

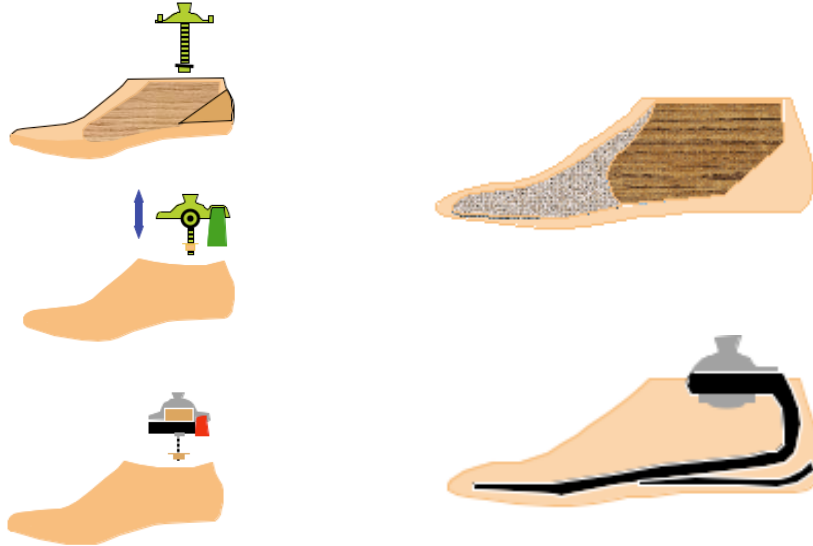
# Effects Of Dynamic Feet On Transtibial Balance & Gait

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## Outline

- What are Dynamic Elastic Response (DER) Feet
- DER Foot Research
- How DER Feet Attempt to Replicate Normal Foot/Ankle Motion
- Prosthetic Alignment Considerations
- Issues Arising with Balance & Gait
- Physical Training of the Amputee
- Take Home Message

## What Are DER Feet?

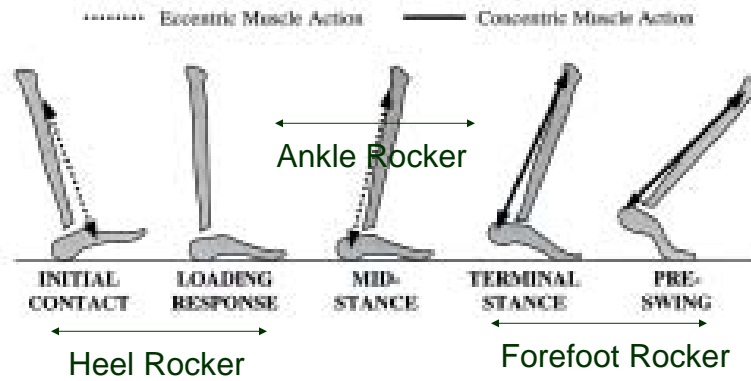


## What Research Says About DER Feet

- Do NOT decrease energy cost of walking
- Do NOT increase gait velocity OR cadence
- Tend to reduce GRF magnitude on sound limb only
- Cannot produce energy output of normal foot/ankle



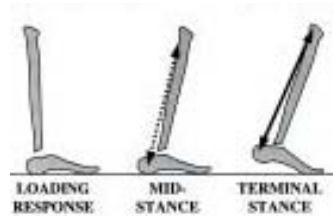
# Normal Foot/Ankle Motion



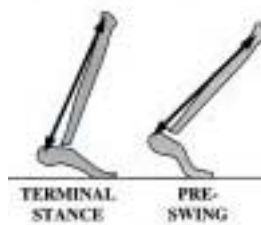
# Simulation of Heel Rocker



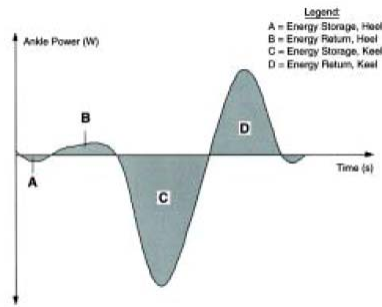
## Simulation of Ankle Rocker



## Simulation of Forefoot Rocker



## Energy in-Energy out



## Effects On Gait & Balance

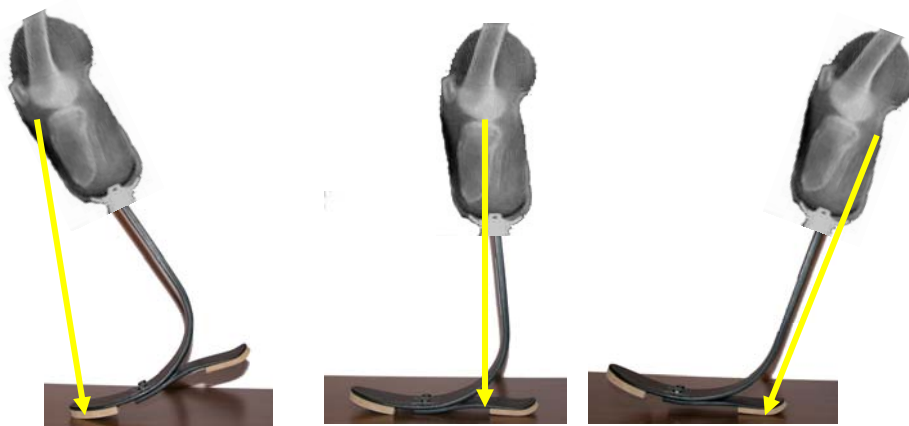
- Function includes both walking and standing
- Lack of proprioception and distal muscle control
- SACH foot : fixed ankle
- DER foot : mobile ankle
- DER foot alignment impacts both gait and balance

## Prosthetic Alignment

- Weight Line Set More Posterior on DER Feet Compared to SACH Designs
- Emphasis On Softening Heel Lever & Stiffening Toe Lever
- Toe out



## Typical Alignment



## Effects of Heel & Toe Stiffness

- Stiffer heel vs Softer heel
- Stiffer toe vs Softer toe
- Adjustments

## Early DER Gait

- Initial Contact to Loading
  - Eccentric quad strength required
  - Weak quads → knee locked in extension
    - Higher COG
    - No heel rocker action
    - Increased energy expenditure
  - Weight line set with proper heel stiffness to allow eccentric quads work during loading

## Early DER Gait

- Diminished forward progression of tibia and femur
- Hip flexion torque not decreased
- Hip extensors need to compensate
- Gluts often weak
  - forward lean to progress body weight

## Early DER Gait

- **Midstance to Terminal Stance**
  - Traditional alignment allows easy rollover
  - Concentric quads required to prevent early knee flexion
  - Active hip extension required for progression
  - Toe lever too stiff → can't get over toe
  - Early weight shift laterally results in less elastic response from foot

## Balance

- Tradeoff - balance vs gait
- Traditional alignment creates balance problems
- Mobile ankle allows weight to fall forward onto toes
- Compensate with sound limb
- More obvious in bilateral amputees



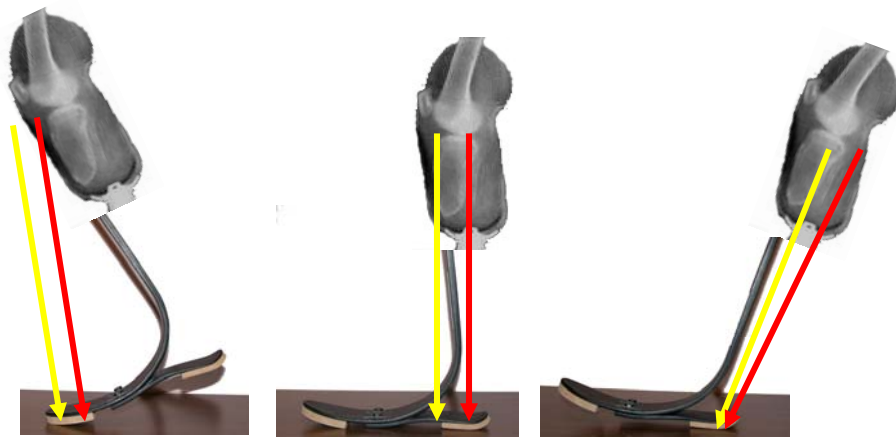
## Physical Therapy Management

- Hip extensor strengthening
- Core strength
- Back extension
- Quads/gluts closed kinetic chain strengthening
- Balance re-training
- Trust exercises

## Advanced Gait Training

- Gait changes with strengthening; improved confidence
- More aggressive initial contact
- Increased forward progression with upright posture
- Weight kept on prosthesis longer
- Start to fall off early over prosthetic toe

## Alignment Consequences



## Advanced Gait

- With toe lever increased:
  - “I can feel my toes now”
  - “that feels better”
  - “it’s easier to walk”
- More use of prosthetic limb, less strain on sound limb
- More efficient gait pattern

## Dare We Compare...

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.

Traditional Alignment

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.

Weight Line Posterior

## Balance

- Static balance improves as weight line brought posteriorly
- Weight more evenly on entire foot
- Less compensation by sound foot
- Much less effort to balance
- Improved posture in standing

## Summary

- Who gets DER  
(Indications/Contraindications)
- Key PT training & Alignment Stuff
- Importance of Rehab Team to Manage and Know When to Prescribe DER