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Full course material can be downloaded from: www.shrinerschildrens.org/aacpdm2017
Course Introduction

I. Four Phases of Single Event Multilevel Surgery (Priorities)
   a. Acute Inpatient Phase (Pain control, safe transfers, avoidance of complications of surgery and immobility)
   b. Early Post-Operative Phase (Pain control, avoidance of complications, gentle improvement in range of motion, preparation for ambulation)
   c. Early Intensive Rehabilitation (Weight bearing, Range of Motion, Gait Training)
   d. Outpatient Rehabilitation (Endurance, Strength, Functional Improvements)

II. SEMLS Journey Board – Appendix 1
Phase 1: Acute Inpatient Phase

I. Principles of Acute Pain Management
   a. Multi-modal pain pathway
   b. Get ahead of the pain

II. Structure of Pain Management Team
   a. Individual Consultants
   b. Co-management
   c. Acute Pain Service
III. Modalities for Pain Management
   a. Neuraxial Anesthesia
      i. Epidural Anesthetic
      ii. Intrathecal Spinal Anesthetic
      iii. Regional Anesthetic
   b. Intravenous Modalities
      i. Ketamine
      ii. Demedetomidine
      iii. Naloxone
      iv. Methadone
   c. Oral Modalities
      i. Opioid
      ii. Acetaminophen
      iii. Non-steroidal anti-inflammatories
      iv. Clonidine

IV. Neuraxial Anesthesia Protocols – Appendix 2

V. Post-Operative Urinary Retention
   a. Frequency (!) of the problem
   b. Prevention of Urinary Retention
   c. Management of Urinary Retention

<table>
<thead>
<tr>
<th>Patient Age</th>
<th>Max Bladder Volume</th>
<th>1/3 rd of Max Bladder Volume</th>
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<td>Formula (under 12 Yrs) (Age x30)+30 = Max bladder volume in mL</td>
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<tr>
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<td>12 to adult</td>
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<td>130 ml</td>
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References


Phase 2 – Early Postoperative Phase

Pain Management and Psychosocial Support

I. Preoperative
   A. Psychosocial Assessment / Patient and Family Education
      1. Therapeutic Child Life and Play Intervention
      2. Cultural Issues and Communication with team
      3. Community Resources
      4. Handouts and Contact Information

II. Early Postoperative
   A. Psychosocial support
      1. Optimize distraction
      2. Behavioral regression
      3. Family encouragement and communication portal
      4. Reminder of goals
   B. Medical comorbidity management
   C. Resumption of routines, i.e., bowel, bladder, nutrition, sleep
   D. Pain management
      1. Premedication for clinic visits
      2. Guidance on when to wean pain medication
      3. Spasticity management
      4. Neuropathic pain
      5. Wound management
   E. Preparation for Early Rehabilitation
      1. Range of motion, Intensive Outpatient Therapy (IOTP) schedule
      2. Referrals and communication
         a. Community rehabilitation facility and primary care
      3. Medication optimization
      4. After cast care, shoes – Appendix 3 and 4
      5. Community and school integration
   F. Preparation for Community Based Rehabilitation
      1. Clinic visits - Observational gait, strength, ROM, orthotic modification
      2. Physical education and school accommodation
      3. Recreational activities
References


Phase 2: Early Post-Operative Phase

Soft Tissue Surgery to Improve Gait in Children with Cerebral Palsy: 
Technique of “Slow Surgical Lengthening”

I. Muscle Function During Gait
   A. Muscle Function in Gait
      1. Force Generation
   B. Children with CP
      1. Compromised
         a. Spasticity
         b. Weakness
         c. Contracture
         d. Selective Control
   C. Rationale for Intervention
      1. Surgical Lengthening of Soft Tissue (Muscle Tendon Unit)
         a. Improve Range of Motion
         b. Optimize (Don’t Compromise!) Force Generating Capacity

II. Muscle Function in Children with Cerebral Palsy
   A. Weaker Than Age Matched Peers
   B. Strength to Weight Ratio
      1. Less Favorable with Increasing Age
   C. Pathoanatomy
      1. Myostatic Deformity
         a. MTU: Short
         b. Tendon: Long
         c. Muscle Belly: Short
         d. Myofibrils: Long(!)

III. Soft Tissue Surgery to Improve Gait: What is the Dose?
   A. Dynamic Deformity / Dysfunction
      1. Botulinum Toxin
      2. Selective Dorsal Rhizotomy
      3. Intrathecal Baclofen Therapy
      4. Surgical Tendon Transfer
   B. Myostatic Deformity
      1. Release
         a. Myotomy,
         b. Tenotomy
      2. Lengthen
         a. Myotendinous Junction (Recession)
         b. Tendon (Z Lengthening)
C. Classical Techniques
   1. Acute, Complete Correction
      a. Complications
         (i.) Weakness (Damage to Myofibrils)
         (i.) Neuropraxia (Nerve Stretch)
   2. Recent Recommendations
      a. Optimize Tone Management
      b. Prioritize Skeletal Surgery
      c. Avoid Soft Tissue Surgery

IV. Slow Surgical Lengthening of the Medial Hamstring Muscles
   A. Alternative Technique
      1. Current Understanding
         a. Pathoanatomy / Pathophysiology
   B. Surgical Technique: Recession
      a. Myotendinous Junction
         b. Minimal Acute Lengthening
            (i.) Δ Popliteal Angle 30 Degrees
         c. No Disruption of Muscle Fibers
C. Post-Operative Management: Subsequent Gentle Stretching

1. Knee Immobilizer / Positional
   (i.) Slow, Gentle Hamstring Stretch in Wheelchair
   (ii.) Knee Extended / Hip Flexed
   (iii.) Minimal Damage to Myofibrils

2. Serial Stretch Casting – Appendix 5
References


Phase 2: Early Post-Operative Phase

Early Orthotic Management Following Single Event Multilevel Surgery (SEMLS) to Improve Gait in Children with Cerebral Palsy

1. Overview
   a. Disruption of Foot Function in Cerebral Palsy
   b. Orthotic Design / Indications / Cost
   c. Clinical Decision Making

2. Foot Function in Cerebral Palsy
   a. Imbalance
   b. Spasticity
   c. Motor Control
   d. Balance
   e. 3 Common Malalignment Patterns
      i. Equinus
      ii. Equinoplenovalgus
      iii. Equinocavovarus
   f. Stance Phase Function
      i. Shock Absorption (Loading Response)
      ii. Stability (Mid Stance)
      iii. Lever Arm (terminal Stance)
   g. Swing Phase Function
      i. Clearance (Mid Swing)
      ii. Pre Position for Initial contact (Terminal Swing)

3. Orthotic Indications / Design
   a. Use of Orthoses in Cerebral Palsy
      i. Protect Surgery (Promote Healing)
         1. Variable Time, Intuitive, Limited Scientific Evidence
      ii. Prevent Deformity With Growth
         1. Little Evidence to Support
      iii. Improve Gait
         1. Specific Indications, Based Upon Biomechanics
   b. Biomechanics
      i. Ankle Plantarflexion / Knee Extension Couple
      ii. Orthosis Provides
         1. Direct Control of Foot / Ankle Alignment
         2. Indirect Control of Knee Alignment
         3. ? Control of Hip Alignment
   c. Materials
      i. Thermoplastics
1. Polypropylene
2. Polyethylene
3. Copolymer
   ii. Carbon Fiber / Fiberglass Strips
   iii. Foam Padding
      1. Plastizote
   iv. Straps / Buckles
      1. Elastic / Velcro
      2. Plastic / Metal

4. Clinical Decision Making ², ⁹⁻¹¹
   a. Diagnostic Matrix
      i. Physical Examination
      ii. Radiographic Examination
      iii. Gait Assessment
      iv. Functional Deficits
         1. Stance / Swing / Both
   b. Common Orthotic Designs
      i. Posterior Leaf Spring Orthosis (PLSO) / Articulated Ankle Foot Orthosis (AAFO)
         1. Primarily Swing Phase Control Orthoses
      ii. Solid Ankle Foot Orthotic (SAFO) / Floor Reaction Ankle Foot Orthosis (FRAFO) / Ground Reaction Ankle Foot Orthosis (GRAFO)
         1. Stance And Swing Phase Control Orthoses
      iii. FRAFO / GRAFO
         1. Most Restrictive Orthotic Design
         2. Used For Subjects With Crouch Gait
      iv. Most Common Orthotic Mistake
         1. Use of a PLSO or AAFO for Crouch Gait
C. Post SEMLS Orthotic Design

1. SAFO Convertible to PLSO: SAFO 4-6 Weeks to 4-6 Months Post-op

2. SAFO Convertible to PLSO: PLSO at 4-6 Months Post-op
C. Indications for Common Orthotic Designs

<table>
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<tr>
<td>FRAFO</td>
<td>EXT &gt; -15 Degrees</td>
<td>EXT &gt; -15 Degrees</td>
<td>DF to neutral; TFA ≤ 30 Degrees</td>
</tr>
</tbody>
</table>

IC = Initial Contact; MST = Mid Stance; TST = Terminal Stance; Sw = Swing; NL = Normal; DF = dorsiflexion; HS = Heel Strike; PF = Plantar Flexion; KE = Knee Extension; KF = Knee Flexion; EXT = Extension; TFA = Thigh Foot Angle; HF = Hip Flexion
REFERENCES


Phase 3 – Early Intensive Rehabilitation

I. Introduction to the Intensive Outpatient Therapy Program (IOTP) – Appendix 6 - 7
   a. Definition and Focus
   b. Participant characteristics
   c. Timing, frequency and duration of IOTP and ongoing outpatient Physical Therapy Services

II. Assessment before IOTP
   a. Skin Integrity and Swelling
   b. Range of Motion, Strength, and Selective Motor Control
   c. Mat Mobility
   d. Transfers
   e. Standing Posture and Weight-bearing Ability
   f. Balance
   g. Gait
   h. Orthotic fit, function, and comfort
   i. Pain
   j. Engagement in Therapy
   k. Patient/caregiver Concerns

III. Setting Goals for IOTP
   a. Focus on functional mobility and increasing tolerance to activity and mobility upon return to home and school settings.
   b. Goals must be clearly defined and agreed upon by client/family caregiver and therapist to maximize motivation and participation.
   c. Functional Goals for IOTP
      i. Transfers: bed, bathroom/toilet, car, home
      ii. Ambulation : household or short community distances with assistive device as needed
      iii. Home Exercise Program for Active ROM, functional strengthening, standing
      iv. Optimization of orthotic/footwear fit and function
   d. IOTP Interventions
      i. ROM and strengthening
      ii. Mat mobility
      iii. Standing and transfer training
      iv. Gait training (parallel bars, overground with AD, treadmill, partial weight support)
      v. Consultation with orthotist as needed to ensure optimal fit and function of AFOs
      vi. Adaptive or stationary cycle
      vii. Skin care/scar management – Appendix 8
      viii. Patient/caregiver education
   e. Surgery-specific PT guidelines for SEMLS – Appendix 9 - 10
   f. Coordination required for transition to Outpatient Therapy – Appendix 11 - 15
i. Patient/caregivers with thorough understanding of precautions, brace wear schedules, and next phase of post-SEMLS rehabilitation
   1. Written summary of patient/caregiver education

  g. All needed equipment for early rehabilitation coordinated
  i. Outpatient PT services scheduled and lines of communication established
     1. Provide written documentation of patient status at discharge to patient/caregiver as well as outpatient /school-based therapist
     2. Written discharge summary in medical record and initiate form for future/follow-up clinic tracking
Phase 4 – Outpatient Based Rehabilitation

I. Goals
   a. Review of pre-operative goals and long-term goals
   b. Emphasis on activity and participation level
   c. Participation in community-based recreation and lifelong wellness opportunities

II. Interventions

III. Frequency and duration
   a. Typically 2-3 times per week initially, decreasing as determined appropriate and progress towards goals assessed.

IV. Clinic Follow-up – Communication between hospital and community based care therapy providers essential!
   a. 4 weeks post IOTP completion – critical follow-up visit for therapist assessment
   b. Additional follow up at 6, 9 and 12 months post-op or according to MD direction
   c. One year post-op, gait study in Motion Analysis Center
      i. Measuring Success with Gait Analysis after SEMLS – Appendix 16

V. Common Challenges in the First Year After SEMLS (Panel)
   a. Casting Decubitus Ulcers
   b. Acquired (and temporary!) gait deviations after SEMLS
   c. Foot sensitivity and pain
   d. Functional and Anatomic Leg Length Difference
   e. Recurrent Knee Flexion Contractures
   f. Difficulty with Bracing