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TBI and Spasticity

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Learning Objectives

After completing this session, you will be able to:

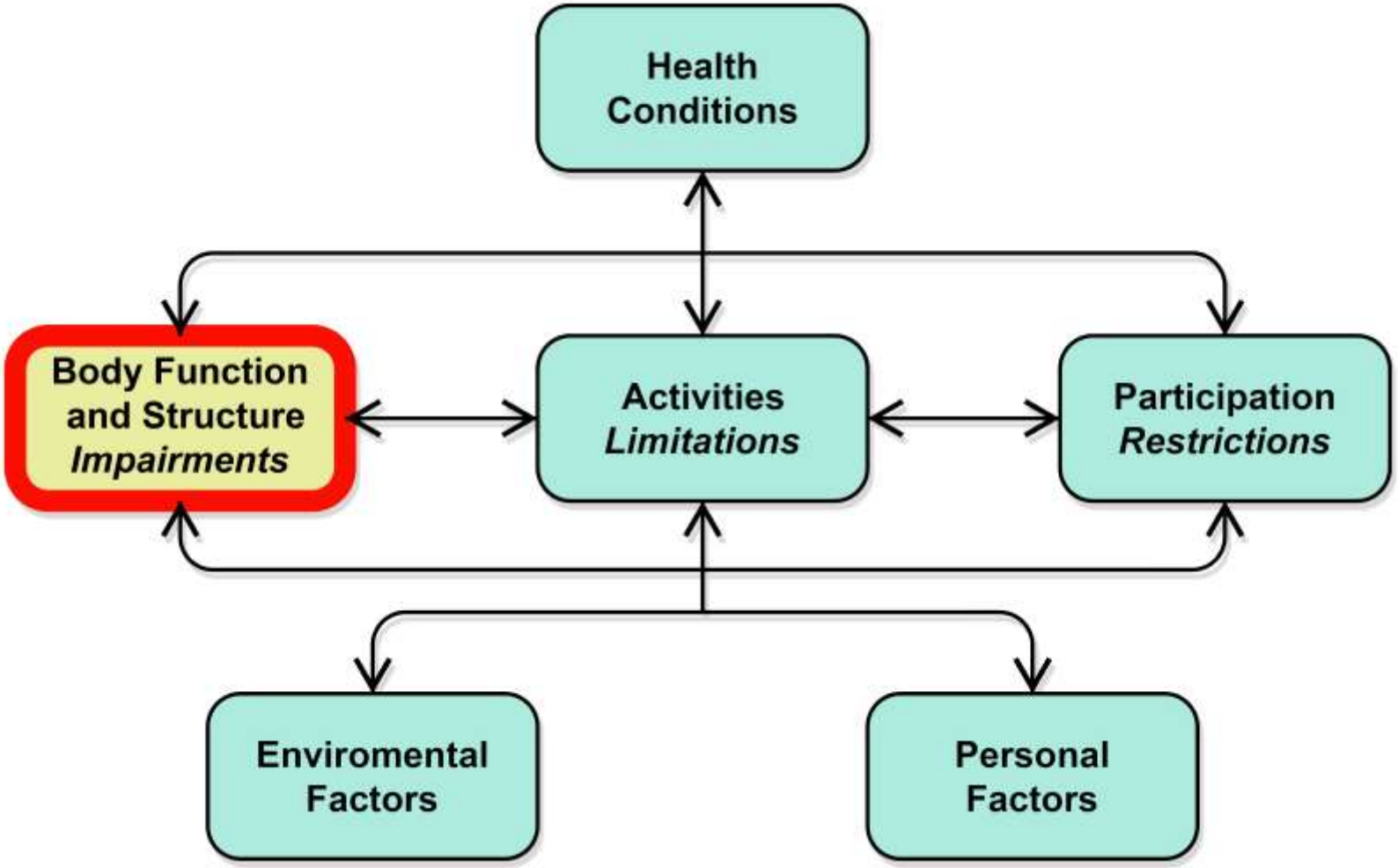
- Define spasticity and describe its underlying pathophysiology
- Analyze both positive and negative effects of spasticity on function in patients with neurologic disorders
- Describe salient outcomes measures used to assess spasticity
- Discuss medical interventions utilized in the management of spasticity
- Identify evidence-based therapeutic interventions employed in spasticity management, including serial casting

Spasticity Defined

Lance 1980

"One component of the upper motor neuron syndrome which is characterized by a velocity dependent increase in the tonic stretch reflexes."

Spasticity and the ICF Model

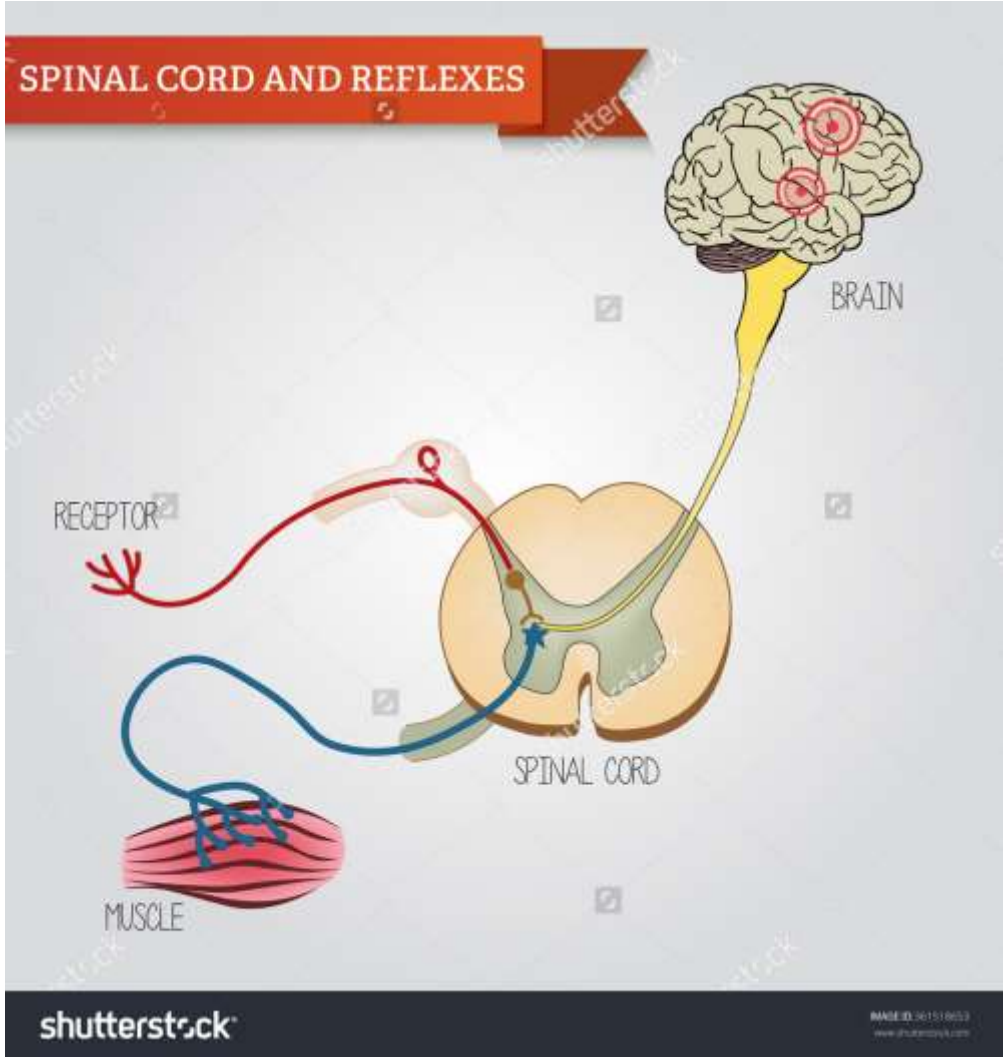


Upper Motor Neuron Syndrome

Positive Signs (excessive normal resting state)	**Negative Signs (less than normal resting state)**
Spasticity	Lack of strength
Rigidity	Lack of motor control
Hyperreflexia	Lack of coordination
Primitive reflexes	
Clonus	

Pathophysiology of Spasticity

shutterstock.com



- Not fully understood
- Imbalance of inhibitory and excitatory inputs resulting in over-activity of the alpha motor neuron
- Hyperactive stretch reflex arc
- Lack of supraspinal inhibition

Prevalence of Spasticity

Spasticity could be present in our patients with upper motor neuron injury or disorder, including patients with:

- Traumatic or acquired brain injury
- CVA
- Multiple sclerosis
- Spinal cord injury
- Cerebral palsy

Spasticity and Brain Injury

- Approximately 50% of patients with acquired or traumatic brain injury develop spasticity
- This is more difficult to study in this population due to wide range of injury from mild TBI/concussion to severe TBI
- Patterns of spasticity development widely variable

Importance of Spasticity

- Lower levels of functional outcomes
- Decreased health related quality of life
- Higher cost of care – increased economic burden
- Increased burden of care on caregivers
- More likely to require institutionalized care

What does spasticity look like?

- Stereotypical patterns of presentation
- Patients present individually
  - Full stereotypical pattern
  - Partial patterns
  - Outside of pattern

Lower Extremity Flexor Pattern

www.Medscape.com via Google image search

Lower Extremity Extensor Pattern

1. Crosswords911.com via Google image search
2. www.pediatric-orthopedics.com via Google image search

Upper Extremity Flexor Pattern

www.physiofunction_co_uk via Google image search

Claw Hand Pattern

1. www.enviaaesthetic.org via Google image search
2. Pixgood.com via Google image search

How does spasticity act in function?

Anna: Patient post TBI

Effects of Spasticity

There are positive and negative effects of spasticity… we must find the balance.

Negative Effects of Spasticity

Contracture

Abnormal posturing

Deformity

Degenerative joint changes

Pain

Decubitus ulcers

Restricted volitional movement

Restricted motor return

Impaired mobility

Impaired ADLs

Positive Effects of Spasticity

Substitute for decreased strength

Allows increased mobility

Improved circulation

Decreased risk of osteoporosis

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Examination of Spasticity

Examination

- Initial observation
- Patient report
  - Penn Spasm Frequency Scale
- Passive motion testing
  - Modified Ashworth Scale (MAS)
  - Tardieu Scale
- Assessment of function

Penn Spasm Frequency Scale

Spasm Frequency	Spasm Severity
0 = no spasm	1 = mild
1 = mild spasms induced by stimulation	2 = moderate
2 = infrequent full spasms occurring < once per hour	3 = severe
3 = spasms occurring > once per hour	
4 = spasms occurring > 10 times per hour	

Penn Spasm Frequency Scale

Psychometrics

Self report measure

ICF: body structure and function

Population studied: chronic SCI

Reliability: test-retest excellent
ICC = 0.91

Recommendations: SCI Edge – reasonable to use, but limited study in target group for acute, subacute and chronic SCI and CVA

Rehabmeasures.org

Clinical Pearls

Nice tool for describing patient perspective of spasticity

Especially helpful when MAS scores low to track spasm

Be mindful of subjectivity of the scale

Modified Ashworth Scale (MAS)

(Bohannon and Smith 1987)

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at end of ROM
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (< half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part is rigid in flexion or extension

Modified Ashworth Scale (MAS)

Psychometrics

ICF: body structure and function

Population studied: adults & children with lesions of the CNS

Reliability: varies by muscle group, population and acuity of patient, from poor to excellent, ICC = 0.36-0.83

Recommendations: SCI Edge reasonable to use; StrokEdge recommended; MS Edge unable to recommend; TBI Edge recommended

Rehabmeasures.org

Clinical Pearls

Training is required to improve reliability

Technique for testing must be standardized to improve inter and intrarater reliability

Annual competencies are recommended

Assessment of Function

Observe and assess the effect of spasticity in the upper and lower extremity in functional tasks

- Bed mobility
- Transitional movements – transfers with varied demands
- Sitting
- Standing
- Gait
- Wheelchair positioning and mobility
- Vary speeds of task
- Add dual task/distraction

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Management of Spasticity

Goals of Spasticity Management

- Minimize changes in the viscoelastic properties of connective tissue and muscle
- Alter neural patterns of spasticity and/or spasms
- Decrease and/or manage pain
- Maintain hygiene and skin integrity
- Promote neuroplasticity
- Improve or maintain function

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Medical Management

Medical Management

<u>Systemic</u>

Baclofen

Tizanidine

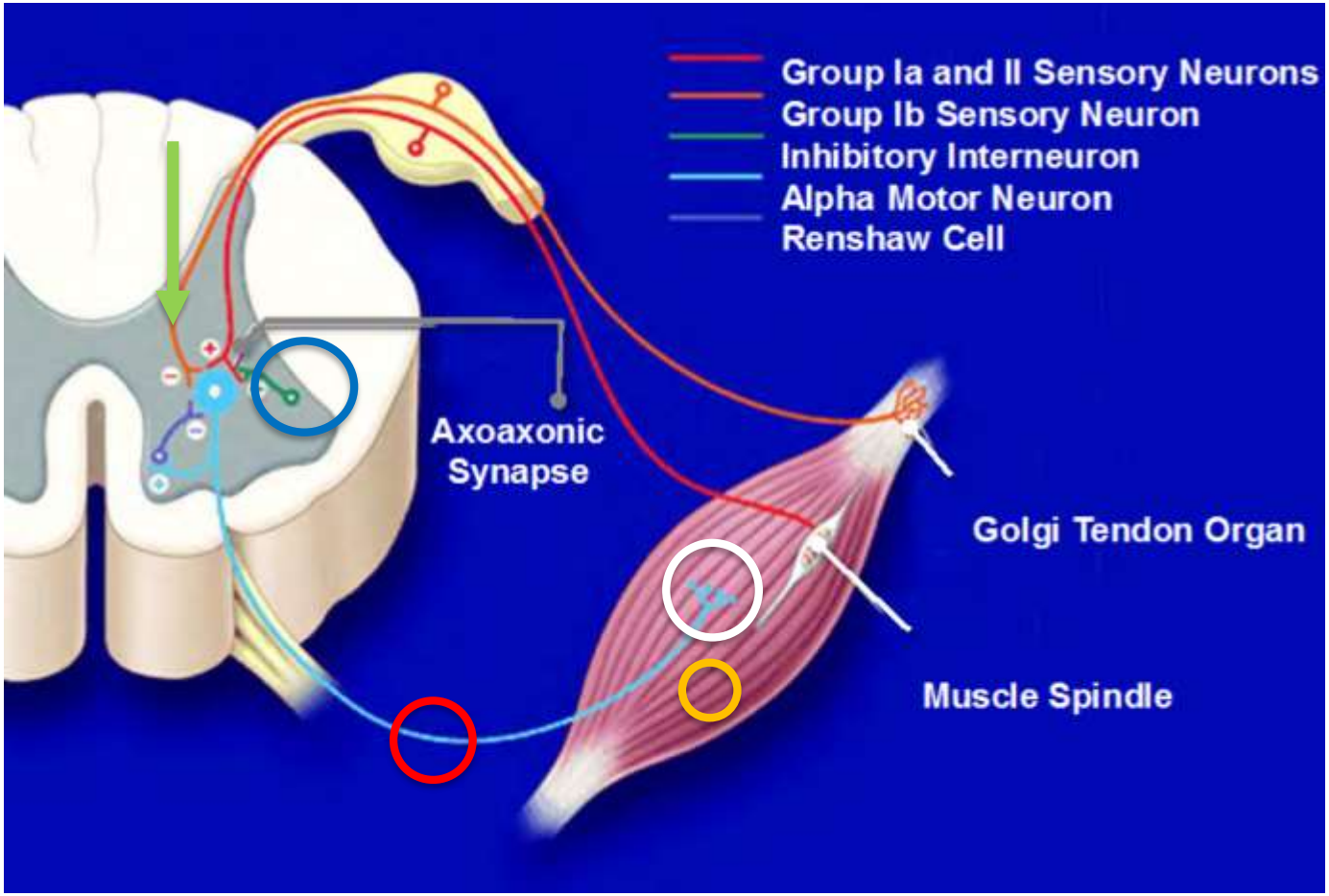
Dantrolene

Cyclobenzaprine
Metaxalone
Carisiprodol
Methocarbamol
Benzodiazepines
Gabapentin

<u>Injected</u>

Botulinum Toxin

Phenol



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Therapeutic Intervention

Therapeutic Interventions

- Weightbearing
- Active Movement
- Passive Movement and Stretching
- Constraint-induced movement therapy
- Positioning – splinting, serial casting

Weightbearing

Benefits/Evidence

Promotes antigravity muscle activation in trunk and lower extremities

Maintains or improves joint and soft tissue flexibility

Modulates neural component of spasticity through prolonged stretch and altered sensory input

Decreases lower extremity spasms

Positive psychological effect

Images: google.com; bioness.com

Active Movement: Progressive Resistive Exercise

Benefits/Evidence

Increased strength and function without increased tone or pain

Enhances motor learning in paretic limbs

Reverse disuse weakness in chronic illness/injury

Strengthen antagonist muscle to those which are spastic

Strengthen spastic muscles

Active Movement: Aerobic Exercise

Cycling, Running, Walking, Swimming

Benefits/Evidence

Increased muscle strength

Increased endurance

Improved AROM

Enhanced motor learning

Decreased spasticity

Images: google.com

Active Movement: Functional Task Practice

Benefits/Evidence

Promotes neuroplasticity

Trains functional movement
for learning

Incorporates weightbearing and
exercise with same
noted benefits

Images: google.com

Active Movement: NMES/FES

Benefits/Evidence

Produces functional movement

May improve motor return, avoiding abnormal patterns

Repeated movement may reinforce neuroplasticity

May assist in skill acquisition

Combined with Botulinum Toxin Injection

Decreased scores on MAS

Increased ROM at the ankle

Improved gait mechanics

Increased gait speed on 10MWT

Decreased cost and burden of care

Decreased secondary effects of spasticity

Images: Bioness.com

Active Movement: Treadmill Training

Benefits/Evidence

Decreases spasticity

Allows early training of postural and stepping reactions

Facilitate motor learning of gait cycle, increased motor recovery

Increased gait speed

Increased balance

Increased stepping with step activity monitor

Increased QOL

Increased gait tolerance

Increased muscle activation on EMG

Decreased spasticity ankle plantarflexors

Active Movement/Passive Movement: Robotics

Benefits/Evidence (Active)

Provides assisted ROM to joints

Reduces spasticity

Benefits/Evidence (Passive)

Reduces spasticity in the upper extremity

Addresses mechanical factors of spasticity

Increased afferent stimulation to motor cortex for motor relearning

Images: marylandva.gov; allinahealth.org

Passive Movement: Stretching

Benefits/Evidence

Maintain or increase joint mobility

Low load, long duration stretch is most effective

Focus on spastic muscles

Image: google.com

Constraint-Induced Movement Therapy

Benefits/Evidence

When combined with Botulinum toxin injection:

Decreased spasticity on MAS

Increased motor control on Fugl-Meyer, Motor Activity Log and Wolf Motor Function test

Increased coordination

Application

Started 1 week post injection

CIMT with mitt for 6 hours per day,

5 days per week for 2 weeks per protocol

Image: youtube.com

Positioning: Casting and Splinting

Benefits/Evidence

Decrease motor neuron excitability (neural component)

Reduce tensile stress of soft tissues (non-neural component)

Increased flexibility

Decreased ankle plantarflexion contracture due to spasticity

Restored biomechanics

Improved gait scores

Improved function

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Serial Casting

Definitions: Serial Casting

Stoeckmann 2001

"The application and removal of a series of casts, with the result of progressively increased range of motion with each casting with the purpose of correction of deformity, lengthened contractures, and reduced spasticity."

Rationale: Serial Casting

- Muscle shortening is reversible
- Prolonged stretch inhibits spasticity
- Controls sensory input to the limb
- Increases patient's visual and tactile attention to the limb
- Both number and length of sarcomeres are increased thereby affecting length–tension relationship

Indications: Serial Casting

- Increased spasticity
- Range of motion loss
- Loss of function in affected limb

Considerations: Serial Casting

- Contraindications
  - Open wounds
  - Unhealed fracture/external fixator
  - Acute inflammation
  - Uncontrolled hypertension
  - Recent episode of autonomic dysreflexia
- Precautions
  - Fluctuating edema
  - Poor skin integrity
  - Reduced sensation
  - Cognitive impairment
  - Agitation

Other Considerations

- Medical stability
- Functional use
- Pain
- HO
- Subluxation
- Timing
- Bi-valve

Evidence: Serial Casting

Best Practice in Serial Casting

- Botulinum toxin injections and casting is better than botulinum toxin alone for improved ankle ROM
- Timing of casting with botulinum toxin injection: 2-4 weeks
- Goals of ankle serial casting: 10 degrees ankle DF in subtalar neutral with knee extended for ambulatory patients; 0 degrees for non-ambulatory patients
- Serial cast change interval: < 5 days best to decrease complication and discontinuation rates

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Serial Cast Application

Disclaimer

These videos and discussion is intended as an introduction to serial casting.

This is a potentially low volume, high risk procedure that requires further training, practice, observation and competency.

Serial Casting Supplies

- Stockinette
- Tongue depressors (2)
- Foam padding
- Cotton roll padding
- Fiberglass
- Bucket
- Lotion (if leaving on only)
- Cast saw
- Cast splitter
- Bandage scissors

Serial Casting: Supine Positioning

- Patient supine
- Bolster under knees
- Knee flexed
- Support ankle in dorsiflexion with subtalar neutral

Serial Casting: Prone Positioning

- Patient prone
- Knee flexed
- Support ankle in dorsiflexion with subtalar neutral

Apply Stockinette

- Stockinette should extend to the knee beyond toes
- Tongue depressors along 1st an 5th metatarsals and extend out beyond toes

Add Foam Padding

- Proximal end of cast – 2 finger widths below fibular head
- Distal end of cast - past toes, around tongue depressors
- Over medial and lateral malleoli
- Along tibia
- Over any additional bony prominences

Apply Cotton Roll Padding

- Work distal to proximal
- Overlap by half
- Avoid wrinkles
- 2 layers of padding

Cotton Roll Padding Application

Completed Cotton Roll Padding Application

Fiberglass Application

Completed Fiberglass Application

- During application:
  - Work distal to proximal
  - Overlap by half
  - Apply 2 layers of fiberglass
  - Do not pull material tightly as you wrap
  - Ensure 2 fingers can fit around proximal end of cast
  - Ensure all toes are visible, but included within the cast

Draw Medial Cut Line for Removal

- Ensure cut line is anterior to the malleolus

Draw Lateral Cut Line for Removal

- Ensure cut line is anterior to the malleolus

Cast Removal

Completed Medial Cut

Completed Lateral Cut

Cast Splitter

Bi-Valved Short Leg Cast

- Remove all padding and stockinette

Bi-Valve Padding Supplies

- Large roll adhesive padding for top and bottom halves of cast
- Edging roll for covering edges of top and bottom halves of cast

Completed Bi-Valved Short Leg Cast

Open

Completed Bi-Valved Short Leg Cast
Closed

- Secure with Ace wraps or strapping
- Ensure proper fit with patient
- Instruct in appropriate wearing schedule

Any Questions?

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Thank you for your attention.