A PROSPECTIVE LOOK AT FOOT SHAPE AND FOOT ULCER DEVELOPMENT

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INTRODUCTION

Diabetic foot ulceration and lower limb amputations cause significant mobility, morbidity and mortality issues as well as substantial health care costs. To date, little prospective data exists on this subject. Prospective analyses will help predict which patients may be at high risk for ulceration. We examined the foot structure of 2939 feet (1484 subjects) and the prospective ulcer occurrence of veterans with diabetes as an extension of the Seattle Diabetic Foot Study [1].

METHODS

All patients of a general internal medicine clinic who were diabetic, ambulatory and did not have foot ulcers were eligible for the study. Exclusion criteria included current foot ulcer, non-ambulatory, or inability to cognitively participate in the study. Subjects were followed prospectively for 3.2 years ± 2.5 years (mean ± SD), to determine which risk factors could be linked to ulceration. Subjects were removed from the study upon ulceration, amputation or death. Subjects were reexamined yearly and were contacted quarterly to ascertain any incidence of foot ulceration. A physical exam conducted by an LPN determined the foot type, presence of foot deformity and neuropathy. Either a t-test (continuous variables) or a chi-squared analysis (categorical variables) was performed to examine demographic differences between the ulcer and non-ulcer groups. A Cox regression analysis was performed to determine the Hazard Ratios (HR) and confidence intervals(CI). An α-level of 0.05 was chosen.

RESULTS

Demographic parameters that were statistically significant between the non-ulcer and ulcer group were: BMI, type 1 diabetes, diabetes duration, insulin use, sensory neuropathy, amputation history, ulcer history (Table 1). Several foot shape or foot deformity variables also significantly differed between groups (Table 2).

Table 1: Demographics of non-ulcer and ulcer feet (mean ± SD or %).

Measurement	Non-ulcer (n=2709)	Ulcer (n=230)	p-value
Age (yr)	62.5 ± 10.7	62.3 ± 9.3	.7
BMI (kg/m^2)	31.0 ± 6.9	30.3 ± 5.9	.083
Female	1.9	1.7	1.0
Type 1 Diabetes	4.3	8.7	.0042
Duration Diab. (yr)	10.0 ± 9.2	12.4 ± 10.1	.0003
Insulin Use	39.1	59.1	<.0001
Sensory Neuropathy	37.3	66.1	<.0001
Amputation History	3.0	13.9	<.0001
Ulcer History	20.0	45.7	<.0001

CONCLUSION

Foot shape and foot deformity parameters such as hammer/claw toes, bony prominences, pes cavus and 'other' foot types were significantly associated with ulceration. (The foot type 'other' consisted of Charcot deformity and drop foot classifications.) Although we did not measure plantar pressure, these biomechanical deformities all tend to increase pressure on the tissues in certain areas of the foot during normal walking. Since these deformities are easily identifiable, measures to protect the feet could be implemented without difficulty. Further analyses will include the consideration of ulcer location to determine if certain foot deformities are more likely to cause ulcers at a certain location on the foot.

REFERENCES

1. Boyko, E.J., et al. *Diabetes Care* **22**, 1036-1042, 1999.

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Table 2: Foot shape and foot deformity parameters for non-ulcer and ulcer feet. (Adjusted for age, gender, BMI, diabetes treatment and amputation history; stratified by presence of neuropathy and ulcer history.) HR=hazard ratios, CI=confidence interval (CI)

Measure	Non-ulcer (n=2709)	Ulcer (n=230)	Adjusted HR (95% CI)	P
Hallux Valgus (%)	45.6	31.3	0.84 (0.63, 1.11)	.2
Hallux Limitus (%)	35.9	30.9	1.03 (0.77, 1.37)	.9
Hammer/Claw Toes (%)	57.4	72.3	1.44 (1.06, 1.95)	.021
Prominent Metatarsal Heads (%)	60.0	69.1	1.25 (0.94, 1.66)	.12
Plantar Callus (%)	51.6	55.2	1.01 (0.77,1.32)	.9
Muscle Atrophy (%)	59.0	63.1	1.26 (0.93, 1.72)	.14
Bony Prominences (%)	59.6	68.3	1.44 (1.05, 1.98)	.022
Foot Type				
Normal (%)	60.1	49.6	1.48 (0.83, 2.62)	.18
Pes Cavus (%)	21.4	28.7	1.91 (1.06, 3.45)	.031
Pes Planus Rigid (%)	7.6	6.1	1.0	
Pes Planus Flexible (%)	8.5	8.3	1.60 (0.78, 3.29)	.2
Other (%)	2.3	7.4	3.11 (1.42, 6.81)	.0044