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Plantar pressure pattern during walking in patient with medial knee osteoarthritis

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I have no COI to disclose

Kyohei Nishida

Background

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- ✓ Knee osteoarthritis (KOA) is a degenerative progressive joint disease characterized by chronic joint pain and stiffness, leading to the limitation of daily living activities and physical function.

- ✓ Given the important role of the foot in receiving and distributing forces during walking, foot characteristics and mechanics may significantly contribute to musculoskeletal conditions of the lower limb.

Saito I. Arch Phys Med Rehabil. 2013
Saito I. Gait Posture. 2018
Fukaya T. Knee. 2016
Katoh H. J Phys Ther Sci. 2019

- ✓ However, the specific associations between foot characteristics and mechanics and KOA have not yet been investigated.

Purpose

To identify the plantar pressure pattern during walking in patient with medial KOA.

Methods

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Subjects　23 patients who underwent AKO for medial KOA

Sex	Male 13　Female 10
Age	60.2 ± 6.7
Height (cm)	163.8 ± 9.2
Weight (kg)	69.9 ±12.5
BMI	26.0 ± 3.6
Shoe size(cm)	26.0 ±1.6
Type of AKO	HTO:13　DLO:10
History od AKO for contralateral knee	HTO:6　DLO:2
%MA	Involved leg　13.4 ±13.9 Non-involved leg 36.7 ±18.0

Preoperative KOOS	
total	49.2 ±15.8
pain	53.3 ±18.1
symptom	56.7 ±19.1
ADL	66.9 ±17.8
sports	33.9 ±22.9
QOL	49.2 ±15.8

AKO; Around the knee osteotomy
HTO; High tibial osteotomy
DLO; Double level osteotomy
%MA; % mechanical axis
KOOS; Knee injury and Osteoarthritis Outcome Score

Methods

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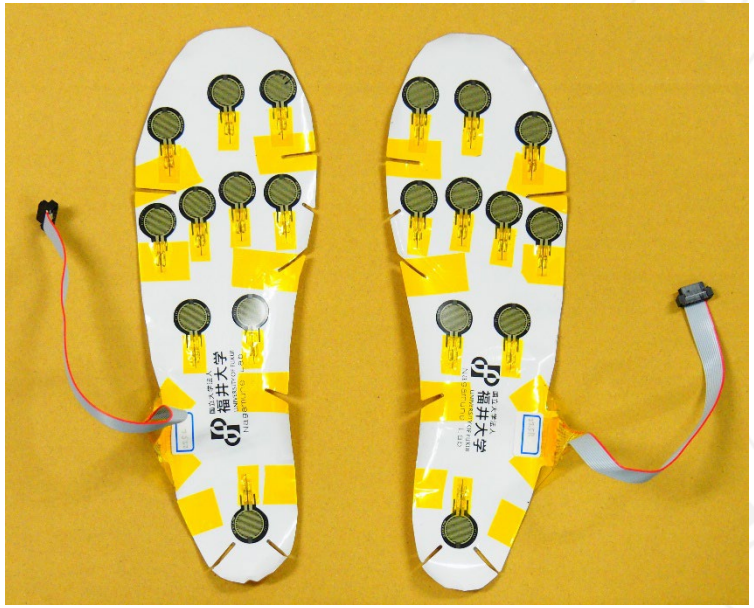
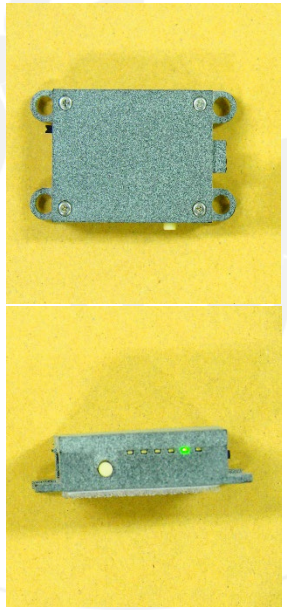
In-Shoe plantar pressure evaluation systems

Sensor



1mm thickness
12g weight
10 sensors

Measuring unit



17g weight
200Hz of sampling rate

Four sizes（23-28 cm）

Methods

Measurement

- Participants were instructed to walk at least 10 steps at a comfortable speed while the plantar pressure was recorded.
- The peak pressure during walking were analyzed in each sensor, and the results were compared between different areas of the foot in the antero-posterior (AP) direction (toes, forefoot, midfoot and hindfoot) and the medio-lateral (ML) direction (medial and lateral). (Fig1)
- The length of the center of pressure (COP) in AP and ML direction during walking were also calculated. (Fig2)

Yamamoto T. J Foot Ankle Res. 2020

Fig1

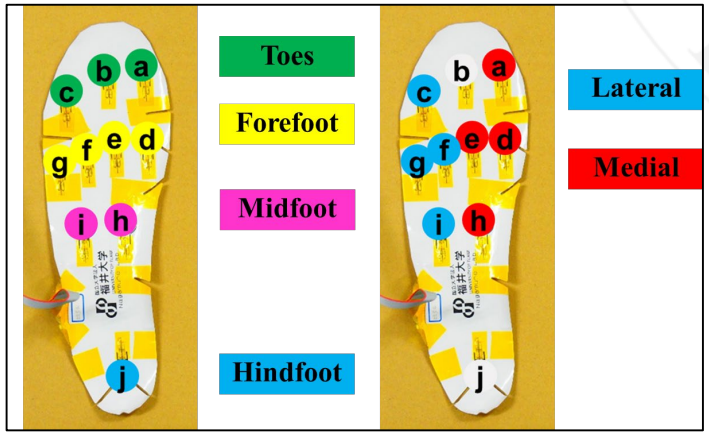
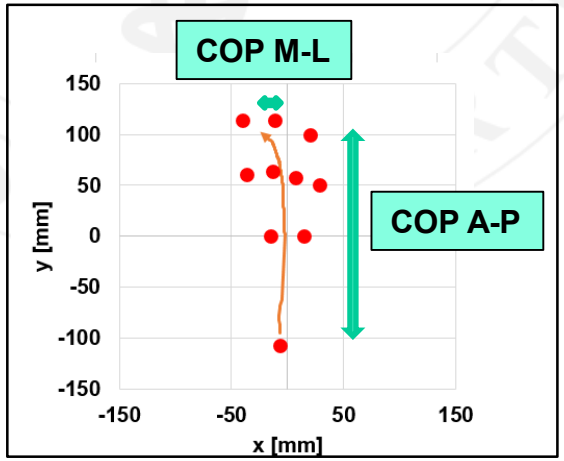


Fig2



Methods

Analysis

① Plantar pressure pattern

② Comparison of affected and contralateral sides(paired t-test)

- Peak pressure(KPa) in each section
- COP A-P
- COP M-L

③ Correation

COP A-P COP M-L	⟺	%MA KOOS

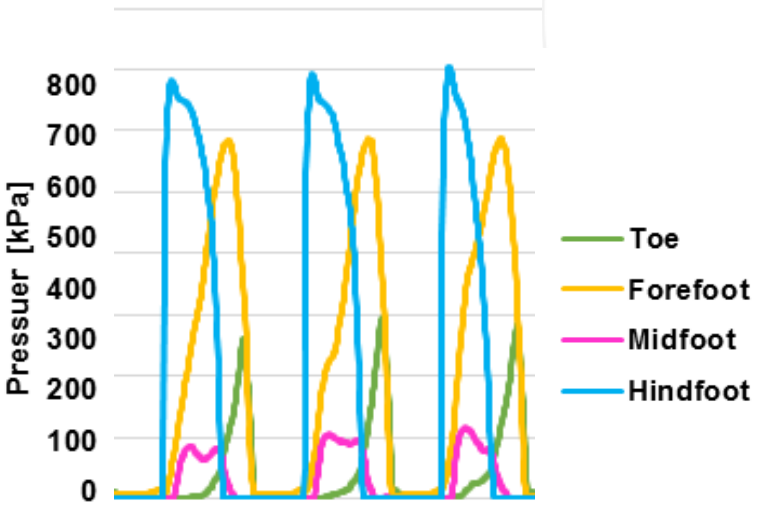
Result

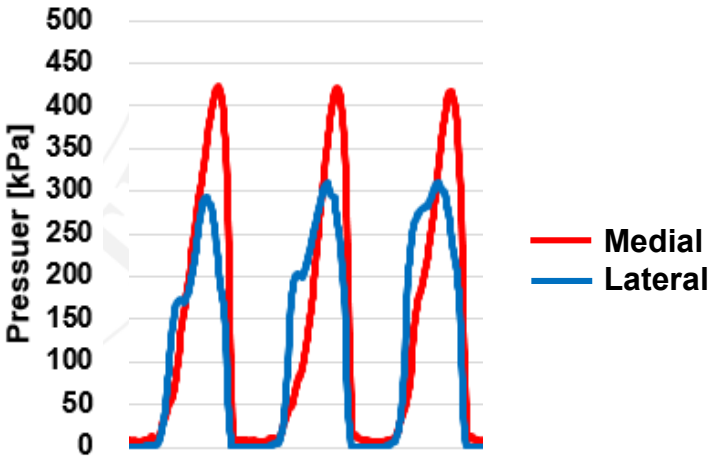
Plantar pressure pattern

- ✓ On both the affected and contralateral sides, the plantar pressure center shifted in the order of hindfoot, midfoot, forefoot, and toes.

- ✓ Pressure on the medial is higher than on the lateral in most participants

medial>lateral affected side18 contralateral side 20
medial<lateral affected side5 contralateral side 3





Sample: 56yo female affected side

Result

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The value of peak pressure (KPa)

	toes	forefoot	midfoot	hindfoot	medial	lateral
Affected side	344 ± 101	516 ± 79	139 ± 48	493 ± 159	390 ±73	343 ± 60
Contralateral side	407 ± 75	535 ± 58	155 ± 55	519 ± 155	408 ± 57	360 ± 56
P Value	0.004	0.25	0.18	0.35	0.30	0.17

The peak pressure on the affected side was significantly lower in toes and tended to be lower in the forefoot, midfoot, and hindfoot than on the contralateral side.

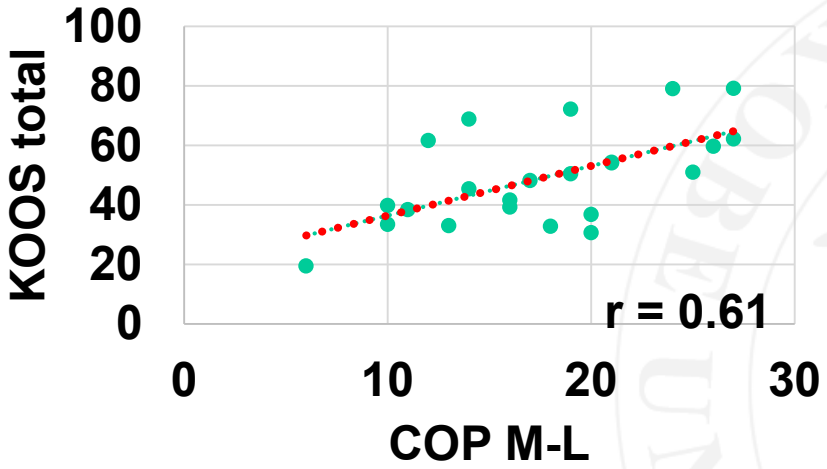
Center of pressure (COP)

(mm)	COP A-P	COP M-L
Affected side	154.4 ± 28.2	17.6 ± 5.7
Contralateral side	160.4 ± 33.0	20.3 ± 5.4
P Value	0.16	0.012

it was significantly shorter in the length of the COP in ML direction on the affected compared to contralateral side .

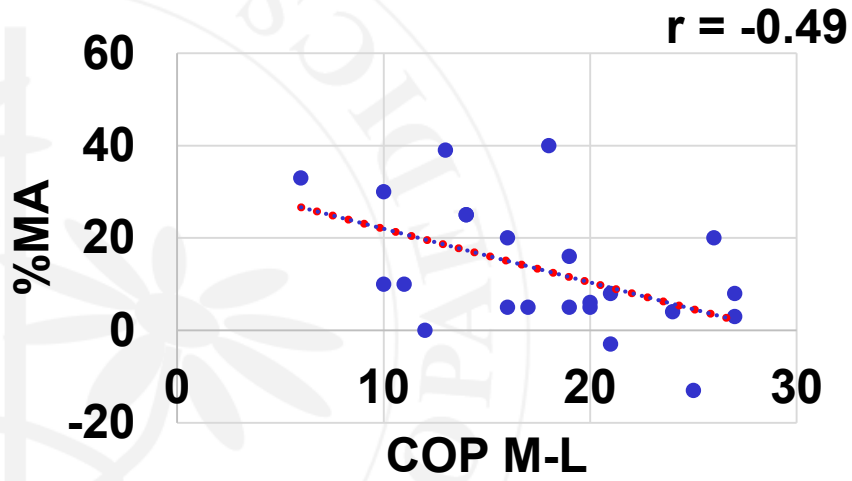
Result

COP M-L and KOOS (affected)



pain	r=0.55
symptom	r=0.45
ADL	r=0.51
sports	r=0.47
QOL	r=0.52

COP M-L and %MA (affected)



There was a moderate positive correlation between the KOOS and the length of COP in ML direction, and a moderate negative correlation between %MA and the length of COP in ML direction

Discussion

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- ✓ The maximum loading in each part reached its peak starting from the hindfoot, the midfoot and the forefoot, consistently.

Yamamoto T. J Foot Ankle Res. 2020

	Peak Pressure (kPa)					
	toes	forefoot	midfoot	hindfoot	medial	lateral
Healthy volunteer (50 male 50 female、32yo)	383.6	530.6	128.4	556.0	408.9	333.3

➡Similar pattern was observed in patient with medial KOA in this study.

- ✓ Low pressure on the heel and hallux parts and short COP A-P were characteristic of individuals with medial KOA who scheduled to receive TKA.
- ✓ The limited range of motion of the knee was associated with shortness of COP A-P.

Saito I. Arch Phys Med Rehabil. 2013

➡Subjects and degree of flexion contracture are different from our study.

- ✓ A moderate positive correlation between the KOOS and the length of COP in ML

➡ Participants may walk with less movement of the COP in ML direction to avoid knee pain.

Conclusion

- Plantar pressure pattern during walking in patient with medial knee osteoarthritis was evaluated using an in-shoe plantar pressure evaluation system.
- The COP translated in the order of hindfoot, midfoot, forefoot, and toes, and the loading pattern was similar to that of healthy subjects reported previously.
- It was suggested that patients with medial KOA may not be able to bear enough weight on the toes compared to contralateral side, and they may walk with less movement of the COP in ML direction to avoid knee pain.