Orthotic and Pedorthic Treatment in the Diabetic Foot

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Diabetic Foot

- ✓ Foot ulcers develop in approximately 15% of patients with diabetes
- ✓ 85% of all amputations are preceded by foot ulcers
- ✓ Most of foot ulcers occur from repetitive trauma resulting from weight bearing or **ill-fitted footwear**
- ✓ Strategies aimed at preventing foot ulcers are cost effective and can even be cost-saving if increased education and effort are focused on those patients with recognized risk factors for foot problems

Risk Categorization
- Pedorthic Aspect -

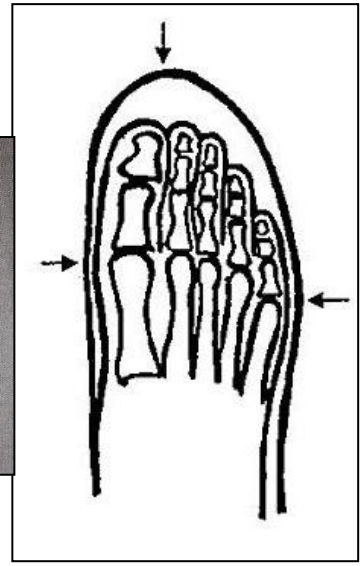
Category	Loss of Protective Sensation	Deformity, Callus, Weakness	History of Ulceration or Ischemia	Follow-up
0	No	No	No	Annually
1	Yes	No	No	6 Months
2	Yes	Yes	No	3-4 Months
3	Yes	Yes	Yes	1-2 Months

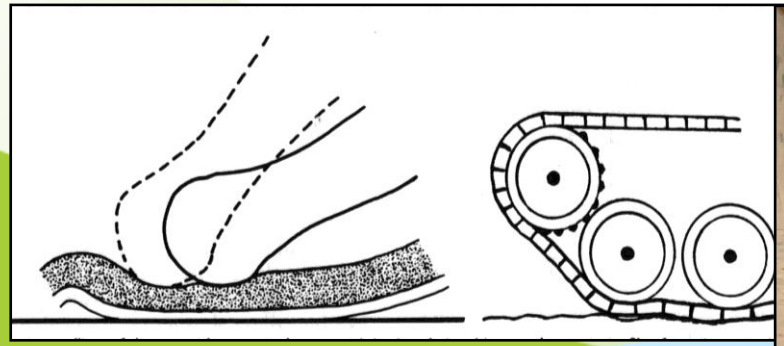
Treatment Recommendations

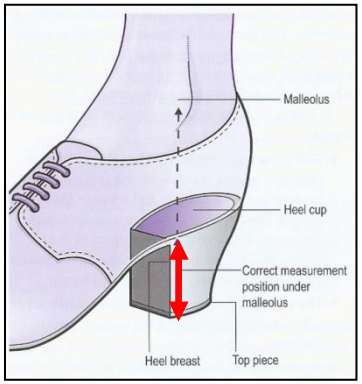
- ✓ Category 0
  - patient education to include proper shoe style selection
- ✓ Category 1
  - review all footwear the patient wear, add soft insoles
- ✓ Category 2
  - custom-molded foot orthoses, prescription footwear
- ✓ Category 3
  - custom-molded foot orthoses, prescription shoes

General Principles of Footwear Prescription

- ✓ Shoe should match the shape of the foot
- ✓ 1/2 to 5/8 inch longer than the longest toe
- ✓ Roomy and in-depth shoes(+1/4 – 3/8″)
- ✓ Triple depth-inlay(removable insole)
- ✓ Minimizing shear/friction
  : high instep, non-leather insole
- ✓ Heel heights: < 2 inches
- ✓ Shoes should be fitted at the end of the day



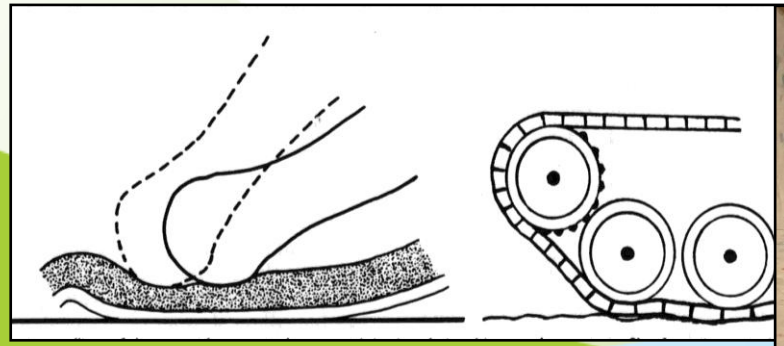


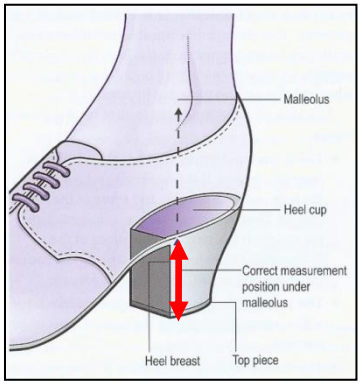


General Principles of Footwear Prescription

The role of therapeutic footwear in diabetic patients is mainly prevention of initial or recurrent ulceration rather than actual healing of ulcers

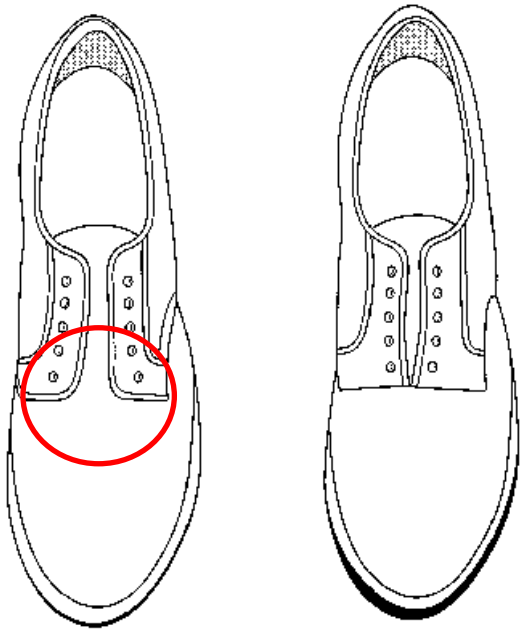
day

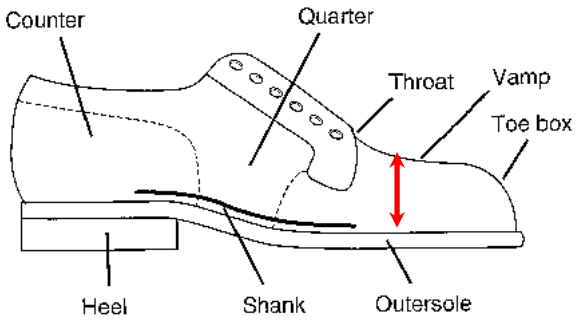




In-depth shoes

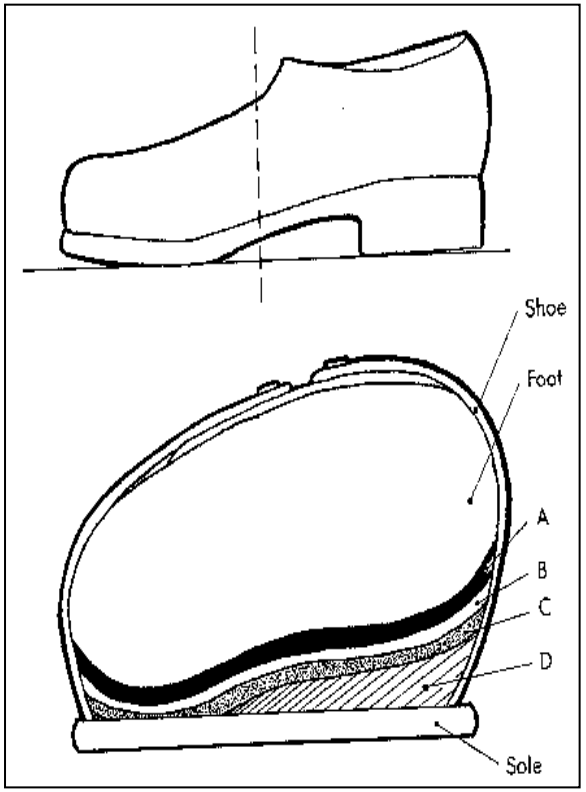
- ✓ **Blucher-style oxford or athletic shoe**
  - increased ease of donning and doffing
  - allows for more adjustability and space
- ✓ **Additional ¼ to ½ inch of depth throughout the shoe**
  - provides the extra volume needed to accommodate both the foot and a TCO
- ✓ **Light-weight, shock-absorbing soles**
- ✓ **Strong counters**
- ✓ **Upper materials**
  - moldable, stretchable and breathable: leather
  - soft, seam-free interior linings
    : plastazote, supple leather
- ✓ **Charcot foot**
  - shaped wider in the midfoot area to accommodate deformity



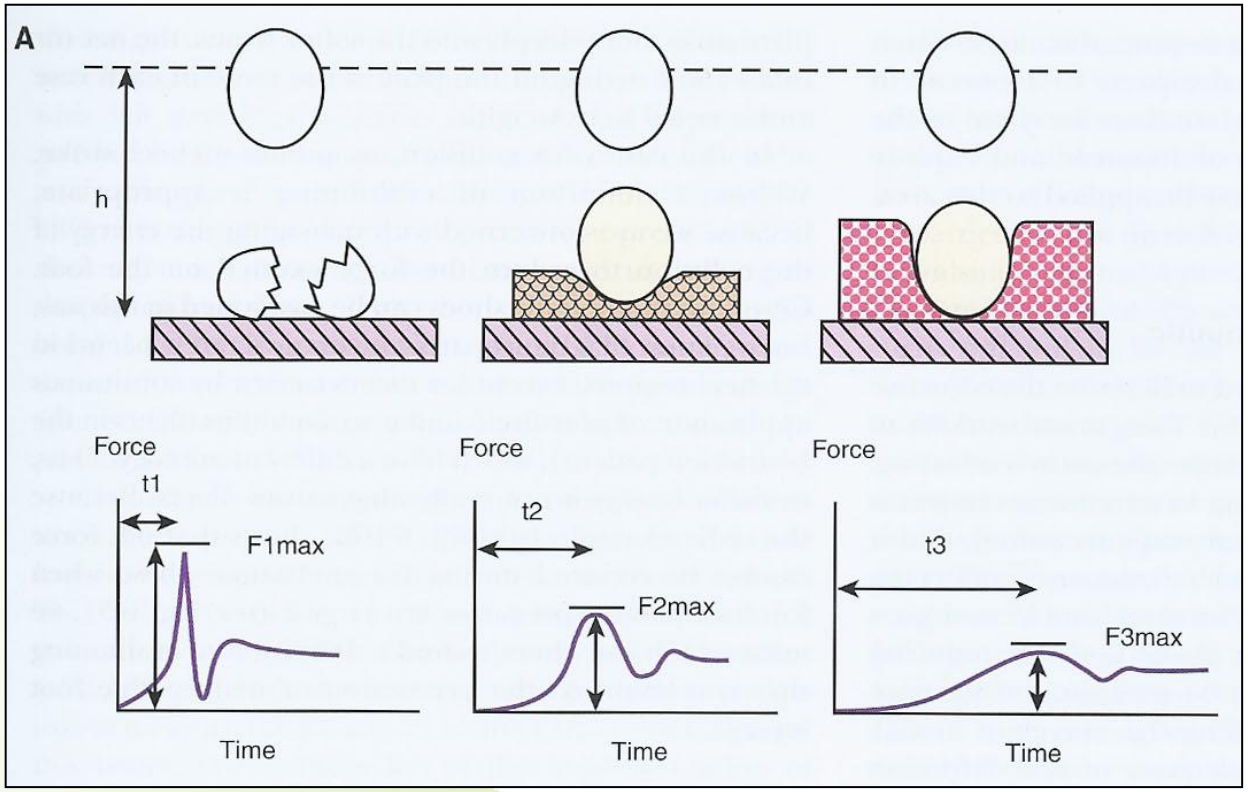


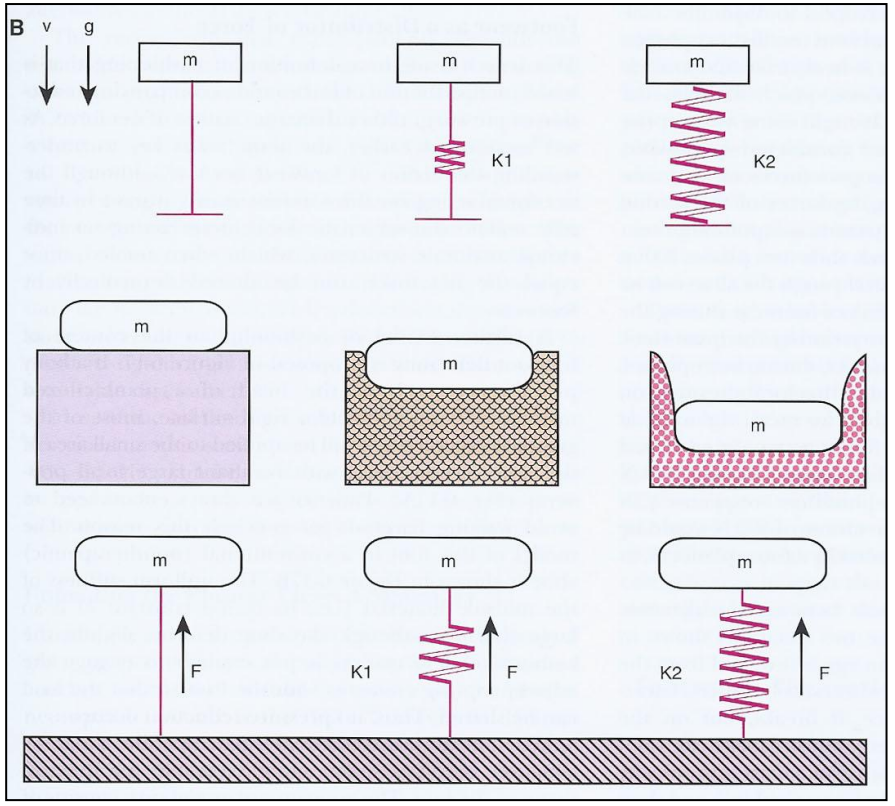
Shoe Inserts

- ✓ **Redistribute plantar forces**
  1. Pressure under one part of the foot can be relieved by increasing the pressure on an adjacent part
  2. Exactly molding an insole to the plantar shape
  3. Soft material take time to compress
- ✓ **Insole design**
  - lamination of different materials
  - a single firm material
- ✓ **Softer component next to the skin for shear relief and firmer materials underneath for structural support**



Effects of Different Types of Cushioning





Dynamic Phase

Quasi-static Phase

Percent Loss in Performance During Dynamic Compression of Dual-Density Insole

Number of Cycles	Materials				
	a	b	c	d	e
1000	7%	13%	8%	4%	22%
10,000	12%	22%	27%	36%	50%
100,000	26%	25%	36%	49%	61%

a. Poron + Plastazote #2
b. Spenco + Microcel Puff Lite
c. Plastazote #1 + Poron
d. Plastazote #1 + Poron + Microcel Puff
e. Plastazote #1 and Plastazote #2

Foto JG & Birke JA, 1998

Upper

- ✓ Limit the amount of shear strain that the tissue on the plantar aspect

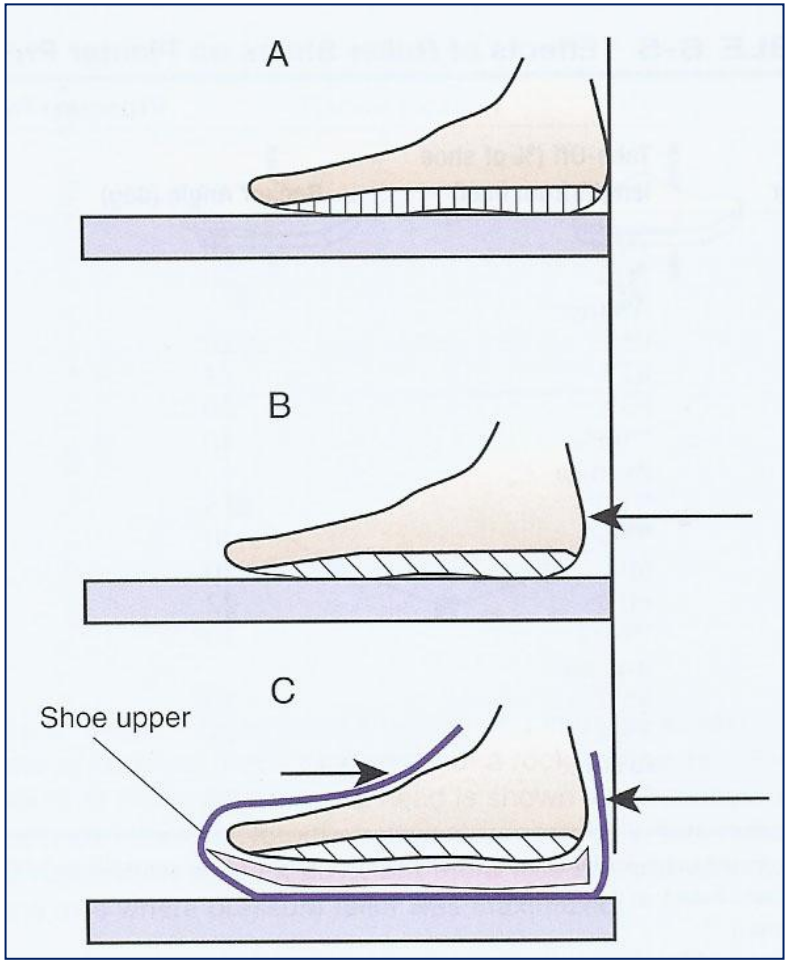
Appropriate insole

+

Well-fitting upper

↓

Reduce plantar injury



The Easiest Way to Reduce Shear Force

- ✓ The shoe size and shape are appropriate for the foot
- ✓ lubricate the surfaces moving against one another
  - shear-reducing socks: acrylic blend fabric
    (traditional cotton socks have a relatively high COF)
  - keeping the feet and sock dry
  - double socks

Shoe Sole Modifications

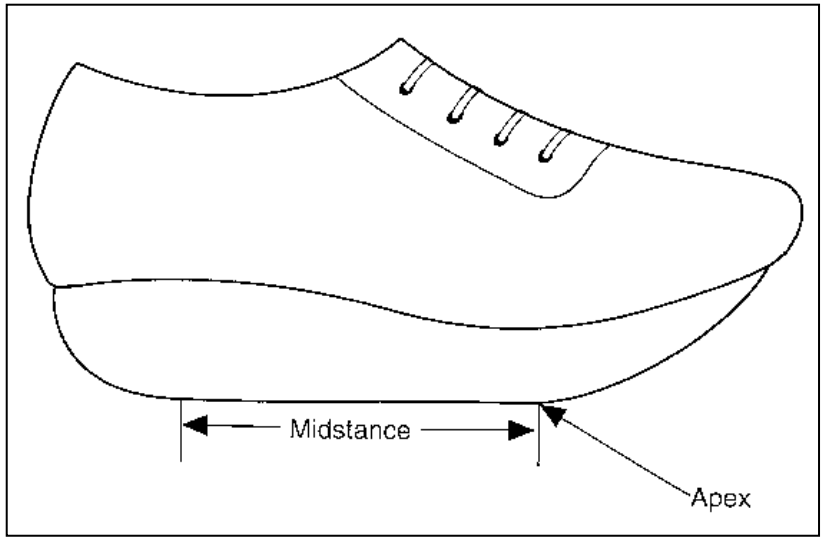
- ✓ Rigid rocker sole
- ✓ Extended steel shank
- ✓ Stabilization: Flare, Stabilizer
- ✓ Cushion heel
- ✓ Wedge

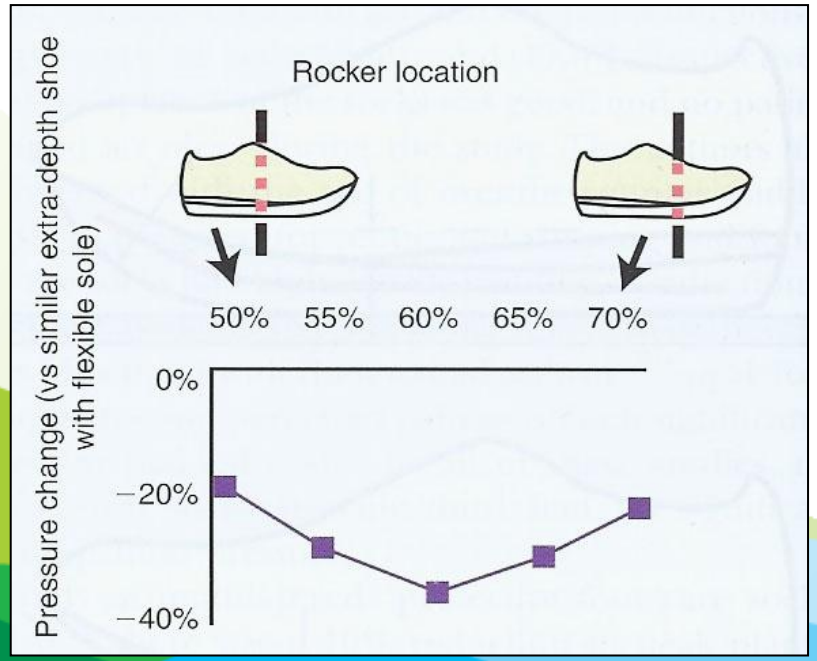
Rigid Rocker Sole

As much as 50% of the pressure can be reduced by use of a rigid rocker sole

- ✓ **Rigid shoe sole**
  - reduce shear stress on the foot
  - limit the damage to toes: limited motion at MTP joint
- ✓ **Rocker sole**
  - restoring lost motion in the foot, ankle, or both
    → overall improvement of gait
  - relieving pressure of a specific area of the plantar surface

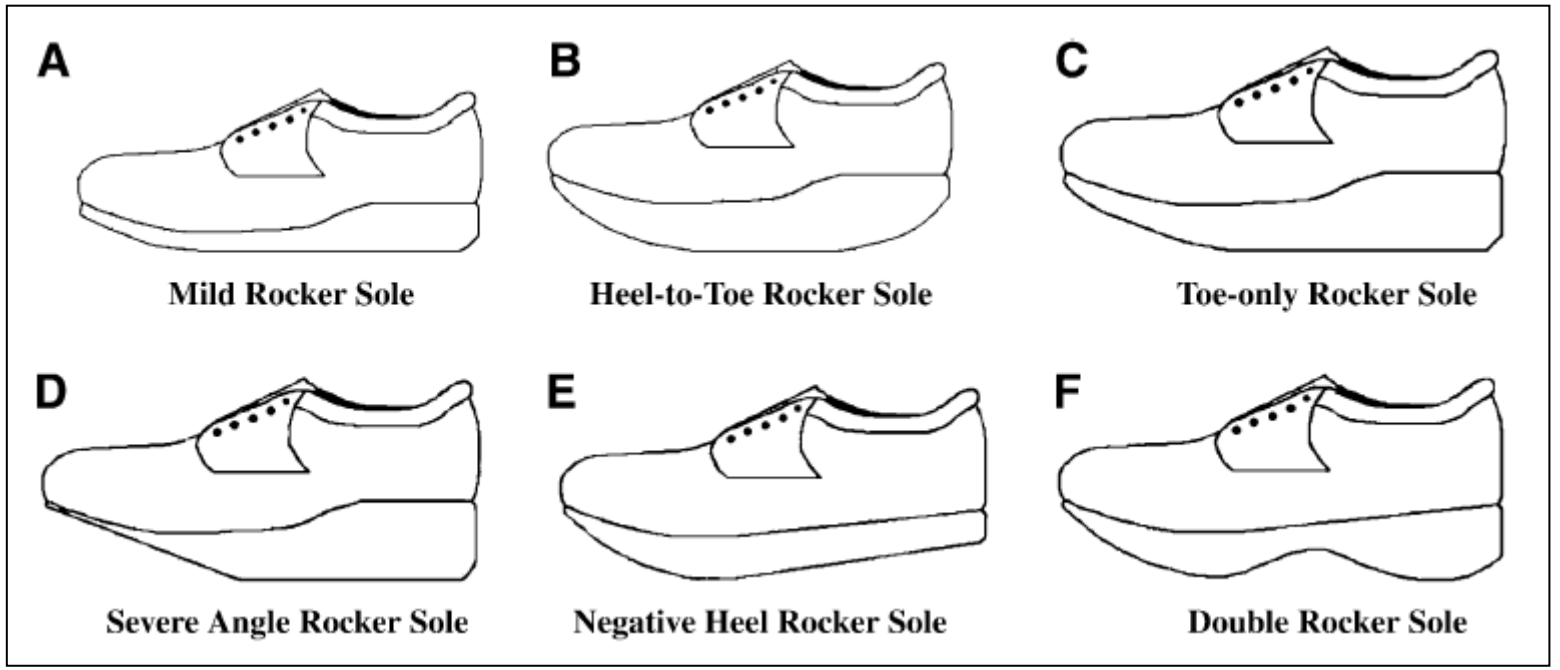
Midstance and Apex of Rocker Sole





- ✓ **Midstance**
  - contact with the floor when in a standing position
- ✓ **Apex**
  - located at the distal end of the midstance
  - must be placed behind any area for which pressure relief is desired
  - reducing MTH pressure: 55%-60%
  - reducing toe pressure: 65%

Six Types of Rocker Soles



A. **Mild**: the most widely used, relieve mild metatarsal pressure, assist in gait
B. **Heel-to-Toe**: ankle or subtalar joint fusion, fixed claw or hammer toe deformity
C. **Toe-only**: forefoot ulcerations with stability or proprioception problems
D. **Severe Angle**: extreme relief of MTH or toe-tip ulcerations
E. **Negative Heel**: accommodate a foot fixed in dorsiflexion, relieve forefoot pr.
F. **Double Rocker**: midfoot pathology

Extended Steel Shank

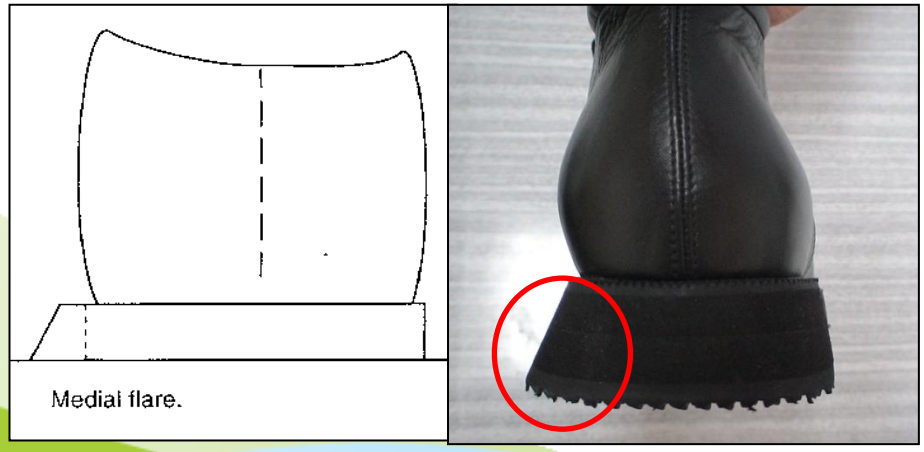
- Strip of spring steel or carbon graphite composite inserted between the layers of the sole, extending from the heel to the toe of the shoe
- most commonly use in combination with a rocker sole and helps maintain the shape and effectiveness of the rocker sole
- prevent the shoe from bending
- limit toe and midfoot motion
- propulsion on toe-off

Flares

- ✓ ¼-inch-wide medial or lateral extensions or the sole or heel
- ✓ Acts as an outrigger
- ✓ Provides a wider base of support for the foot
- ✓ Partial foot amputation

Fixed varus or valgus ankle deformity

Unstable foot or ankle



Flare

Temporary Pressure Relief Methods

Total Contact Cast

Fiberglass Cast
with a Metal Stirrup

Scotch Cast

Forefoot Relief Shoe

Heel Relief Shoe

Felted Pads

Orthoses

- ✓ In patients whose foot problems have already advanced to foot ulceration or Charcot joint, orthosis play an important role.
- ✓ Orthosis provide
  - stability
  - restrict unnecessary joint motion
  - control deformity
  - off-loading

Physical Properties of Orthoses Material

- ✓ **Soft / flexible**
  - low-temperature polyethylene foams
    : Plastazote, Pelite, Aliplast
  - Others
    : ethylene vinyl acetate(EVA), Poron, PPT
- ✓ **Semirigid**
  - graphite laminates
  - polypropylene
  - polyethylene
- ✓ **Rigid**
  - acrylic plastics
  - acrylic plastic and carbon fiber-mesh composite

Prefabricated Removable Walking Braces

- ✓ Rigid rocker sole
- ✓ Padded with a protective insole
  - Plastazote or PPT®
- ✓ May be removed for bathing, skin checks, and dressing changes

- ✓ CAM Walker
- ✓ Pneumatic Walker
- ✓ Diabetic Conformer

Removable Walking Brace

- ✓ Pressure reduction similar to those of TCC

  New Engl J Med 2004;351:48-55

- ✓ Lower healing rates

  - Walking brace: 65% (mean time: 50 days)
  - TCC: 90% (mean time: 34 days)

  Diabetes Care 2001;24:1019-1022

- ✓ The removable walking brace was not as effective as the TCC simply because patients were not compliant with wearing a removable device

Irremovable Cast Walker

- ✓ Identical to a removalbe walking brace
- ✓ “irremovalbe” by wrapping it with a layer of cohesive or plaster bandage or fiberglass tape
- ✓ Healing rates – In a 12-week follow-up
  - irremovable cast walker: **80% - 83%**
  - TCC: **74%**
  - removable walking brace: 53%

- ✓ Irremovable cast walker took **less time** to apply and remove and **cost less** than TCC

Diabetes Care 2005;28:551-554

Diabetes Care 2005;28:555-559

PTB (Patellar Tendon-Bearing) Orthosis

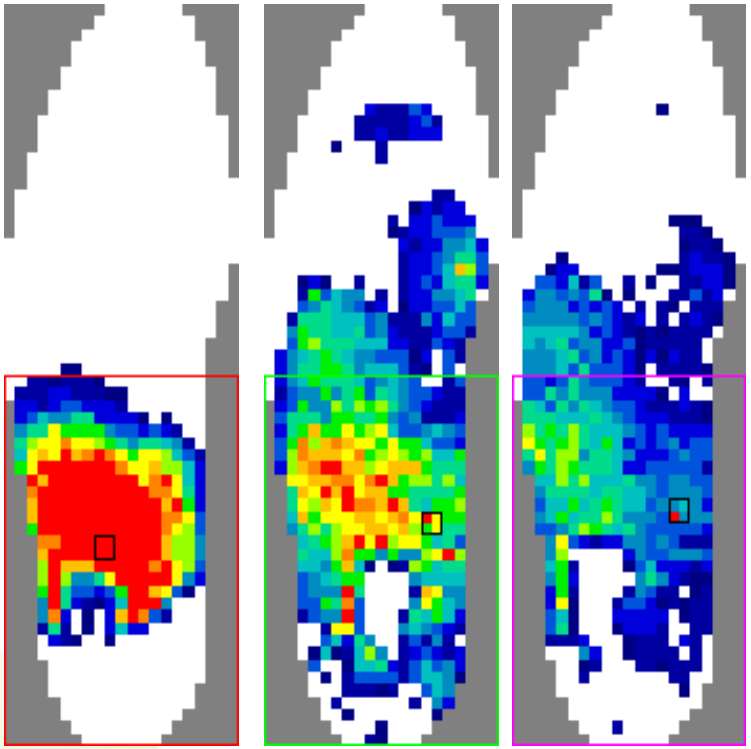
- ✓ PTB brace with custom-molded footwear
- ✓ Saltzman et al. at the Mayo Clinic (Foot Ankle. 1992;13:14-21)
  - Reduce the mean vertical peak force by only 15% compared with vertical force in a shoe
  - Adding extra padding to the brace may decrease mean vertical peak force by only 32% compared with shoe

  → limited benefit in the acute stage

  helpful adjunct for management of the stage of consolidation
- ✓ Tapering PTB brace may be considered after 6 to 24 months in the foot remains stable

PTB (Patellar Tendon-Bearing) Orthosis

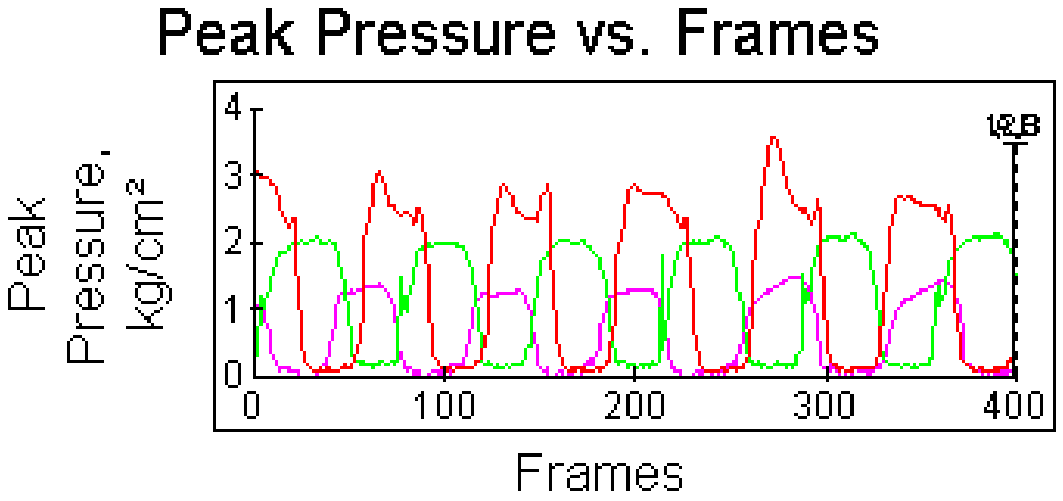
F-Scan Study of PTB Brace



Darco

PTB-Ant-Ext

PTB-Ant-Int



Arizona Brace

Calf Corset Brace

CROW
(Charcot Restraint Orthotic Walker)

- ✓ **Some similarity to a bivalved TCC**
  - better hygiene and comfort
- ✓ **Custom, bivalved, total-contact, full-foot enclosure AFO consisting of a polypropylene outer shell, rocker sole, and well-padded inner lining**
- ✓ **Benefit**
  - edema control
  - effective ankle and foot immobilization
  - near normal ambulation
  - excellent patient satisfaction
- ✓ **Disadvantage**
  - high costs of fabrication and maintenance

CROW
(Charcot Restraint Orthotic Walker)

Alignment Control Strap

Arch Phys Med Rehabil 2007;88:120-123

Summary

- ✓ The key to avoiding diabetic foot infections is to prevent the opening of a portal of entry for infection to occur

  (eg, pressure ulcerations or minor traumatic skin wounds)
- ✓ Proper footwear recommendation according to different categories
- ✓ General principles of footwear prescription
- ✓ In-depth shoes with laminated insole
- ✓ The way to reduce shear force

  - acrylic socks vs. cotton socks, double socks
- ✓ Off-loading methods for fixed deformity

  - Walking braces, PTB orthosis

Thank You for Your Attention!

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