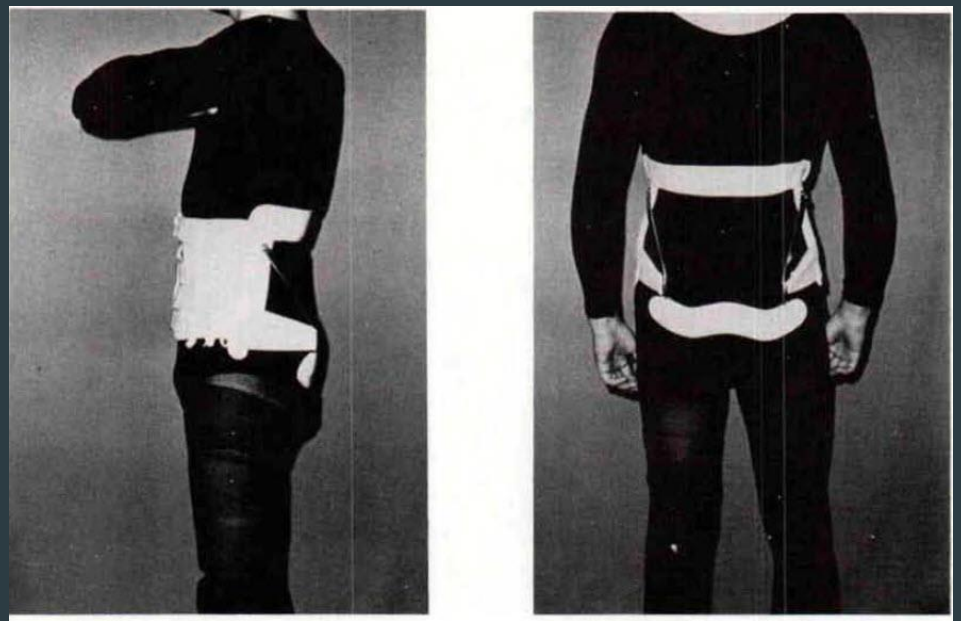


Fig. 9B: Williams Brace—side.

Fig. 9C: Williams Brace—rear.

Edmonson: Spinal Orthotics, 1977

- Components
  - Pelvic band
  - Thoracic band
  - Lateral uprights
    - Pivotable attachments
    - No posterior upright
- Indications:
  - Creates Lumbosacral flexion
    - Includes extensor activity of hip and spine
    - Relieves postural imbalance in low back pathologies with lordosis
    - Spondylolysis
    - Spondylolisthesis

Williams Flexion LSO

Sagittal and Coronal Plane Control

Fig. 9B: Williams Brace—side.

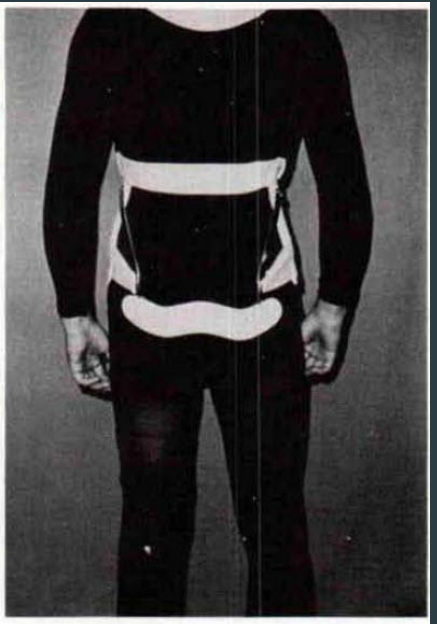


Fig. 9C: Williams Brace—rear.

- Tightening the abdominal support
  - creates intra-abdominal pressure ?
  - It connects the thoracic and lumbar cavities as rigid wall “chambers”
    - increases lumbosacral flexion

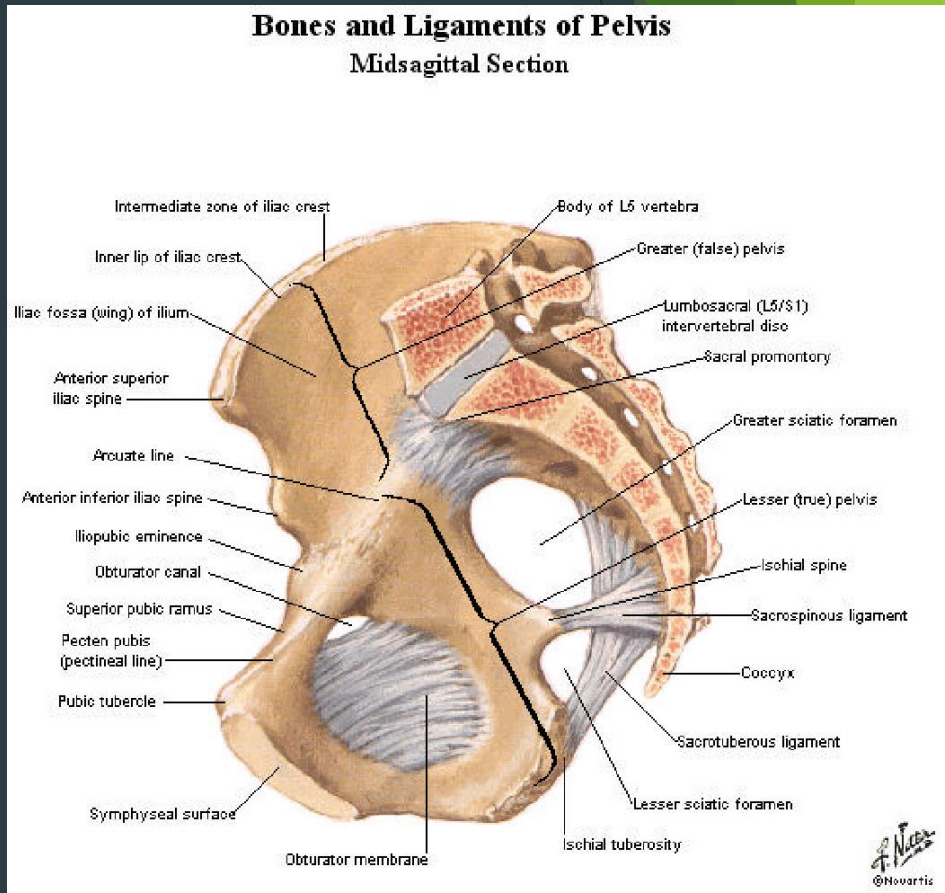
Flexion-Extension-Lateral Control

Custom-molded,plastic LSO

- More rigid support

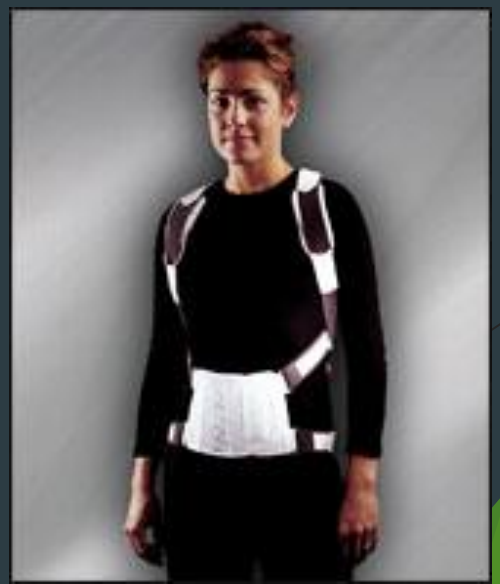
Sacroiliac Joint Belt (SO)

- Provides confidence and proprioceptive awareness to the SI joint
- Only minimal relief of strain of the SI joint ligaments
  - Sacrotuberous ligaments
  - Sacrospinous ligaments.
- Decreases sacroiliac joint rotation around the transverse axis



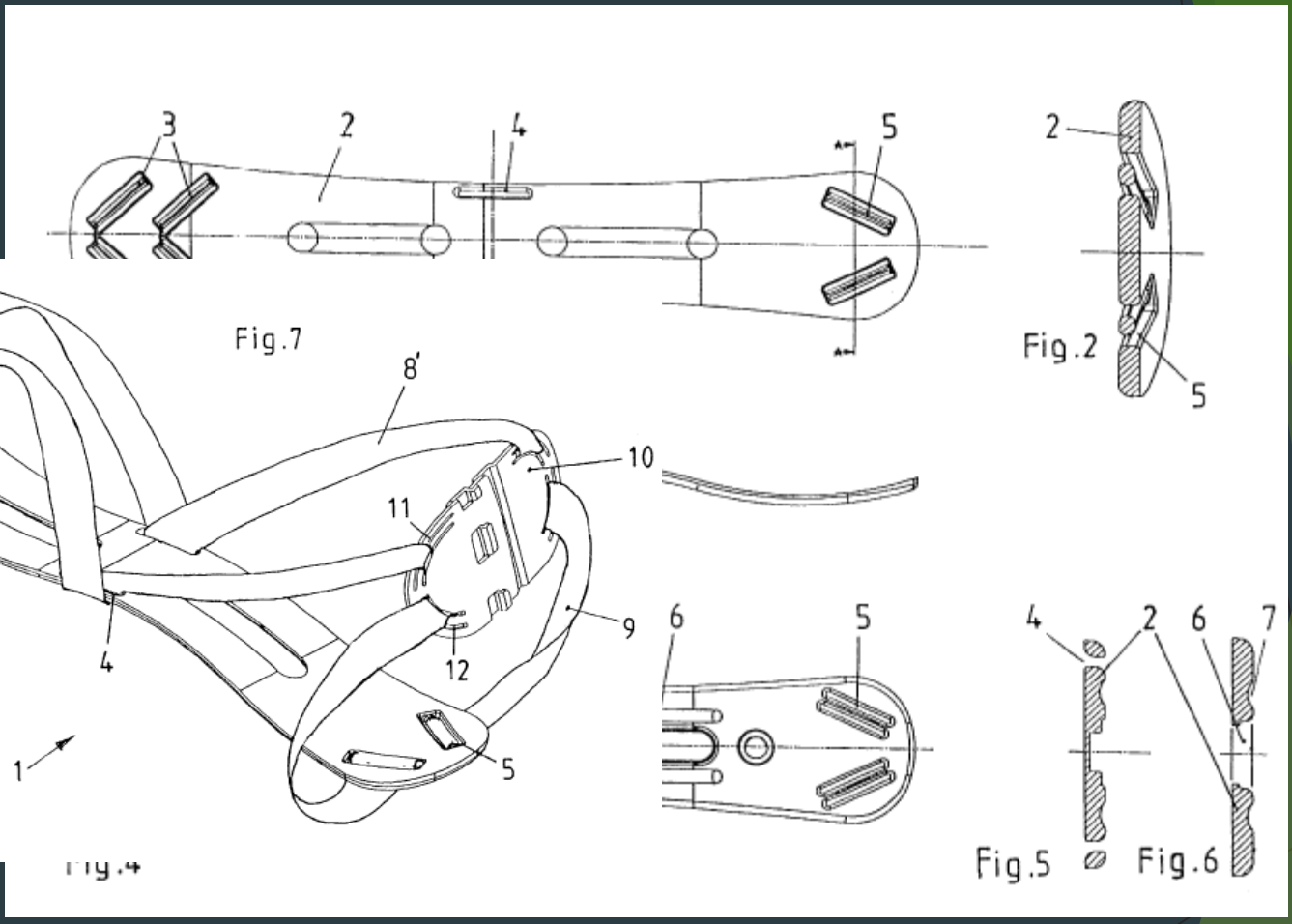
Orthotic Treatment Compression Fracture

- Only 2 Orthotics scientifically studied for efficacy:
- Spinomed®-activates back muscles to straighten the dorsal spine and decrease kyphosis to treat chronic VCFs



http://www.spsco.com/press/07-12-06c.html

Pfeifer M, AJPMR 2004



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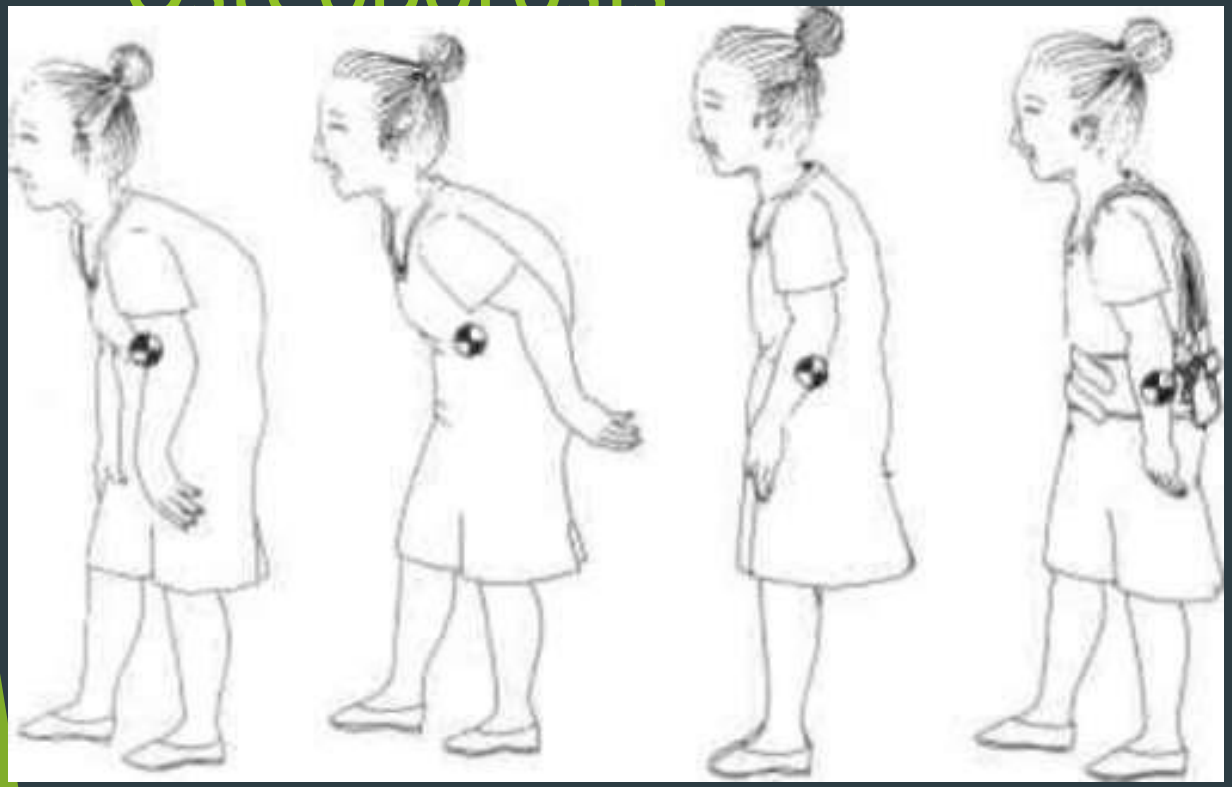
Increased back weakness?

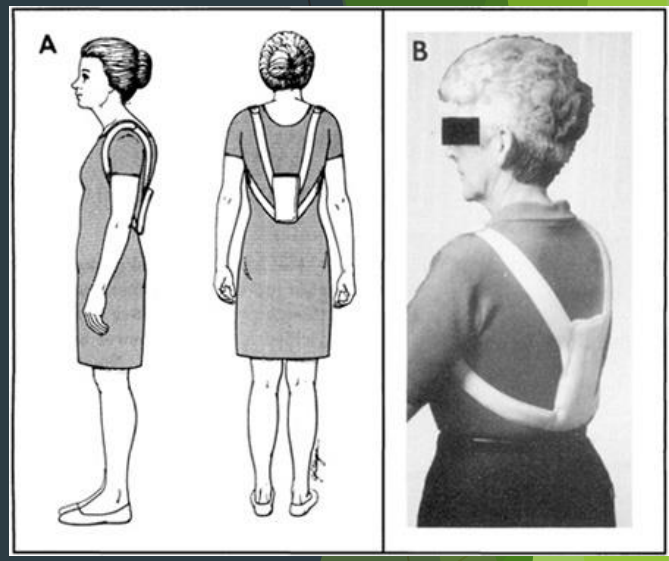
- Lantz and Schultz, *Spine* 1986
  - Increase electrical activity of back muscles when LSO worn
  - Principle effect may be a biofeedback mechanism
- Pfeifer M, AJPMR 2004
  - Females with one clinical vertebral fracture caused by osteoporosis and an angle of kyphosis of 60 degrees as measured by stereophotomorphometry.
  - Noted: Significant increase in trunk muscle strength
    - Increase muscular activity while wearing the LSO

Spino-Med by Pfeifer

- Wearing the orthosis for 6-mo period, 2 hours per day
  - 73% increase in back extensor strength
  - 58% increase in abdominal flexor strength
  - 11% decrease in angle of kyphosis
  - 25% decrease in body sway
  - 7% increase in vital capacity
  - 38% decrease in average pain
  - 15% increase in well-being
  - 27% decrease in limitations of daily living.
- Overall tolerability of the orthosis was good
  - no side-effects were reported
  - drop-out rate of 3% was rather low.

Rucksack Orthosis for Osteoporosis





Characteristic postures arising from weakened back muscles and improved walking posture with rucksack spinal orthosis

Postural Training Support(PTS)

- Encourages back extension through the addition of weights
  - Limits flexion
  - Posterior pocket holds 2.5 lb weight
    - Allows progressive build up of weight
  - Adjustable straps to accommodate fitting
    - Sizing done by shoulder measurement
    - Weights made of vinyl with steel fillers
    - Velcro closure for easy donning/doffing

Spinal Orthosis by Segment

Spinal Orthosis Options by Spinal Segment

Region	Brace[a]
Upper cervical spine (occiput-C1, C1-C2)	Miami J (Össur, Paulsboro, NJ)/Minerva Halo vest
Mid cervical spine (C2-C6)	Miami J or any rigid collar
Cervicothoracic junction (C6-T5)	Miami J/Aspen (Aspen Medical Products, Irvine, CA) with thoracic extension SOMI Minerva Custom-molded cervicothoracic orthosis Halo
T6 and T7	Off-the-shelf TLSO Custom-molded TLSO CTLSO Halo-TLSO
T8-L2	Dorsal lumbar corset Jewett brace CASH brace (sternal pad adjusted high for higher fracture) Custom-molded TLSO
L3 and L4	Off-the-shelf LSO Custom-molded LSO
L5 and lumbosacral junction	Off-the-shelf LSO with thigh extension Custom-molded LSO with thigh extension

[a] In order of increasing rigidity

CASH = cruciform anterior spinal hyperextension, CTLSO = cervicothoracolumbosacral orthosis, LSO = lumbosacral orthosis, SOMI = sternal-occipital-mandibular immobilizer, TLSO = thoracolumbosacral orthosis

Scoliosis Orthoses

TLSOs:

Accommodative and Corrective

Accommodative TLSO

- Fabricated of soft pelite
  - Reinforced with Kydex or rigid plastic
- Ambulatory and non-ambulatory patients
- Fixed alignments

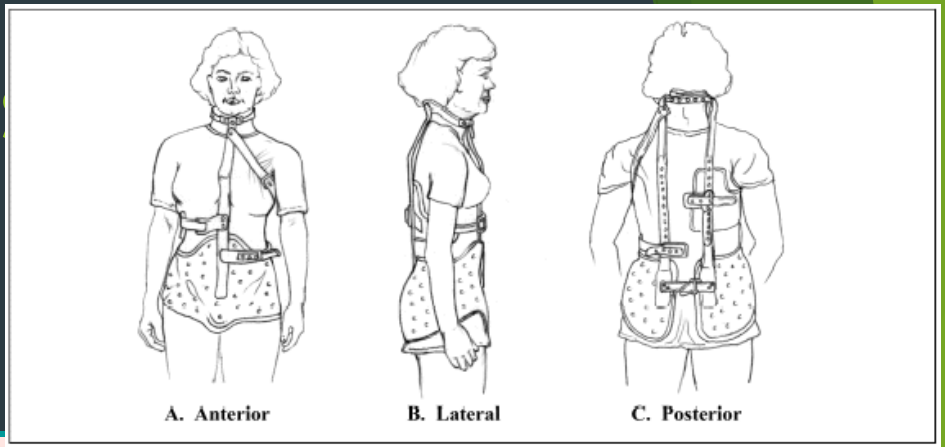
Accommodative TLSO

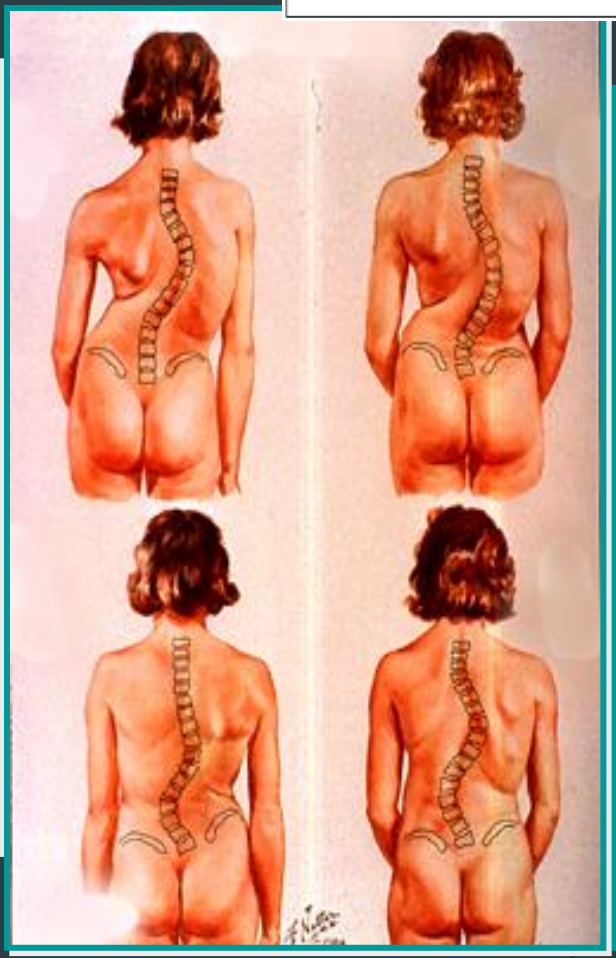
- Maintain head and trunk over pelvis
  - Level shoulders
  - Reduce or minimize shear forces
  - Allows patient to increase upper extremity use or decrease dependence

Accommodative TLSO

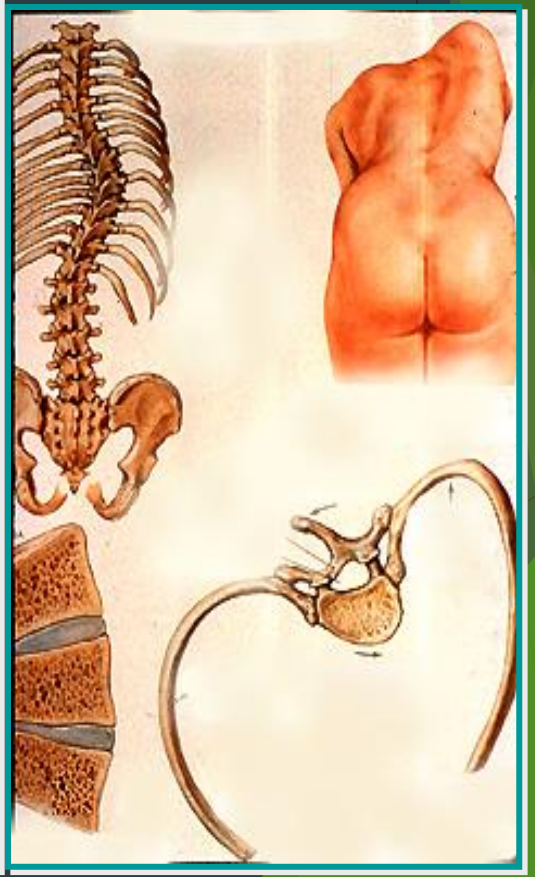
- Key to good positioning!
  - Enhances mobility base
  - Assists patients with pulmonary compromise
  - Used with fixed position wheelchair, tilt in space, or molded seats

Idiopathic Scoliosi





Milwaukee-style CTLSO



Biomechanic in Scoliosis

- Large curves are more readily straightened by elongation
- Smaller curves are more readily straightened by application of lateral forces
  - Usually placing pad below the apex causing lifting force
- Supine more effective force of TLSO than upright
  - Key to using bracing at night
- Elongation of curve
  - Reducing lumbar lordosis more effective in treating scoliosis in lumbar and thoracic spine
  - Reduction of the lumbar lordotic curve at the expense of flattening the thoracic kyphotic curve (may be problem)
  - Correct coronal plane motion but much less 3-D motion

Watts, Bracing in Spinal Deformities 1979

Corrective TLSO

- Progressive correction of idiopathic spinal curvatures
  - Supple curves (20˚-40˚)
    - 20˚-30˚ observe initially, if curve progresses by 5˚ then brace
    - 30˚-40˚ prompt use of orthosis
    - 40˚-50˚ requires surgery, but orthoses may retard progression long enough to allow further trunk growth prior to fusion
    - Indicated Risser ≤2
- Stabilization of congenital spinal curvatures
- Prevention of progression
  - Usually same curve beginning and end of use
  - *Moe + Winter "purpose of bracing is to "keep small curves from getting bigger, not to make big curves smaller"*
- Used full-time
  - 16-20 hrs/day until skeletal maturity
  - -Optimum is 23 hrs/day

Risser Sign:

Apophysis closes from anterior to posterior

Spinal Orthotics in Scoliosis

- Curves w/ apices T-8 or lower may be treated w/ underarm braces
  - Wilmington brace (custom made)
  - Boston brace (prefabricated)
- High thoracic curves may require the Milwaukee Brace
  - "Metal vertical suprastructure with pelvic foundation"

Milwaukee Brace

Boston

Charleston Brace

- Prescribed for part-time wear, usually 8 hours at night
- Is designed to ‘unbend’ the scoliotic curve
- Few long-term follow-up studies

- “Heuter-Volkmann Law”
  - “That growth is retarded by increased mechanical compression and accelerated by reduced loading in comparison of normal valgus”

Boston vs. Charleston

- Katz: 1996
  - compared the effectiveness of the TLSO Boston brace versus the TLSO Charleston brace
  - Both were statistically comparable in preventing curve progression and surgery in single curves of 25-35°
  - Boston brace was more effective in treating curves 36-45 ° and multiple curves
- Watts 1977
  - Boston not use if apex above T10 or curves greater than 40°

Scoliosis Orthoses

Weaning from TLSO in Scoliosis

- Slow wean is the best
  - Want no loss of correction up to 3 degrees
    - Off 2 h/day then Repeat X-ray 3 months
    - Off 4 h/day then repeat X-ray 3 months
    - Off 8 h/day then repeat X-ray 3 months
    - Off 12h/day then repeat X-ray 3 months
    - Use TSLO “night only” for minimum of 1 year

Orthotics for Spinal Deformity, Robert Winter: Clinical Orthopaedics & Related Research No:102, July-August 1974 pg 72-91

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