Benefits of Early Intervention in the Developmentally Challenged Child

Joseph C D’Amico DPM, DABPO
New York, New York

Objectives
- to present an overview of the developmentally challenged foot
- to review its occurrence, identification & clinical significance
- to discuss the importance and benefits of early intervention

Increasing Lifespan
- 65 yrs and above fastest growth
- 65 yr old can expect 20+ years
- 70 yr old “young elderly”
- 75 yr old can expect 10+ years
- 85 yrs old can expect 6+ years
- 78 yrs life expectancy
A Century of Walking

Myths and Misconceptions

All children under 18 months of age appear flatfooted with an absence of the longitudinal arch.

Ozoff MB Pediatric Orthopedic Radiology Saunders Phil

The appearance of low arches in neonates and infants is primarily caused by the presence of fat deposits in the soles of the feet.

Mann RA Principles of examination of the foot and ankle in Mann RA Surgery of the Foot Mosby St Louis
The feet of most children present with a discernible longitudinal arch. Due to an increased plantar fat pad the untrained observer is led to believe that the longitudinal arch is absent.

Myths and Misconceptions

The feet of the normal child is pronated until 6 yrs of age or later.

Blount WP Fractures in children Krieger NY

res ipso loquitor
Since the feet of most children are flat, asymptomatic and non-deformed they are assumed to be normal.

Prevalence or commonality should never be confused with normalcy.

Normal implies ideal.

Herman R Tax

Lower extremity strength and toning programs improve alignment, function and osseous development.
Foot exercises, whether intrinsic or extrinsic, cannot be expected to alter foot architecture.


Scwartz RP, Heath AL. Conservative tx of functional disorders of the foot.

**Myths and Misconceptions**

Don’t worry they’ll grow out of it!

**Reality**

Very few individuals are born with perfectly aligned feet.

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Realty

Foot exercises, whether intrinsic or extrinsic, cannot be expected to alter foot architecture.


Scwartz RP, Heath AL. Conservative tx of functional disorders of the foot.
Very few individuals possess perfectly structured feet.

Over 80% of the population suffers from foot problems. The vast majority begin in childhood and are musculoskeletal. The symptomatology may not begin until the third or fourth decades.

Reality: Over 80% of the population suffers from foot problems.
The vast majority of these initially asymptomatic musculoskeletal problems begin in childhood.

Often symptomatology does not begin until the third or fourth decades, or sooner...
Myths & Misconceptions
Barefoot walking is good for you

Reality
Foot morphology is not suited to the environment in which it must function.

Pediatric Flatfoot Etiology
- Calcaneovalgus
- Convex pes valgus
- Syndrome component
- Neuromotor disturbance
- Iatrogenic
- Obesity
- Mechanical
Pediatric Flatfoot Etiology

Mechanical
- Equinus: IPS, HS, G/S, FF, Met, Ankle
- Forefoot varus
- Flexible forefoot valgus
- Genu valgum
- Accessory navicular
- Morton’s syndrome
- Transverse plane deficiencies
- Limb length discrepancy

Developmental Flatfoot
- An excessively pronated usually asymptomatic flexible flatfoot in the weightbearing pediatric population under 6 yrs of age
- The most commonly occurring and most often neglected musculoskeletal condition affecting children under 6 years

Identification
- Arch present off weight none present on weight
- Talar protrusion
- Convex medial border
- Concave lateral border
- Calcaneal eversion
- “Too many toes” sign
- Hubscher maneuver & Jack’s test normal
Identification via Elimination

- distinguish from other disorders
- diagnosis is by elimination or exclusion
- Both knowledge and skill are required in the diagnosis of a condition which is as vital to the individual as wheels to a carriage and wings to a bird

G F Domisse

Developmental Flatfoot Etiology

Phylogeny
Ontogeny
Osseous malalignment
Osseous immaturity
Neuromotor immaturity
Ligamentous laxity

Phylogeny

The story of the human foot is one that is millions of years old

Herman R Tax DPM
The story of the human foot is one that is millions of years old. Herman R. Tax, DPM.

Due to a primitive semi-arboreal ancestry, it was more important for feet to be prehensile organs to quickly climb a tree rather than walk long distances.

Since there was no need for shock absorption, the foot remained flexible and flat. Development of the longitudinal arch proceeded as this need increased.
The human infant is born with many characteristics inherited from a primitive tree-dwelling ancestry.

The low-arched flexible flatfoot seen in many children is an atavistic trait or reversion to type.

Evolutionary Scars

- External rotations
- Ligamentous laxity
- Coxa varum
- Genu varum
- Tibial varum
- Anterior femoral bowing
- Anterior tibial bowing
- Minimal tibial torsion
Evolutionary Scars  
R O Schuster  
DPM
- Hip flexion
- Knee flexion
- Ankle flexion
- Talar neck adductus
- Metatarsus adductus
- Met primus adductus
- Subtalar varus
- Forefoot varus

Ontogeny  

Hoeckle’s Law of Recapitulation  
During embryological development an organism passes through stages which resemble the structural form of several ancestral types of the species as it evolved

Ontogeny  
The human infant has the largest head and longest legs which are crowded into a relatively snug uterine environment
Ontogeny

The relatively long legs of the fetus causes it to crouch during the late in-utero period.

Ontogeny

Experts believe that even the full term infant is born in an underdeveloped state necessitating a premature birth.

Ontogeny

The newborn is not a bipedal organism. A considerable degree of developmental unwinding must take place before the organism possesses all the requisites necessary for human gait.
Osseous Malalignment

tibial varum 15-20°
subtalar varus 8-10°
forefoot varus 10-15°
Total varus 33-45°

Osseous Malalignment

tibial varum 0-2°
subtalar varus 2-4°
forefoot varus 0-2°
Total varus 2-8°

Up to 6 years of age alignment and pedal development are dictated by the nature and severity of the deforming forces directed through it and by its ability to resist these forces.
Osseous Malalignment

If allowed to continue these forces retard ideal development and encourage the retention of inherited neonatal deficiencies.

Osseous Immaturity

- Ossification occurs RF to FF
- Birth talus & calcaneus first
- Navicular last to ossify
- 2 yrs girls 3 yrs boys
- 8 years basic form complete
- 13-15 yrs skeletal maturity

2½ yrs F

Osseous Immaturity

- 7-9 mos unassisted stance
- 9-15 mos beginning walker
- 3 yrs mature walker
- 6 yrs lower extremity musculoskeletal structural deficiencies should reach adult norms
2½year F

3 yr M

Osseous Immaturity
6 yrs M
Neuromotor Immaturity

- 4-6 mos in-utero myelination begins
- 1-2 yrs initial maturity
- 9-15 mos beginning walker
- short forward bursts
- instability
- low center of gravity
- marked pronation
- hip and knee flexion
Neuromotor Immaturity

- 6 yr old adult coordination
- lower extremity last to receive myelin coating

Ligamentous Laxity

- peaks 2-3 years age
- reduces 6-8 years girls 8-10 years boys
- most commonly ascribed pediatric flatfoot etiology however arch morphology is derived from bony alignment not from ligamentous support
Arch Morphology

- building blocks
- ligaments
- reinforcement rods

Arch Morphology

- bones
- ligaments
- musculotendinous framework
Arch Morphology

The height of the arch is not a criteria to determine the amount and extent of pathology produced. Both the high and the low arched foot may function well. Morton & Hoffman

It is the medial shift in body weight that increases stress producing symptomatology and deformity rather than flatness of the longitudinal arch. Tachdjian M Pediatric Orthopedics

Pathomechanics

With calcaneal eversion all joints in the midfoot are unlocked with maximum motion at the talonavicular and calcaneocuboid articulations. Conversely if the heel is inverted the foot is converted to a more rigid structure therefore the everted foot is less stable than the inverted foot. Inman VT The human foot Manitoba Med Rev 1966

- excessive subtalar and midtarsal joint pronation
- maximum calcaneal eversion
- forefoot abduction
medial shift COF, medial displacement COG, increased talocalcaneal angle, talonavicular joint, calcaneal eversion, forefoot abduction, decreased calcaneal inclination, midtarsal unlocking, instability, hypermobility, altered application of force, stretching and overworking of peroneus brevis, PTT, tendons, peroneus brevis, tibialis anterior, and Achilles tendons, medial torsion Achilles, Spring ligament stress, strain, & permanent elongation, medial collateral ligaments of the ankle & knee stress, strain, & permanent elongation, abnormal epiphyseal stresses, internal tibial rotation, internal limb rotation, knee flexion, hip flexion, decreased height, increased Q angle, increased lumbosacral angle, increased dorsal thoracic kyphosis, increased cervical lordosis, poor posture, increased midstance, decreased
Functional Deficiencies

Static
- inefficient, inappropriate support segment

Dynamic
- excessively mobile adaptor
- ineffective propulsive rigid lever
Significance

The infant foot is immature, malaligned and subject to the deforming effects of gravity and the environment in which it must function.

Pathologic forces are being applied to an extremely malleable weightbearing segment of the lower extremity musculoskeletal system at a time when it is undergoing marked ontogenetic.

Effect

- delay of normal development
- retention of in-utero positions
- progressive dysfunction, deformity and disability

Early Intervention

An established conservative approach to the recognition and management of excessive pronation and its sequela in a generation of children whose feet may have to last 100 years or more.
Absence of symptoms is an unreliable indicator of optimum foot and limb function.

Excessive pronation is a poor postural position that sets the stage for future dysfunction and deformity. HR Tax Flexible flatfoot in children JAPA 1977

Excessive pronation should always be neutralized and if it can be visualized it is excessive. HR Tax.
Benefits of Early Intervention

- realignment of osseous & soft tissue structures
- restoration of normal lower extremity function
- redirection of pathologic epiphyseal stresses
- improved COF & COG pathways
- rectus forefoot
- locked MTX

Benefits of early intervention include bony remodeling to more normal alignment. Bordelon, Berzin, Reiman, et al.
Benefits of Early Intervention
- reduced angle of Kite
- reduced talar declination
- increased calcaneal inclination
- reduced midstance
- increased propulsion
- reduced Q angle
- reduced LSA

Benefits of Early Intervention
- reduced lumbar & cervical lordosis
- reduced dorsal kyphosis
- improved posture
- improved postural complex alignment
- knee and hip extension
- increased height

Rose G Pes planus in Disorders of the Foot Jhass MH 1982
If the foot can be put in a corrected, balanced stable posture and held in that position during the early years cure will result.
154 children 10 yr follow-up
medial Y strap, lateral bar
Objective: maintain foot in corrected stable position while normal diminution of ligamentous laxity occurs and to
Rose G Pes planus in Disorders of the Foot Jhass MH 1982

only 6 failed to achieve a stable position and all were over 6 at the start of the program
all other cases treatment began within 1 yr of birth
improvement beyond age 7 is rare and initiation of treatment cannot be delayed until that time

"Nevertheless because the ultimate condition

Benefits of Early Intervention

It is possible to correct an idiopathic hypermobile flatfoot in a child non-operatively through a regimen of prescription foot orthoses

Bordelon RL Correction of hypermobile flatfoot in children by molded insert Foot & Ankle 1980
Growth and development may be effectively used as long as the orthotic is worn faithfully and for a prolonged period of time. RA Mann
Failure to Intervene
- delay of normal development
- retention of in-utero positions
- progressive dysfunction, deformity, distress & disability
- loss of golden window of opportunity

Doing nothing will do nothing!

Intervention Guidelines
- begin with weightbearing 7-9 mos
- check STX neutral alignment & device functionality q 3mos, 6 mos and q 3-6 mos thereafter
- repeat and compare radiographs q 2 years
- change devices q 1-2 yrs, q 2 shoe sizes, or when foot morphology does not conform to orthotic module
- correction may be staged
- inflexible non-compressible materials suggested
... one should not shun the opportunity to identify and treat flatfoot before the child stands since casts and splints are truly effective in this younger group.

Foot orthotics are indicated in children anytime the navicular differential is greater than 3/8" or 9mm with or without pain.
Pediatric Foot Orthoses

Acrylics
- Polydor
- high control
- well tolerated
- lightweight
- fracture prone
- <3 yrs of age
Dynamic Stabilizing Innersole System

- podiatry designed Schoenhaus & Jay
- better tolerated than Roberts-Whitman even in equinus
- suborthelene shell
- medial and lateral flanges

DSIS

- central slit
- medial and lateral control arms
- 5 degree calcaneal offset
- add medial arch cushion

- may be forefoot tip posted
- STS arch reinforcement
- enhanced frontal and transverse plane control
HDPE Sport Orthotic
- polyolefin plastic
- semi-rigid
- resists deformation
- will not fracture
- butadiene posts

IDPE Sport Orthotic
- forefoot posts extended to sulcus
- soft tissue extension to toes
- reduce shell thickness in equinus
Graphite Composites

- semi-rigid
- non-compressible
- will not fracture
- will not deform
- lightweight
- fits in shoes
- low profile
- butadiene posts

Subortholene

- ultra high molecular weight polyethylene
- lightweight
- flexural forgiveness
Subortholene

- butadiene posts and arch fill
- 1/8" heel raises
- high level of control

Subortholene

- medial and lateral flanges
- 3/4" to 7/8" heel seat improves RF control
- omit undercut

Functional UCBL
Summary

Periodic monitoring of the immature foot will not improve pedal development, function or alignment.

Early intervention provides immediate and long-term benefits including structural realignment, improvement in function, and

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