


## Polio - A Model for Overuse and Aging


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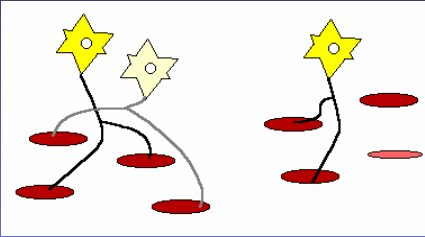
## Acute Poliomyelitis

- Acute viral infection of anterior horn cells in spinal cord
  - Pain
  - Stiffness
  - Fever
  - Paralysis



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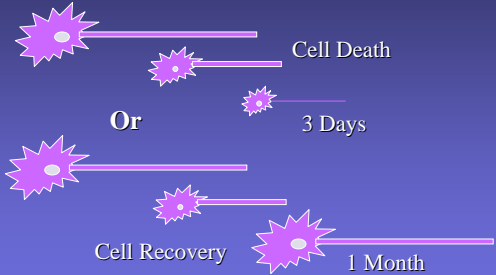
## Acute Polio Infection



95 % of Anterior Horn Cells Involved  
in the Initial Infection

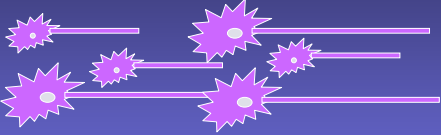
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## Acute Infection of Anterior Horn Motor Cells:



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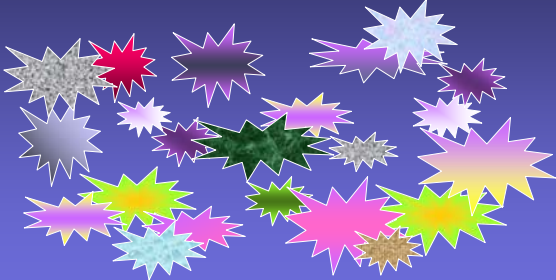
## Course of Acute Polio Infection:



Average 47 % of Anterior Horn Cells  
Recovered (12 - 91 %)

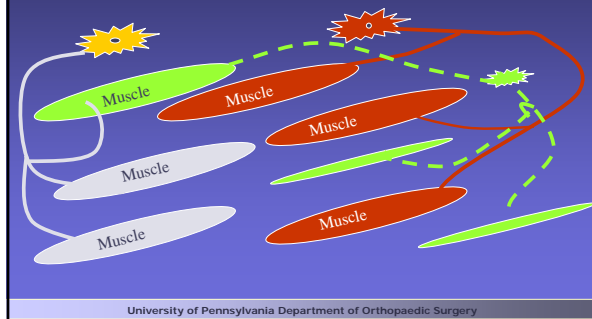
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## Pattern of Nerve Cell Recovery Was Random

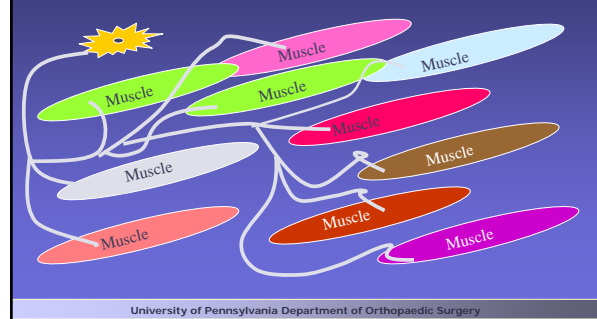


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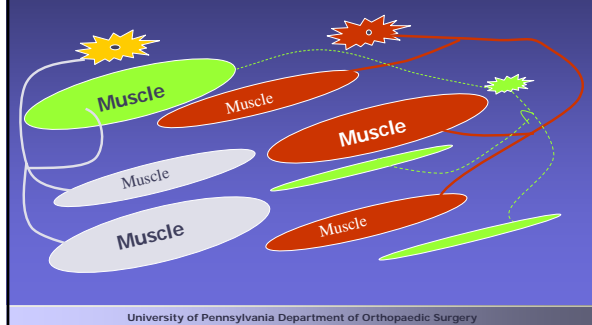
## Recovering Muscle Function by Axon Sprouting



## Neurons Grow New Axons to Adopt "Orphaned" Muscles



## Recovering Strength by Muscle Hypertrophy



## Recovery from Acute Polio

1. Anterior horn cell recovery
2. Axon sprouting
3. Muscle hypertrophy



## Polio Survivors



- 1.5 million polio survivors in North America
- 75 % now with PPS



## Polio Still a Major Problem



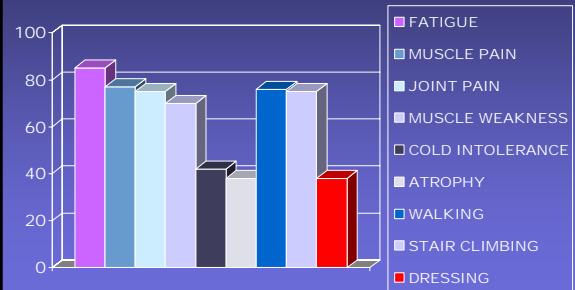
## Post-Polio Syndrome

- Common Symptoms:
  - Fatigue
  - Muscle Pain
  - Joint Pain
  - Muscle Weakness
  - Cold Intolerance
  - Sleep Apnea
  - Difficulty Breathing
  - Difficulty Swallowing



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## Frequency of New Problems in Post-Polio Patients



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## Manual Muscle Testing

### Old View

- Grade 5 – Normal
- Grade 4 – Good
- Grade 3 – Fair
- Grade 2 – Poor
- Grade 1 - Trace



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## Manual Muscle Testing: Reality

- Grade 5 – 0 to 70 %
  - No detectable weakness
- Grade 4 – 60 %
  - Able to resist pressure
- Grade 3 – 40 %
  - Able to lift against gravity
- Grade 2 – 20 %
- Grade 1 - 5 %



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## Post-Polio Syndrome

- Over estimated residual muscle strength
- Under estimated demands of everyday living
- Work > Capacity = Fatigue



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## Treatment Approach

- Periodic evaluation
- Education
- Peer support
- Modified exercise
- Activity adjustment
- Bracing
- Surgery



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## Orthotics for Post-Polio

- Braces must be light weight
- Mostly helpful during stance phase of gait



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## What Do Braces Achieve ?

- Substitute for weak muscles by using mechanical "tricks"
- Help hold joint in alignment
- Provide limited active forces



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## When Are Leg Braces Working ?

- During standing
- During walking on level ground
- Braces not helpful on stairs or ramps
- Braces do not help while sitting
- Braces do not help during swing phase



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## The Job of the Calf Muscles

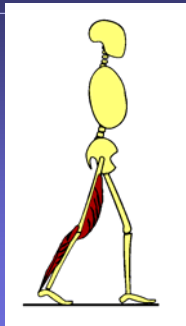


- Keep the tibia bone of the leg from falling forward when the body's weight is in front of the ankle joint

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## Compensation for Weak Calf Muscles

- Take shorter steps to keep your weight from getting too far ahead of the ankle
- Keep your knee stiff using the quad muscles to hold the tibia bone back



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## Problems with Strategies for Weak Calf Muscles

- Short steps are less efficient
- The quad muscles are over-used which will eventually weaken them further or cause patellar pain
- The capsule of the knee joint is stretched and back knee can result



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## How Does a Brace Help Weak Calf Muscles ?

- By limiting the upward motion of the ankle joint, a brace keeps the tibia from falling forward when body weight moves in front of the ankle.



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## Why Should a Brace Have a Mobile Ankle Joint ?

- Normally as the foot contacts the floor, the foot moves downward to provide better balance
- If the ankle cannot move, the tibia is pulled forward and the quad muscle must work harder to keep the knee from buckling



Ankle-Foot Orthosis — Loading Response

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## Goals of PPS Surgery

- Pain relief
- Correction of deformity
- Re-direction of muscle forces
- Stabilization of unstable joints
- More effective bracing

**NOT** for elimination of braces

**NOT** to improve muscle strength

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## How Is the Rotator Cuff Injured in PPS ?

- Using the arms to push up from and lower into a seated position
- 
- Not from using crutches



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## Rotator Cuff Tears

- Chronic use of arms to push up or lower into a chair
- Associated with leg weakness
- Results of surgical repair for polio survivors same as general population



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## Wrist Problems

- Chronic Pressure on Hands from Use of Crutches Causes
  - Carpal Tunnel Syndrome
  - Subluxation of Carpal Bones
  - Arthritis



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## Wrist Fusion



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## Equinus

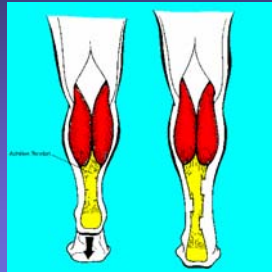
- Must flex the hip and knee higher during swing to clear the toes
- The toes contact the floor first
- The knee is pushed backwards as the weight is put on the foot



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## Achilles Tendon Lengthening

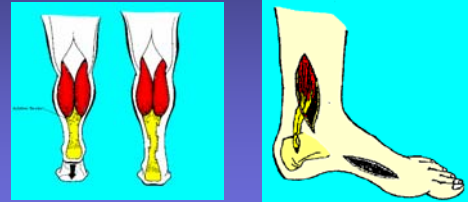
- Hoke Triple Hemisection Technique
- Simple and Fast
- Reliable Outcome



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## Achilles Lengthening and Toe Flexor Transfer

- Transfer to heel increases calf strength



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## Claw Foot and Toes

- Painful Deformity
- Unable to Control Toe Position in Shoes



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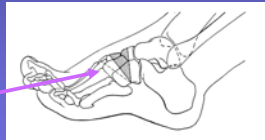
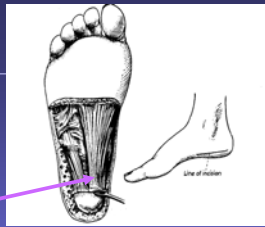
## Toe Flexor Release



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## Cavus Foot

- If no arthritis or bony changes, then release of the plantar fascia will correct cavus
- When there are bony changes, a wedge osteotomy is needed



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## Equinocavus Foot



Equinus and cavus following old fusion



Osteotomy done through fusion mass

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## Valgus Foot

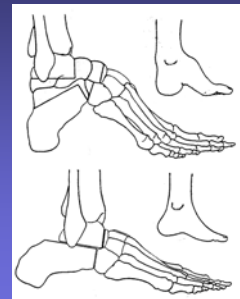
- Painful
- Pressure on inside of foot and ankle
- Puts valgus (knock knee) strain on the knee joint
- Difficult to fit in brace and shoe



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## Correction of Valgus Foot

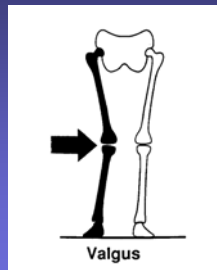
- A triple arthrodesis (fusion) is usually needed to correct this deformity
- Excellent long term results as long a foot is well aligned



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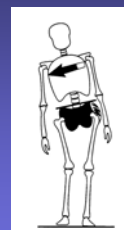
## Knee Valgus

- Valgus deformities are common
- Knee valgus can result from:
  - A tight ilio-tibial band
  - A valgus foot deformity
  - A short leg
  - An adduction contracture of the hip



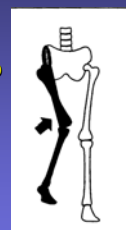
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## Knee Valgus



Hip abductor weakness or a short leg causes a lean to the side

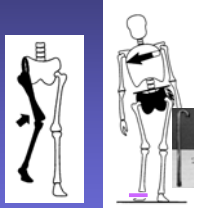
A tight ITB also can cause knee valgus



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## Treating Knee Valgus

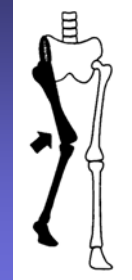
- Use a cane in the opposite hand to compensate for hip abductor weakness
- Use a shoe lift to correct leg inequality
- Use a long leg brace to push knee over
- Surgical Options:
  - Release tight ITB
  - Release tight hip adductor muscles
  - Do osteotomy of the distal femur
  - Do a total knee replacement



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## Ilio-Tibial Band Contracture

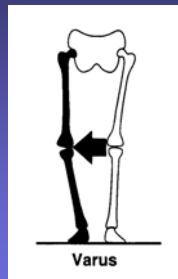
- Lengthening of the ilio-tibial band (ITB) is the preferred treatment
- Many people use the ilio-tibial band to support the leg while standing
- Complete release of the ITB should be avoided



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## Knee Varus

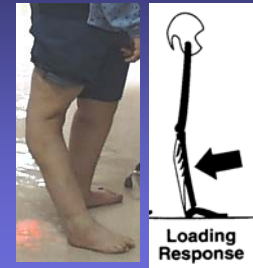
- Usually seen with knee arthritis
- If flexible, can use a long leg brace (KAFO) This is less effective than with valgus knee
- Consider total knee replacement if severe arthritis



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## Knee Recurvatum

- Can use a short leg brace (AFO) to support the lower leg, if the knee recurvatum is mild
- Must use a KAFO for more severe back-knee
- Reconstruction of posterior knee capsule is **NOT** possible
- Consider total knee and KAFO if severe arthritis



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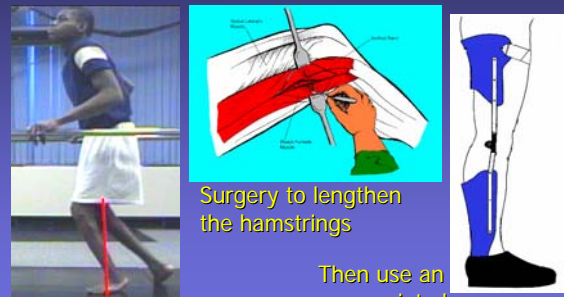
## Knee Flexion

A flexion contracture of the knee requires the quad muscles to work constantly. This is very difficult. Most people then need to lean on their arms for support.



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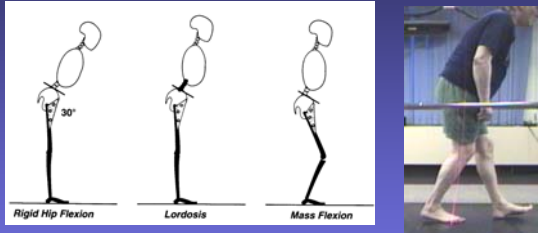
## How to Treat a Flexed Knee



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## Hip Flexion



A hip flexion contracture causes postural problems and is very energy inefficient

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## Total Joint Replacement in Post-Polio Patients



Can they be done safely?

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## Special Considerations

- Joint Contracture
- Joint Laxity
- Muscle Strength
- Adequate Bone Stock
- Cooperation with Post-Op Limitations

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## Hip Replacement in Flaccid Paralysis

- Need grade 4 hip abductor strength
- Need grade 4 hip extensor strength
- Need adequate bone stock
- Correct other leg deformities
- May need distal orthosis

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## Arthritic Hip

- Very painful
- Often has flexion contracture



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## Excessive Hip Weakness

- Contraindication to prosthetic arthroplasty
- Consider alternate surgical choices



6 years post-op

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## Total Hip Replacement

- 3 Post-Polio Patients
  - 2 had flexion contractures of 45 and 15 degrees
  - Average hip ROM 20 to 83°
  - all had severe pain
  - Mean ambulation score 2.86
- Mean follow-up 68.3 months



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## Total Hip Replacement

- Results of THA in PPS:
  - No complications or loosening
  - Mean HHS from 94 to 172.7
  - No contractures post-op
  - Mean hip ROM 0 to 110°
  - All were independently ambulatory after surgery
  - Mean ambulation score improved from 2.86 to 4.0



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## Knee Replacement in Flaccid Paralysis

- Need adequate bone stock
- Correct other leg deformities first
- Use an unconstrained prosthesis
- Must protect leg with a KAFO forever



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## TKA in PPS

- 4 post-polio patients
- All had severe pain
- Mean knee ROM -19 to 102°
- 3 had valgus and recurvatum
- 1 had varus and flexion contracture
- Mean Knee Society Score 27.5
- All were limited ambulators



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## Bracing for Rehab

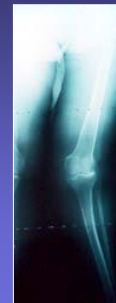
A brace is fitted in the operating room to allow the rehab program to progress safely



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## C.M. – Before Surgery

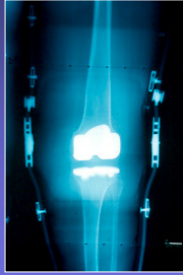
56 year old woman with arthritis and deformity in a completely paralyzed leg from polio



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### C. M. After Surgery

Now 10 years post-op and still walking independently



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### C.M. Polio: Pre-Op Total Knee



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### C.M. Polio: Post-Op Total Knee



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Polio



2 years post-op

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### L.L. - Polio: Valgus Knee



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### L.L. - Polio: 2 Weeks After Total Knee



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Post-Polio Clinics Directors Network  
April 18, 2006

**Disclaimer: The following are unofficial notes that have not been read by or approved by the speaker.**

Points of Discussion:

- Dr. Keenan concentrated on orthopaedic surgery and its role.
- The most important thing is that Dr. Keenan never talks to a patient about surgery unless it would be part of a total treatment.
- Patients have anxiety about anesthesia and unrealistic expectations about what surgery can do.  
The most common thing done is to make a limb more braceable.
- In response to a question from Dr. Calmes regarding patient anxiety about anesthesia--Dr. Keenan said she has not had a problem with anesthesia for polio patients.
- Suggests avoiding muscle relaxants or use in very low doses.
- When asked whether or not her polio survivors had more pain than other patients, she did not find that to be true. She uses anesthesia around the incision. Where she can, she uses a regional anesthesia.
- Biggest consideration is what technique the anesthesiologist is comfortable with. She talks to patients about letting the anesthesiologist do whatever he recommends and she works with them.
- Dr. Keenan has not found the need to use perioperative steroids.
- Upper extremity problems: most common is the rotator cuff tear. Weakness in the lower extremities causes patients to use their arms more to push up from and lower into a chair.
- When someone has a large tear, the first question is, is it repairable? If they do not have signs of arthritis, then the next question is what was the underlying muscle strength they began with. Most of the time there is sufficient muscle left to do a repair.
- Looking at the results of a repair, the polio patients have less strength but they had less strength to begin with.
- Most critical thing before you repair the rotator cuff, explore with the person how to put the excess weight on their shoulder so as not to tear it again. Suggest a power lift chair.
- There is a lot of carpal tunnel syndrome and arthritis in the hand when they lean heavily on canes. Try to alleviate the underlying cause of the arthritis.
- Lower extremity problems: Looking at all the cases done over the years on polio survivors, the most common thing is Achilles Tendon problems. Achilles Tendon lengthening and also transfer of the long toe muscle to the heel have good outcomes.
- Try to get better options for better bracing.
- Another problem is a cavus deformity of the foot which makes shoe pressure.  
Question is whether or not there is significant arthritic or bony structure changes in the foot. If no arthritis or bony changes, then you can release the plantar fascia to

correct cavus. When there are bony changes, a wedge osteotomy is needed.

- Dr. Keenan also sees many patients who have had previous arthrodesis of the equinovarus. It has done damage to the knee joint.
- She has seen many polio survivors who had triple arthrodeses done.
- Question: Achilles Tendon lengthening--have you had issues with individuals with weak quadriceps?

Dr. Keenan said it is not uncommon. If they have a small equinus deformity and is not developed from a torn meniscus, she does not do surgery. But if it is a significant equinus, it is doing damage at the knee. Recommends fixing the ankle and giving the knee stability with bracing.

- Most of the time we are talking about correcting the deformity.
- Some of the knee abnormalities which lead to arthritis problems in older patients -- it is common to see adults with knee valgus deformities. Lengthening of the Ilio-Tibial Band is the preferred treatment.
- Try to stress to keep asking yourself why this person ended up with this particular alignment.
- We try to identify and eliminate as much as possible the underlying knee valgus or varus.
- You have to look at it in the context of the entire situation. That is the big challenge for all of us but a lot of physicians who do not deal with polio survivors have a more difficult time putting it together.
- We are now talking about doing more replacement surgery when people have a knee deformity.
- Dr. Keenan makes the patient agree that they will use a KAFO.
- Some patients also have severe osteoporosis and the bone should not be stretched.
- There is a paper about doing joint replacement in polio survivors but it doesn't talk about rehab and the total picture.
- A paper is in the process to stress certain items. It is not the surgery that is important. It is really more important about the total management for the patient because the surgeons do not have a good feel for it. It's risky for some patients to have surgery if they do not have someone to work with them to help with the other part of the equation.

**Question: How many patients with severe DJD of the hip are candidates for arthroplasty?**

Most are candidates for it. If a surgeon hasn't had experience with polio, the rehab physician should talk to him to plan for the care of that person.

**Question: How many orthopaedic surgeons in the U.S. are capable of arthroplasty?**

Dr. Keenan said there are some people they have trained and some trained at Rancho Los Amigos. She has done only about 17 arthroplasties on polio survivors. Suggested patients ask a local surgeon and see who is willing to be educated about it also.

**Question: What are your criteria for arthroplasty in the polio population?**

Criteria for surgery is no different in either polio or general population. Dr. Keenan tries to find out why they have problems with the knee.

If there is some identifiable reason for them to get the hip or knee problem, you have to correct those other problems.

When asked what the Dr. Keenan procedure is, she said to do the old procedures with a little more understanding now that we have had all this experience from the past.