CLUB FOOT:
My Long-Term Perspective

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TEV

Clubfoot Surgery-soft tissue

Gradual move to extreme surgery and back

- Brockman---staged surgery
- Turco---one stage posteromedial releases
- Simons---complete subtalar releases
- McKay---mechanism of reduction
- Carroll---two incision technique
- Bensahel—a la carte

George Lloyd-Roberts

Hospital for Sick Children

Great Ormand Street, London

My First Report

1975-1980, I did 101 PMR in 76 children, among those 35 feet in 24 patients satisfy the including criteria

8 patients did not follow up because of distance

Studied: 26 feet in 18 patients followed for 8.2 years average age at surgery was 1.6 years

Evaluation including clinical, radiographic and foot tracing

Results: excellent: 38.9%

good: 26.9%

fair: 15.6%

poor: 18.6%----further surgeries required

Posteromedial release for idiopathic talipes equinovarus: a long- term follow-up study, CORR 242, 1989

Revision Surgery

1981-1987	Study Group
70	Patients
86	Feet
133	Prior procedures
98	Revision procedures
3.25	Average years of follow up

First International Clubfoot Congress, Milwaukee, 1990

Revision clubfoot surgery: The Clubfoot, editor G. Simons, 1993

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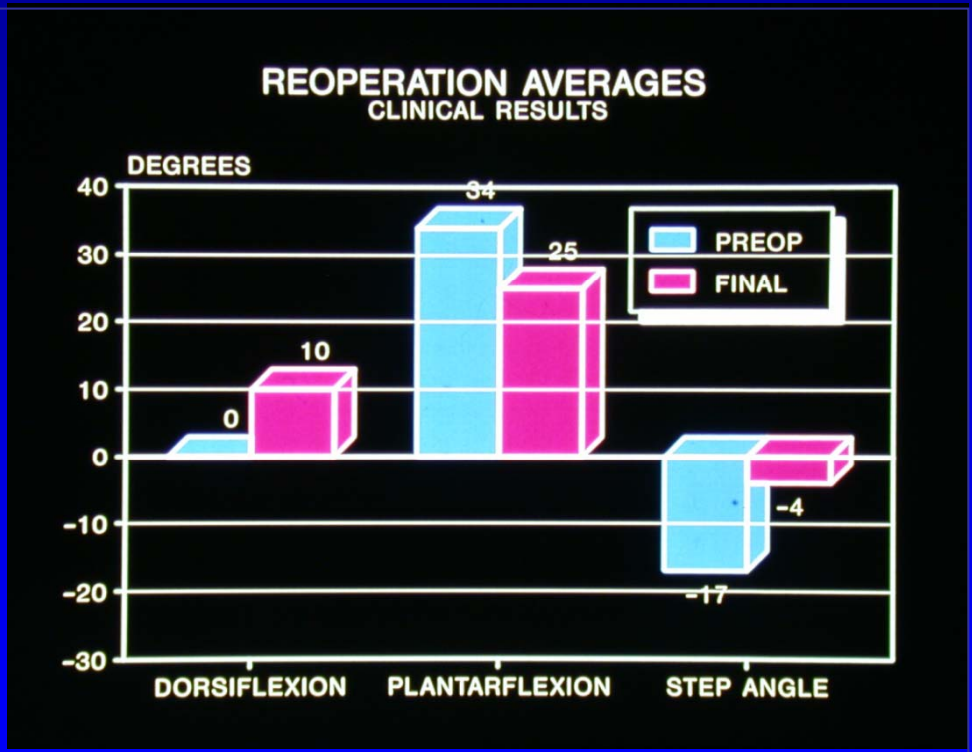
Ankle Range of Motion

Total ROM did not change after Revision surgery, just move the arc of motion



Pseudoaneurysm after foot surgery

- Four PAs were identified after 2,756 foot operations, an overall incidence of 0.14%.
- One of the case was after PMR in TEV
- Typically had symptoms between 2 and 3 months after index operation with an enlarging, pulsatile, compressible mass in the plantar medial aspect of the foot.

- *Pseudoaneurysm after foot surgery: JPO 11(5):657-62* 1991

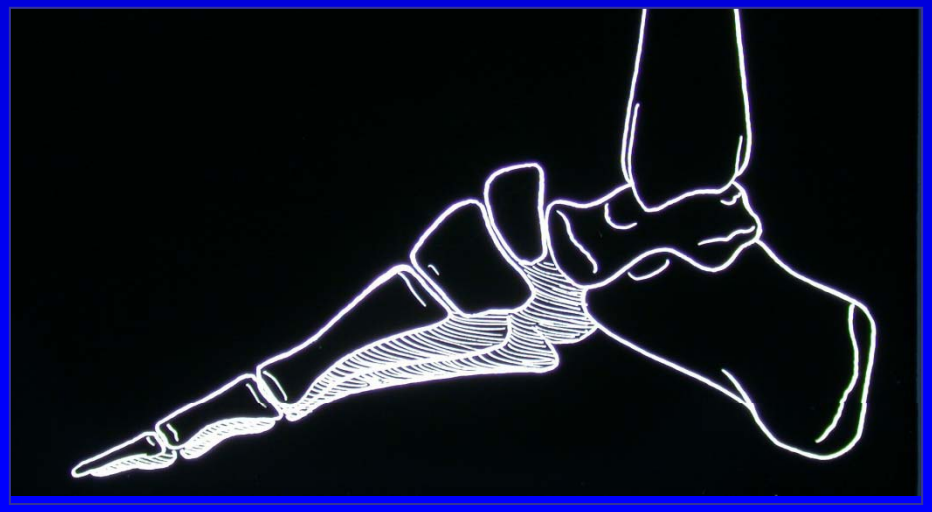
Down's Syndrome and Clubfoot

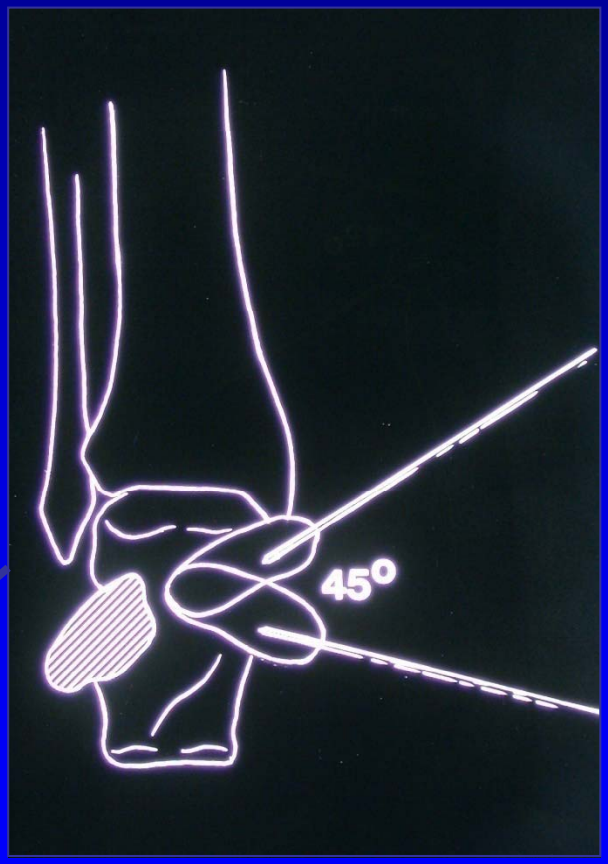
- Eight patients with a total of 15 clubfeet
- 2 patients had evidence of arthrogryposis as well as Down's syndrome
- Fourteen of the 15 feet required surgical intervention to afford correction of the deformity
- Down's syndrome is usually characterized by ligamentous laxity, when clubfeet are associated with this syndrome they can be rigid

- *Clubfoot deformity in Down's syndrome: Orthopedics 18(5):449-52 1995*

Rotatory Dorsal Subluxation of Navicular

Rotatory Dorsal Subluxation of Navicular





Net Effects of Rotatory Dorsal Subluxation

- Shortening of medial column
- Plantar flexion of metatarsal joint
- Forefoot adduction
- Forefoot supination
- Cavovarus foot

Rotatory subluxation of navicular: A complication of clubfoot surgery, JPO 15:770, 1998

Rotatory Dorsal Subluxation of Navicular

Management:

- Realignment of talo-navicular and calcaneo-cuboid axis
- Excision of navicular
- Talo-navicular fusion

Congenital Constriction Band Syndrome and Clubfoot

- The bands were considered to be of significance if located in the calf region (zone 2).
- Group A-consisted of 26 clubfeet without neurologic deficit and had 1.4 surgeries per clubfoot.
- Group B consisted of 11 clubfeet with neurologic deficit and had 3.7 surgeries per clubfoot.
- Children with grade 3 bands in zone 2 were most likely to have a neurologic deficit.
- Group B had poorer results than Group A.

- *Resistant talipes equinovarus associated with congenital constriction band syndrome: JPO 0(2):240-5, 2000*

Anterior tibial tendon transfer

Full transfer vs. split transfer
for
Residual Functional Forefoot
Supination Deformity

Anterior tibial tendon transfer in residual clubfoot Deformity, JPO:21:35-41, Jan. 2001

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TENDON TRANSFER

Full transfer (FT): the tendon is transferred to middle or lateral cuneiform

Split transfer (ST): the lateral half of the tendon is transferred to cuboid

SPLIT vs. FULL TRANSFER

- Both procedures are excellent in correcting dynamic supination and adduction
- Full transfer may give a little better correction, however there is chance to overcorrect the deformity
- Split transfer definite preserve a better inversion function of the foot

Tendon fixation

We now use bio-absorbable screw for tendon anchoring unless foot is too small

The use of the Bio-absorbable screw in a split anterior tibial tendon transfer: A preliminary result, JPO-B 18:69-72, March 2009

Dorsal Bunion

Major Factors in Dorsal Bunion Formation Following Clubfoot Releases

- Weak Achilles Tendon
- Overpowering of FHL
- Strong Anterior Tibia Tendon
- Weak Peroneous Longus

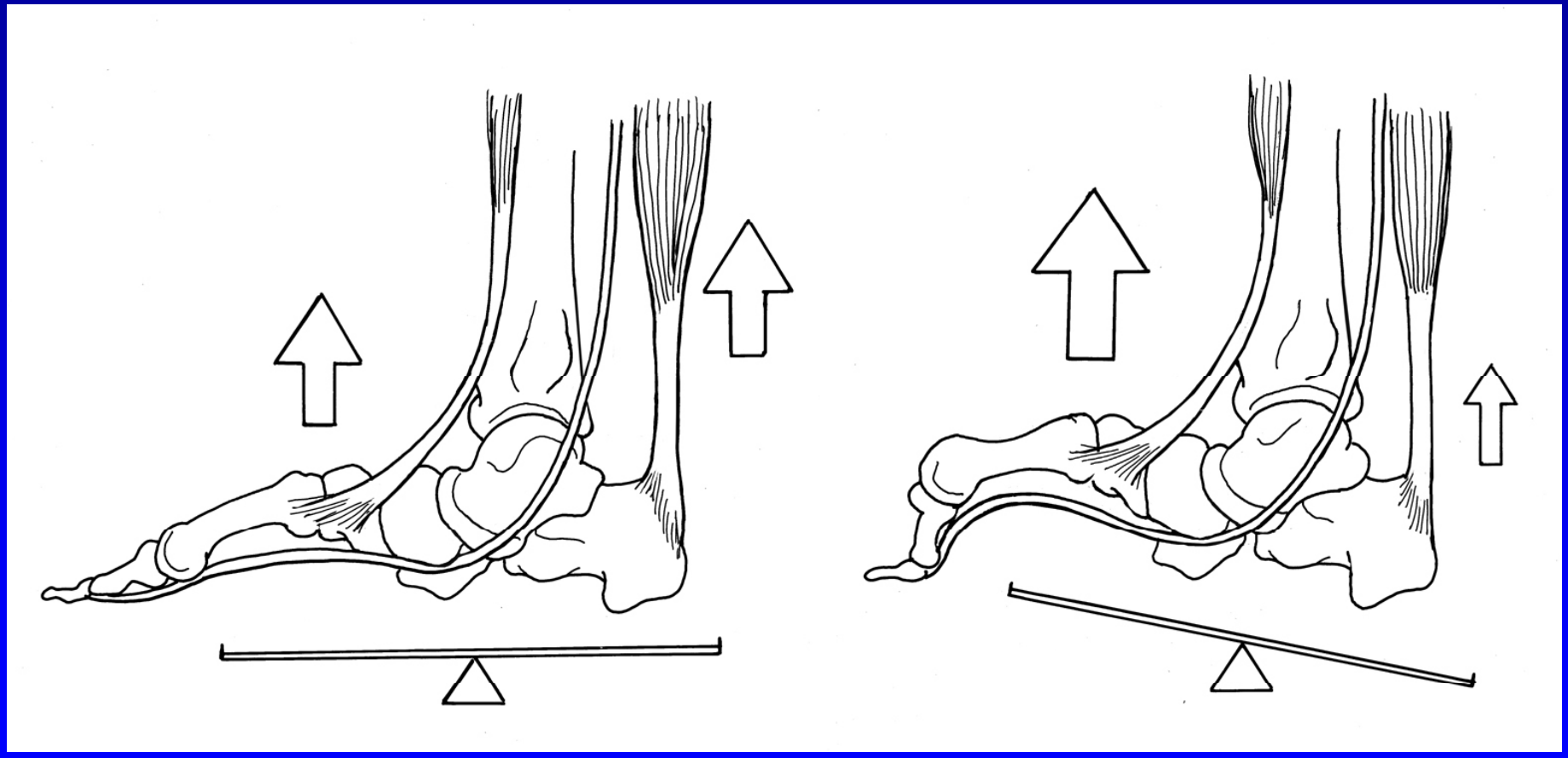
Reverse Jone's transfer for dorsal bunion following clubfoot surgery
The Clubfoot, Editor: G. Simons, 1993

Etiology: Muscle Imbalance

Polio

Cerebral Palsy

Clubfoot Residual



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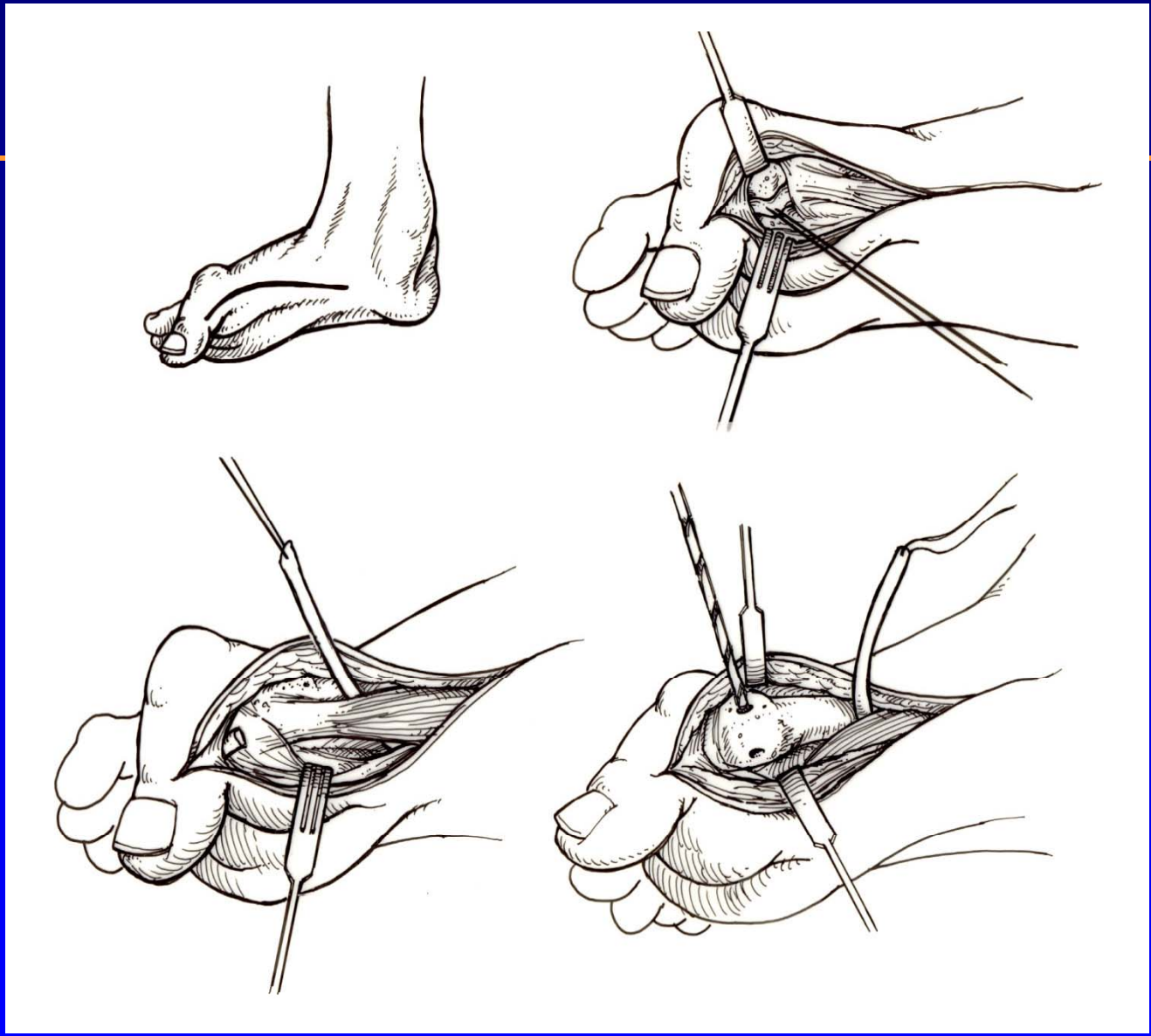
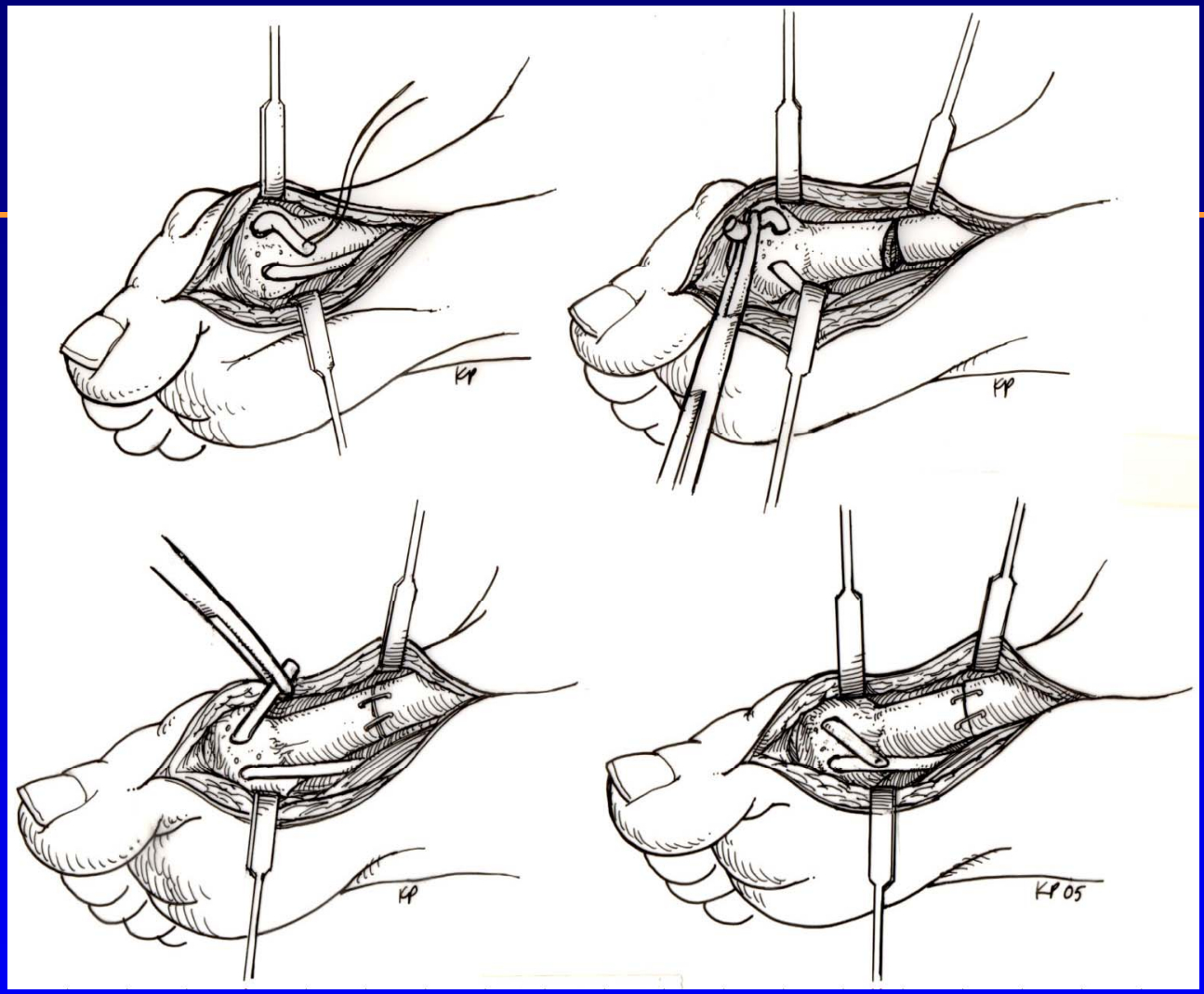
Dorsal Bunion

Management:

- FHL transfer--Reverse Jone's transfer
- First metatarsal flexion osteotomy when tarso-metatarsal joint is stiff
- Split anterior tibia tendon transfer when forefoot is in supination position with strong anterior tibia tendon





Dorsal Bunion following Clubfoot Surgery: Outcome of Reverse Jones Procedure. JPO Oct-Nov issue, 2007

Dorsal Bunion

Residual Deformity following Clubfoot Surgery

- *Correcting Residual Deformity Following Clubfoot Releases: Clinical Orthopaedics and Related Research, 467:1326-1333, May 2009*

Analysis of Failure

- Between January 1988 and December 1991
- 134 clubfeet in 95 children
- 72 boys , 23 girls
- 56 unilateral, 39 bilateral
- Average age at time of surgery: 12 months
- Average time of follow up: 4+6 years

RESULTS--Analysis of failure

21 feet required additional surgeries for the residual deformities of the following:

Forefoot adduction and supination:	20 feet (95.23%)
Cavus Deformity:	7 feet (33.33%)
Hindfoot varus:	8 feet (38.09%)
Hindfoot equinus:	5 feet (23.81%)

(A foot may have more than one deformity)

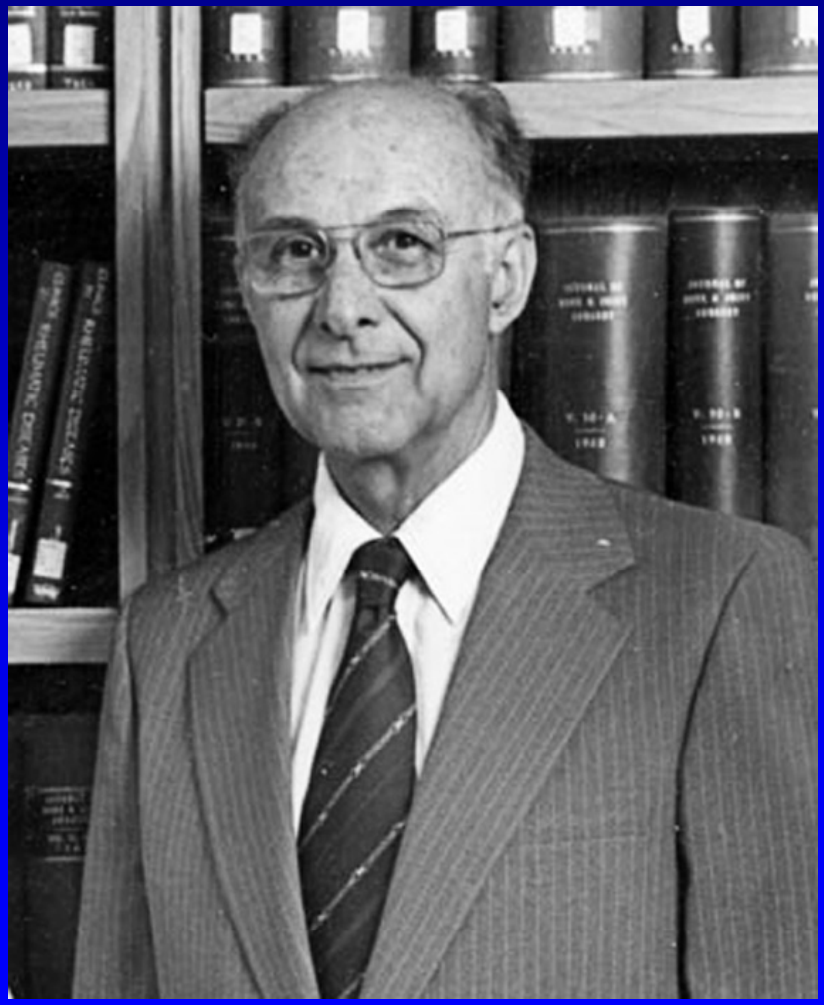
Ippolito et al(2003): better long term outcome in patients treated with manipulation and limited posterior release as compared with extensive releases

Dobbs et al(2006): poor outcome in surgical release at long term follow up

The wind changed direction

- Aggressive Surgery → Non-Surgical

Ponseti Method



The Ponseti Method- my latest in Taiwan

- Mean follow up period was 5y10m (4y3m to 7y)
- 19 patients with 30 idiopathic clubfeet
- Ponseti method of casting and may be followed by percutaneous Achilles tenotomy, all had Dennis-Browne Bar afterward

The Ponseti Method

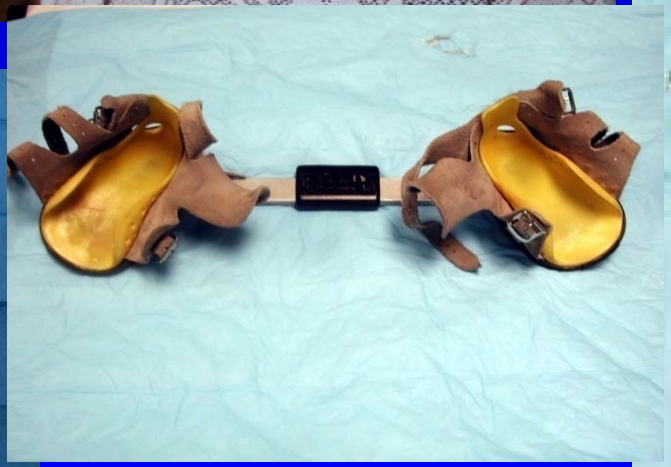
- Percutaneous Achilles tenotomy in 23.3% of the feet at an average age of 3m1wk (5 wks to 8m).
- Anterior tibial tendon transfer required in 10% of the feet at an average age of 2y10m (2y to 3y9m).
- 7% of the feet required further surgery

The Ponseti Method

- Good- Plantigrade foot after Ponseti method with/ without percutaneous Achilles tenotomy.
- Fair- Relapse that required subsequent SPLATT.
- Poor- Recurrence after SPLATT that required further surgery.
- Same as Steve Richards criteria

	Good	Fair	Poor
4y3m minimum F/U (30 feet)	**90 %** (27 feet)	**3 %** (1 feet)	**7%** (2 feet)

Foot Abduction Brace



Question?

- Brace---external splinting
- Anterior tibial tendon transfer---internal splinting

International Clubfoot Study Group

ICFSG was formed in early 1990's by

Henri Bensahel

Ken N Kuo

Morris Duhaime

It is an informal group held meeting once or twice a year to discuss mainly on unifying the clubfoot language

ICFSG Outcome Score

International Clubfoot Study Score using morphology, range of motion, and function, with total point of 60 the worst, 0 being the best.

Reference: Bensahel, H., Kuo, K.N., Duhaime, M.: Outcome Evaluation of the treatment of Clubfoot: the International language of Clubfoot.: J. of Pediatr. Orthop-B 12 :269, 2003

Outcome Evaluations

Evaluation instruments

- Ponseti classification—function and pain
- Turco classification---morphology
- Simons classification---radiographic
- Pirani classification---progress of treatment
- International clubfoot study group---morphology, muscle strength, radiographic, function and pain.

Outcome Evaluations

Gait analysis

- Texas Scottish-Rite Children Hospital. Conventional gait study –Lori Karol
- Chicago Shriners Hospital for Children and Medical University of Milwaukee—foot and ankle motion study –Peter Smith, Ken N Kuo, Gerald Harris

  etc.

A Twenty-One Year Follow-Up of Adults after Comprehensive Soft-tissue Release for Clubfoot Deformity

Long-term outcome evaluation in young adults following clubfoot surgical release, JPO, 30(4):379-85, June 2010

Shriners Hospital for Children, Chicago

Methods

- Consecutive series of adolescent patients treated with comprehensive releases for clubfoot as infants
- Comprehensive soft-tissue surgical release within first year of life
- Surgery performed by same surgeon (KNK)
- At least 18 years of age
- 16 subjects (13M, 3F, mean age 21 y; 16 clubfeet)
- 21 age matched normal subjects

Methods

Measurement Tools

Gait Analysis

Physical Examination (ankle ROM, Heel Rise test)

Isokinetic strength testing

SF-36 - Short Form Health Survey

FFI – Foot Function Index

AOFAS – American Orthopaedic foot & Ankle Society

DSI – Disease Specific Index

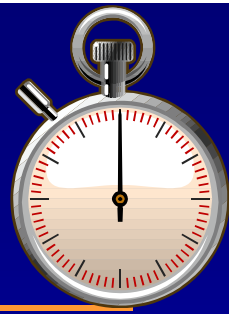
Turco

International Clubfoot Study Group (ICFGS)

Heel Rise Test grading: 5 = 20 heel rises, 4 = 10-19 heel rises, 3 = 1-9 heel rises, 2+ = Able to clear heel from floor, 2 = Completes full ROM, 2- = Partial ROM without resistance, 1 = slight contraction, no motion, 0 = No palpable/visible contraction

5 – Biodex is the isokenetic testing. It is measured in N-m per kilogram so is based on the patient's weight.

Spatial/Temporal Parameters



	Mean (SD)	
	Clubfoot	Normals
Stride Length (m)	1.14 (0.1)	1.32 (0.1)*
Cadence (steps/min)	104.0 (8.9)	110.62 (6.7)*
Walking Speed (m/s)	0.99 (0.1)	1.22 (0.1)*
Foot Off (%GC)	62.6 (1.8)	60.34 (1.0)*

* significant at $p<0.0125$

Outcome Measures

	Clubfoot (stdev) N=25 feet	Contralateral (stdev) N=7 feet	Normals
AOFAS Hindfoot	81.28 (10.51)*	100 (0)	99.52 (2.16)
AOFAS Midfoot	81.84 (11.14)*	99.00 (2.65)	99.43 (2.18)
ICSFG	14.92 (6.86)	3.86 (2.27)	____

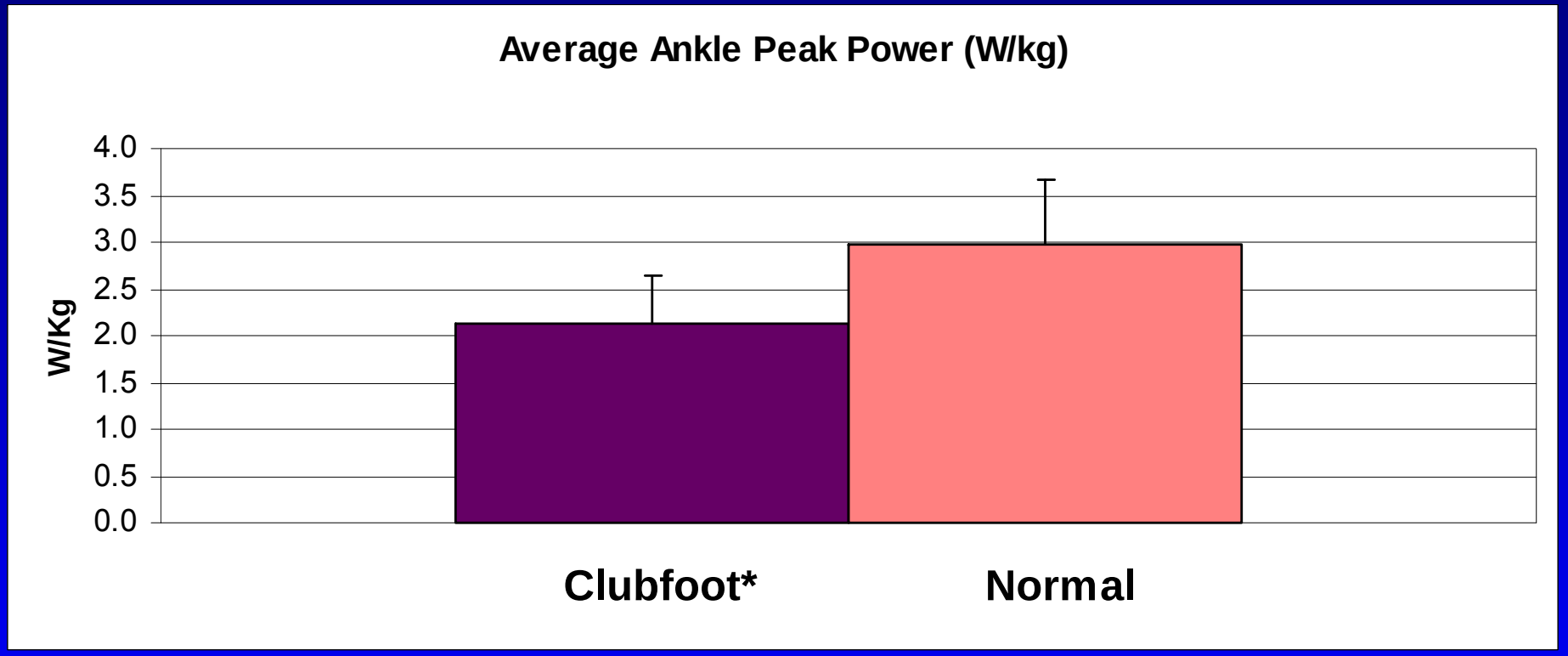
* P $\leq$0.05, clubfoot significantly different from normals

SF-36

	Clubfoot (stdev) N=25 feet	Normals
Physical Function	86.88 (14.48)*	99.52 (1.50)
Role-Physical	79.69 (30.58)	94.05 (22.23)
Bodily Pain	61.25 (27.64)*	90.62 (13.62)
General Health	78.38 (13.82)	87.71 (10.83)
Vitality	69.69 (17.27)	65.48 (15.72)
Social Functioning	94.53 (9.09)	97.62 (7.52)
Role-Emotional	93.75 (25.0)	95.24 (21.82)
Mental Health	81.00 (13.27)	81.71 (13.48)

* $P \leq 0.05$, clubfoot significantly different from normal

Ankle Kinetics



*significant at p<0.004

Long Term Outcome following PMR

- Surgical correction of CTEV was successful in providing a functional plantigrade foot as the patients reached adulthood
- However, limitations including:
  - Foot pain with activity
  - Diminished temporal spatial parameters
  - Reduced foot range of motion
  - Significant ankle plantarflexion weakness

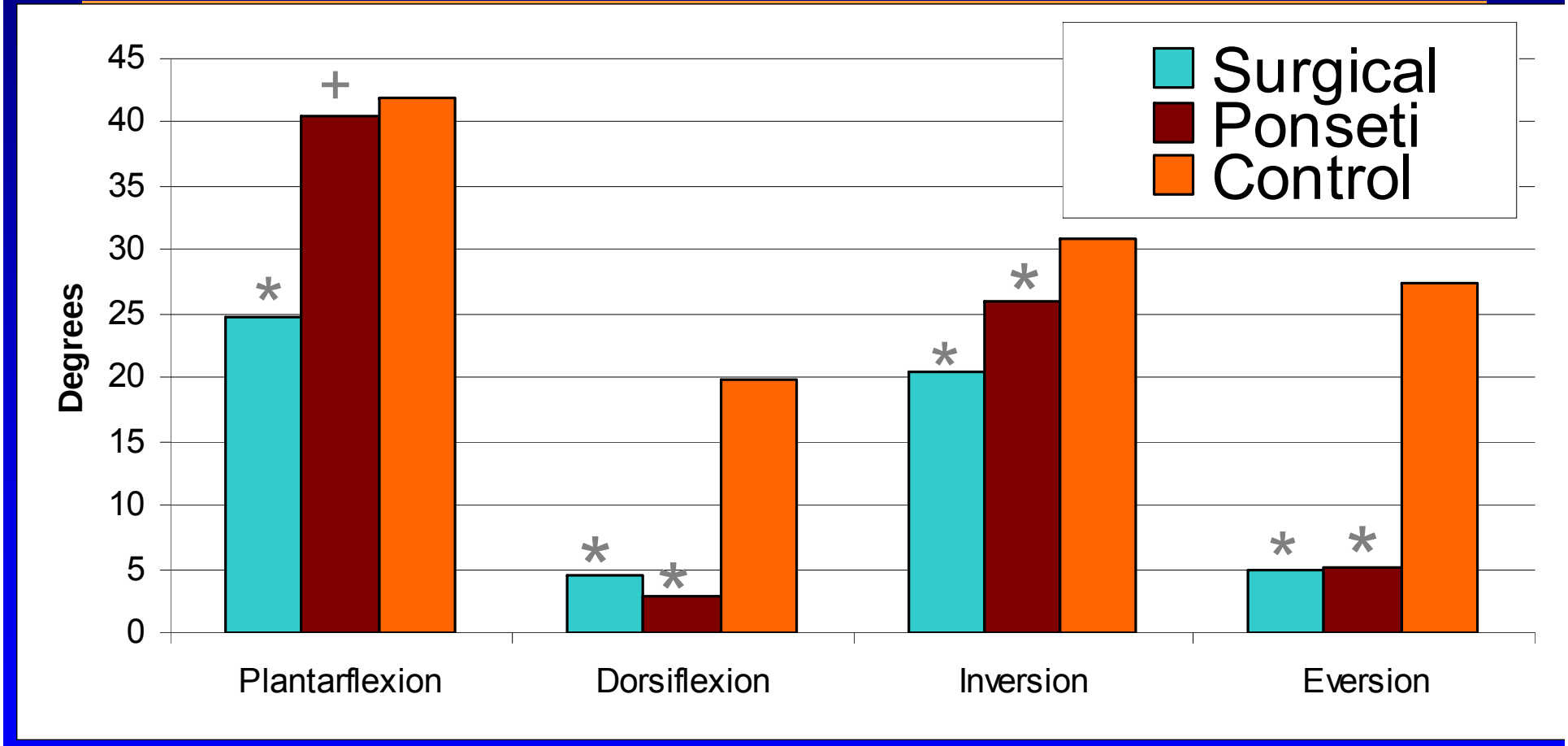
Long Term Outcomes of Comprehensive Surgical Intervention vs. Ponseti Method in the Treatment of Idiopathic Clubfoot

Methods

Subjects: 3 Groups

- 24 Surgical Clubfoot Subjects (21.8 ± 2.4 years) from Shriners Hospital for Children in Chicago
- 19 Ponseti Clubfoot Subjects (29.2 ± 5.5 years) from University of Iowa Hospital
- 48 Age-Matched Controls (23.3 ± 2.4 years)

Passive Range of Motion

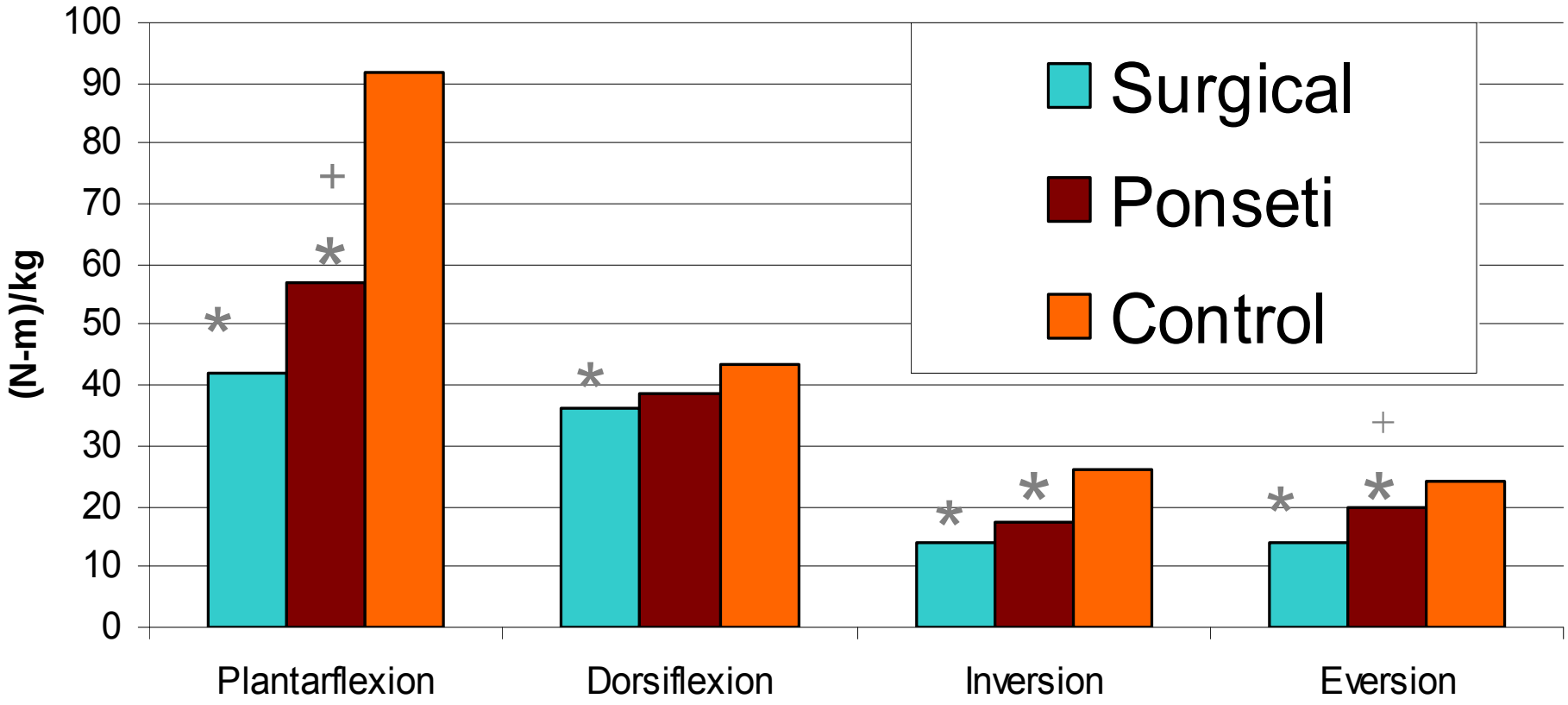


*Indicates significantly different from Control Group ($p<0.05$)

+Indicates significantly different from Surgical Group ($p<0.05$)

Strength

(Peak Torques Normalized to Body Weight)



*Indicates significantly different from Control Group ($p<0.05$)

+Indicates significantly different from Surgical Group ($p<0.05$)

Results

Temporal Spatial Parameters (St. Err)

Group	Walking Speed (m/s)	Cadence (strides/min)	Stride Length(m)	Foot Off (%GC)
Surgical	1.01(0.03)*	106.3(1.57)*	1.13(.02)*	60.6(1.57)
Ponseti	1.10(0.04)	108.6(2.2)	1.22(0.03)	62.1(0.9)
Control	1.18(0.02)	110.5(1.3)	1.28(0.02)	60.5(1.0)

*Indicates significantly different from Control Group ($p<0.05$)

Results

- Surgically treated clubfoot patients demonstrated a low but abnormal incidence (11%) of ankle arthritis at 20yo
- Both clubfoot groups demonstrate diminished passive range of motion in all planes, strength and push off power during gait compared to controls

Clinical Significance

- Both clubfoot groups demonstrate diminished outcome scores compared to control subjects at young adulthood
- In all areas the Ponseti group more closely resembled the control subject group, and showed significant improvement over the comprehensive surgery group in plantarflexion strength and pain

Clinical Significance

These findings indicate that compared to surgical intervention, treatment of CF via the Ponseti casting method results in better outcomes and ambulatory function when these individuals reach the age where they enter the workforce.

The Ponseti method should be the preferred intervention over comprehensive surgical release for the treatment of CF. There is still room for improvement.

Recurrence after Ponseti

Crawford et al: 14/40 feet required surgery

New Zealand, JBJS 2010

Park et al: 19/48 feet required surgery

Ulsan, Korea, JBJS-B 2009

Richards et al: 37% recurred on initially corrected feet (initially 94.4% corrected)

TSRH, JBJS 2009

Pediatric Orthopaedic Surgeons should understand the pathologies and how to take care of the recurrence

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