

왜 보행분석을 하는가?

뇌성마비 환자의 보행 데이터 기반 치료 현황 및 미래

2023. 04. 22.

박 문 석

분당서울대학교병원

서울대학교 의학과

동작(보행)분석이란?

1) 동작(보행)을

(특정 장비를 이용하여)

2) 분석하는 것

- 동작의 모양 (비디오, 모션캡처)
- 물리적인 역학 (힘판)
- 기타: 근육의 활동, 에너지소모 등



보행분석이란 무엇인가요?



보행분석은 인간이 보행하는 방식을 연구하고 이를 분석하는 학문입니다. 이 학문은 인간이 보행하는 과정을 이해하고, 이를 기반으로 건강 상태 평가, 운동 재활, 보행 보조 기기 개발, 인간-로봇 상호작용, 스포츠 생체 역학 등의 분야에서 응용됩니다.

보행분석은 보행 과정에서 발생하는 다양한 생체신호를 수집하고 분석하여 인간의 보행 기능을 평가하는데 사용됩니다. 이러한 생체신호에는 다양한 센서를 통해 수집된 걸음걸이 패턴, 근전도 신호, 심전도 신호, 혈압 등이 포함됩니다. 이러한 생체신호는 다양한 분석 기법을 통해 해석되며, 이를 통해 보행의 기능적, 생리학적, 생물역학적 측면을 평가할 수 있습니다.

보행분석은 또한 장애인이나 노인 등과 같은 보행 장애를 가진 사람들의 보행 기능 평가와 재활 프로그램 개발에도 적용됩니다. 이를 통해 재활 기간을 단축하고, 보행 기능의 향상을 도모할 수 있습니다.

요약하면, 보행분석은 인간의 보행 기능을 이해하고 평가하기 위한 학문으로, 보행 분석을 통해 건강 상태 평가, 운동 재활, 보행 보조 기기 개발 등 다양한 분야에서 응용됩니다.



what is the clinical gait analysis?



Clinical gait analysis is a specialized field of study that involves the evaluation of human walking patterns for clinical purposes, particularly in the diagnosis and treatment of patients with walking difficulties or gait abnormalities. It is a comprehensive and multidisciplinary approach that combines the expertise of physicians, physical therapists, biomechanists, and engineers to provide a detailed assessment of gait mechanics and identify any underlying issues that may be causing gait abnormalities.



The analysis typically involves the use of advanced motion capture systems, force plates, electromyography (EMG), and other sensors to capture and quantify various aspects of gait, including joint angles, muscle activity, ground reaction forces, and timing and coordination of movement. These data are then analyzed and interpreted by a team of experts to identify any deviations from normal gait patterns, which may be due to musculoskeletal, neurological, or other disorders.

Clinical gait analysis is commonly used in the diagnosis and management of a wide range of conditions that affect gait, including cerebral palsy, stroke, multiple sclerosis, Parkinson's disease, and orthopedic conditions. It can help to identify the specific impairments that are contributing to gait abnormalities, guide the selection of appropriate interventions, and monitor the effectiveness of treatment over time.

In summary, clinical gait analysis is a specialized field that involves the comprehensive evaluation of gait mechanics and identification of underlying issues for clinical purposes. It utilizes advanced technology and the expertise of a multidisciplinary team to provide valuable insights into gait abnormalities and guide effective treatment strategies.

기술의 “내적 필연성”

- 1) 기술은 발전할 수 있는 방향으로 발전한다.
- 2) 인간이 원하는 방향으로 발전하는 것은 아니다.



동작분석이 발전해온 방향

- 모션캡처
 - 임상 보행분석
- 가속도계

병적 상황이 얼마나 자주 일어나는가?

- Pathologic event
- 매 주기마다 일어난다.
 - 까치발, 평발, 안짱걸음...
- 가끔 일어난다.
 - 낙상

병적 상황의 치료가 국소적인가 전반적인가?

- 국소적
 - 까치발, 평발, 안짱걸음...
- 전반적
 - 파킨슨병

왜 임상 보행분석이 발전하였나?

보행은...

- 1) 일정한 주기를 따라 반복
- 2) 정형화(패턴)가 되어 있어서, 의도하지 않아도 동작
- 3) 일상생활에서 많이 사용하는 동작
- 4) 적당한 속도
- 5) 적당한 관절의 가동 범위

뇌성마비에서의 보행분석의 이용

- 1) 증상이 보행에서 도드라져 보인다.
- 2) 관절 하나의 문제이고 눈으로 보아서 무엇이 원인인지 알기 쉽다면 보행분석을 이용하지 않을 것이다.
- 3) 뇌성마비는 전신 관절에 영향을 준다. 보행에 미친 영향을 쉽게 파악할 수 없기 때문에 객관적인 검사가 필요.

임상보행분석의 실례

골반

골반

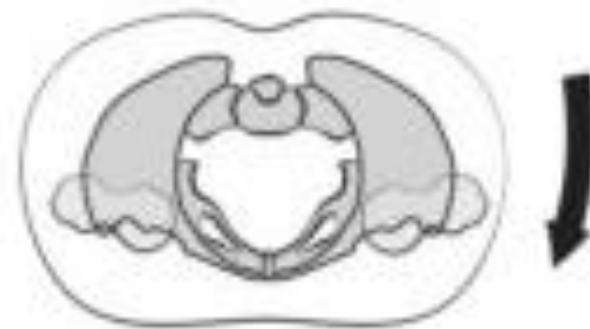
- 시상면, 관상면, 횡단면으로 묘사를 하지만...
- 사실은 하나의 모션이다.
- 골반과 대퇴골의 움직임은 눈으로 파악하기가 힘들다.



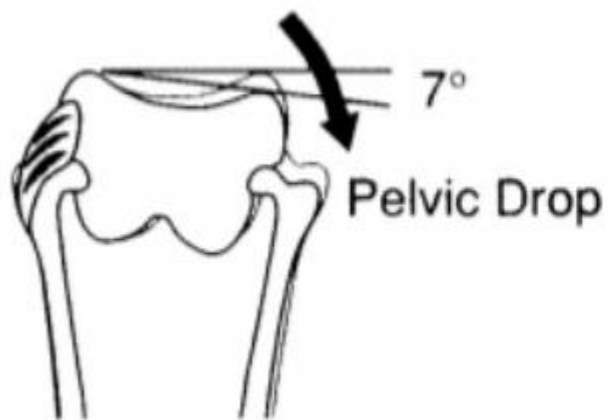
Anterior Tilt



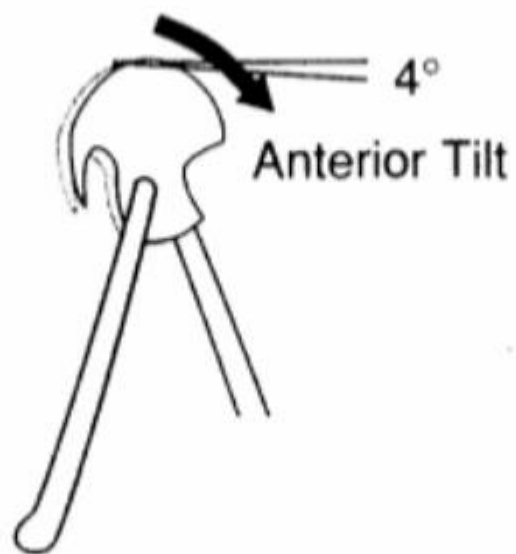
Pelvic Obliquity



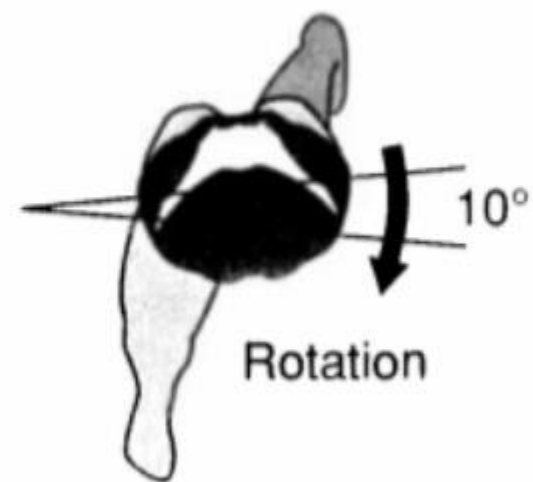
Pelvic Rotation



Pelvic Drop

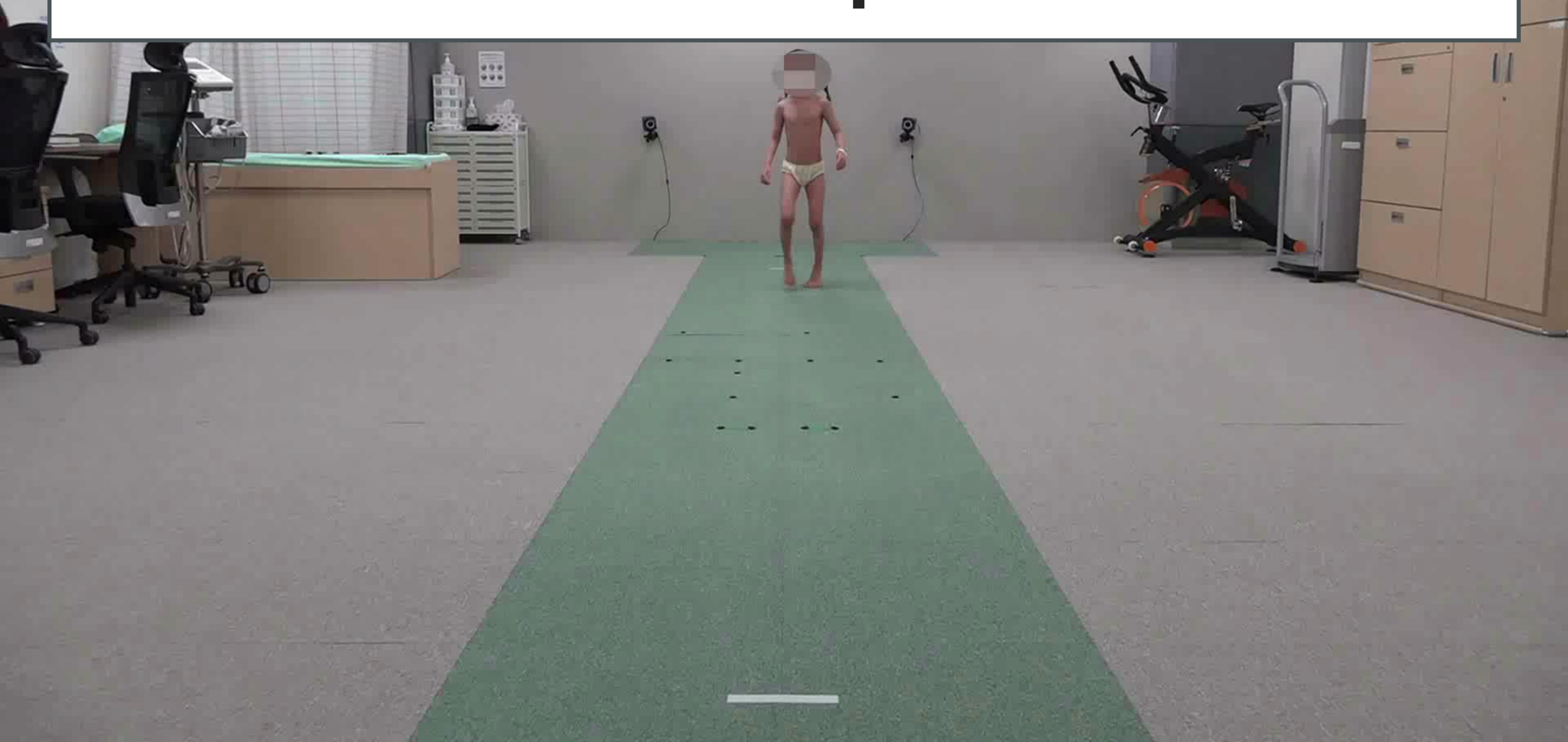


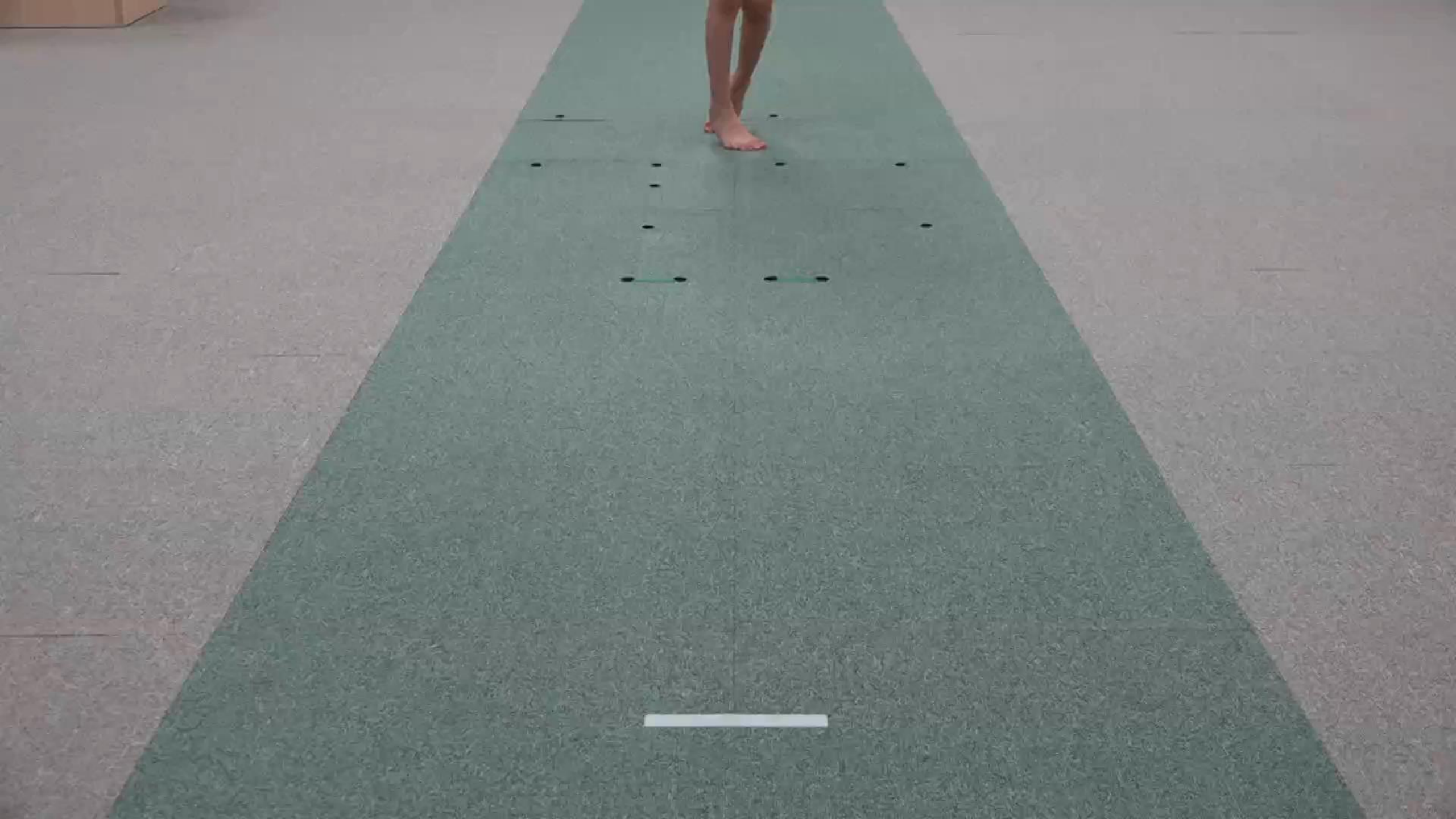
Anterior Tilt



Rotation

Preop





P/E SHEET (PREOP, 7Y)

Hip ROM>	Rt	Lt
FF	135	135
FC	20	20
Extension (Staheli test)	20	30
Abd. (at Extension state)	40	40
Abd. (at flexion 90' state)	60	60
Adduction	35	30
ER (prone)	40	20
IR (prone)	50	70

Anteversion (prone)	30	50
TFA (prone)	-10	-30

Knee ROM>		
FC	15	10
FF	150	150
Popliteal angle (unilateral)	70	70
Popliteal angle (Bilateral)	50	50
Duncan Ely	+	+

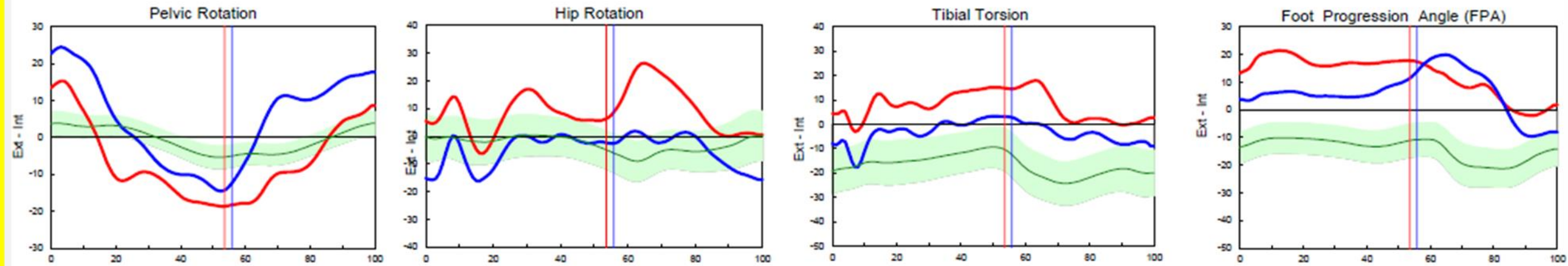
Ankle ROM>		
Plantarflexion	60	65
Dorsiflexion (at knee 90')	-10	-20
Dorsiflexion (at knee 0')	-20	-30

Foot>		
Hindfoot		
Valgus	N	N
Varus	N	N
Flexibillity	Y	Y
Midfoot		
TN subluxation(pronation)	N	N
TN subluxation(supination)	N	N
Flexibillity	Y	Y
Forefoot		
Adduction	N	N
Abduction	N	N
Flexibillity	Y	Y

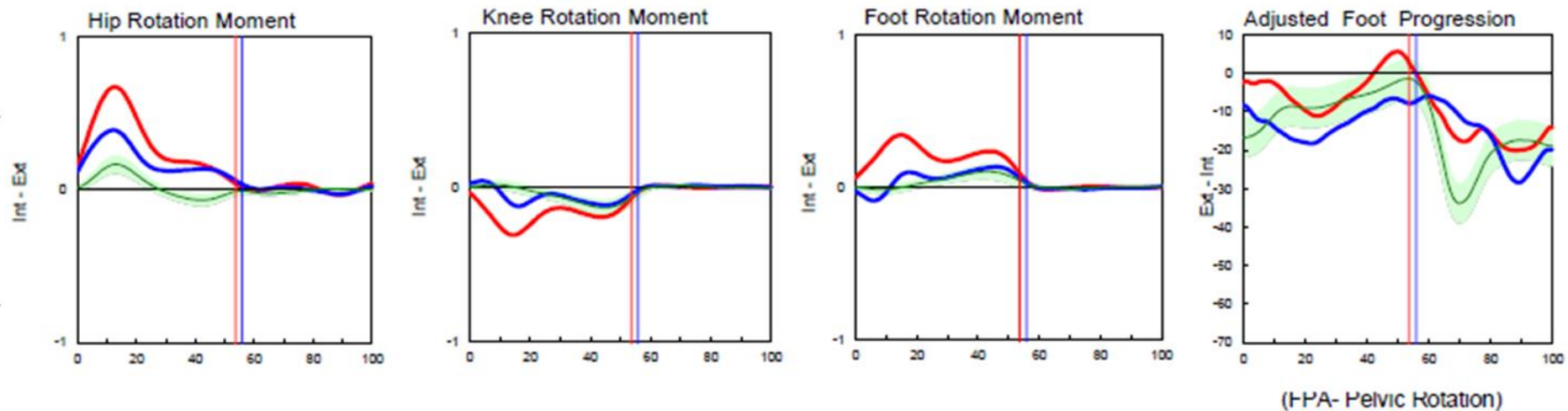
Other test>		
Ankle clonus	N	N
Babinski	N	N
Confusion test	N	N

MOTION ANALYSIS

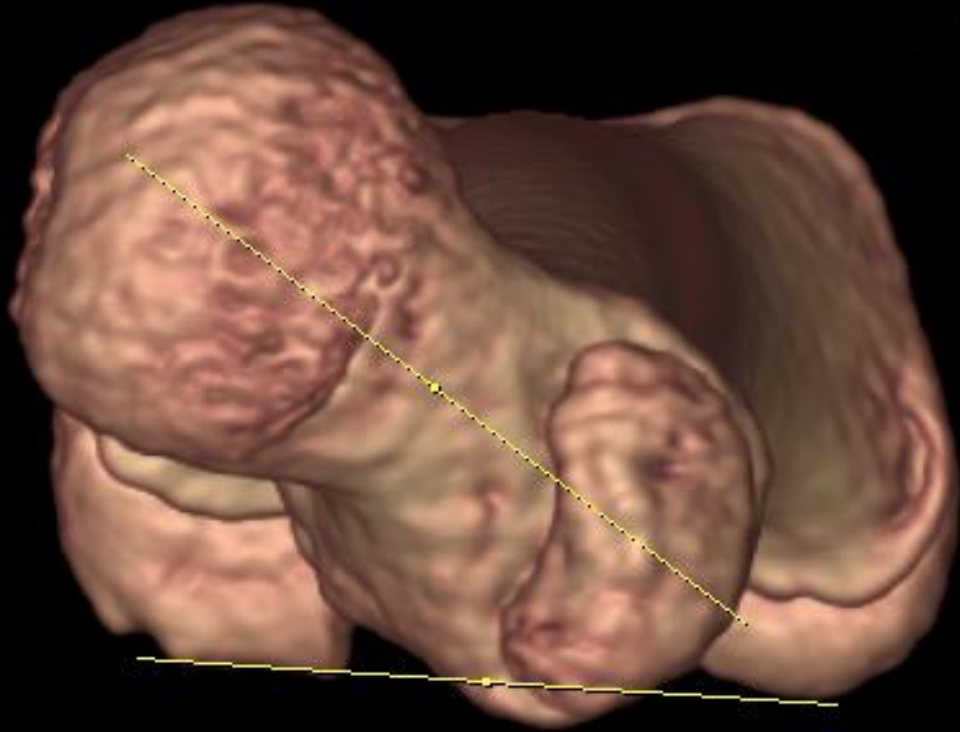
Transverse Plane



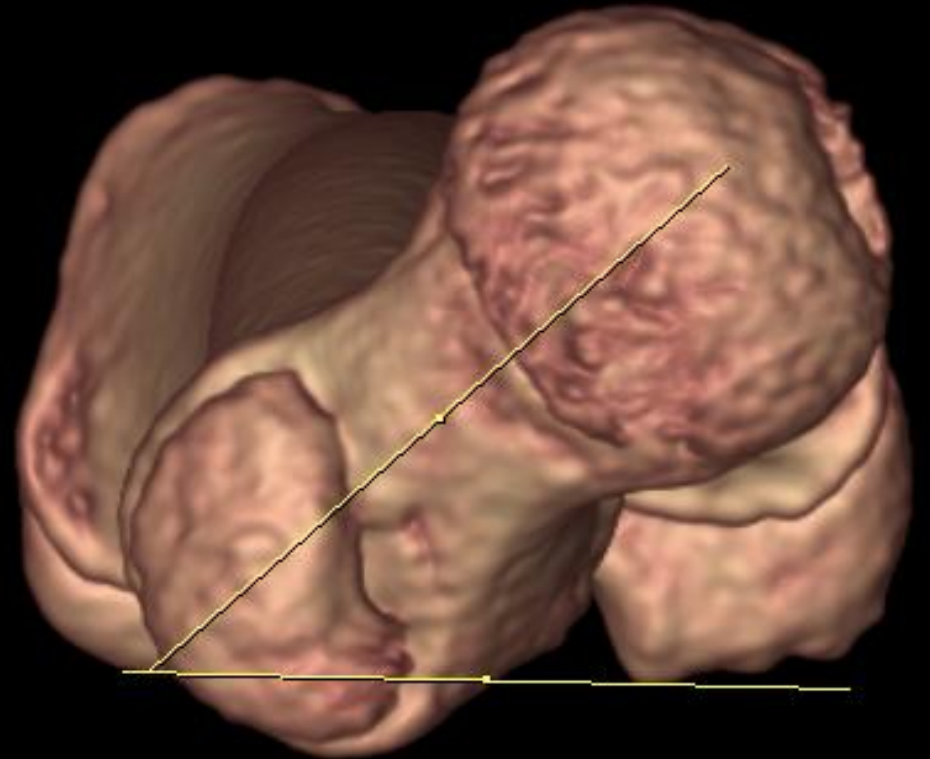
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나이:	7.1
환자번호:	0
검사일자:	2020/05/11
활보장(Strides):	3
오른쪽	— (Blue line)
왼쪽	— (Red line)



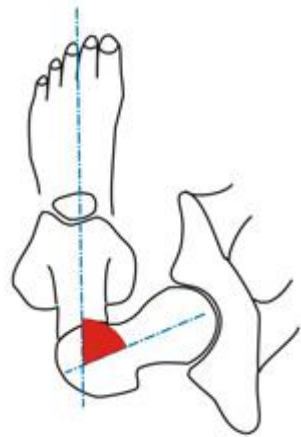
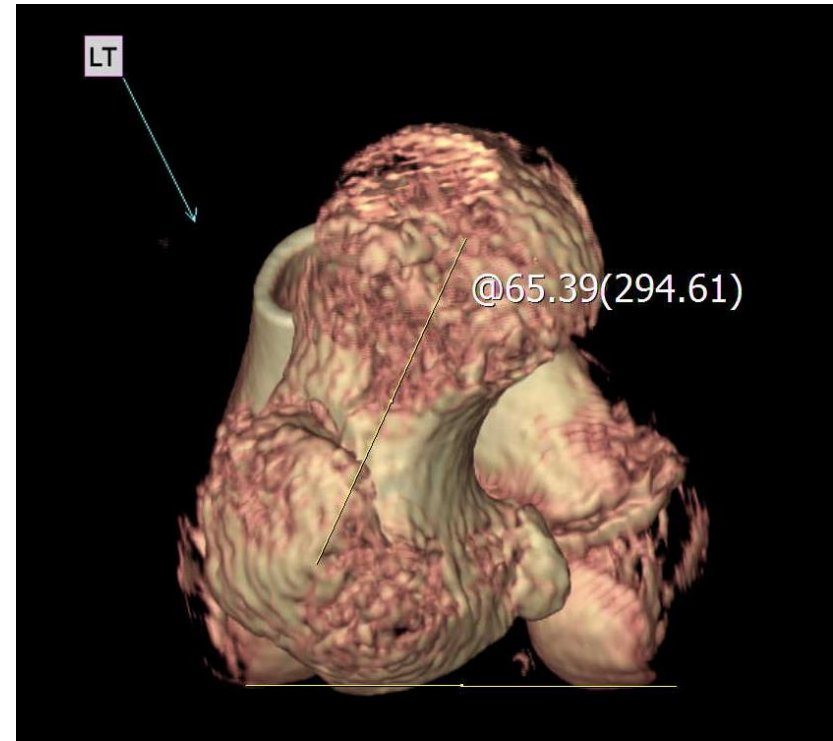
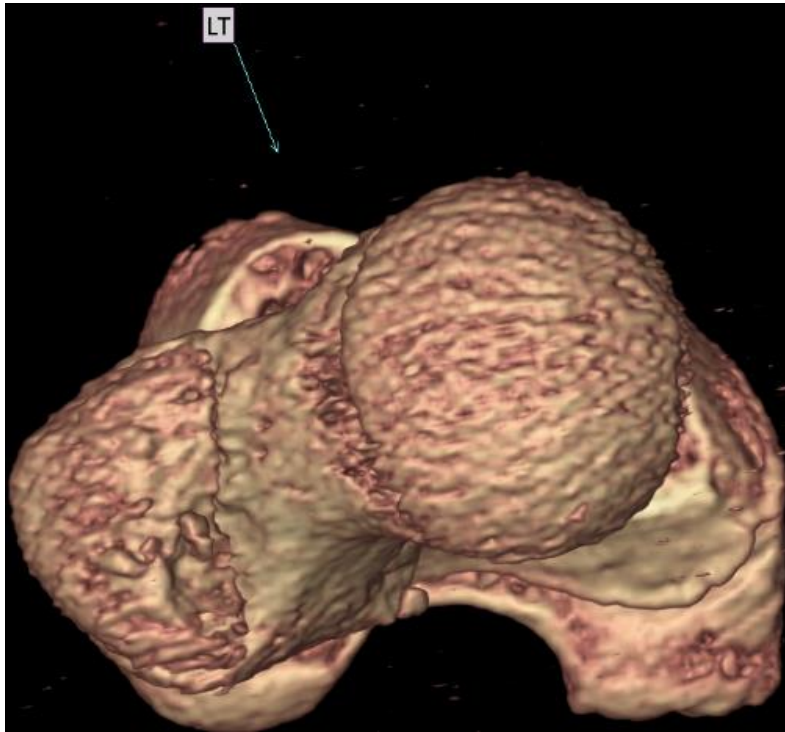
FEMUR ANTEVERSION



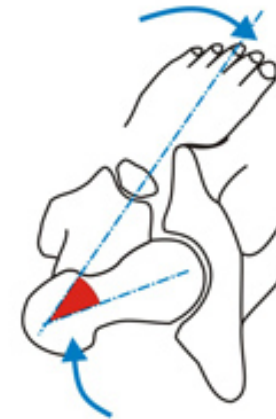
@33.32(326.68)



@42.71(317.29)



정상 범위



원위부의 내염전 = 전염전의 증가



A

NORMAL HIP



B

**FEMORAL
ANTEVERSION**



C

**FEMORAL
RETROVERSION**

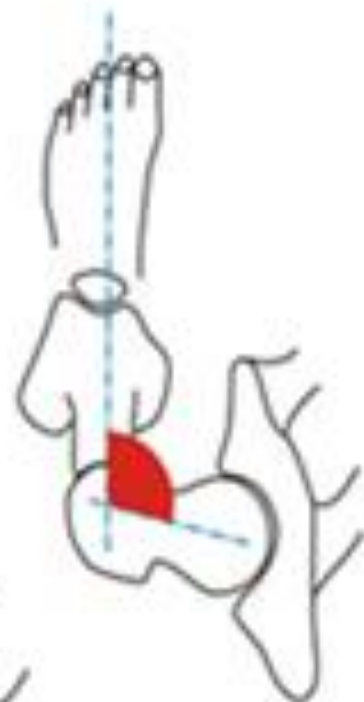
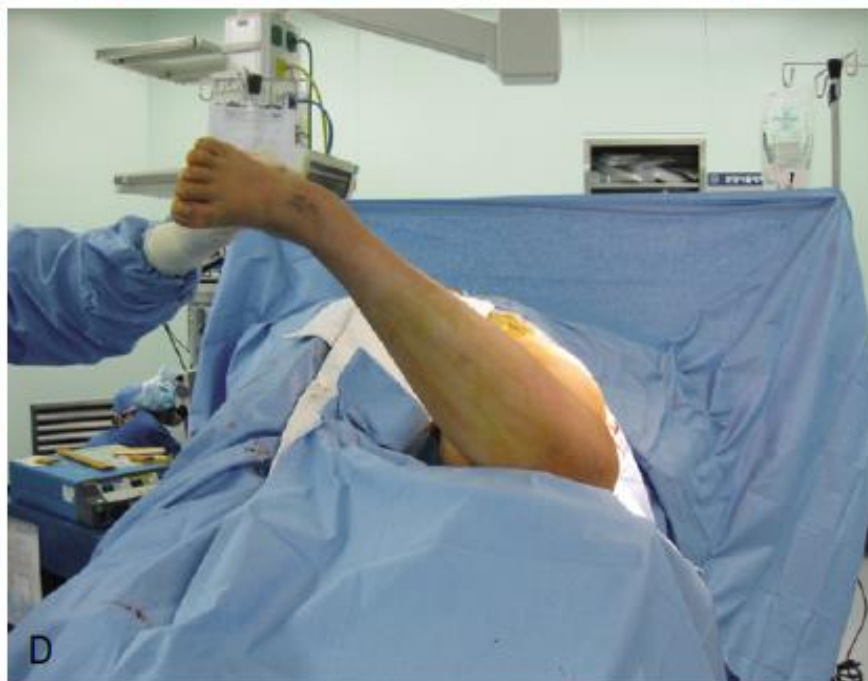
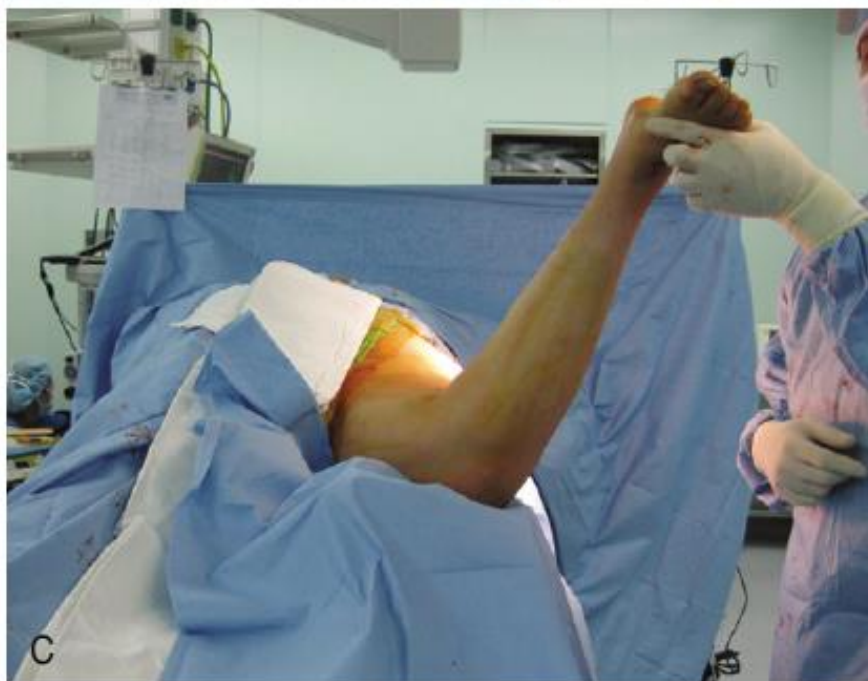
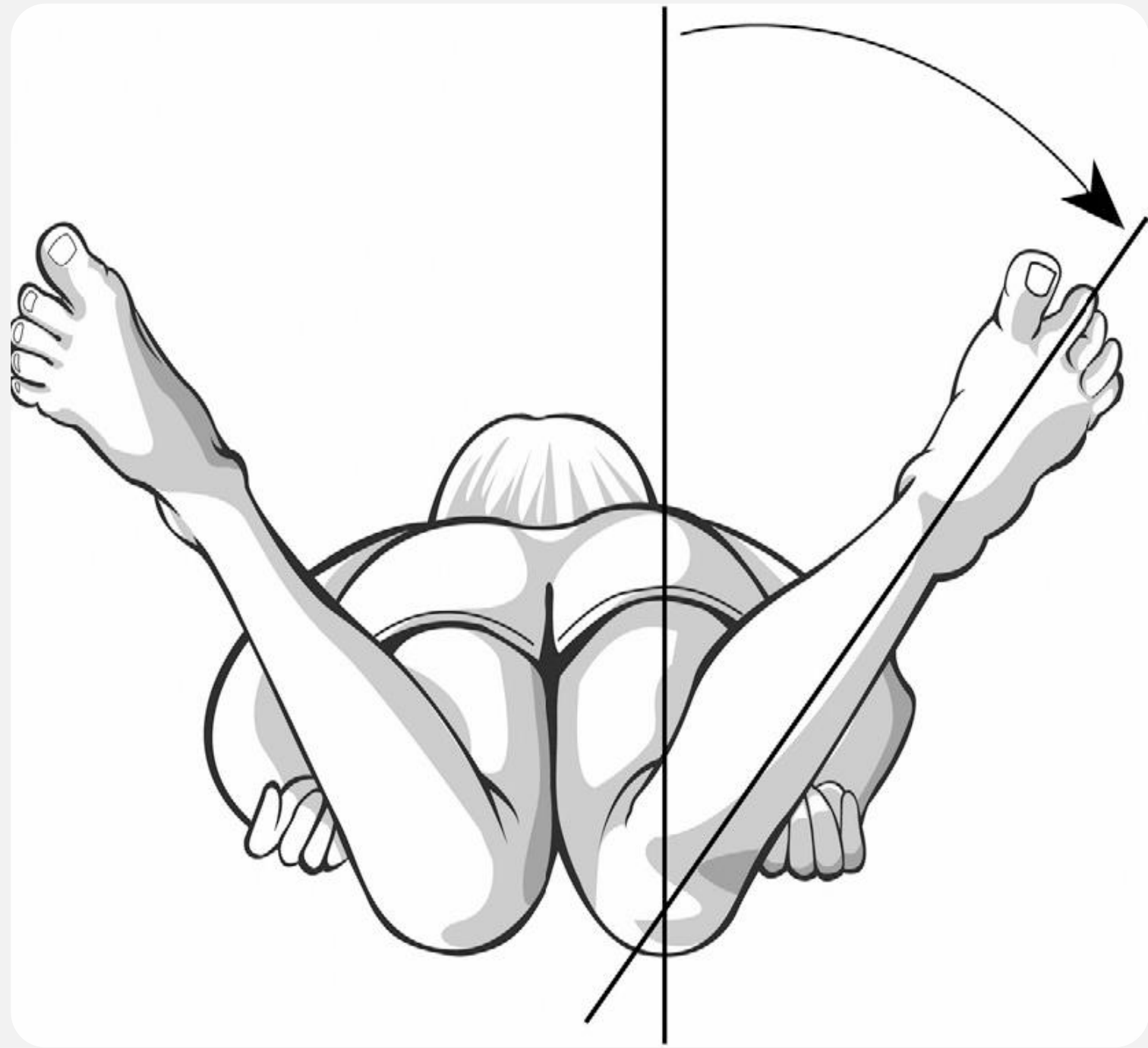


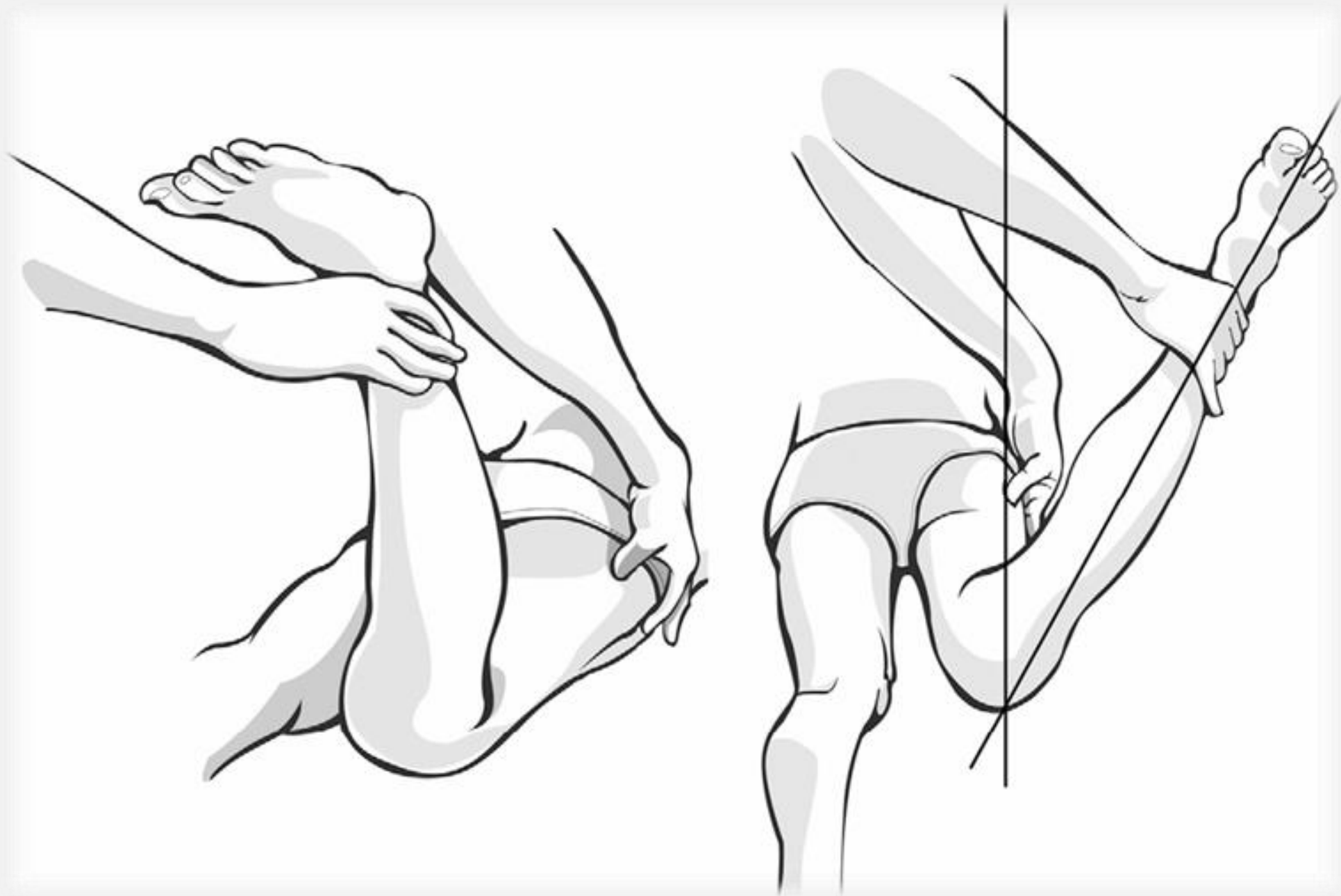
Table 3. One-Way Analysis of Variance, Mean, SD, 95% CIs and *p* Values for the Difference of Age Groups

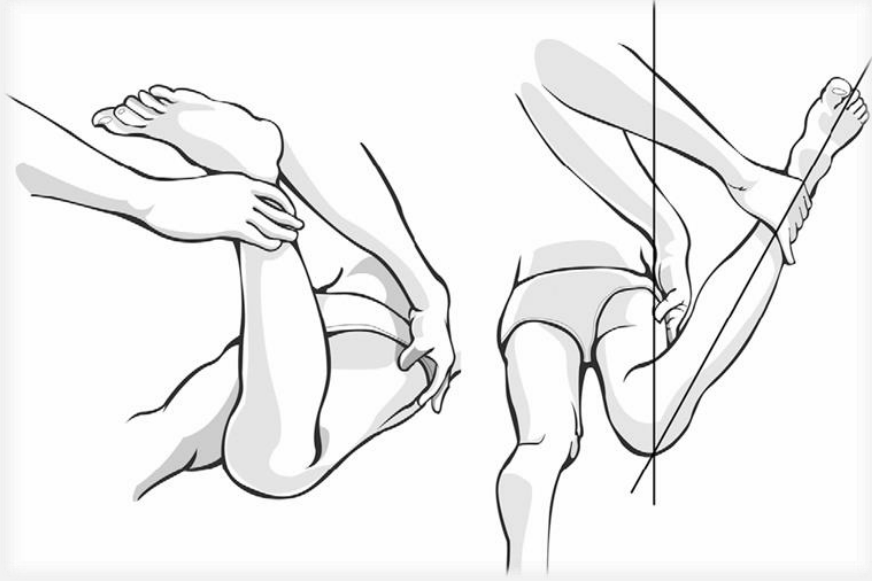
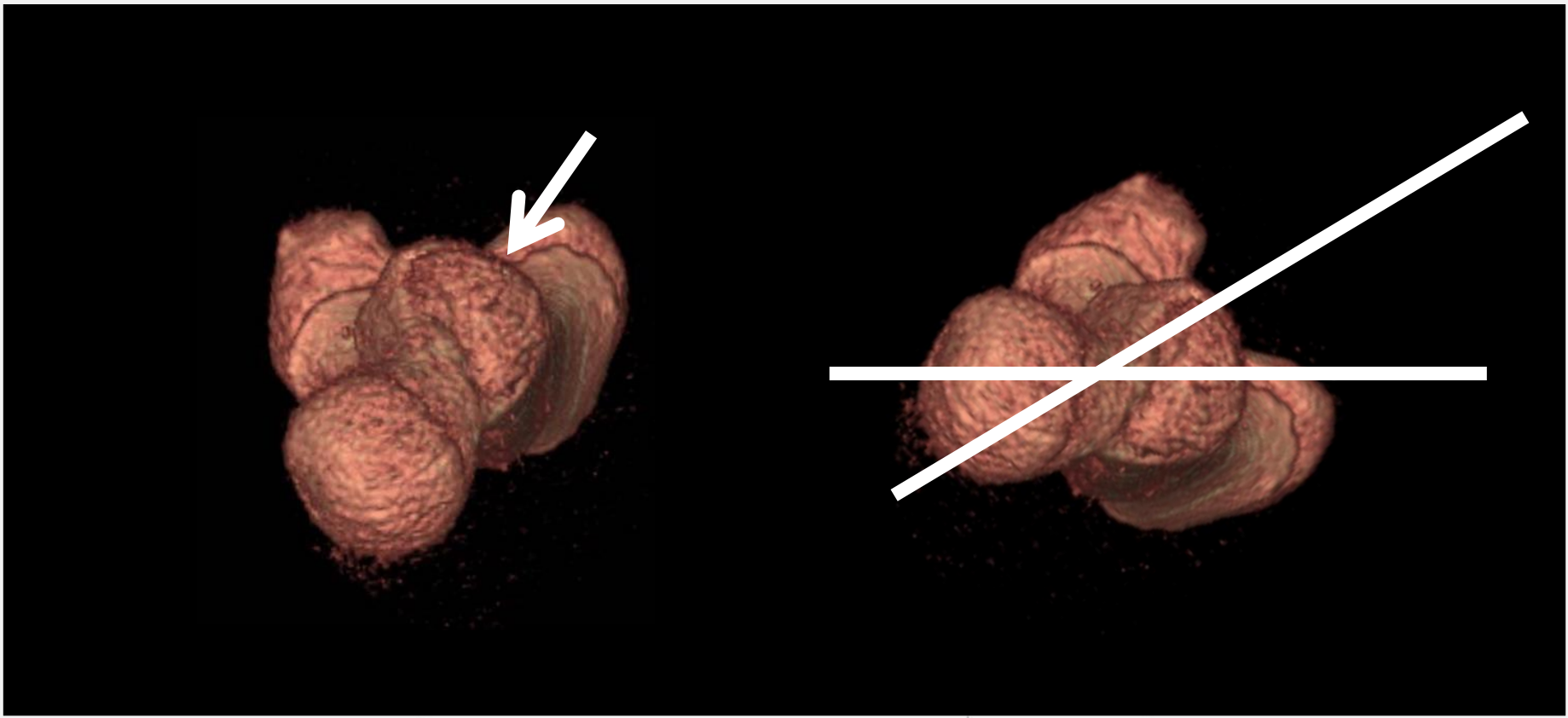
Examination	Mean (SD) [95% CI] (degrees)					<i>p</i> value
	13–20 years	21–35 years	36–50 years	Over 51 years	Total	
Thomas test	0.0 (0.2) [0.0 to 0.1]	0.3 (0.9) [-0.1 to 0.6]	0.3 (1.2) [-0.1 to 0.8]	0.3 (1.0) [-0.1 to 0.7]	0.2 (0.9) [0.1 to 0.4]	0.591
Staheli test	-20.9 (4.6) [-18.7 to -22.8]	-18.0 (3.2) [-16.7 to -19.3]	-17.0 (2.9) [-15.8 to -18.2]	-18.0 (3.6) [-16.5 to -19.4]	-18.4 (3.9) [-17.7 to -19.2]	0.002*
Hip flexion	126.8 (7.6) [123.7 to 129.8]	126.6 (6.4) [124.0 to 129.2]	125.8 (4.6) [123.9 to 127.6]	125.5 (6.1) [123.1 to 128.0]	126.2 (6.2) [125.0 to 127.4]	0.850
Hip abduction with extension	47.6 (6.2) [45.1 to 50.1]	46.3 (6.1) [43.8 to 48.7]	49.3 (4.9) [47.3 to 51.2]	47.3 (5.6) [45.0 to 49.6]	47.6 (5.7) [46.5 to 48.7]	0.298
Hip abduction with 90° flexion	55.6 (7.5) [52.6 to 58.7]	53.3 (6.7) [50.6 to 56.0]	56.1 (5.3) [53.9 to 58.2]	54.0 (8.9) [50.4 to 57.6]	54.8 (7.2) [53.3 to 56.2]	0.472
Adduction of hip	28.6 (8.9) [25.0 to 32.2]	30.9 (7.6) [27.8 to 33.9]	33.3 (6.5) [30.7 to 36.0]	32.4 (7.7) [29.3 to 35.5]	31.3 (7.8) [29.8 to 32.8]	0.146
Hip external rotation	40.1 (8.5) [36.7 to 43.6]	41.0 (8.8) [37.4 to 44.6]	43.5 (7.3) [40.6 to 46.5]	40.5 (8.3) [37.2 to 43.9]	41.3 (8.3) [39.7 to 42.9]	0.445
Hip internal rotation	40.1 (11.1) [35.6 to 44.5]	39.2 (8.3) [35.8 to 42.5]	39.4 (8.7) [35.9 to 42.9]	37.6 (7.8) [34.4 to 40.7]	39.1 (9.0) [37.3 to 40.8]	0.788
Trochanteric prominence angle test	17.6 (4.5) [15.7 to 19.4]	18.9 (4.3) [17.2 to 20.6]	19.1 (4.6) [17.2 to 20.9]	17.9 (6.1) [15.4 to 20.3]	18.4 (4.9) [17.4 to 19.3]	0.611











FDO

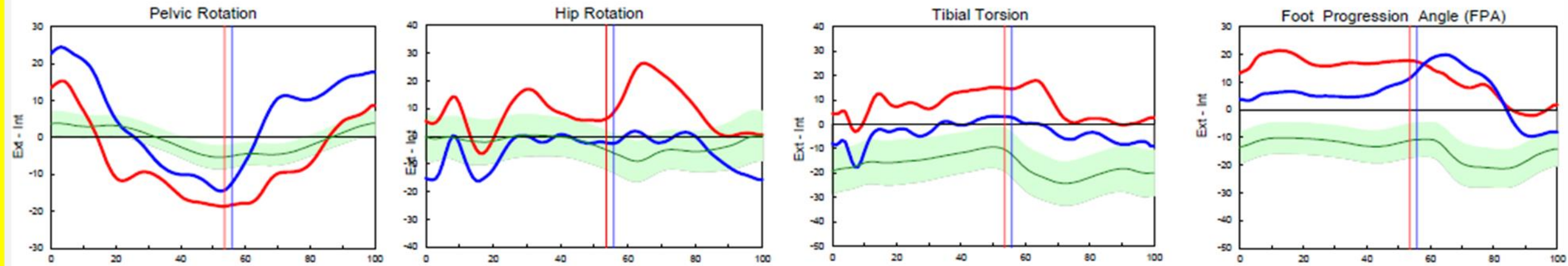
- **Femoral derotation osteotomy**
- **Correct femur anteversion**

TARGET OF CORRECTION

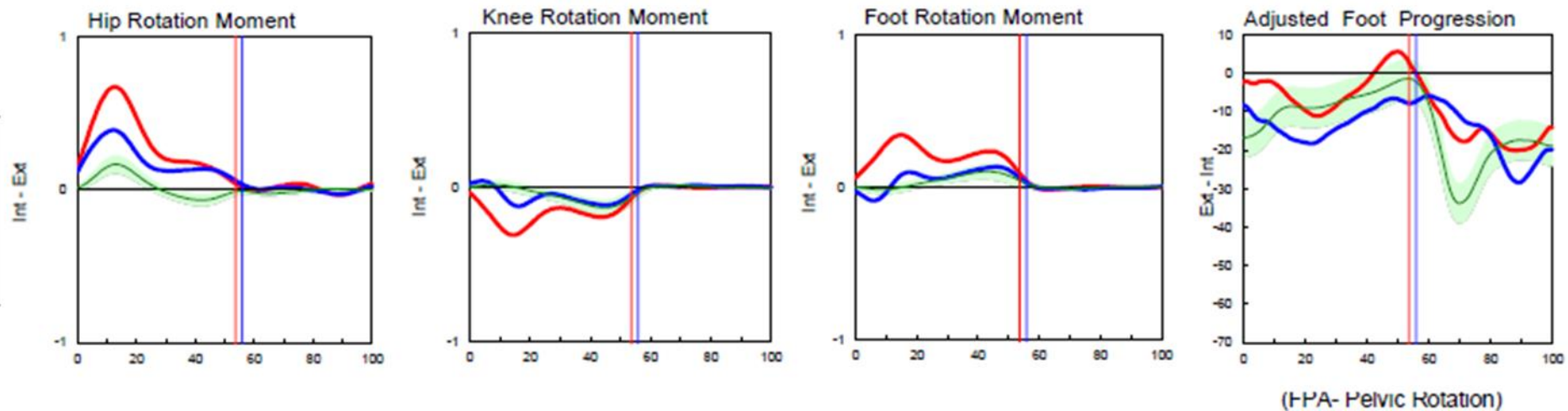
- **Femur anteversion (CT) vs Foot progression angle ?**
- **Anatomical vs Functional ?**
- **Left only vs bilateral ?**

MOTION ANALYSIS

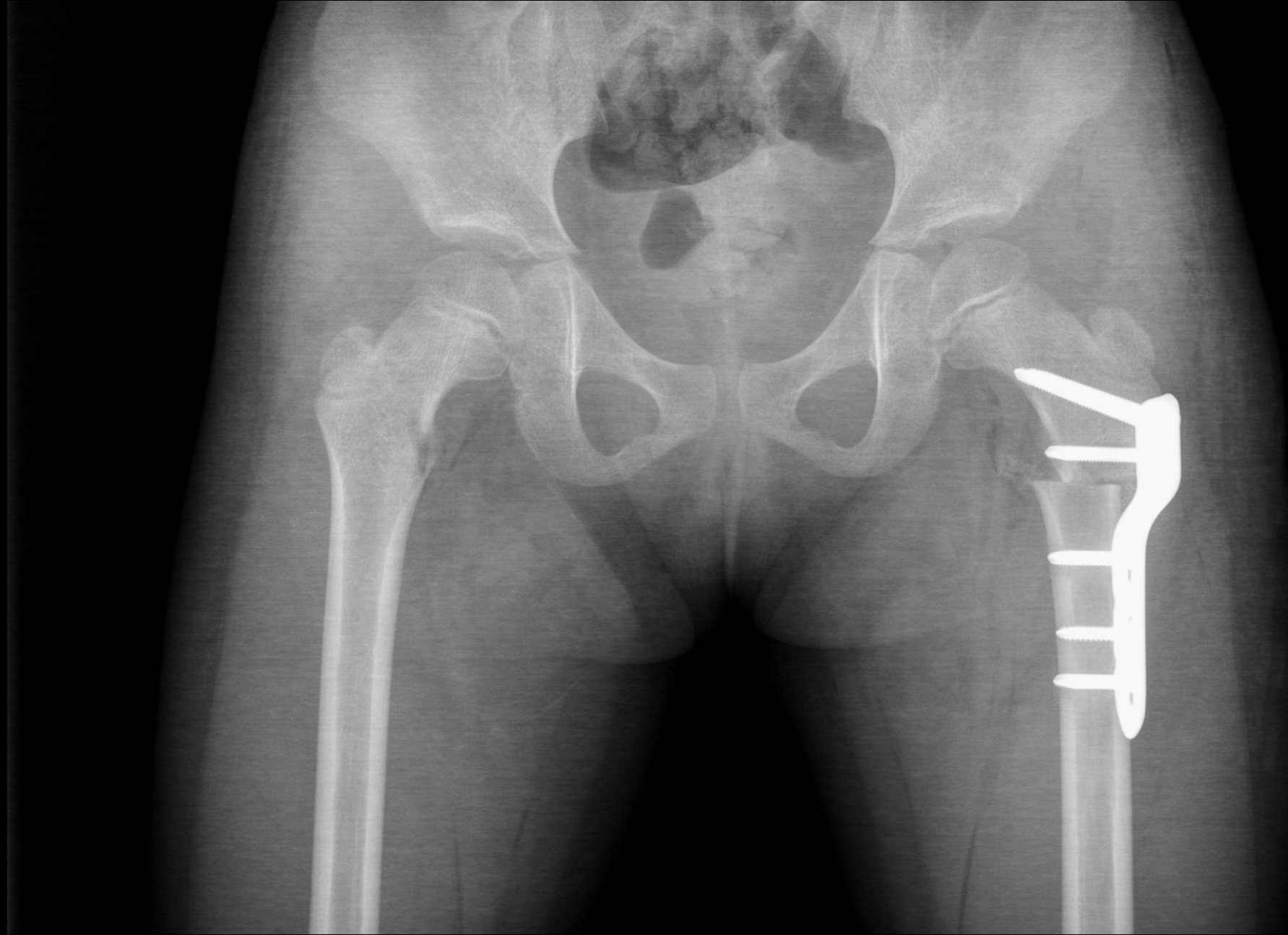
Transverse Plane



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오른쪽	— (Blue line)
왼쪽	— (Red line)



Immediate postop



Postop IY



P/E SHEET (POSTOP 1Y)

Hip ROM>	Rt	Lt
FF	135	135
FC	0	0
Extension (Staheli test)	-10	-5
Abd. (at Extension state)	50	45
Abd. (at flexion 90' state)	55	60
Adduction	45	35
ER (prone)	40	50
IR (prone)	45	45
Anteversion (prone)	20	25
TFA (prone)	10	10

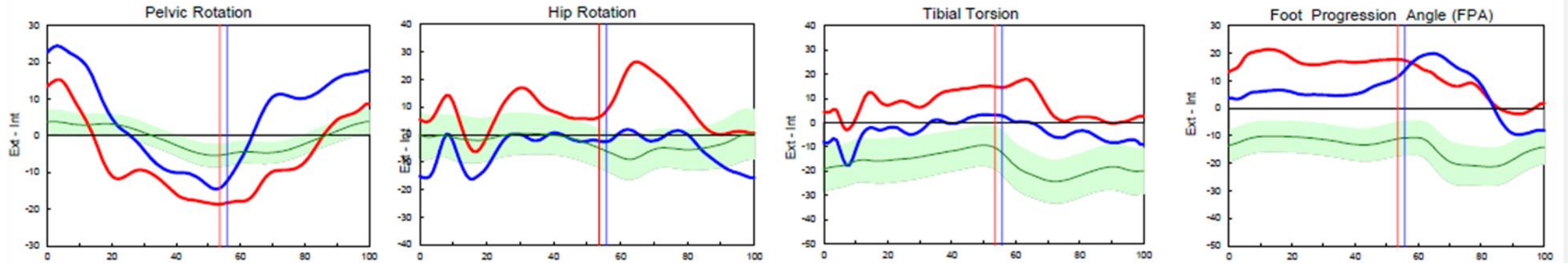
Knee ROM>		
FC	0	5
FF	150	150
Popliteal angle (unilateral)	25	25
Popliteal angle (Bilateral)	20	20
Duncan Ely	-	-

Ankle ROM>		
Plantarflexion	50	50
Dorsiflexion (at knee 90')	10	10
Dorsiflexion (at knee 0')	5	0

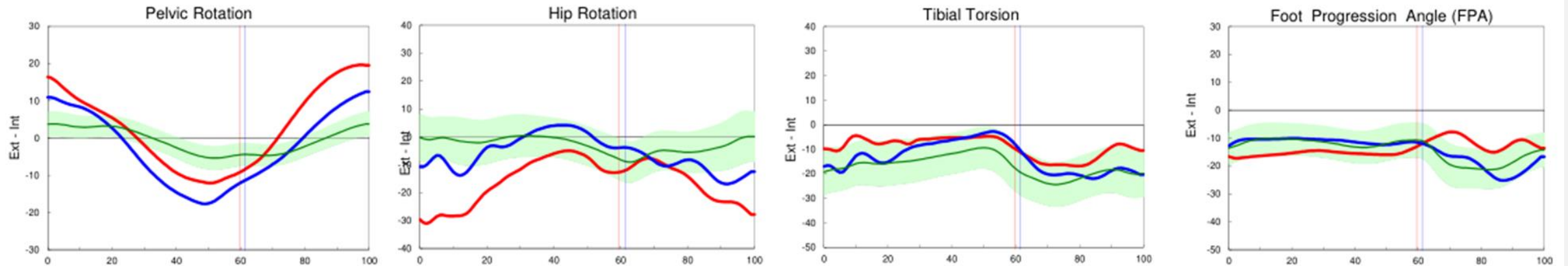
	Rt	Lt
	135	135
	20	20
	20	30
	40	40
	60	60
	35	30
	40	20
	50	70
	30	50
	-10	-30
	15	10
	150	150
	70	70
	50	50
	+	+
	60	65
	-10	-20
	-20	-30

MOTION ANALYSIS

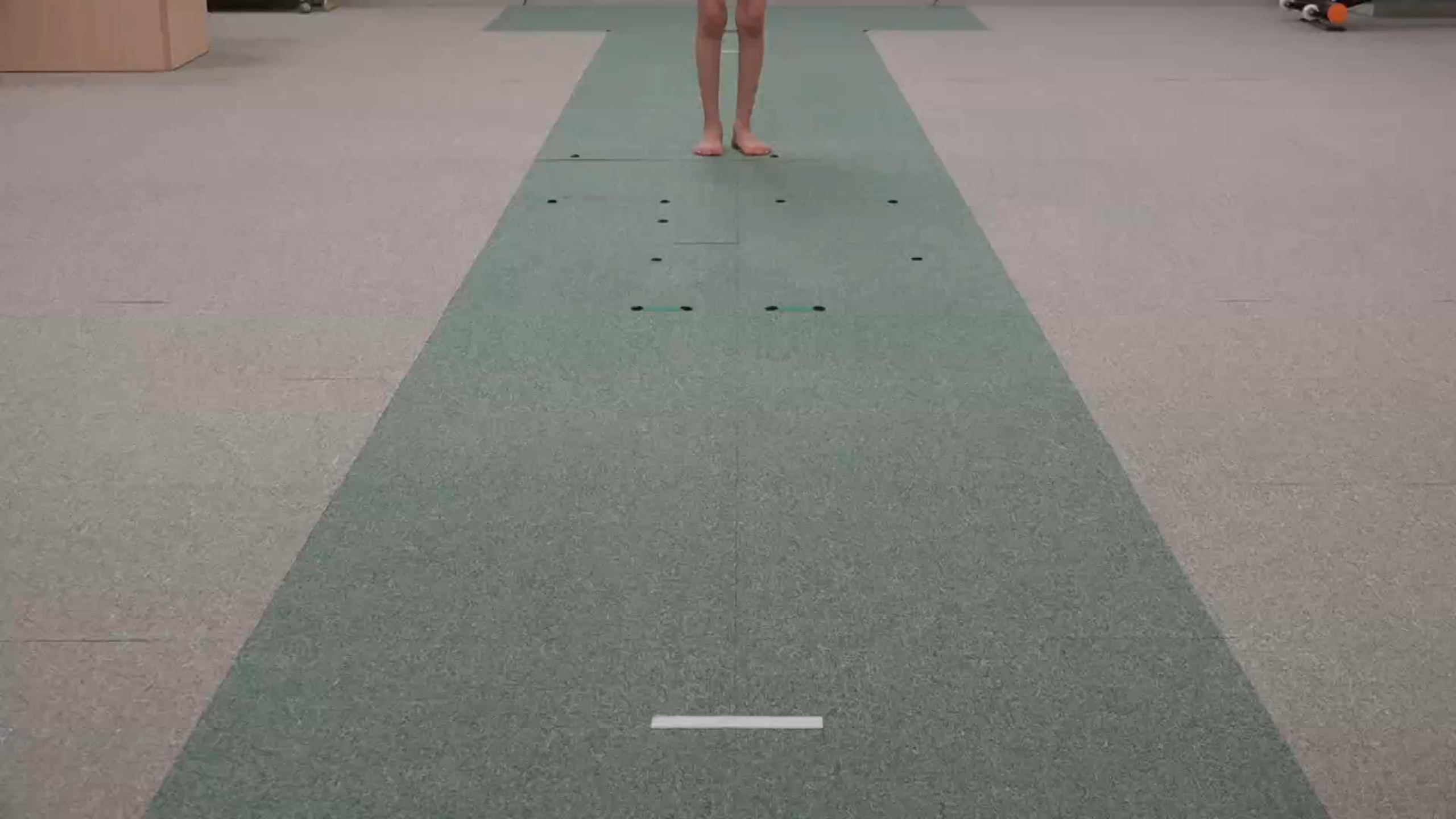
Transverse Plane



Transverse Plane







Thank you for your attention !!!

