How to assess sensory function of the foot and leg in children with MMC?

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Introduction

- In children with myelomeningocele (MMC) both motor and sensory pareses have been reported (Copp 2015)
- In children with arthrogryposis (AMC), born with multiple joint contractures, both normal sensation and proprioception deficits has been identified (delle-Vedove et al. 2016)
- In children with MMC sensory loss usually follows motor loss within one or two segments (Stark 1971)
- Knowledge of sensory function in the lower limbs is important for several reasons (pressure injuries in orthoses, evaluation pre-post neurosurgery…)
- It is however unclear *to which extent* sensory stimuli is perceived
- We were interested in both groups of rare diagnoses but focus of this presentation is on MMC

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Between February 2023 and May 2024: 57 children with AMC and MMC treated at Karolinska University Hospital were contacted

42 children agreed to take part in a cross-sectional study
(17 females and 25 males, with a mean age of 12 (7–18) years)

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Aim of the study

- The aim was to investigate somatosensory status in the feet and legs in AMC and MMC
- The hypothesis was that children in both groups perceive somatosensory stimuli less clear than children with typical development (TD)
- Focus in this presentation will be on MMC

Participants

	AMC (n = 19)	MMC (n = 23)	TD (n = 22)
Age (years)	10.6	12.4	12.1
Motor classification)	AMC1: 4 AMC2: 9 AMC3: 6	MFC I: 7 MFC II: 7 MFC III: 8 MFC IV: 1	-
Functional ambulation	Ca:13 Ha: 2 N-f: 3 N-a: 1	Ca:12 Ha: 3 N-f: 7 N-a: 1	-
Orthoses (n/%) Bilateral/unilateral limbs (n) Insole AFO KAFO-F KAFO-L THKAFO	19/100 18/1 10 13 4 8 1 (both legs)	19/83 18/1 10 10 10 5 1 (both legs)	-

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Muscle function classes

MMC (n = 23)
MFC I: 7 MFC II: 7 MFC III: 8 MFC IV: 1
Ca:12 Ha: 3 N-f: 7 N-a: 1

Functional ambulation
(Hoffer et al)

Ca: walking outside
(without or with need of orthoses)
Ha: walking indoors
N-f: e.g. in therapy
N-a: no walking function

Muscle pareses mainly in:

MFC I: Foot intrinsic muscles
(Flat foot)


MFC II: Plantar flexors
(Lack of ankle stabilization)


MFC III: Hip extensors, hip abductors
remaining quadriceps strength
(Excessive lordosis, knee flexion and valgus)


MFC IV: Hip adductors, hip flexors
(decreased knee and hip stabilization)



Not all children achieve expected ambulatory function following additional neurological disturbances!

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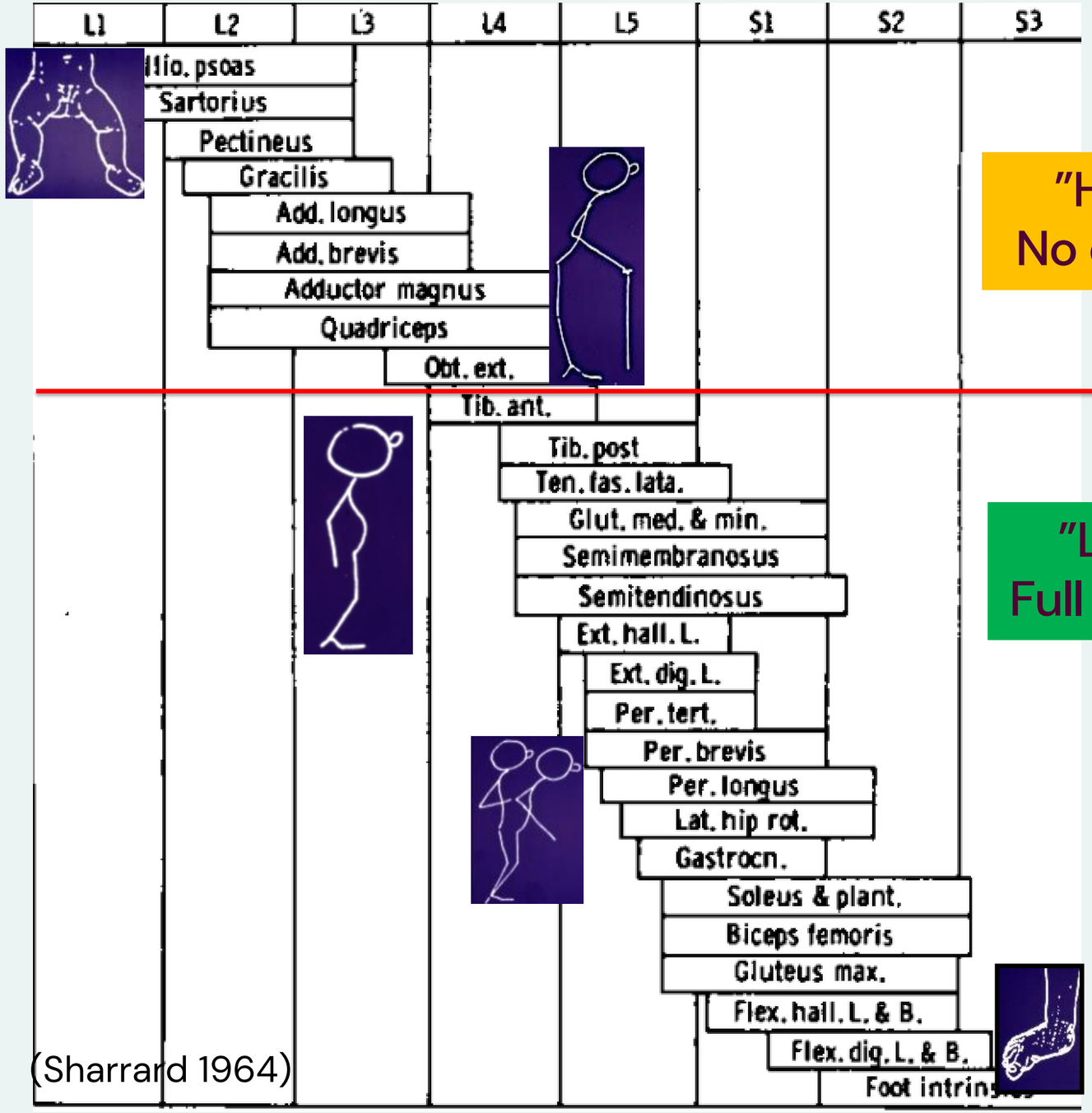
MFC classes



(Sharrard 1964)

"High level"
No quadriceps

"Low level"
Full quadriceps

MFC V
(Thoracic level)

MFC IV
(high lumbar)

MFC III
(mid lumbar)

MFC II
(low lumbar)

MFC I
(sacral)

Original Research Report

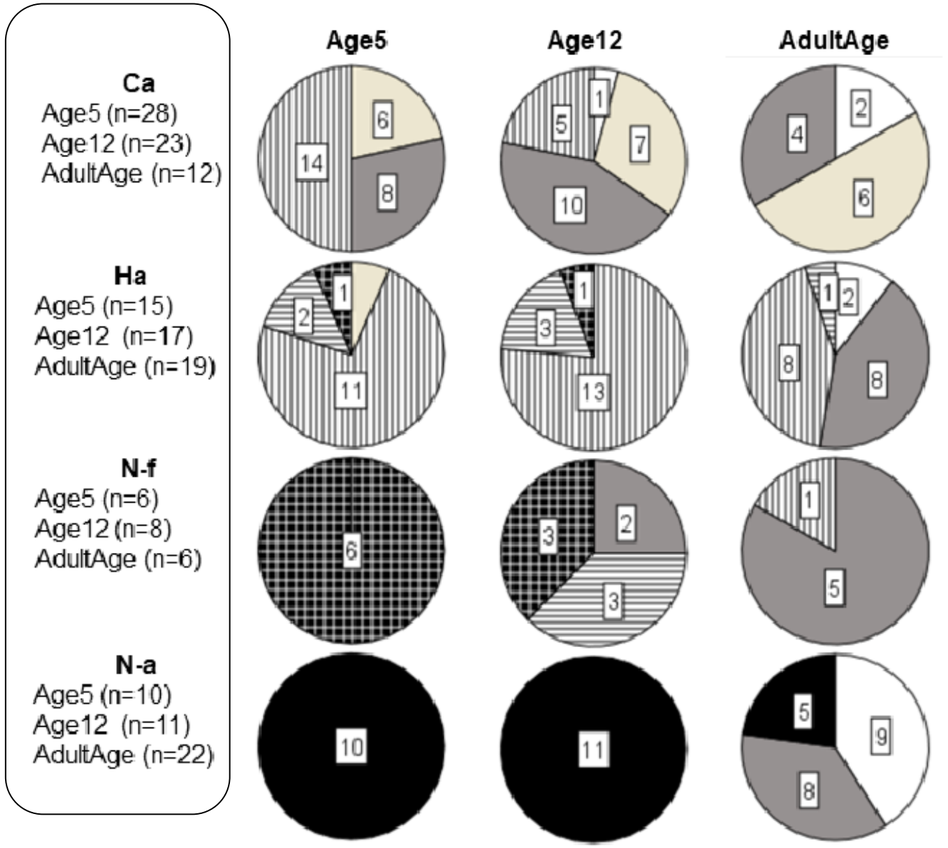
2023

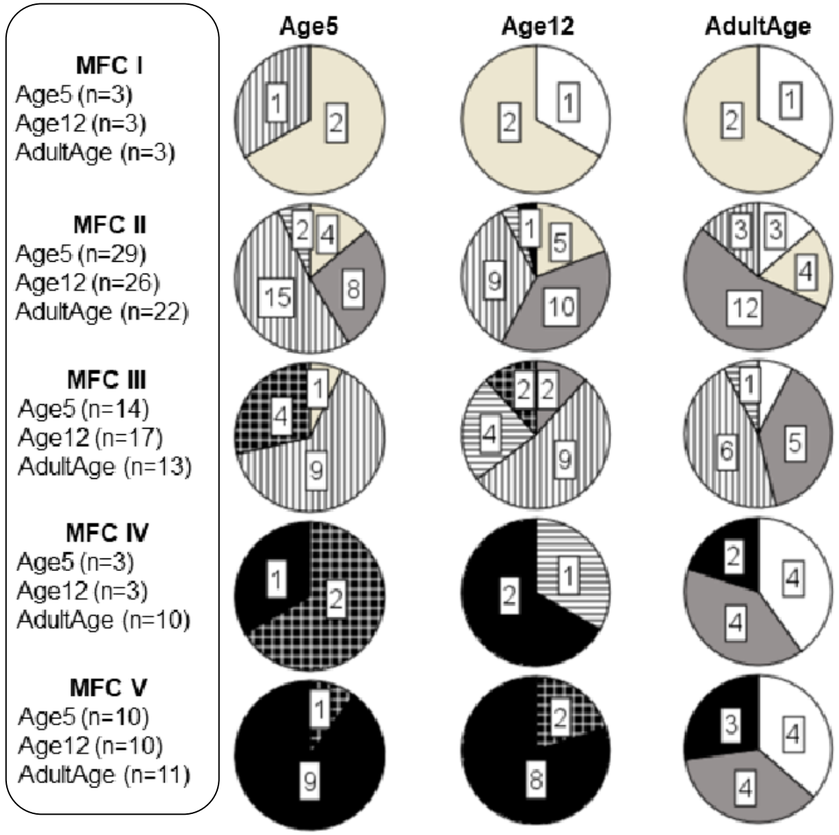
Prosthetics and Orthotics International

OPEN

Orthosis use and ambulation in adults with myelomeningocele after orthotic management from childhood

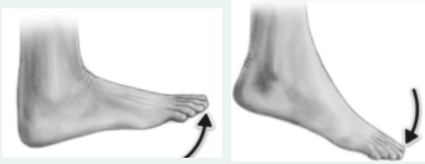
Marie Eriksson, PhD,[1] and Åsa Bartonek, PhD[1]





Somatosensory clinical test battery (Zarkou et al.2021)

- Light touch pressure with a 6-item monofilaments kit
- Two-point discrimination with an aesthesiometer
- Vibration sensation with a 128 Hz tuning fork
- Joint kinesthesia in the ankle joint by passive motion



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Methods Foot tactile sensation

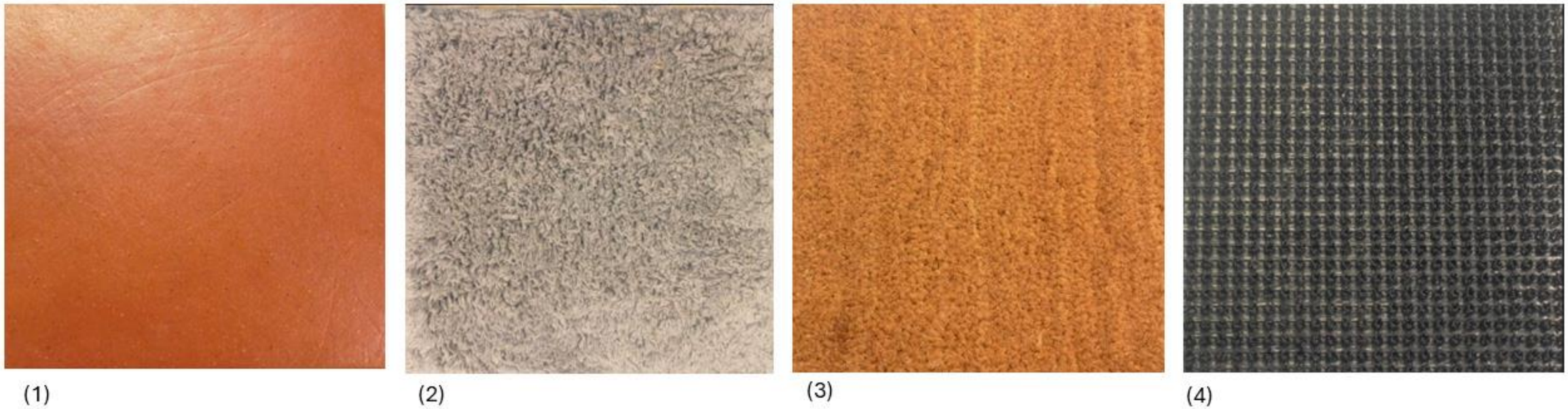

Figure 2. Floors of 30 cm × 30 cm of the following materials: (**1**) ceramic tile floor (“stone floor”), (**2**) textile (“soft bath carpet”), (**3**) coconut husk (hall mat indoor”), (**4**) plastic turf (“entrance mat outdoor”).

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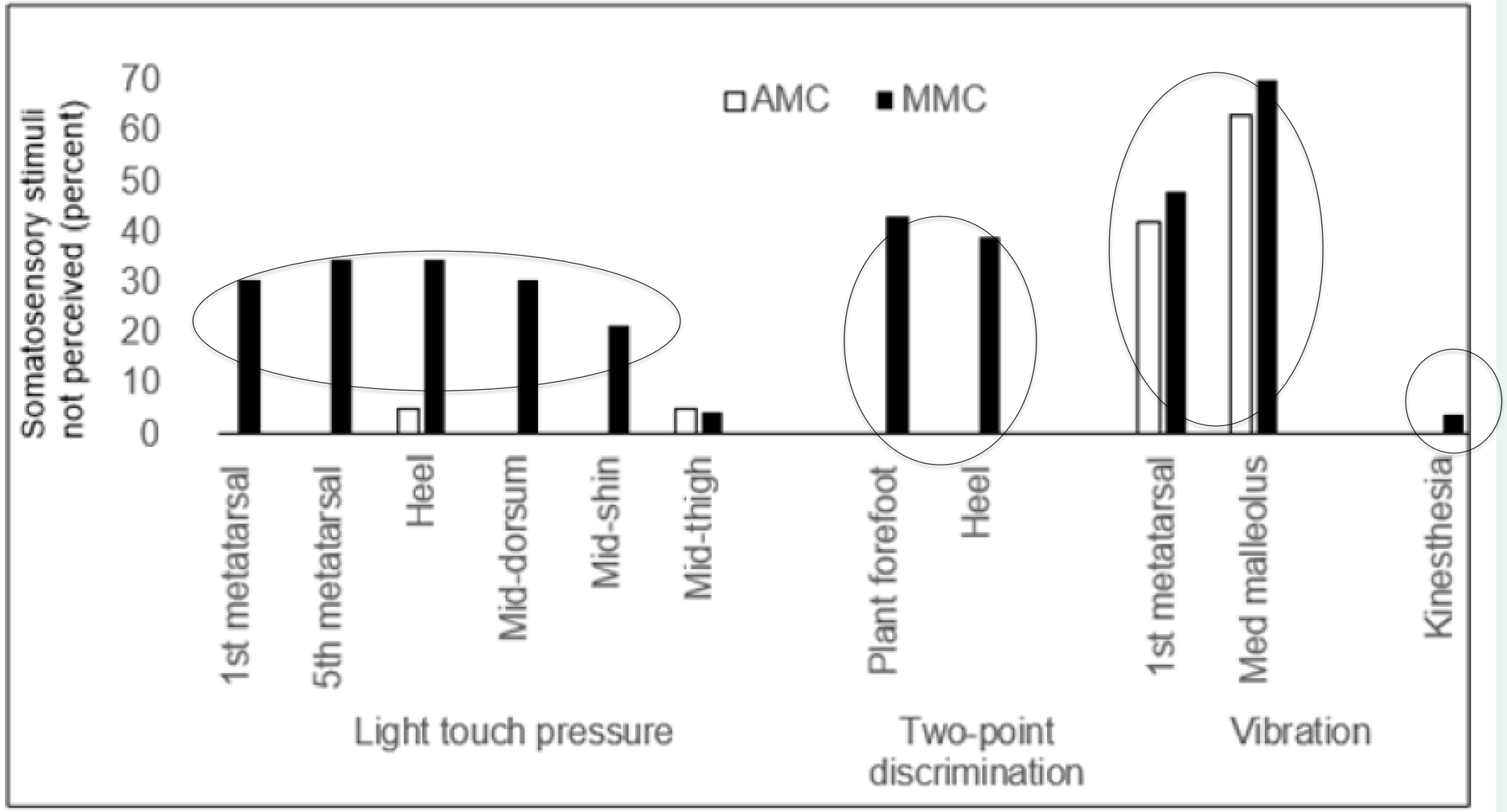
Results Non- Identified sensation



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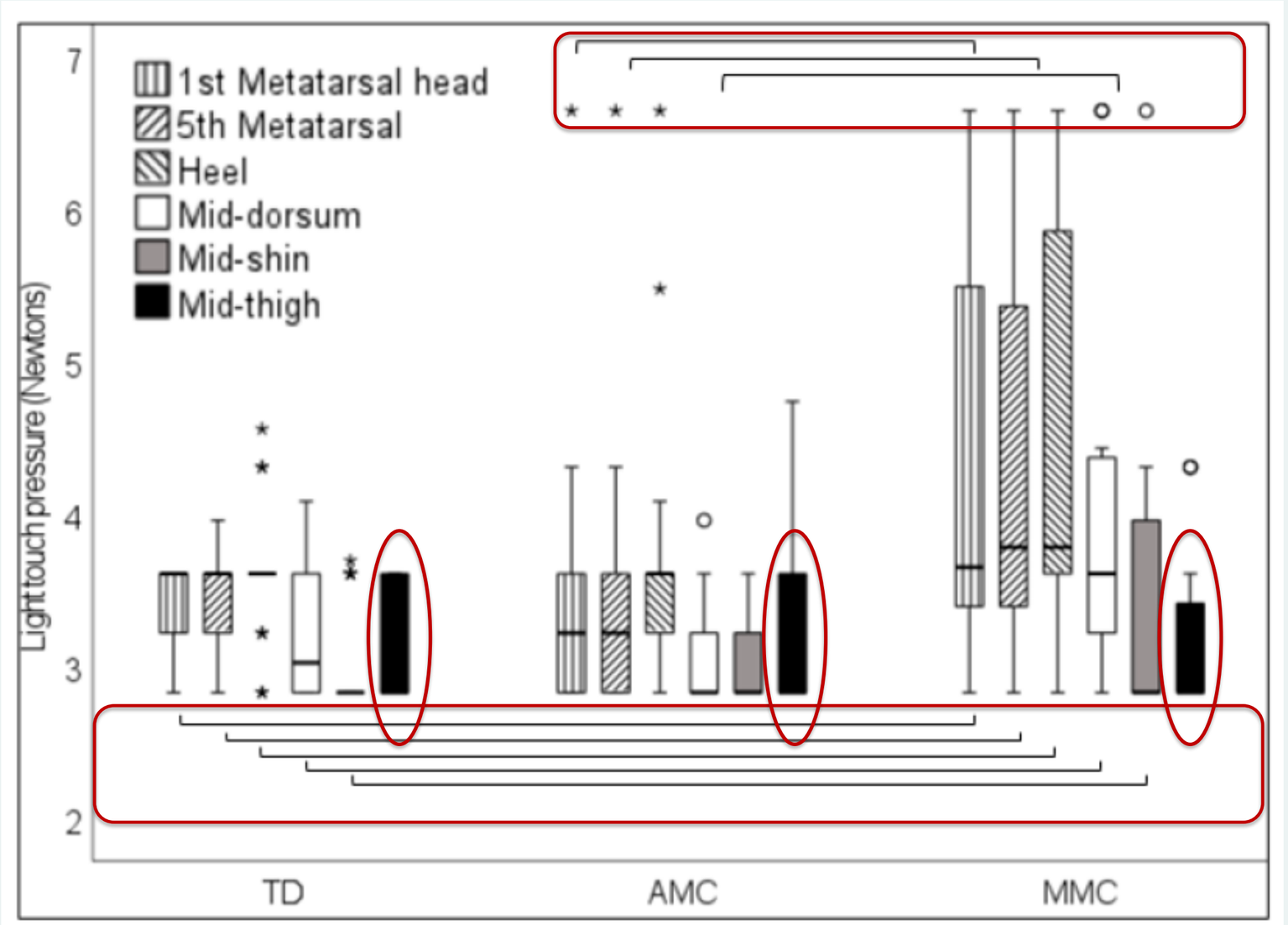
Bartonek Å Eriksson M

Results Light touch pressure (mean of right and left legs)

MMC had higher tactile sensation tresholds than TD at all sites except mid-thigh

No differences on mid-thigh



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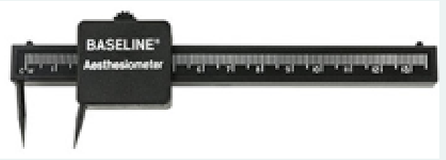
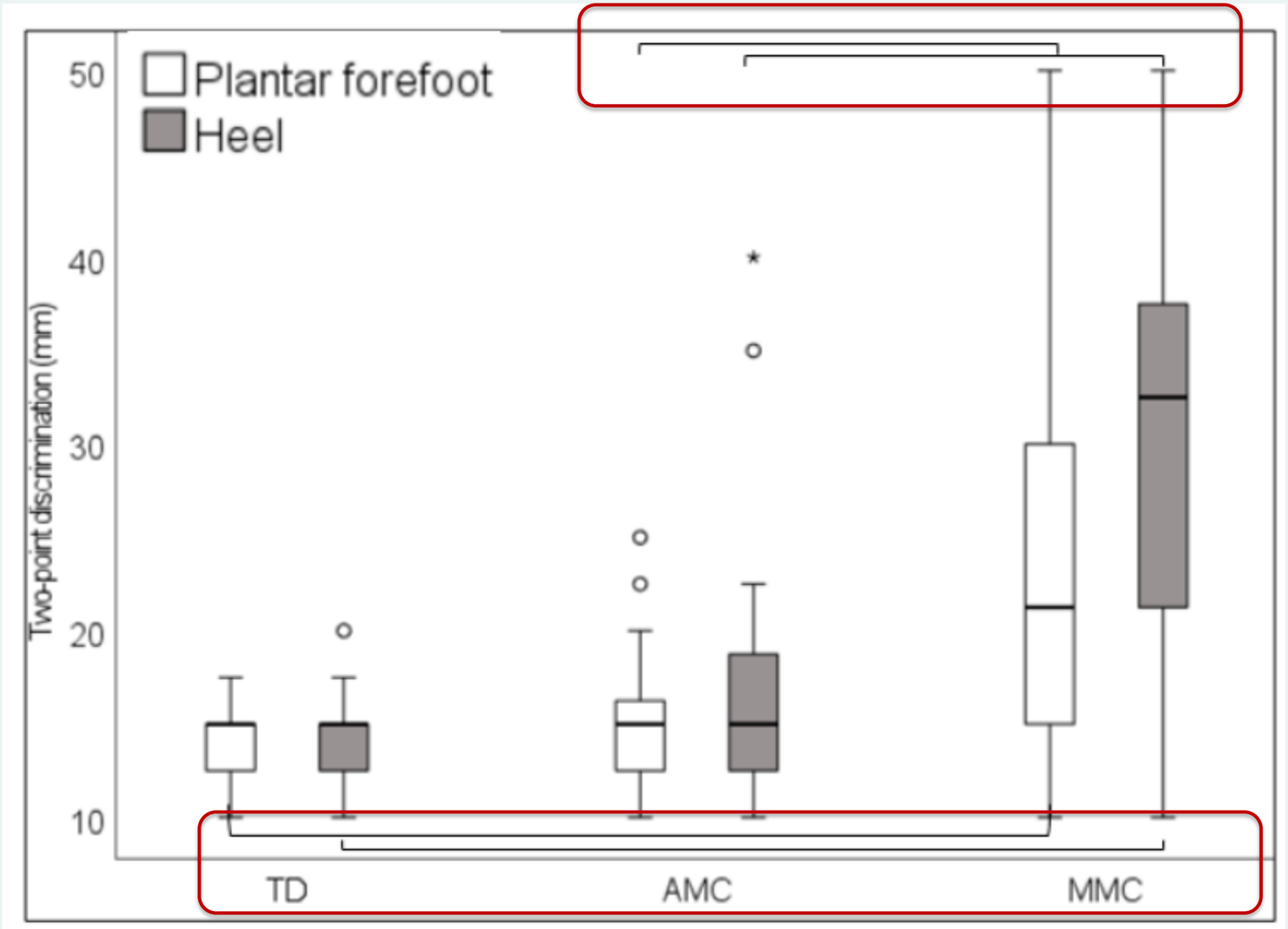
Results Two-point discrimination (mean of right and left measures)



MMC required greater distances on both forefoot and heel than TD and AMC



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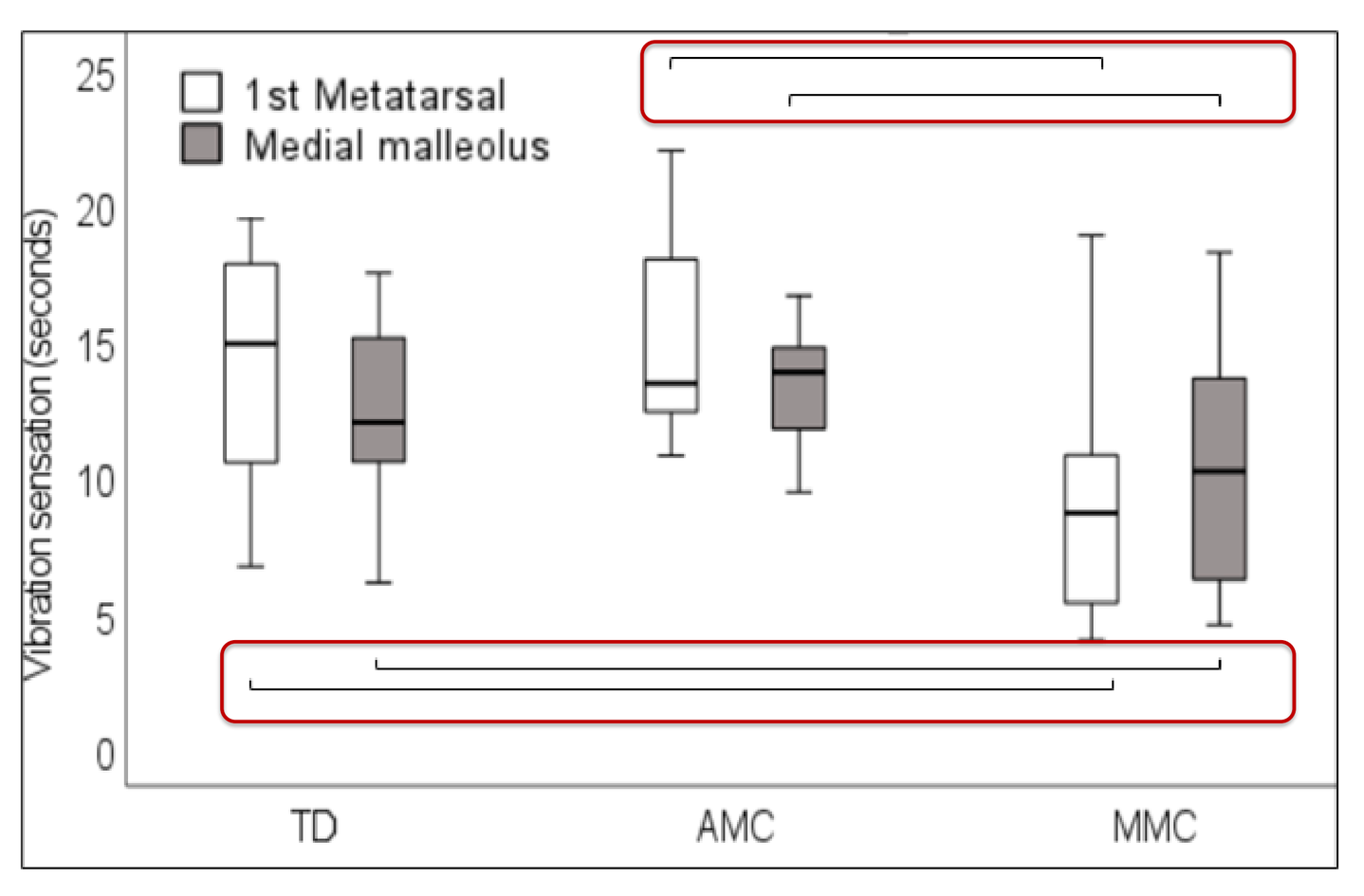
Results Vibration (mean of right and left measures)

MMC perceived shorter time duration on both 1th metatarsal and med malleolus than TD and AMC



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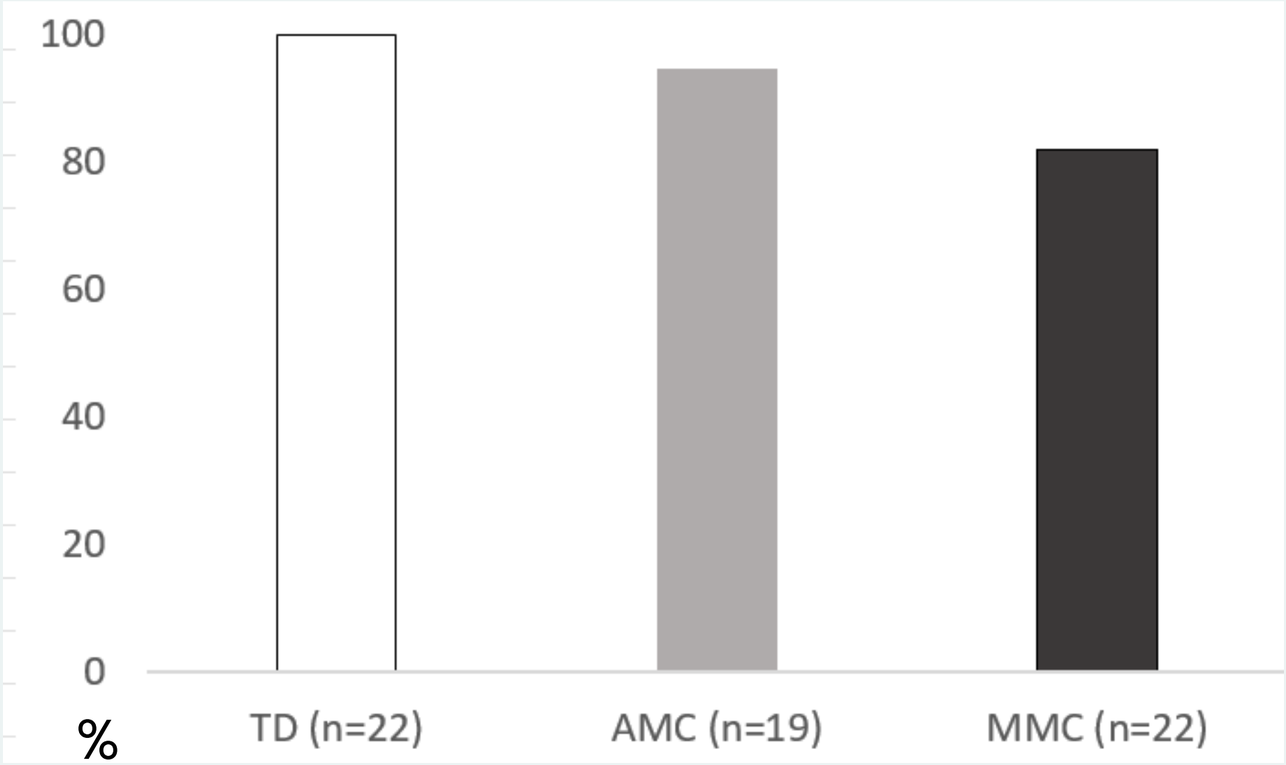
Results Kinesthesia in the ankle joint (mean of right and left measures)

No differences between the groups



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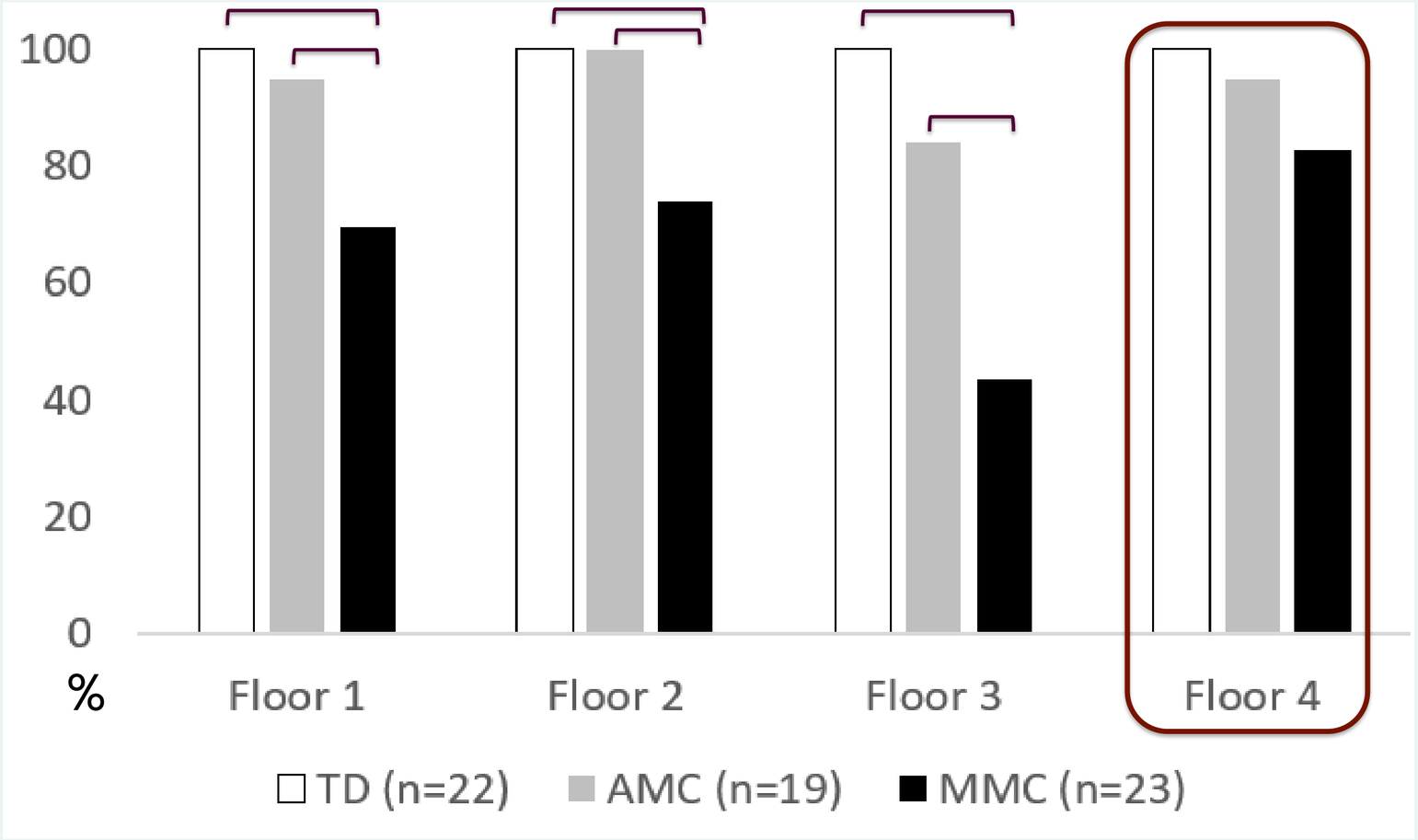
Results Floor sensation ≥ 3/5

MMC perceived
Floor 1
Floor 2
Floor 3
more seldom than TD and AMC

Floor 4 was perceived similarly between the groups



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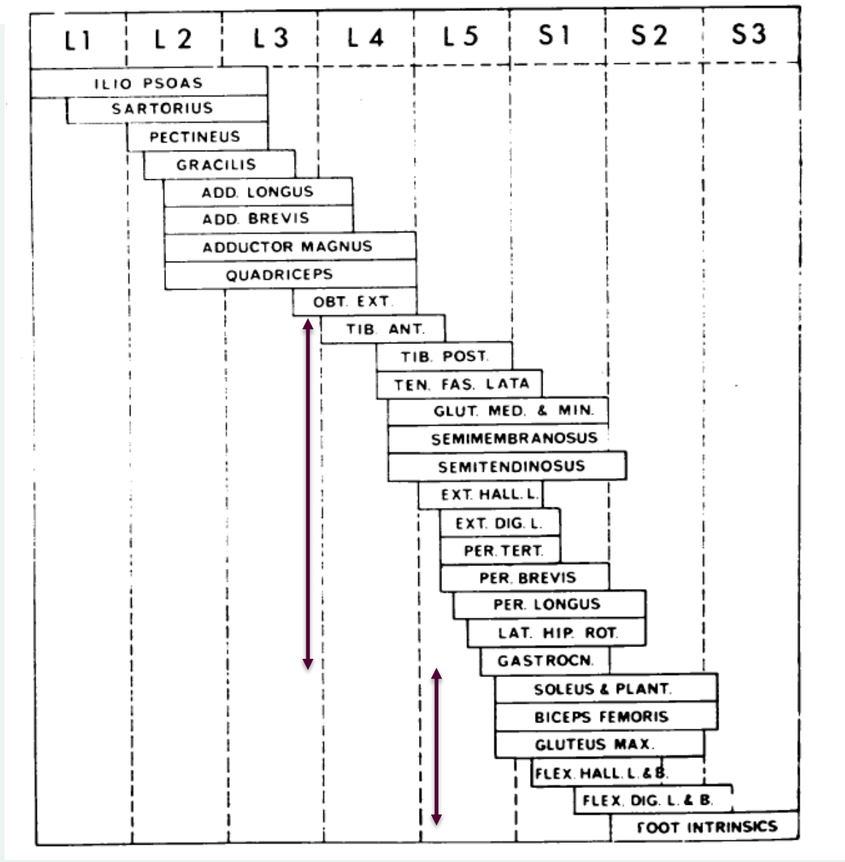
Results Subgroups MMC



Sharrard 1964

Kinesthesia

- Higher scores in MFC I-II (100%) vs MFC III-IV (55%)

Kinesthesia

- Higher scores in Ca **(**100 %) vs in Ha **(**55%)

Floor sensation

- Higher points in MFC I-II vs MFC III-IV:
  - ✓ Floor 1
  - ✓ Floor 2
  - ✓ Floor 3
  - ✓ But not Floor 4

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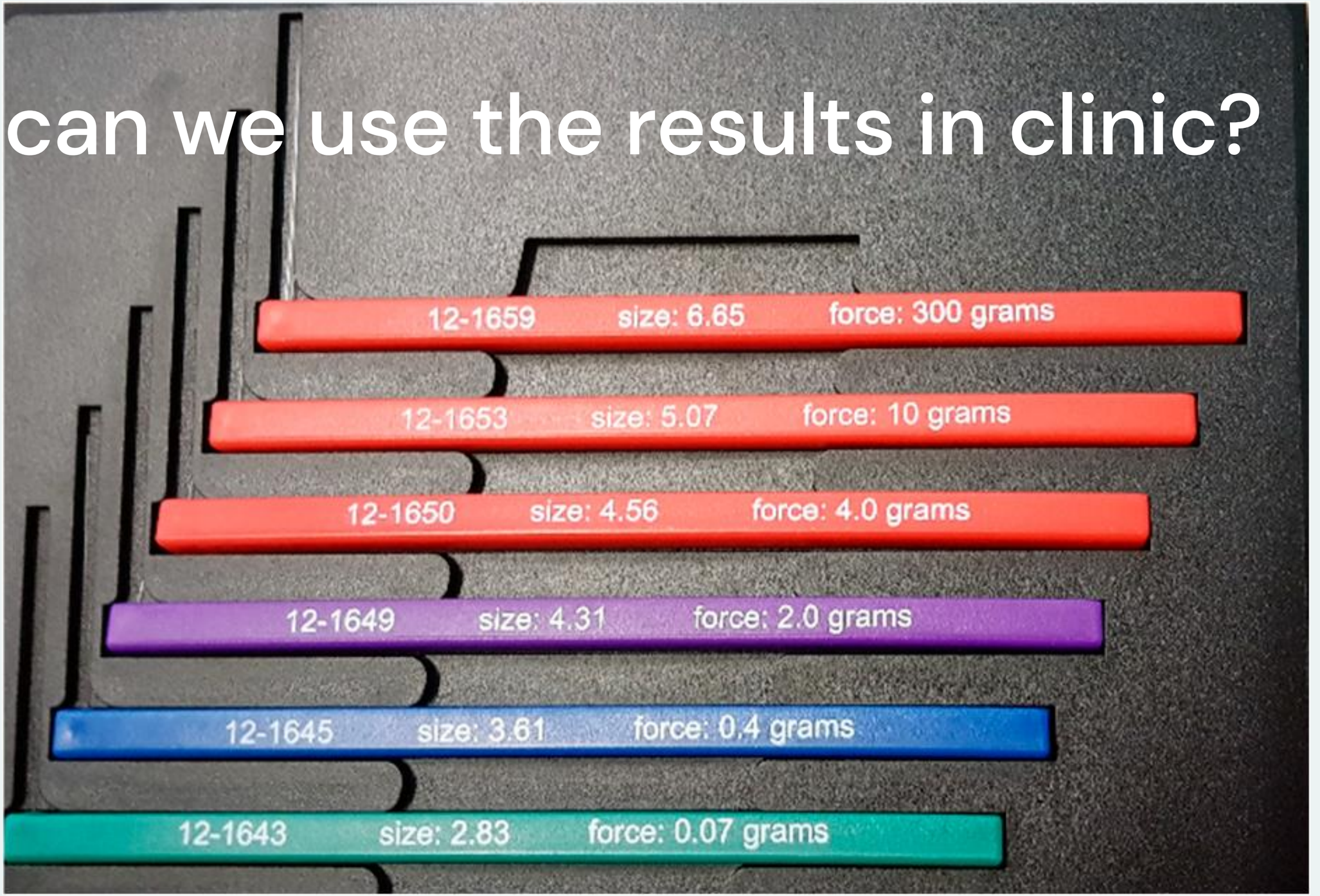
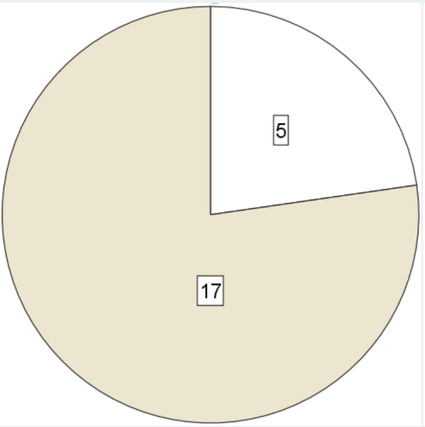
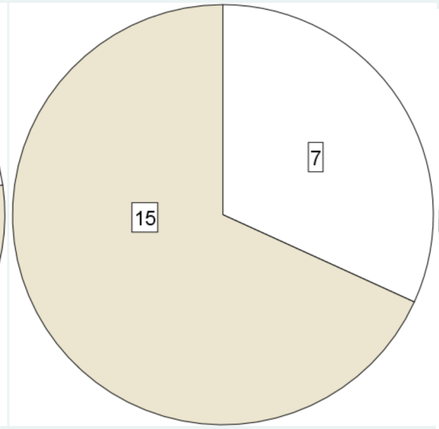
How can we use the results in clinic?



Metatarsal head I

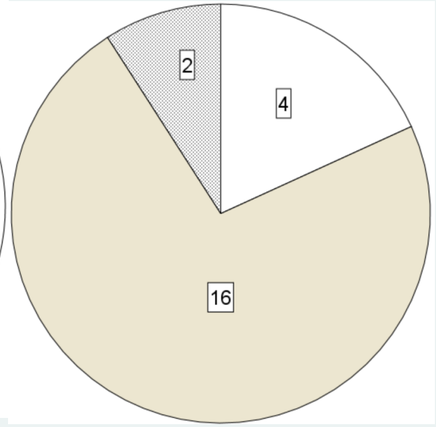
R L

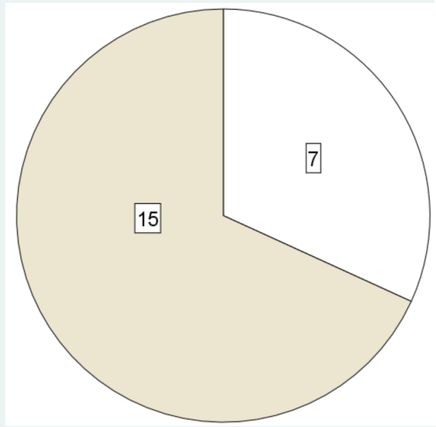




Metatarsal head V

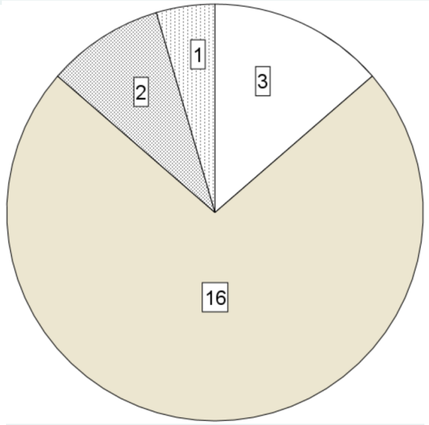
R L

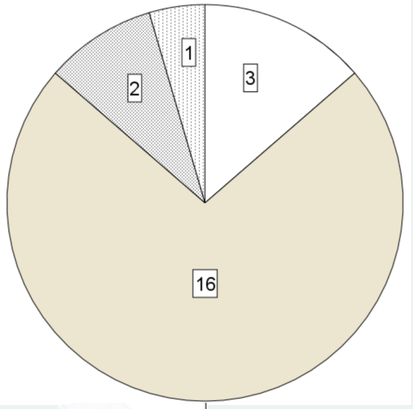




Heel

R L

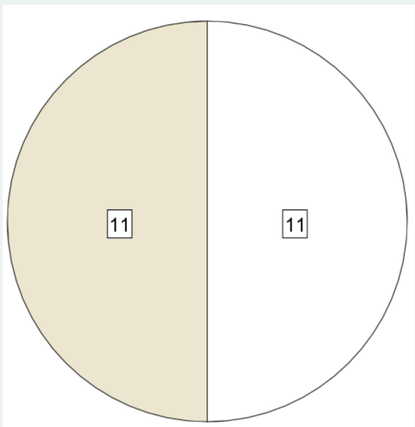


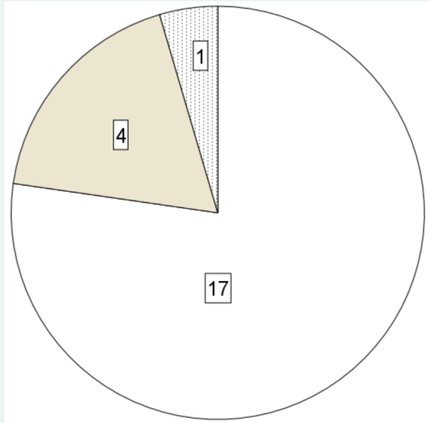


Monofilament tested in 22 Control children

Mid-foot

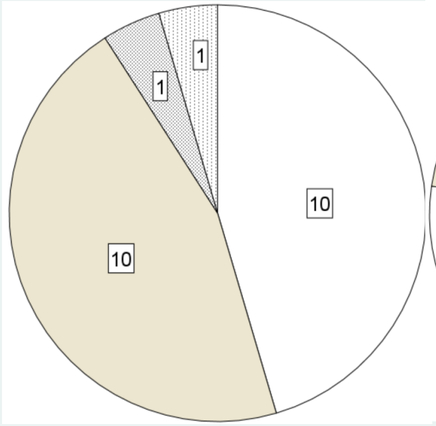
R L

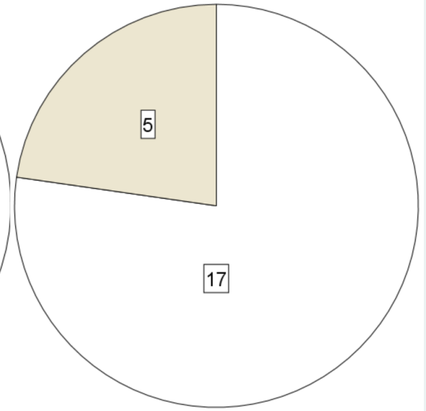




Mid-shank

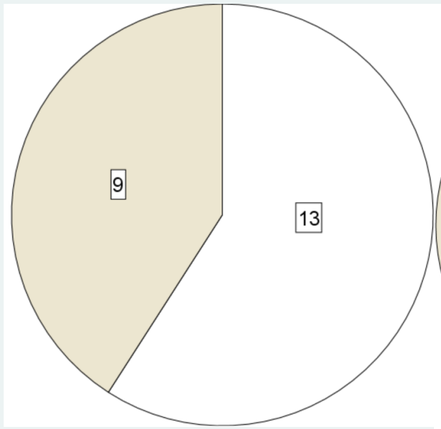
R L

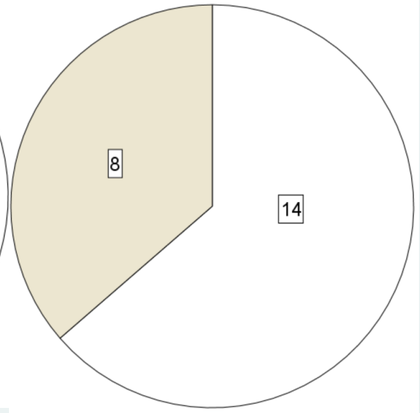




Mid-thigh

R L





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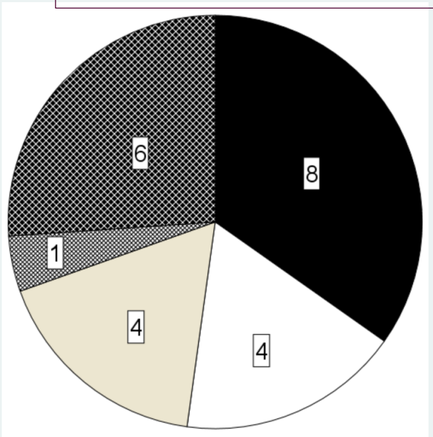
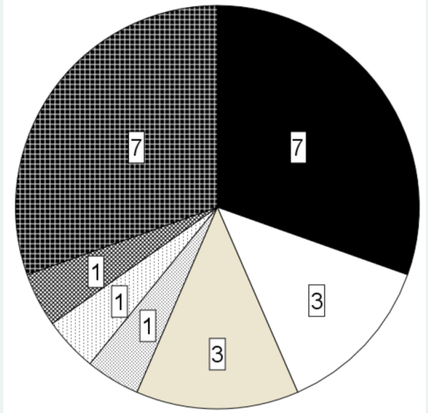
Metatarsal head I

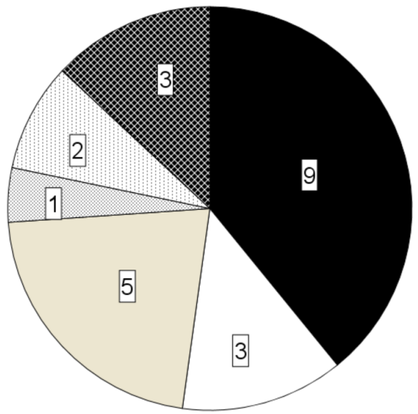
R L

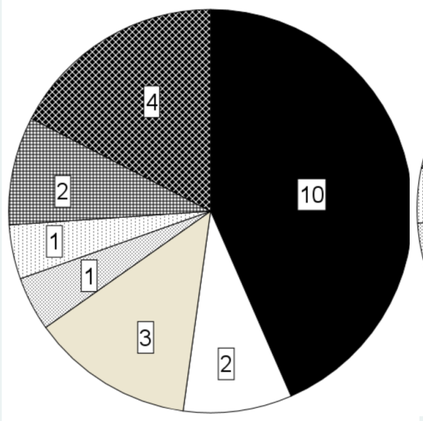




Metatarsal head V

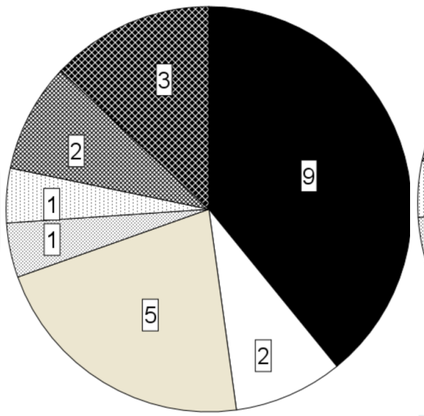
R L

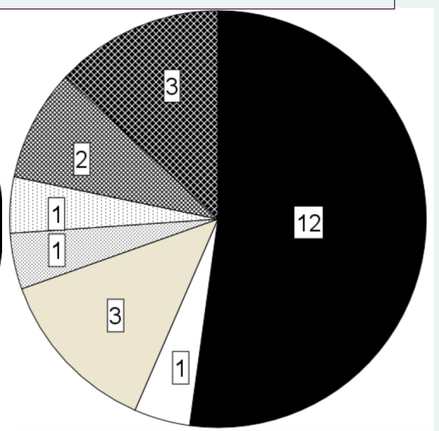




Heel

R L

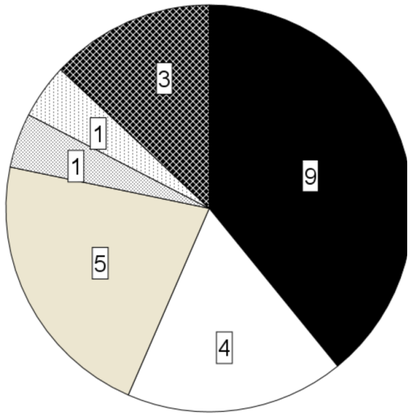


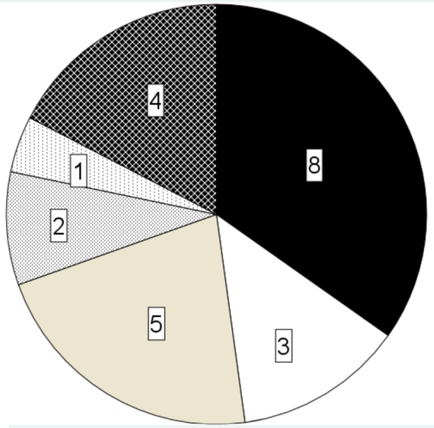


Monofilament tested on 23 children with MMC

Mid-foot

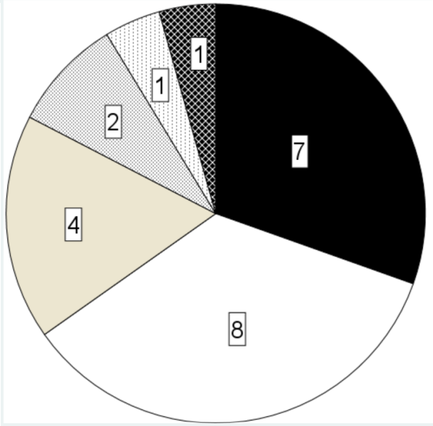
R L

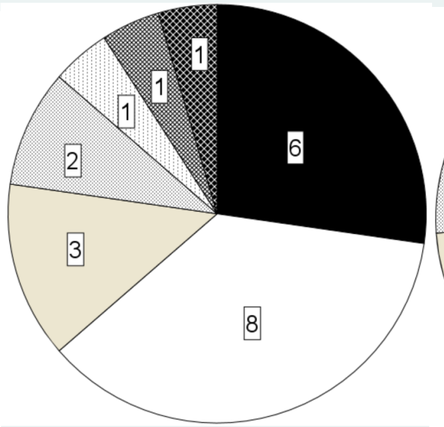




Mid-shank

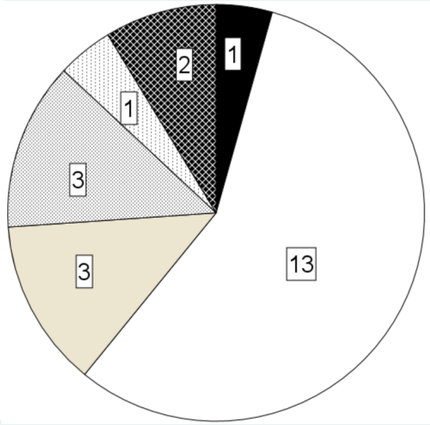
R L





Mid-thigh

R L



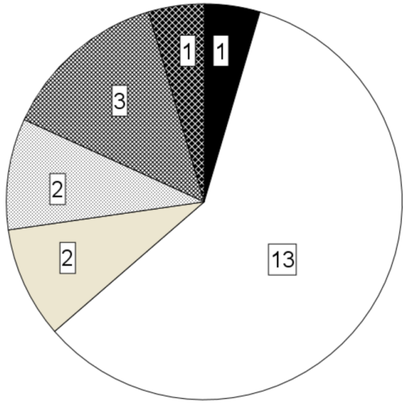


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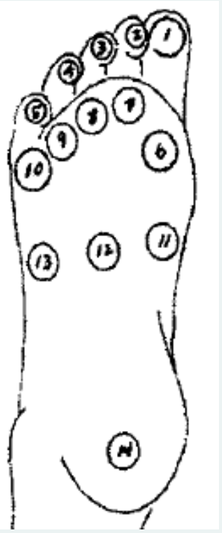
Table 2 The standard error of the mean

CULTANEOUS SENSITIVITY OF THE FOOT USING SEMMES-WEINSTEIN MONOFILAMENT TESTING

	Up		Down	
Postion	Mean	SEM	Mean	SEM
Plantar				
1	3.67	0.04	3.58	0.05
2	3.44	0.04	3.43	0.04
3	3.38	0.04	3.34	0.04
4	3.43	0.04	3.38	0.04
5	3.53	0.04	3.498	0.04
6	3.77	0.05	3.69	0.05
7	3.69	0.04	3.64	0.04
8	3.67	0.04	3.67	0.04
9	3.69	0.04	3.67	0.04
10	3.92	0.04	3.86	0.04
11	3.57	0.04	3.37	0.04
12	3.56	0.04	3.64	0.04
13	3.74	0.04	3.64	0.04
14	4.18	0.03	4.12	0.03
Dorsal				
Hallux	3.57	0.04	3.46	0.04
3rd Toe	3.49	0.04	3.39	0.04
5th MT	3.81	0.03	3.64	0.04
Heel				
Medial	3.83	0.04	3.69	0.04
Lateral	3.88	0.03	3.75	0.04
Overall	3.67	0.01	3.59	0.01

Note: The values represent the mean of the lowest monofilament that was sensed by the subjects. The values listed for Up were obtained by the testing from lower to higher monofilaments values (increasing stiffness), while those for Down were done in the opposite direction. The data was obtained from 40 subjects, as described in Methods.



Jeng C, Michelson J, Mizel M. **Sensory thresholds of normal human feet**. Foot Ankle Int. 2000 Jun;21(6):501-4.

Based on the normal values, the inability to feel a monofilament of **5.07** means that roughly 98% of the sensory ability has been lost

Monofilament Nr 5 = **5.07**

The mean sensitivity for all sites was **3.63**

Monofilament Nr 2= **3.61**

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Recommendation of sensory testing in MMC

1. Start with monofilament Nr 5.
   - ✓ Is the child able to perceive?
   - ✓ If not, 98% of the sensory ability is reduced

2. If the child is able to perceive monofilament Nr 5
   - ✓ Continue with monofilament Nr 2.
   - ✓ If yes, sensation corresponds to the majority of control children

514014
Aesthesio Precise Sen.Eva. 5,07/10g

514006
Aesthesio Precise Sen.Eva. 3,61/0.4g

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FYSIA US

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In Summary

- In accordance with the hypothesis MMC perceived somatosensory stimuli less clear than children with typical development (TD)

- Non-identified sensation of was found at:
✓ Light touch in 30-40% (except mid-thigh)
✓ 2-point discrimination in 40-50 %
✓ Vibration in 40-70 %

- With respect to MFC subgroups:
✓ Kinesthesia in the ankle joint was greater in MFC I-II (100%) vs MFC III-IV (55%)
✓ Floors 1,2,3 were sensed better in MFC I-II vs MFC III-IV, but more similar in Floor 4

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In Summary

- Lack in joint proprioception should be considered when planning for ambulation and orthotics

- Knowledge of light touch pressure is important to
  - ✓ avoid possible skin irritations
  - ✓ examine possible changes /deterioration in sensation

- Light touch pressure examination with monofilaments is useful to grade sensation

Thank you for listening!

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