

Pathophysiology and prevention of contractures in children with cerebral palsy

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Muscle stiffness



Muscle stiffness

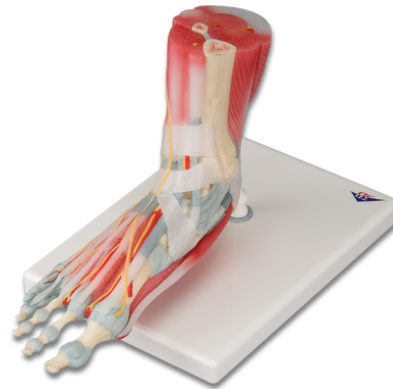
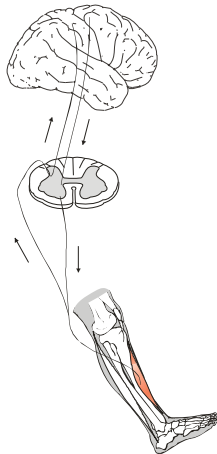
“the sensation of resistance felt as one manipulation of a joint through a range of motion, with the subject attempting to relax”

Lance and McLoud 1981



Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the affected parties moved in flexion or extension
1 +	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the range of motion
2	More marked increase in muscle tone through most of the range of motion, but the affected part is easily moved
3	Considerable increase in muscle tone, passive movement is difficult
4	Affected part is rigid in flexion or extension

Muscle stiffness



Difficult to distinguish between the different features of stiffness in the clinic

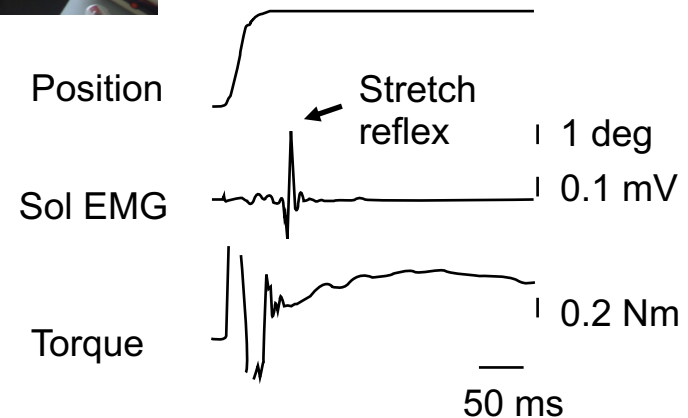
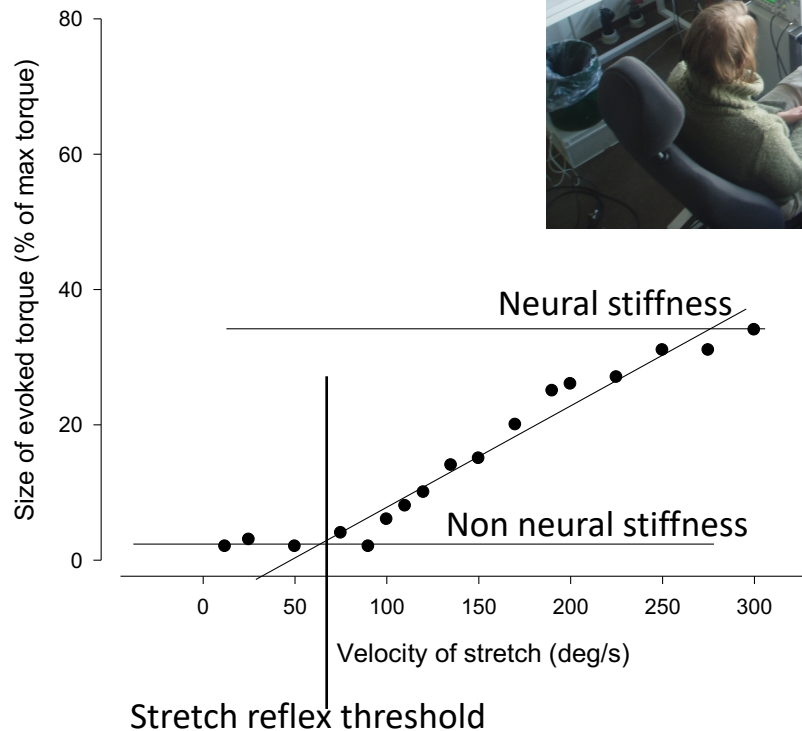
- Ashworth Scales are unreliable for the assessment of muscle spasticity. Ansari NN1, Naghdi S, Moammeri H, Jalaie S. Physiother Theory Pract. 2006 Jun;22(3):119-25.
- Theoretical and methodological considerations in the measurement of spasticity. Burridge JH1, Wood DE, Hermens HJ, Voerman GE, Johnson GR, van Wijck F, Platz T, Gregoric M, Hitchcock R, Pandyan AD. Disabil Rehabil. 2005 Jan 7-21;27(1-2):69-80.
- Spasticity: clinical perceptions, neurological realities and meaningful measurement. Pandyan AD, Gregoric M, Barnes MP, Wood D, Van Wijck F, Burridge J, Hermens H, Johnson GR. Disabil Rehabil. 2005 Jan 7-21;27(1-2):2-6.
- Assessment of spasticity after stroke using clinical measures: a systematic review. Aloraini SM1,2, Gäverth J1,3, Yeung E1, MacKay-Lyons M1. Disabil Rehabil. 2015;37(25):2313-23.

“limited evidence to support the use of most of clinical measures of spasticity for people post-stroke....There is a need for objective clinical tools for measuring spasticity that are clinically feasible and easily interpreted by clinicians”

- Spasticity-assessment: a review. Biering-Sørensen F, Nielsen JB, Klinge K. Spinal Cord. 2006 Dec;44(12):708-22. Epub 2006 Apr 25. Review

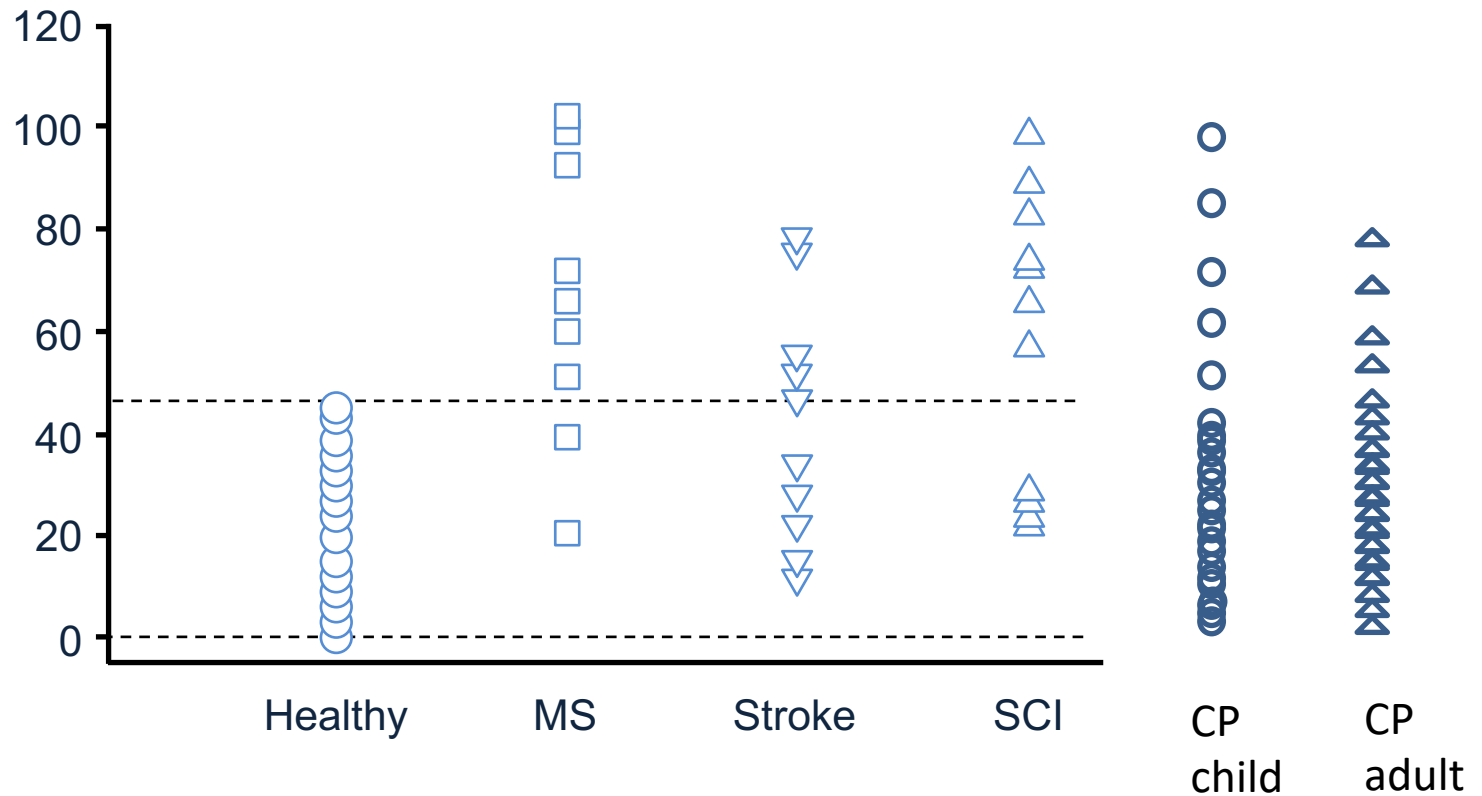
“A combination of electrophysiological and biomechanical techniques shows some promise for a full characterization of the spastic syndrome. There is a need of simple instruments, which provide a reliable quantitative measure with a low interrater variability.”

Objective evaluation of neural- and non neural stiffness using biomechanics and electrophysiology



Neural stiffness

Max torque with subtraction of passive stiffness (% of max torque evoked by supramaximal electrical stimulation)

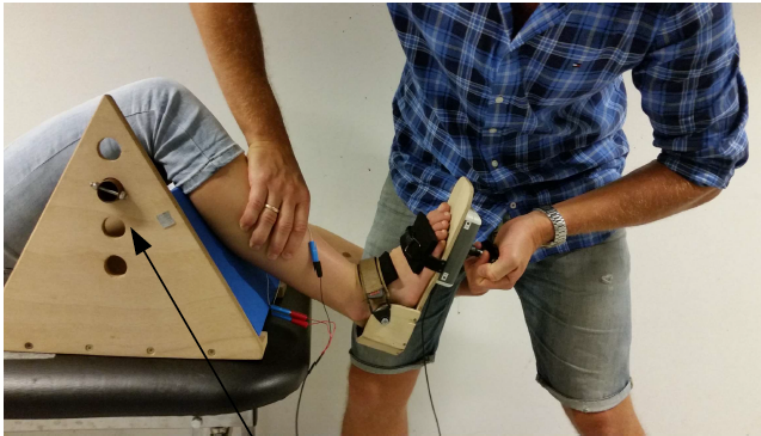


Lorentzen et al. Clin Neurophysiol 2010

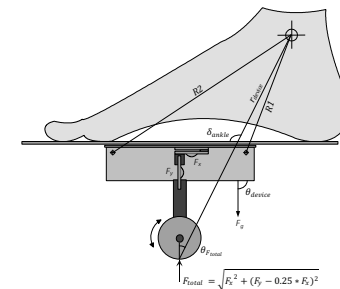
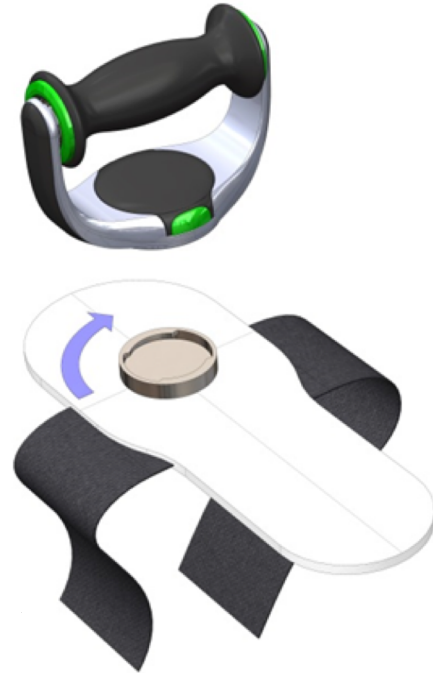
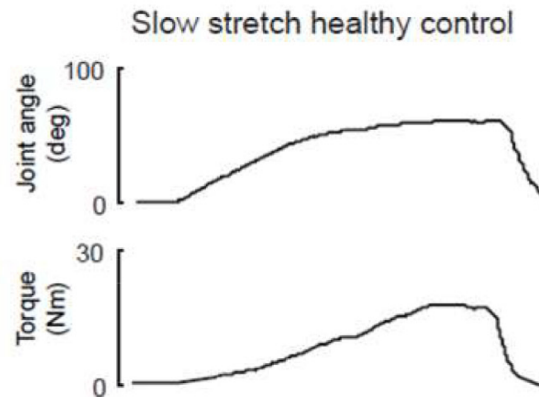
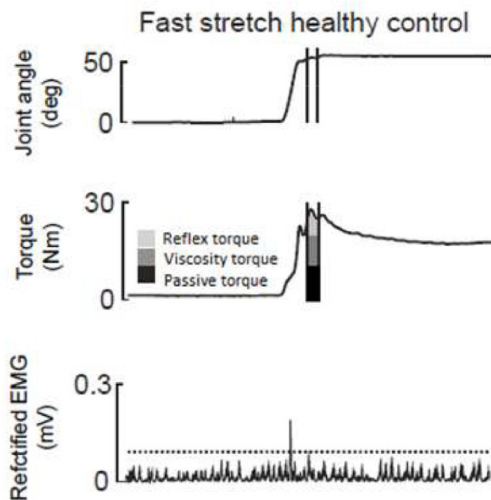
Willerslev-Olsen et al. Neurorehabilitation 2014

Lorentzen et al. Disabil Rehabil 2017

Instrumented evaluation of stiffness



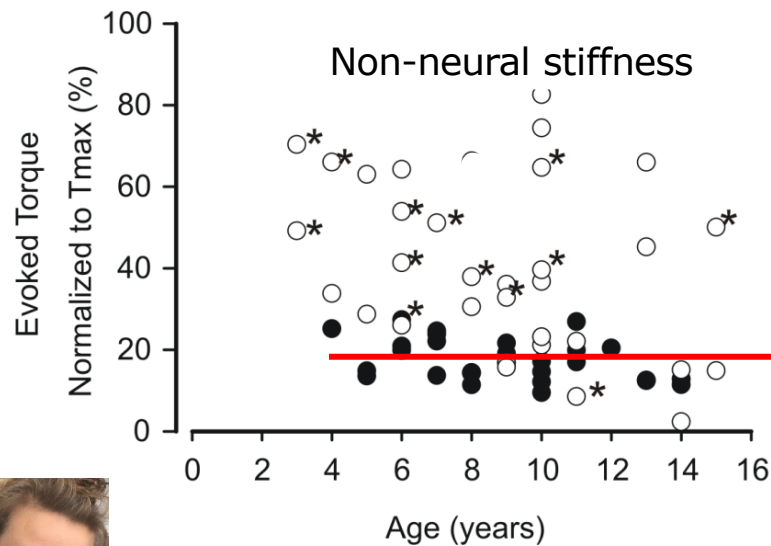
A firm splint is used to position the knee in a fixed angle.



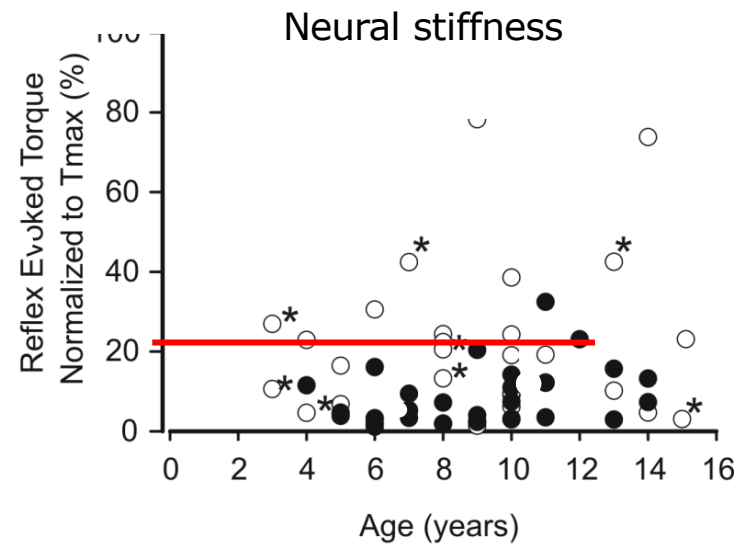
Non-neural is increased in many children with CP

Figur 3.

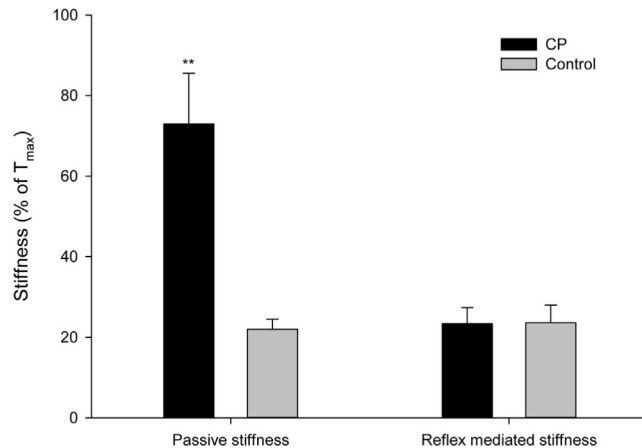
A



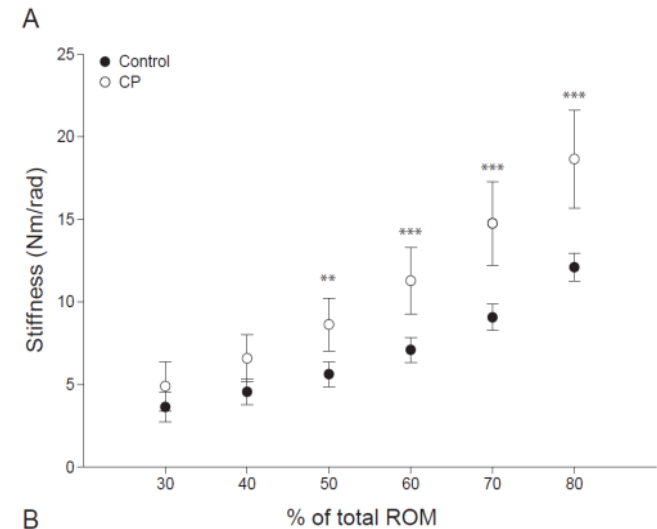
B



Non neural stiffness is increased in adults with CP



Geertsen et al Clin neurophysiology 2015

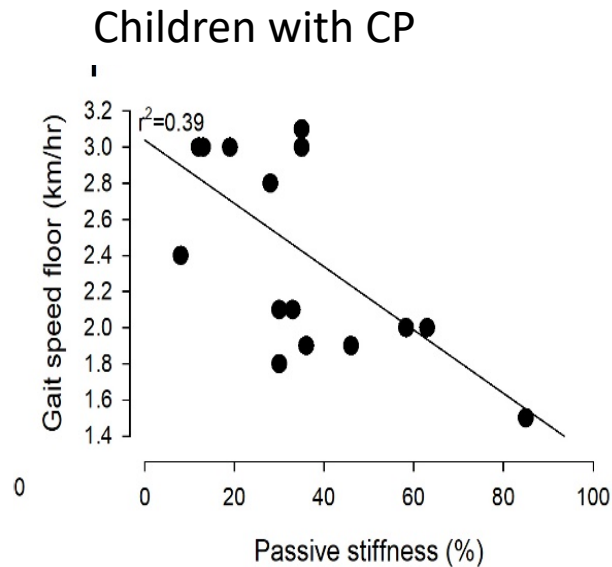


Lorentzen et al. Clin Neurophysiol 2018; in Press

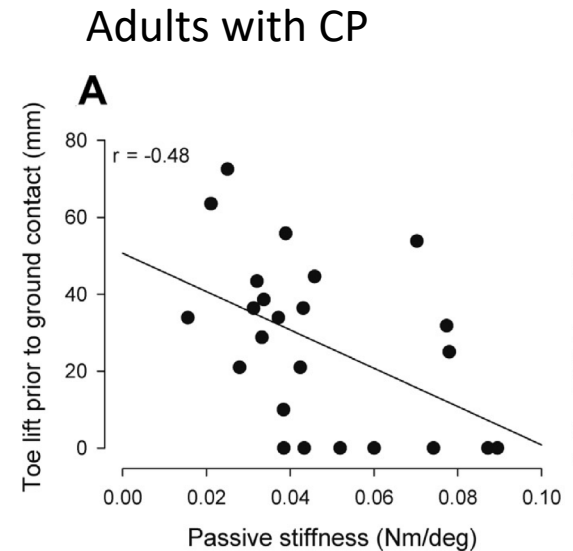
”muscle fibres undergo changes which are responsible for increased muscle tone”

Dietz V 1981 Brain

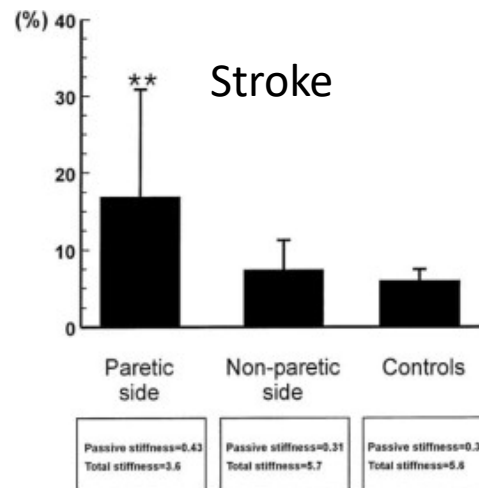
Increased non neural stiffness influence on gait



Lorentzen et al. Brain 2018 in Press



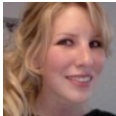
Geertsen et al Clin neurophysiology 2015



“increased non neural stiffness as a compensation for reduced muscle strength”

Lamontagne et al. 2000

TRAINING INTERVENTION: PILOT STUDY



Anna Herskind



Maria Willerslev-Olsen

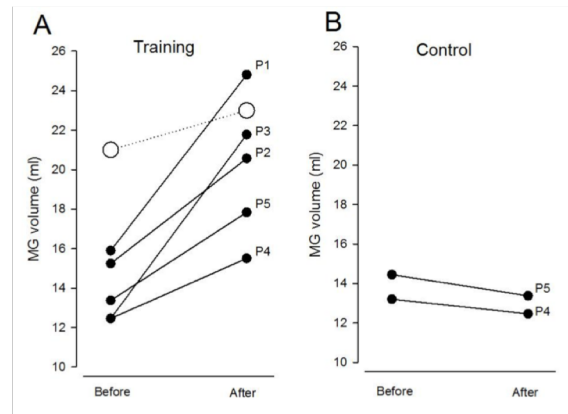


Line Zachø



Anina Ritterband-Rosenbaum

- 5 children in intervention group and 2 "control" children.
- Age: 15 – 28 month
- 3 month of training 5 times a week



Herskind A et al. Adv Pediatr. 2016



Jakob Lorentzen



Maria Willerslev-Olsen



Anina
Ritterband-Rosenbaum



Mikkel Justiniano

ACTIVE



Agency, activity

Contractures, cognition

Training

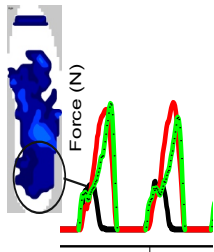
Incentive

Vitamins

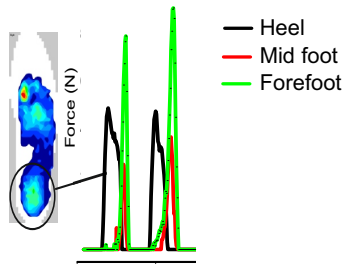
Enriched Environment,

Contractures may be treated by active training

Before
Training



After
Training



— Heel
— Mid foot
— Forefoot



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Schram Christensen M, Jensen T, Voigt CB, Nielsen JB, Lorentzen J.
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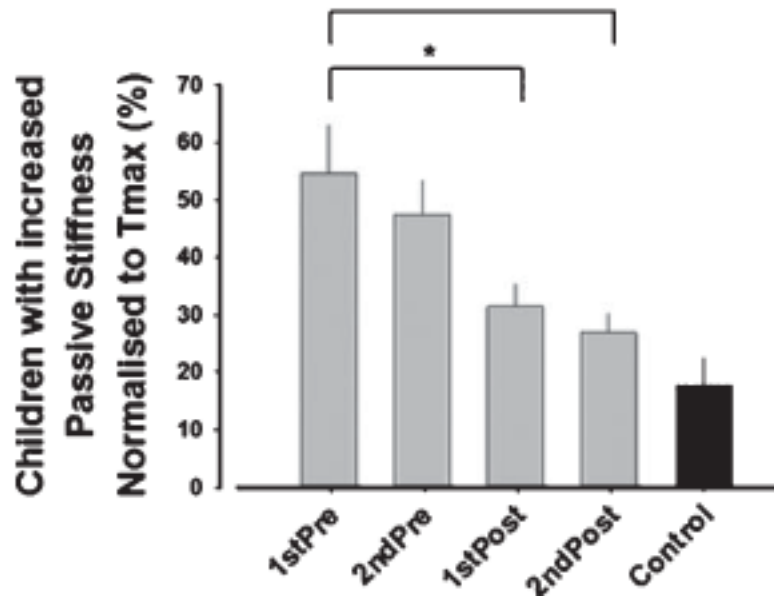
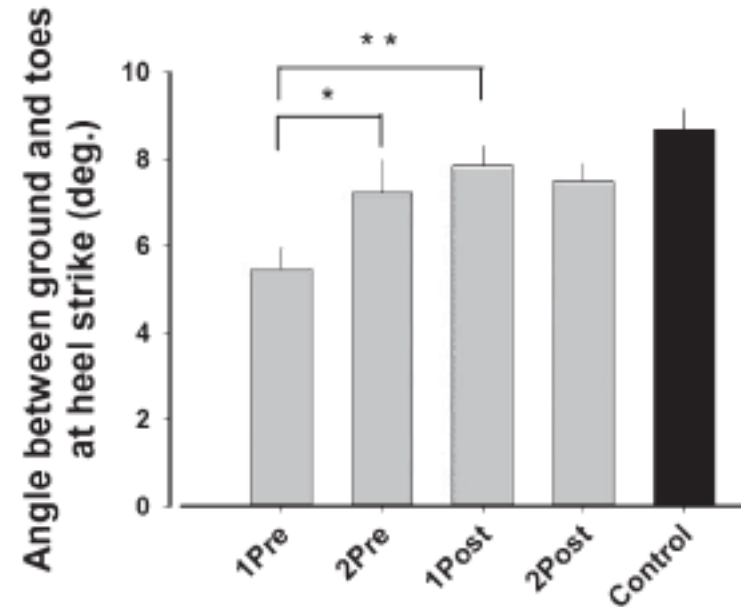
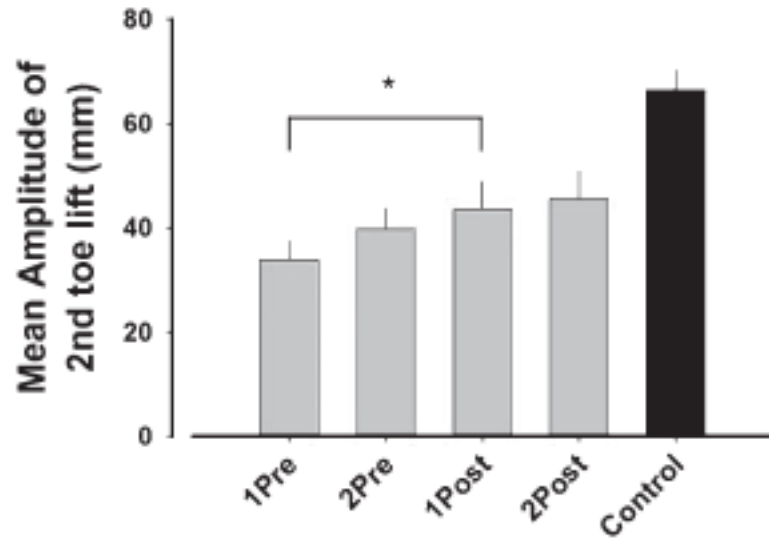
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Brain. 2015 Mar;138(Pt 3):589-603

Willerslev-Olsen M, Lorentzen J, Nielsen JB.
NeuroRehabilitation. 2014;35(4):643-55

Gaittraining in children with cp





Climbing



☐	☐ <u>Total duration</u>	☐ <u>Physical activity</u>	☐ <u>Ankle joint</u>	☐ cp pre-post
☐ All (N=17)	☐ 02:32:42	☐ 01:45:32	☐ Stiffness ²	☐ Z=-1.002, p=0.533
☐ CP (N=11)	☐ 02:33:38	☐ 01:45:27	☐ ROM ²	☐ Z=2.764, p=0.0114*
☐ TD (N=6)	☐ 02:31:00	☐ 01:45:40	☐ Strength ³	☐ Z=1.387, p=0.304

Thanks to our colleagues and collaborators

Elsass CP research group



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Rosenbaum
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Thank You for your attention

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Quiz questions:

- Increased non neural stiffness is related to development of contractures? A) Yes B) No
- Is non neural stiffness caused by changes in connective tissue? A) Yes B) No
- Is a muscle with contractures characterized with muscle A) atrophy or B) hypertrophy?