Effect of Diabetes duration on plantar pressure distribution patterns

Diamanto Maliotou, foot-forward, Cyprus
www.foot-forward.com
Tatiana Tsvetkova, novel SPb, Russia
www.novel.de
Lenia Maliotou, foot-forward, Cyprus
Despina Theodorou, foot forward, Cyprus

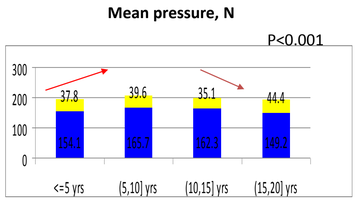
Background and aim

Abnormal pattern of feet loading in patients with diabetes is changing with time; thus leading to various complications of the foot, ulcerations. The need of effective pressure distribution with adequate footwear is vital for preventing ulcerations and re-ulcerations that is caused by high plantar pressures. It is important to note that re-ulceration is common in patients with diabetic neuropathy even with adequate footwear use (Reiber et al 2002). The purpose of this study was to reveal the effect of duration of diabetes on plantar pressure patterns.

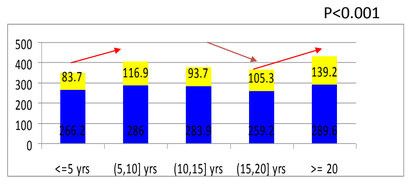
Characteristics of patients from 5 groups (1st study) (n=261)

Groups	Diabetes period, yrs	Patients (m/f)	Age, yrs	Diabetes duration, yrs
Group 1	<=5	53 (26/27)	60±14	2.8 ±1.7
Group.2	(5,10]	72 (32/40)	57 ±15	8.5 ±1.5
Group 3	(10,15]	42 (21/21)	62 ±12	13.3 ±1.5
Group 4	(15,20]	37 (32/5)	65 ±9	18.4 ±1.6
Group 5	>20	57 (31/26)	62 ±11	28.8 ±7.5

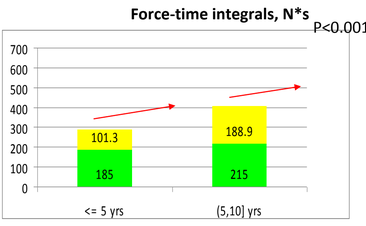
Hindfoot (groups 1 - 4)
Mean pressure, N



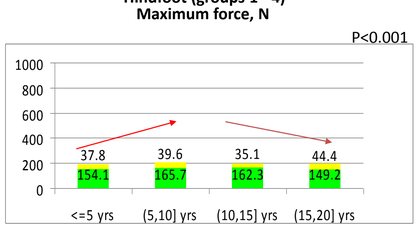
Hindfoot (groups 1 - 5)
Peak pressure, N



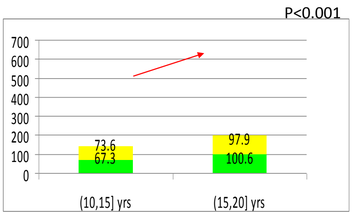
Hindfoot (groups 1 and 2)
Force-time integrals, N*s



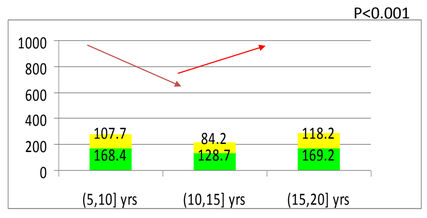
Hindfoot (groups 1 - 4)
Maximum force, N



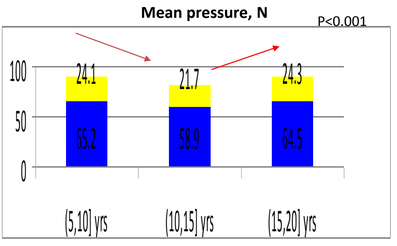
Midfoot (groups 3 and 4)
Force-time integrals, N*s



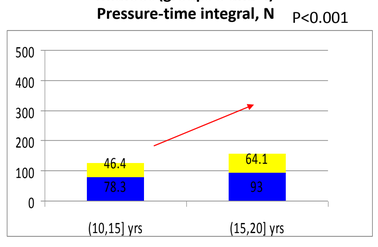
Midfoot (groups 2, 3 and 4)
Maximum force, N



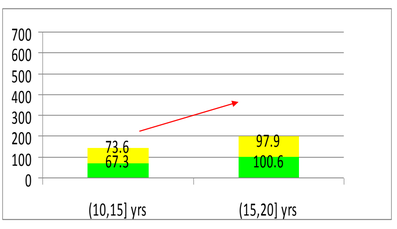
Midfoot (groups 2 -4)
Mean pressure, N



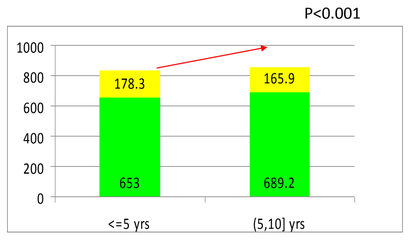
Midfoot (groups 3 and 4)
Pressure-time integral, N



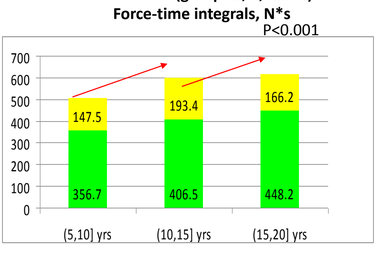
Midfoot (groups 3 and 4)
Force-time integrals, N*s



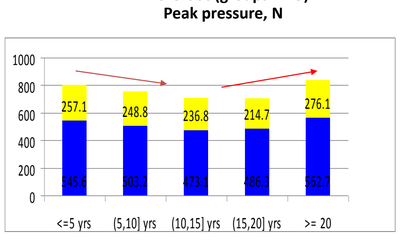
Forefoot (groups 1 and 2)
Maximum force, N



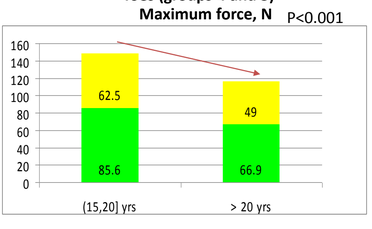
Forefoot (groups 2, 3, and 4)
Force-time integrals, N*s



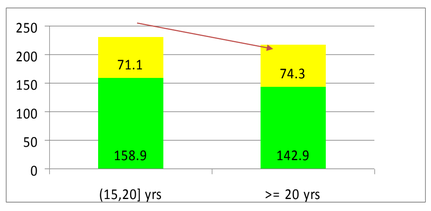
Forefoot (groups 1 - 5)
Peak pressure, N



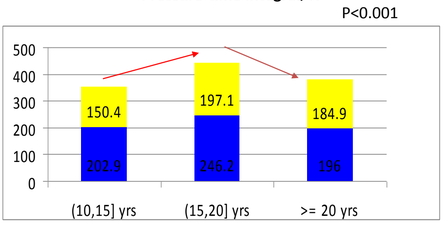
Toes (groups 4 and 5)
Maximum force, N



Toes (groups 4 and 5)
Maximum force, N



Toes (groups 3, 4 and 5)
Pressure-time integral, N

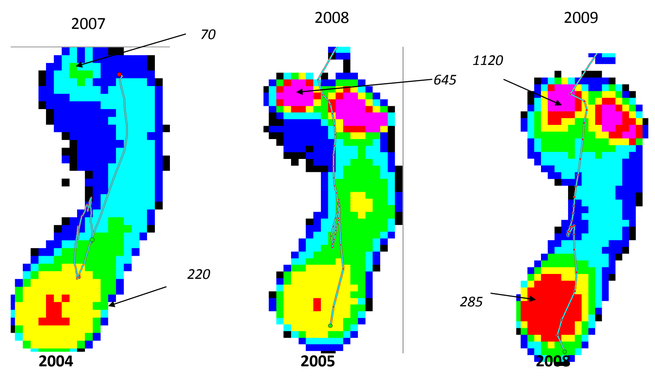


Methods

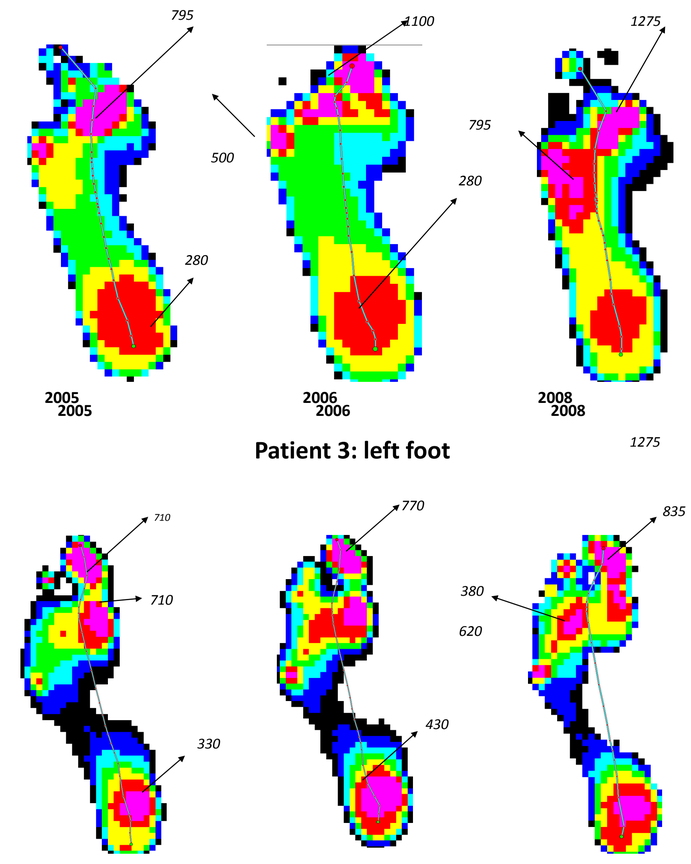
History of diabetes: age, gender, type of diabetes, duration of DM (yrs.)
Clinical foot examination
•vascular assessment: (presence of dorsalis pedis and posterior tibial pulses)
•loss of temperature perception, loss of protective sensation, (inability to sense the SW monofilament)
•vibration perception threshold (tunnig fork)
•presence of deformities, calluses, healed and current ulcers, amputations
Pressure distribution measurements (PDM) were carried out with emed AT-25 platform,

Examples

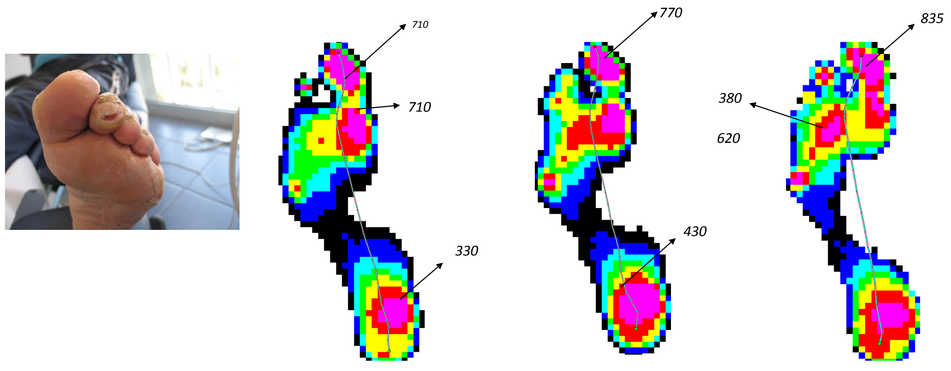
Patient 1: right foot



Patient 2: left foot



Patient 3: left foot



Conclusions

Reduction of hindfoot loading and increase of forefoot loading in patients having diabetes more than 10 years confirm the findings of the other researchers. Lavery (1998) reported a trend towards increased pressure with increasing numbers of foot deformities which are significantly associated with plantar pressure distribution and ulceration (Bus et al 2004). Increase of contact time influences on time dependent parameters (pressure-time and force-time integrals) also supported by Merolli et al 2005). Brill et all (1996) have reported that approximately 20% of patients with diabetes will develop clinically significant DPN within 10 years of onset, and this frequency can increase to 50% after 10 or 15 years (Cavanagh et all 1993).

Pressure distribution measurement protocol and data analysis

Five dynamic records of each foot were made with first step procedure

novel database medical was used to store clinical and pressure measurement data: Peak and mean pressures, maximum force, force-time integrals were calculated with novel-projects

automask program was used for foot areas detection (hindfoot, midfoot, forefoot, toes).

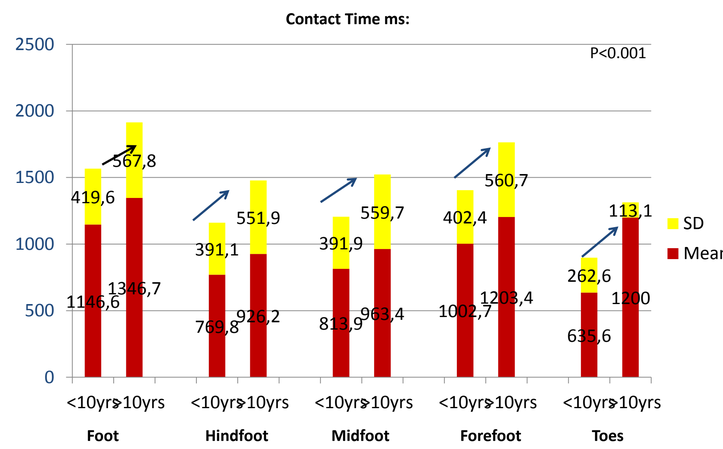
Parameters were calculated for each subject and averaged across the groups. Statistical analysis was performed with ANOVA

Characteristics of patients from 2 groups (2nd study)(n=261)

Groups	Diabetesperiod, Yrs	Patients (m/f)	Age,yrs	Diabetes duration,yrs
Group1	<=10	125(58/67)	59±15	6.1±3.2
Group	>10	136(74/62)	63±11	21.2±8.4

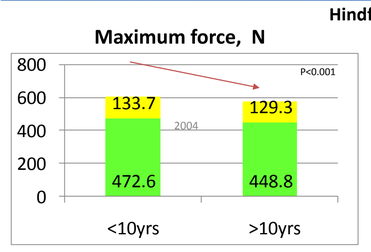
DM less than 10 years vs. DM more than 10 years

Contact Time ms:

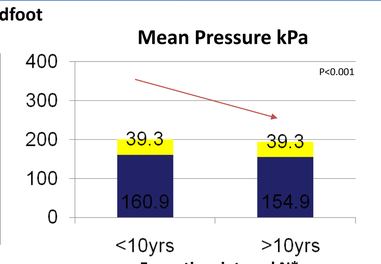


Hindfoot

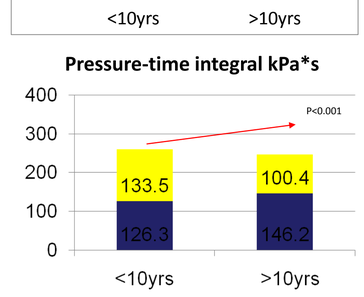
Maximum force, N



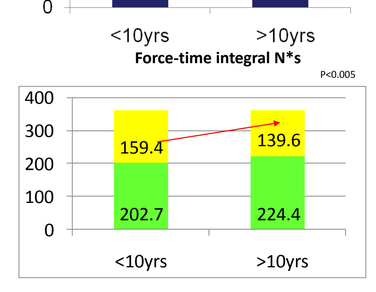
Mean Pressure kPa



Pressure-time integral kPa*s

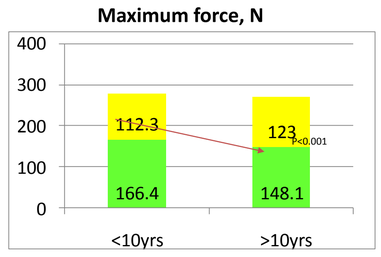


Force-time integral N*s

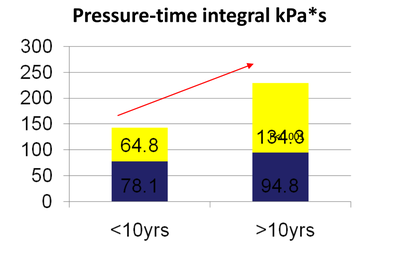


Midfoot

Maximum force, N

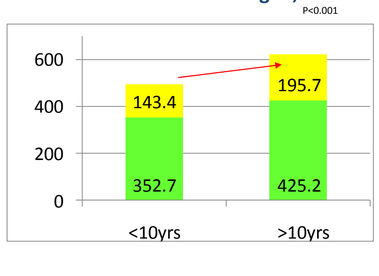


Pressure-time integral kPa*s

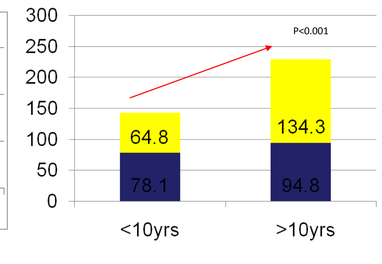


Forefoot

Force-time integral, N*s



Pressure-time integral kPa*s



References

1. *Reiber* GE, Smith DG, Wallace C, *et al*. Effect of therapeutic footwear on foot reulceration in patients with diabetes. JAMA. *2002*;287:2552-2558

2. *Lavery* LA, Armstrong DG, Vela SA, Quebedeaux TL, Fleischli JG. Practical criteria for screening at high risk for diabetic foot ulceration. Arch Inter Med. 26; 158:157-162, 1998.

3. *Bus S. A., Maas M., Cavanagh P. R., Michels R. J., Levi M.,* 'Plantar Fat-Pad Displacement in Neuropathic Diabetic Patients With Toe Deformity'. *Diabetes Care*, vol. 27 (10), October 2004, pp. 2376-2381.

4. *Merolli. A., Uccioli, L.* Plantar pressure distribution in patients with neuropathich diabetic foot. Journal of Applied biomaterials and bioemchanics 2005; Vol.3. no.1:61-64.

5.Brill LR, Cavanagh PR. , Gibbons GW, Levin ME. Prevention of lower extremeties with diabetes. Treament of Chronic Wounds. Curative services; 1996 No.7.Available at:http://www2.curative.com/CUEBIC/ CURATIVE/localdata/ Mono7.pdf.Accessed:April 25, 2005.

6.Cavanagh PR, Simoneau GG, Ulbrecht JS. Ulceration, unsteadiness, and uncertainty: the biomechanical consequences of diabetes mellitus. *J Biomech*. 1993;26(Suppl 1):23–40.