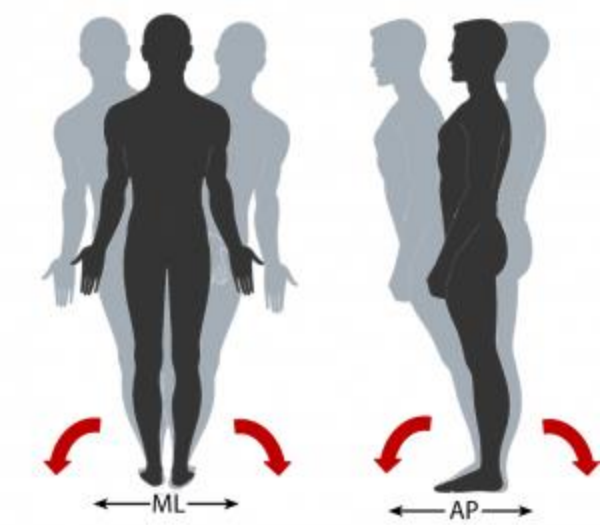
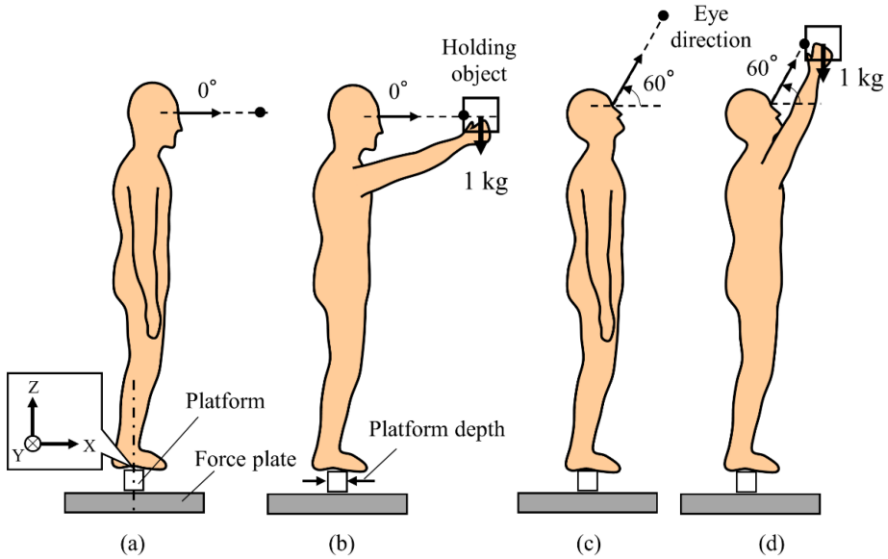
Zagadnienia stabilności posturalnej człowieka

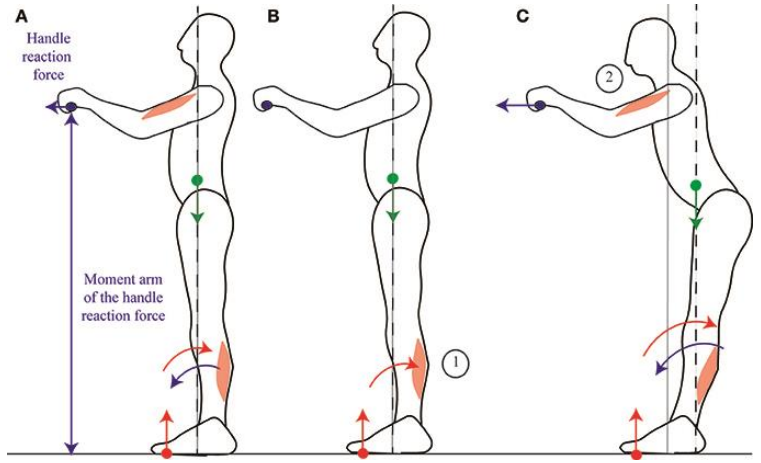
Bartłomiej Zagrodny

Stabilność posturalna – (zbyt) ogólna definicja

zdolność do utrzymywania i odzyskiwania stanu równowagi

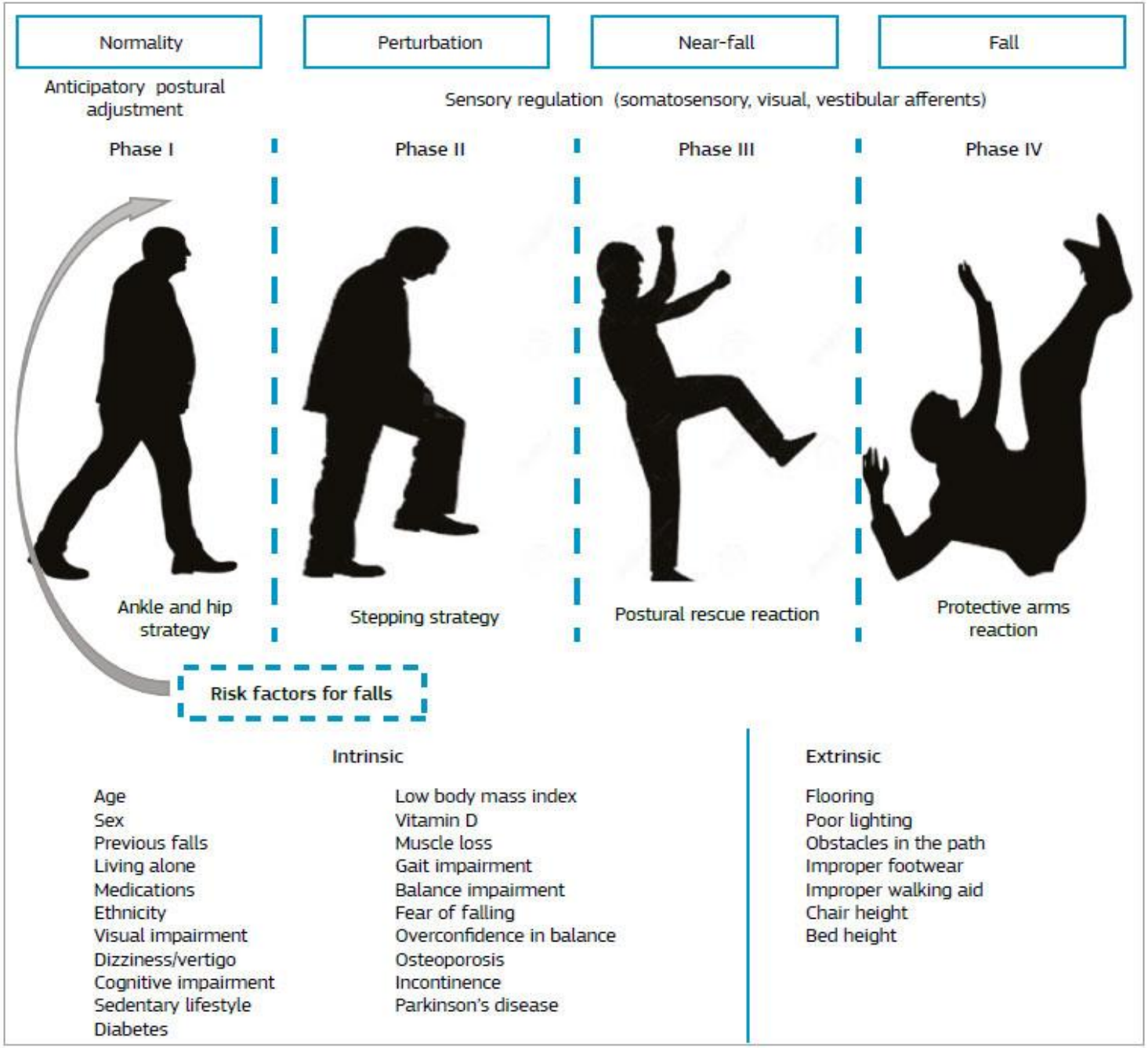






Czynniki

Geriatrics, gerontology and Aging



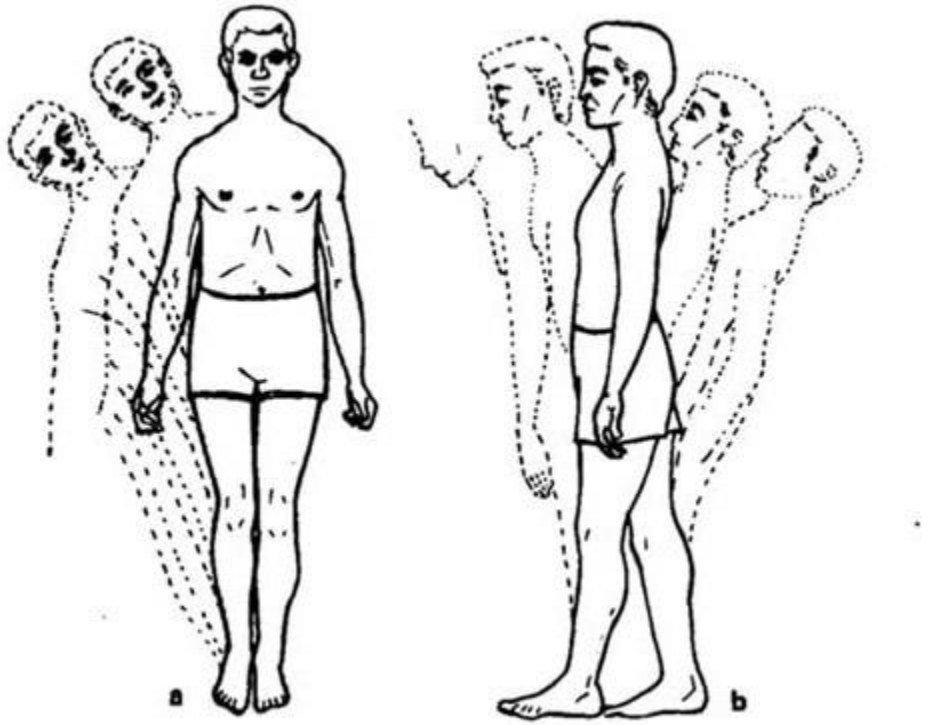
Od czego zależy utrzymanie postawy stojącej

- narządu przedsionkowego ucha wewnętrznego (narządem równowagi)
- narządu wzroku (uświadomienie postawy ciała w korze mózgu i niwelowanie jej zaburzeń)
- prawidłowego działania szlaków aferentnych w sznurach tylnych rdzenia kręgowego (dostarczają informacji o czuciu proprioceptywnym ze stóp)
- móżdżku (nadrzędnego narządu zbierającego informację z powyższych układów i koordynującego ruchy i postawę ciała)

Prioprocepcja

Inaczej kinestezja, zmysł kinestetyczny, czucie głębokie – zmysł orientacji ułożenia części własnego ciała. Receptory tego zmysłu ulokowane są w mięśniach, ścięgnach i stawach. Dostarczają mózgowi informacji o tonusie mięśniowym. Dzięki temu zmysłowi mózg wie, jak ułożone są kończyny bez patrzenia na nie.

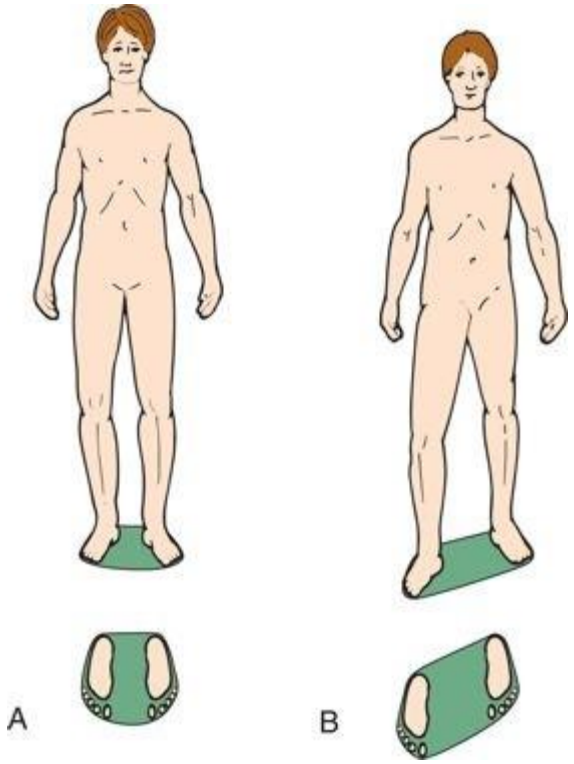
Badanie stabilności posturalnej – próba Romberga

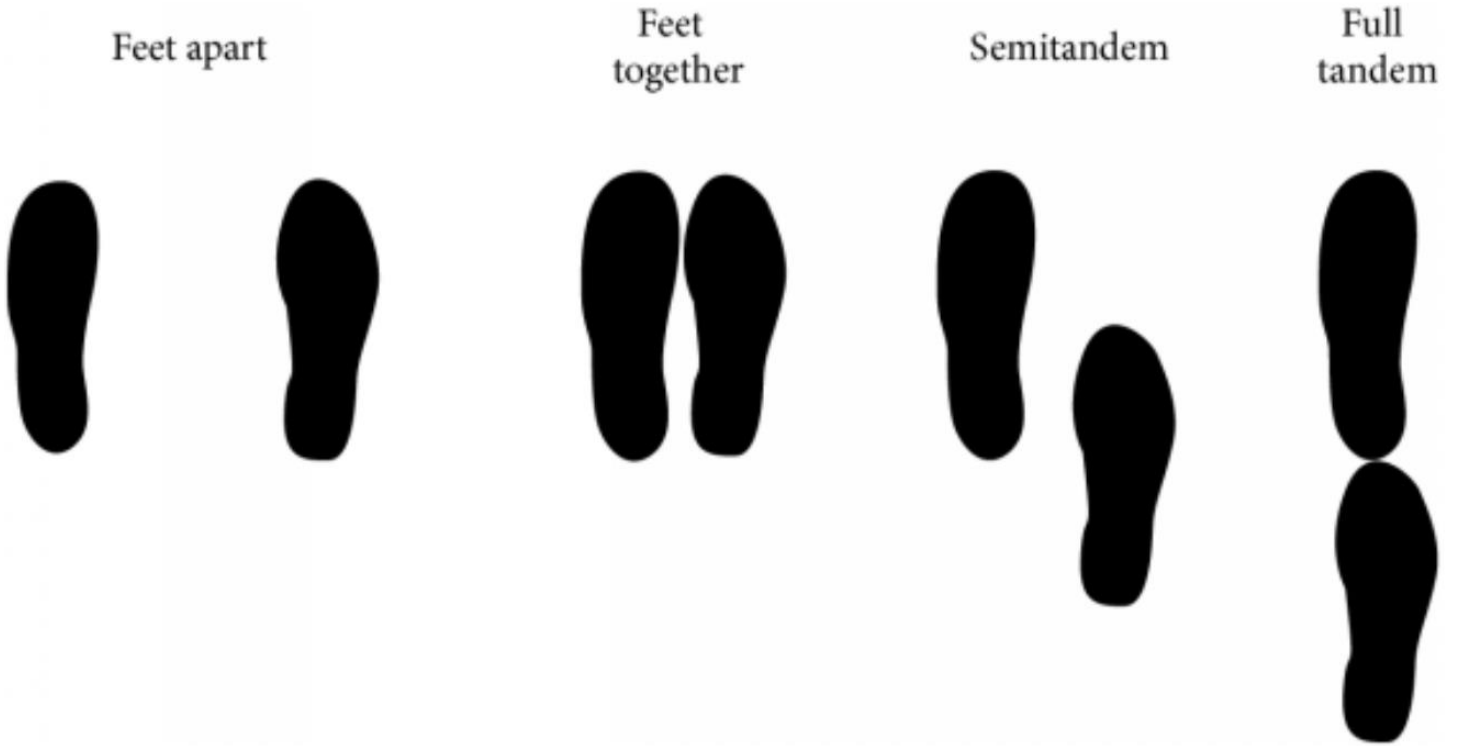


Zaostrzone/zmodyfikowane wersje próby Romberga i test ECTR

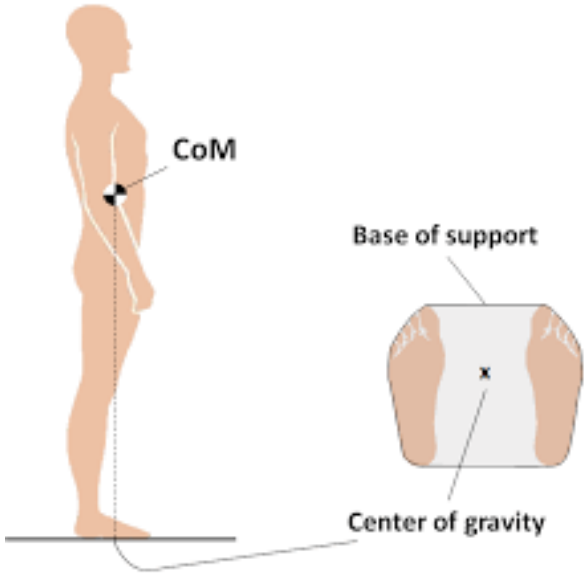
Romberg Test Variants	
Test	Difficulty
Eyes Open Regular (EORR)	Easy
Eyes closed Regular (ECRR)	Harder
Eyes open tandem (EOTR)	Harder yet
Eyes closed tandem (ECTR)	Very difficult

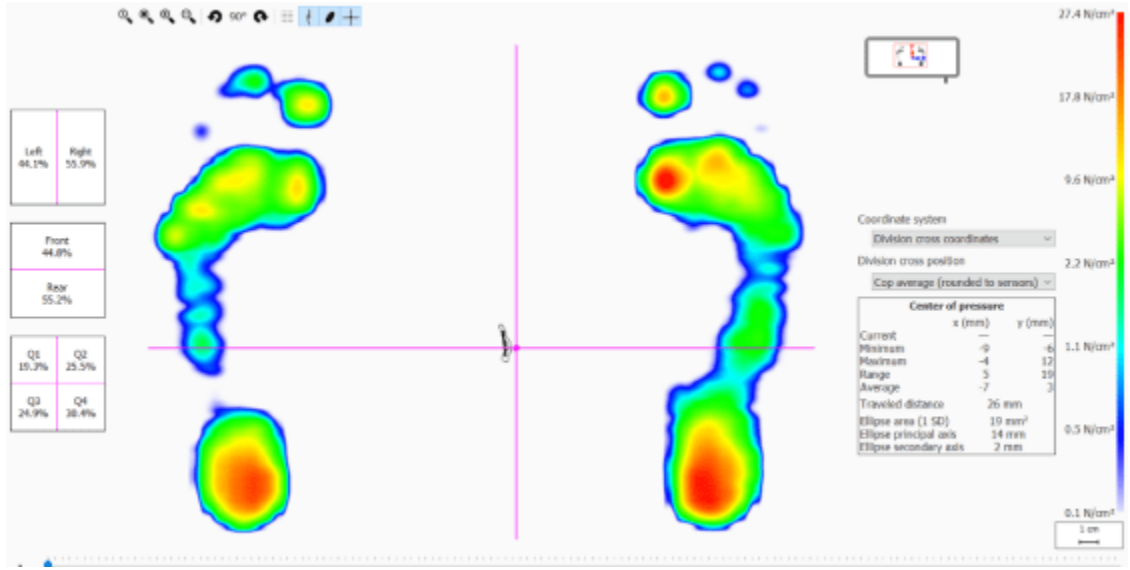
BOS

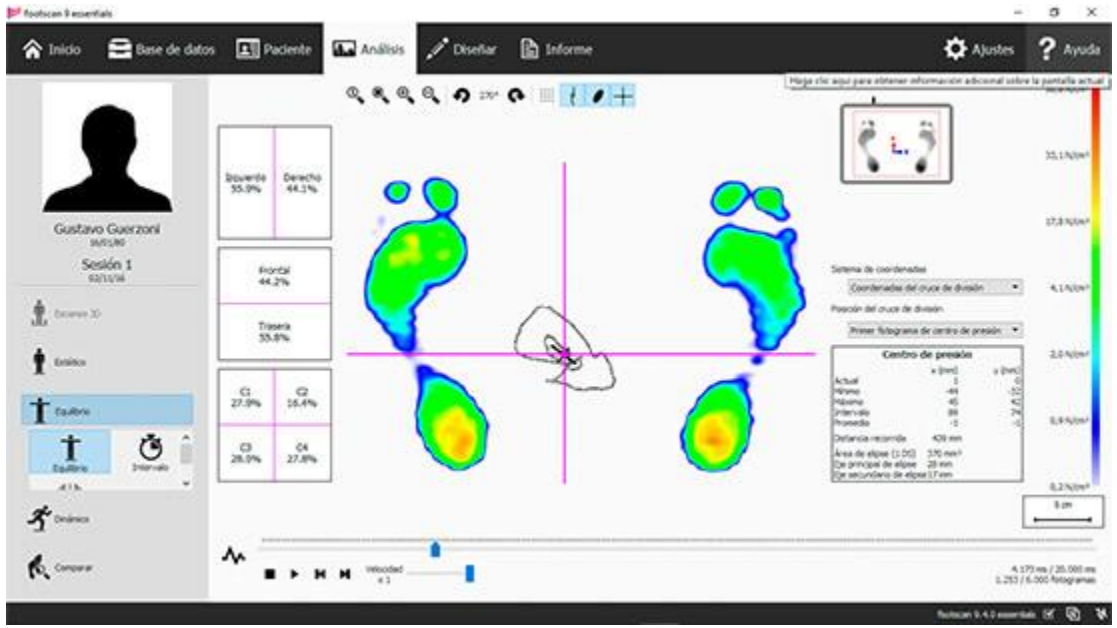




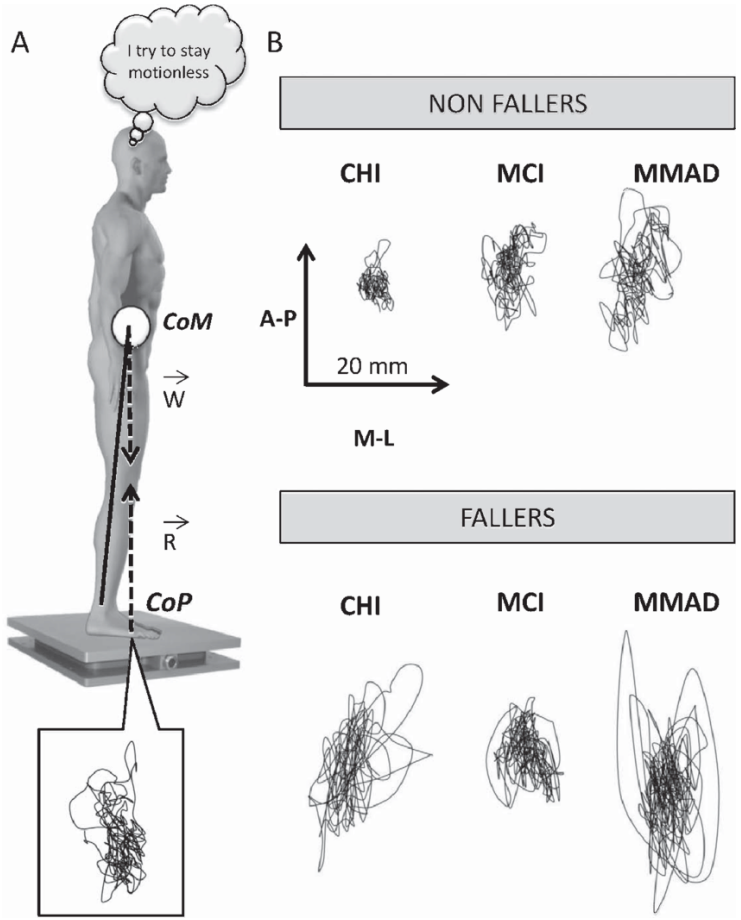
COP


CoM
Base of support
Center of gravity




Inicio
Base de datos
Paciente
Análisis
Diseñar
Informe
Ajustes
Ayuda
Gustavo Guerzoni
Sesión 1

COP - trajektorie



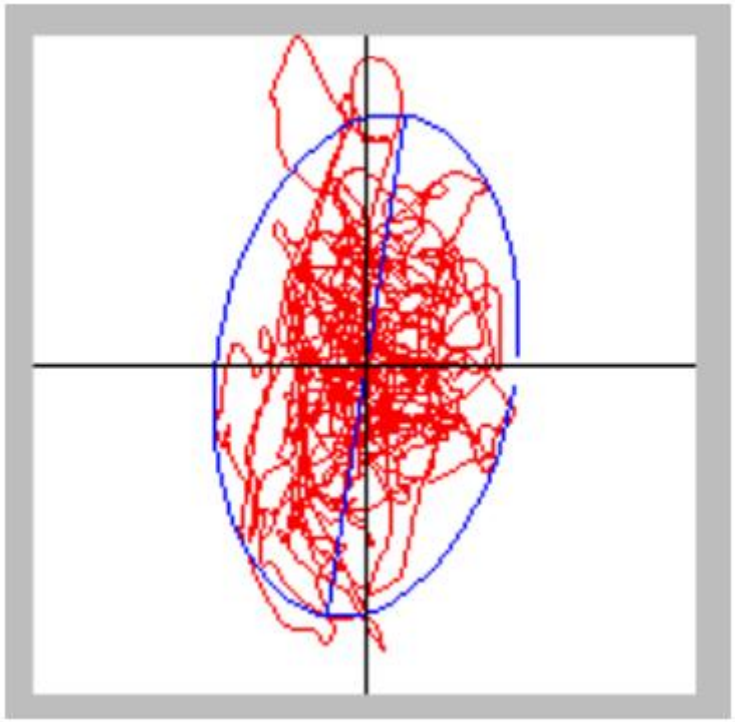
Journal of Alzheimer's Disease 41 (2014) 431–439
DOI 10.3233/JAD-132657
IOS Press

Postural Sway, Falls, and Cognitive Status: A Cross-Sectional Study among Older Adults

Jean-Baptiste Mignardot[a], Olivier Beauchet[b], Cédric Annweiler[b,c], Christophe Cornu[a] and Thibault Deschamps[a,*]
[a]*Laboratory "Motricité, Interactions, Performance", University of Nantes, Nantes, France*
[b]*Department of Neuroscience, Division of Geriatric Medicine, UNAM, Angers University Hospital, Angers, France*
[c]*Robarts Research Institute, The University of Western Ontario, London, ON, Canada*

Miary stabilności bazujące na COP

- Elipsa (the 95 % confidence ellipse) – najmniejsza elipsa pokrywająca 95% diagramu COP



Miary stabilności bazujące na COP cd.

- Vśr
- Vmax
- amax, a M-L, a A-P
- Długość drogi COP
- Entropia
- Wykładniki Lapunowa
- Fractal time series analysis

Eksperyment

Poszukiwana odpowiedź na pytanie:

Czy można zastąpić próbę Romberga bezpiecznym i mierzalnym testem z wykorzy?staniem narzędzi biomechanicznych?

Próba ECTR+

Etapy testu ECTR+ (2.x)

ECTR Test, the volunteer perform a quiet standing as following:

Stage 2.1: feet together, eyes open and hands by the sides,

Stage 2.2: as 2.1 but eyes closed,

Stage 2.3: as 2.2, arms in horizontal position, thumbs connected, eyes closed,

Stage 2.4: tandem stance, other as in 2.2,

Stage 2.5: as 2.4, head/neck in full extension,

Stage 2.6: as 2.4, head in right lateral flexion,

Stage 2.7: as 2.4, head in left lateral flexion.

Modyfikacja próby Romberga do wykonania na platformie pedobarograficznej

Etapy testu na platformie (1.x)

Modified Romberg Test on the Pedobarographic platform, the volunteer perform a quiet standing as following, each step lasted 20s:

Stage 1.1: standing in comfortable position with feet shoulder-width apart, arms alongside the torso, eyes open,

Stage 1.2: as in 1.1 but eyes closed,

Stage 1.3: as in 1.1, arms in horizontal position, thumbs connected, eyes closed,

Stage 1.4: as in 1.3, head/neck in full extension,

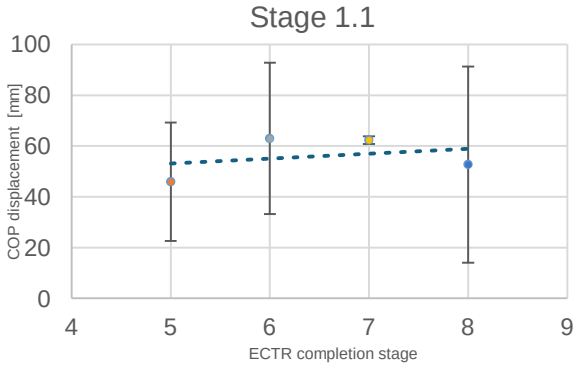
Stage 1.5: as in 1.3, head in right lateral flexion,

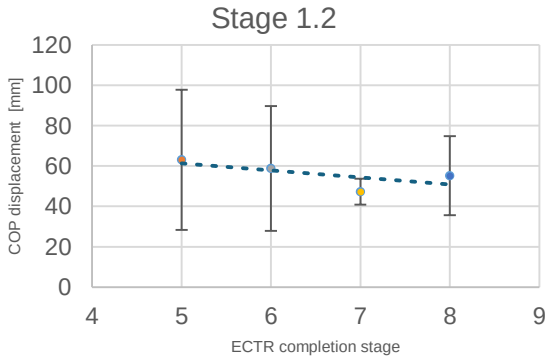
Stage 1.6: as in 1.3, head in left lateral flexion.

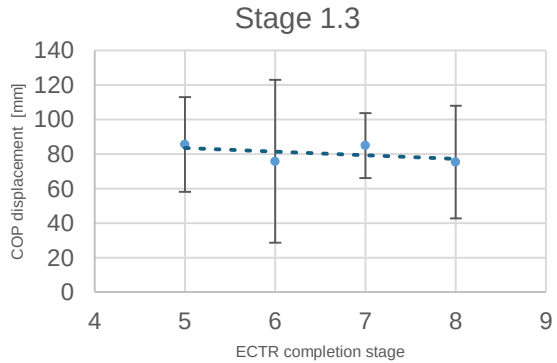
Podstawowe dane ochotników

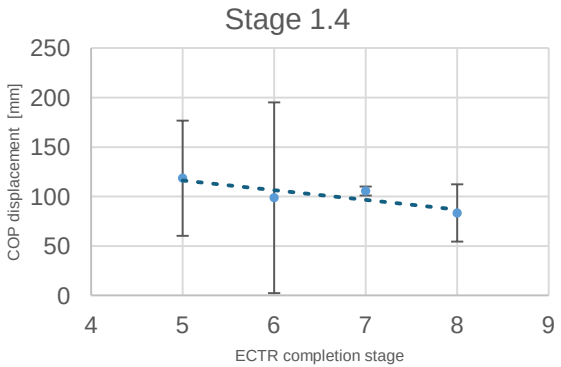
Avg ± Sd	Age (Years)	Body weight (kg)
Female (12)	20,91 ± 0,79	62 ± 11,54
Male (16)	24,31±4,74	83,69 ± 14,29
Average for all volunteers	22,86±5,76	74,5±21,86

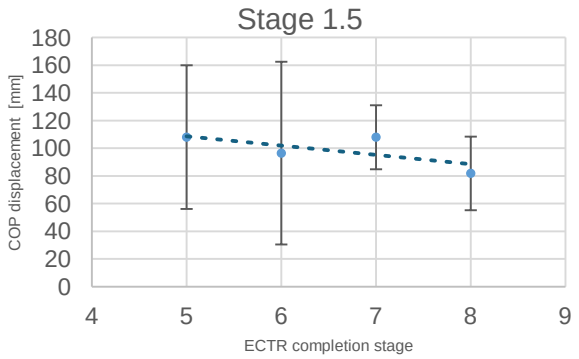
Wyniki ECTR+ - etap zakończenia testu a ścieżka COP

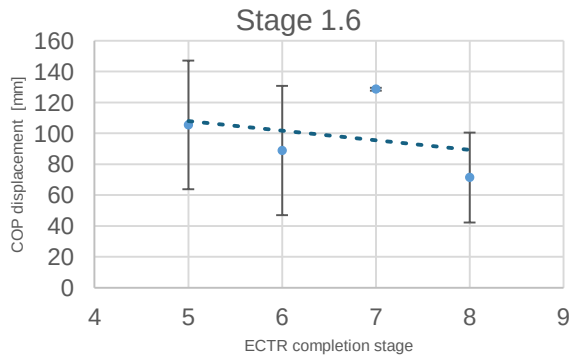




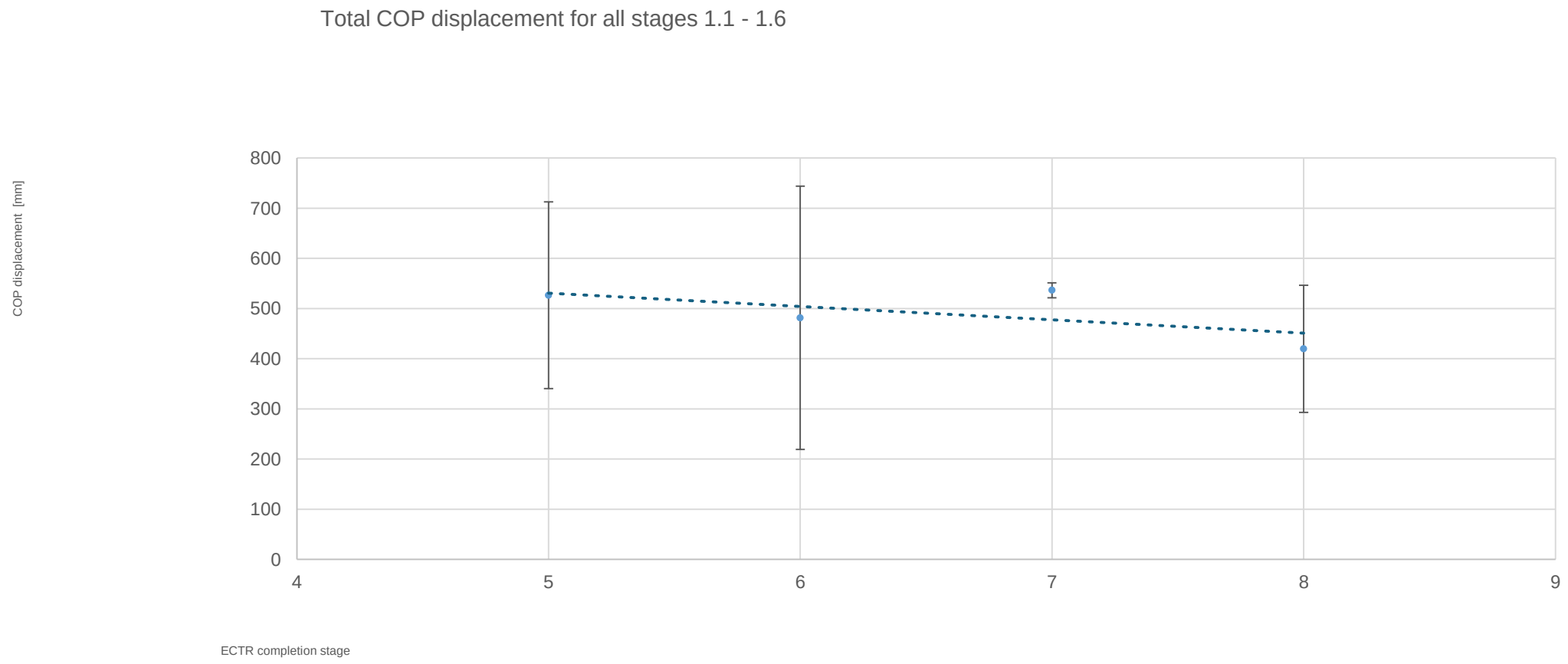




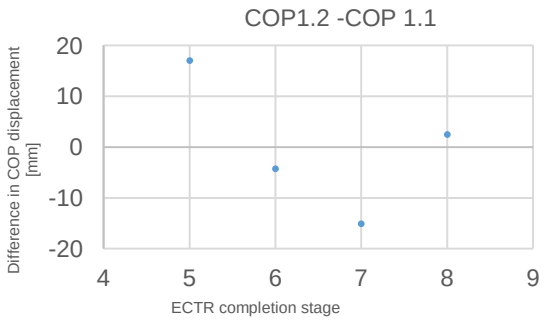


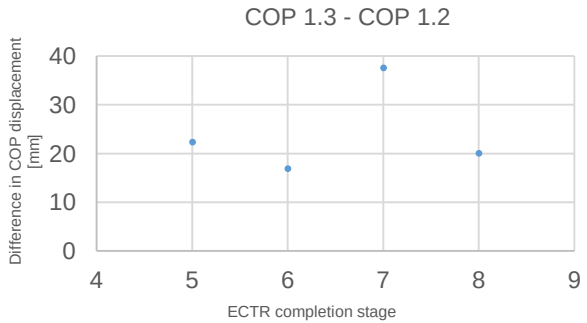


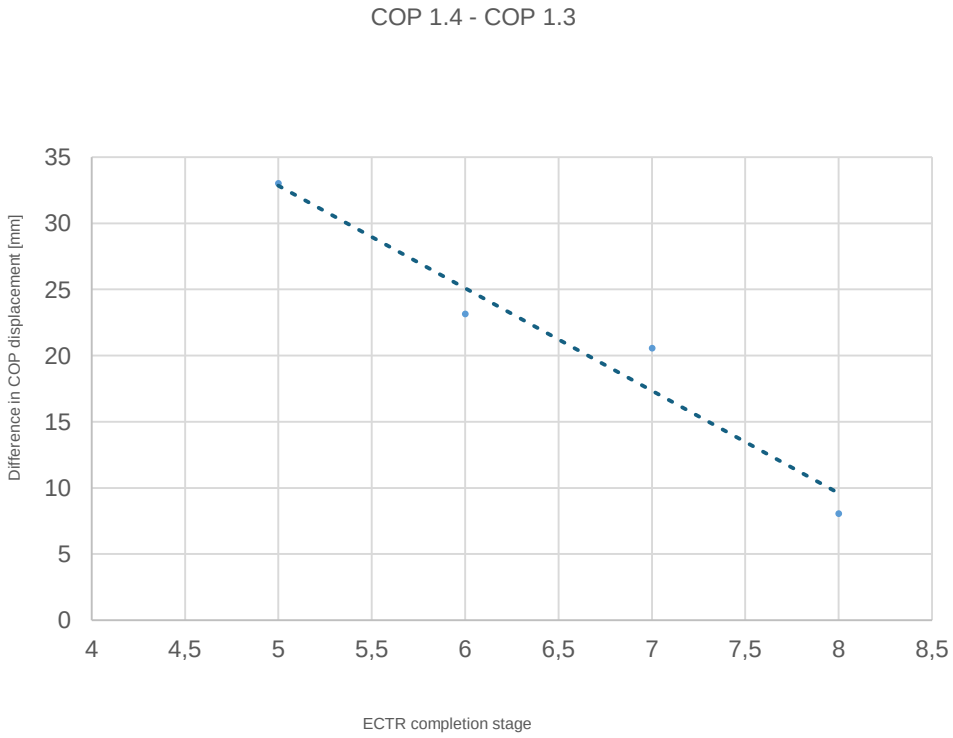
Droga całkowita

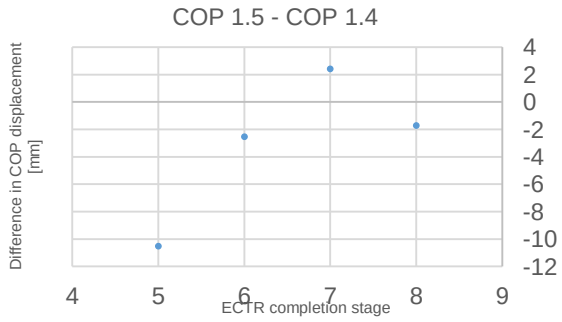


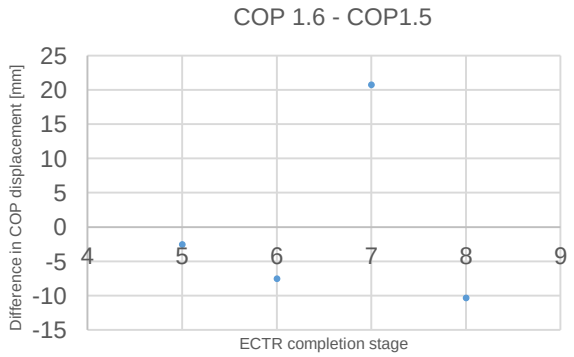
Różnice pomiędzy etapami











Korelacja COP1.4-COP1.3 = 0,97

Wnios(e)k(i)

The discovery of a strong correlation between COP displacement differences in stages 1.4 and 1.3 suggests that the entire test can be replaced by two measurements and the calculation of an appropriate coefficient to determine at which stage of the ECTR test the subject drops out. This is a significant finding that can shorten the time needed to conduct the test and facilitate the interpretation of results.

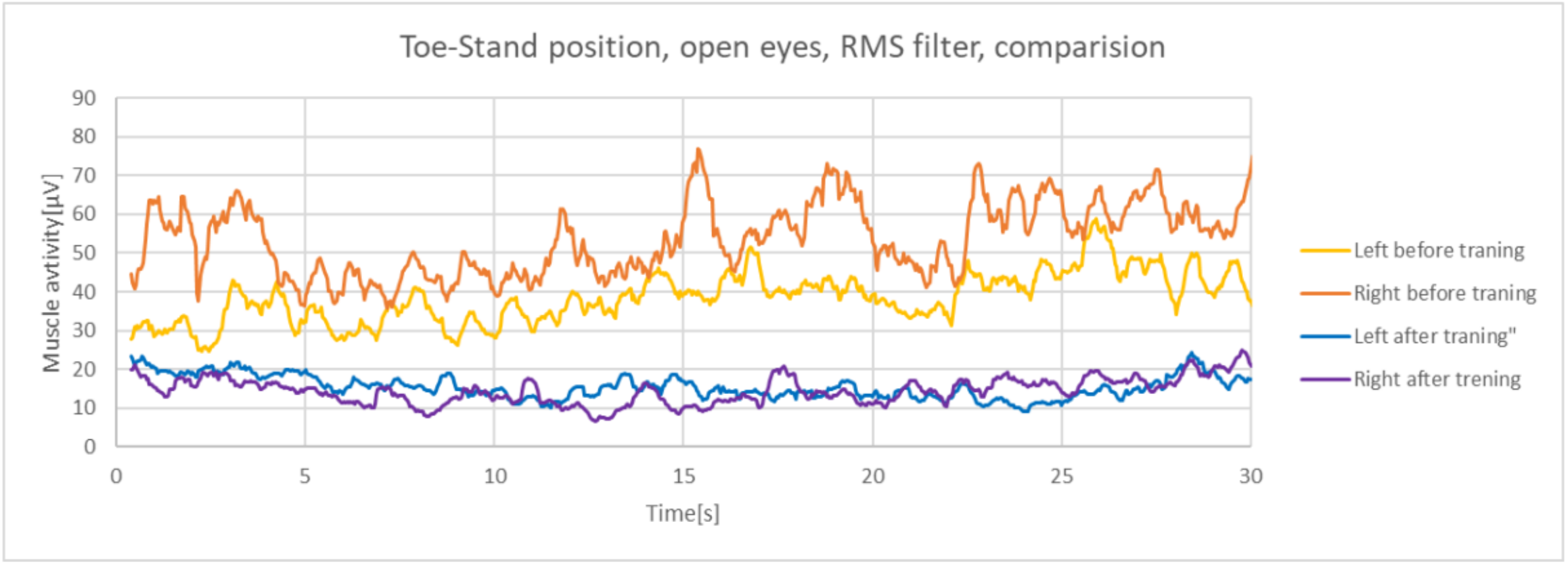
Współpraca z CIOPem

Application of engineering biomechanics methods to assess the influence of sensorimotor training on human postural control

Table 4.4.1 Comparision of COP elipse area [mm^2] results (Volunteer 1).

	T1-OE	T2-OE	T3-OE	AVG	Falls	T1-CE	T2-CE	T3-CE	AVG	Falls
Tip-Top initial	133	144	149	142	0	165	1 fall	121	143	1
Tip-Top final	119	75	43	79	0	62	1 fall	41	51	1
Toe-Stand initial	1 fall	1 fall	44	44	2	6 falls	5 falls	5 falls	-	16
Toe-Stand final	81	44	49	58	0	254	181	173	203	0

EMG



Plot 4.4.3 Comparision of initial and final results in Toe-Stand position with open eyes (Volunteer 1).

Exercise instructions

The training plan included the following exercises:

- Standing on one leg - Stand straight, look straight ahead. Bend one leg and raise your knee to hip height. You can spread your arms to the sides. Hold this position, then close your eyes and try to maintain your balance for a moment. Do some repetitions and then switch legs.
- Toe squat - Bring your feet together. Straighten your back, pull in your stomach, tighten your buttocks and lower your tailbone slightly as if you were trying to stretch your spine. Spread your arms to the sides, stand on your tiptoes as high as possible and from this position do a deep squat. Try to do it without faltering. Then return to the standing position.
- Closed and open passé - Ballet exercise. Starting position: back straight, spine extended, abdomen and buttocks tense. Stand on your toes, spread your arms to the sides. Bend your leg at the knee and lift it up to hip level (the foot should be at the knee of the other leg, and the thigh should form a right angle with the torso) - this is the so-called passé closed. Then go to the open passé: very slowly move the knee of the bent leg to the side - so that a right angle is created between the thighs. Return to the closed passé and lower your leg. Do reps for each side. Beginners can do this exercise against a wall.
- Swallow - Stand with your legs together. Lean your torso forward and at the same time stretch one leg back. For better balance, spread your arms to the sides. The torso and leg should be parallel to the ground. Hold for a while and change legs. Repeat the exercise on each side.
- Lunges on one leg - This exercise, in addition to improving balance, is a great workout for the thighs and buttocks. Stand straight with your legs together, arms out to the sides. Raise your right leg to the side (the foot should be about 30 cm above the ground). Take a step forward with the same leg, placing your foot diagonally to the left. Bend your knees, rise and return to the position with your leg raised to the side. Then take a step back, also diagonally. Bend both legs, return to the starting position. Do repetitions for each side.

Training plan

Recommendations:

- Frequency: 2 days a week,
- Breaks between training days: minimum 2 days
- Breaks between repetitions: 1-2 minutes
- Training duration: 20-35 minutes

Plan:

- Week 1-2

  Standing on one leg (3 reps per leg, 20s with eyes open, 5s with eyes closed, 2 sets)

  Toe squat (5 reps, 2 sets)

  Closed and open passé (3 reps per leg, 2 sets)

  Swallow (3 repetitions per leg, 10 s with eyes open, 5 s with eyes closed, 2 sets)

  Single leg lunges (5 reps per leg, 2 sets)

- Week 3-4

  Standing on one leg (3 reps per leg, 40s with eyes open, 10s with eyes closed, 2 sets)

  Toe squat (10 reps, 2 sets)

  Closed and open passé (5 reps per leg, 2 sets)

  Swallow (3 repetitions per leg, 20s with eyes open, 5s with eyes closed, 2 sets)

  Single leg lunges (10 reps per leg, 2 sets)

- Week 5-6

  Standing on one leg (3 reps per leg, 60s with eyes open, 15s with eyes closed, 2 sets)

  Toe squat (15 reps, 2 sets)

  Closed and open passé (7 reps per leg, 2 sets)

  Swallow (3 repetitions per leg, 30s with eyes open, 10s with eyes closed, 2 sets)

  Single leg lunges (15 reps per leg, 2 sets)

VR, prioprioceptcja, ruchomy horyzont

- Rollercoaster
- Ruchomy horyzont

Dziękuję za uwagę