Research Article

Diabetic Foot Infection: Predictors of Outcome

Mohamed R. Abdella, Ahmad Atiya and Emad Elsageer
Department of General Surgery, Faculty of Medicine, El-Minia University

Abstract
Objective: The aim of this study was to evaluate the affection of different predictors on the outcome of diabetic foot infection. **Patients and methods:** This study included ٥٠ patients with diabetic foot infection that were admitted to The Department of General Surgery, Minia University Hospital between July ٢٠١٣ to July ٢٠١٤. **Results:** Fifty patients were submitted to the study ١١ of them were females and ٣٩ were males. Gender in our study was not found to be an important predictive factor for limb loss (*P*= ٠.٤٨٤). The age ranges between ٤٠ and ٧٥ with main age of ٥٩.١ ± ٧.٦ years, patients who underwent major amputations were older. There was a significantly higher number of smokers in the metatarsal and major amputation group. Patients underwent major amputations had higher Wagner score and lower ABI than other patients with the p = ٠.٠٠٠ in both. As regard laboratory data obtained from the patients, all were significant except random blood sugar and bleeding profile. **Conclusion:** Outcome of diabetic foot infection is not equal in all patients and is affected by different predictors which make a great change in final results. We studied some of them and still there are more predictors as duration of diabetes, type of its control, and time between onset of diabetic foot lesion and its presentation which can be fulfilled in other studies in the future.
Keywords: Predictors, Diabetic foot, Infection

Introduction
Diabetic patients are more susceptible for limb amputations ٢٥ times more than those who do not suffer from this disease and about ٧٠٪ of limb amputations happen to diabetic patients. Foot disorders are a major source of morbidity and a leading cause of hospitalization for persons with diabetes.(١)

Vascular disease, abnormalities in blood flow distribution, peripheral neuropathy (PN), autonomic neuropathy, physical stress and infection are the major factors involving the pathogenesis of foot problems in diabetic patients.(٢)

Foot infections are a common and serious problem in persons with diabetes. Diabetic foot infections typically begin in a wound, most often a neuropathic ulceration.(٣)

Foot infections in patients with diabetes are difficult to treat because these individuals have impaired micro vascular circulation, which limits the access of phagocytes to the infected area and results in a poor concentration of antibiotics in the infected tissues. In addition, diabetic individuals can not only have a combined infection involving bone and soft tissue called fetid foot, a severe and extensive, chronic soft-tissue and bone infection that causes a foul exudates, but they may also have disease that involves the large vessels, as well as micro vascular and capillaries that results in peripheral vascular disease.(٤)

In general, foot infections in persons with diabetes become more severe and take longer to cure than do equivalent infections in persons without diabetes.(٥)

Foot ulcer is the main cause of lower limb amputation, It develops in approximately ١٥٪ of patients with diabetes at one time or another.(٦) Foot disorders are the leading cause of hospitalization among such patients, about ٦٪ of diabetics with foot ulcers required hospitalization, which has astronomical cost.(٧)

About ٨٥٪ percent of lower-limb amputations in patients with diabetes are preceded by foot ulceration. The most common cause of admission of diabetic patients to hospitals is to treat the infected diabetic foot.[٨]

Patients and Methods

Fifty patients were presented to El- Minia university hospital between July ٢٠١٣ and July ٢٠١٤. Their ages ranged between ٤٠ and ٧٥ years old, were suffering from diabetic foot infection and were subjected to intervention evaluation of potential predictors of the outcome of diabetic foot infections after approval of the study protocol by the Local Ethical Committee and obtaining written fully informed patients' consent. Personal history especially age, sex and smoking, general examination especially nutrition and chronic diseases, description of the foot lesion which were classified according to the Wagner classification as grade ١ Ulcerated skin and subcutaneous tissue, grade ٢ Deeper lesions that could penetrate to tendon, bone or joint capsule (there is as yet no abscess or osteomyelitis), grade ٣ Deep tissues are involved, abscess, osteitis or osteomyelitis are present. Grade ٤ Local gangrene, and grade ٥ diffuse gangrene

Vascular condition of the limb by palpation of the peripheral pulsations, arterial ultra-sonographic examination of affected limb was done for all examined patients, Ankle Brachial index was done to all patients using a handheld Doppler. Patients with absent or reduced pedal pulses or ABI <٠.٩ underwent conventional Doppler examination and angiography and revascularization procedure was done to the ischemic patients. X-ray was done to evaluate the shape &condition of the foot bone. culture taking, and laboratory findings were evaluated for all patients in the form of complete blood picture (hemoglobin, white cells, PMNs and platelets), glycosylated hemoglobin, random blood sugar, creatinine, urea, ALT, AST and bleeding profile (INR, Pt).

After hospital admission all patients underwent primary surgical operation according to the degree of their foot condition ranging from simple foot debridement, toe or more than one toe amputation, metatarsal amputation or directly below or above knee amputation. Ischemic patients underwent vascular intervention by the vascular surgeons before they have their foot operations.

We consider infection to be present in the examined patients when the wound has purulent secretions or at least two of the following: redness, pain, tenderness, indurations, warmth, lymphangitis, foul smell, or gas formation .culture taking from all patients after admission to hospital and after first debridement. Samples were obtained by deep-needle aspiration, bone biopsy or curettage of the ulcer.

After primary operation all patients stay in our hospital for daily dressing, wound observation and taking medications. Patients whom wounds were improved were discharged and followed up at the outpatient clinic. Other patients underwent further operations according to their foot conditions. Some patients had one operation others had more than one according to the condition.

Treatment consisted of daily wound care, bed rest, special materials used to avoid putting pressure on the affected area when ambulating, parenteral antibiotics and debridement or amputation (minor or major) when indicated. Wound debridement was performed routinely to remove extensive callus and necrotic tissue (Fig. ١).

Infected diabetic foot ulcer was defined according to the Infectious Diseases Society of America guidelines as the presence of purulent wound drainage or ≥٣ designated systemic or local inflammatory findings.

Antibiotics were started as empirical parenteral treatment covering gram +ve, grame –ve and anaerobic organisms; change in antimicrobial regimen was guided by culture results and clinical

follow-up. Parenteral antibiotic treatment was followed by prolonged oral therapy.

Follow up was done after hospital discharge where all patients were observed at the diabetic foot outpatient clinic weekly for the next ٣ months.

Fig. (١): patient underwent midfoot debridement.

Results

In our study on ٥٠ patients with diabetic foot infection admitted to our hospital ١٥ patients started with foot debridement operation, ٢٥ patients started with toe or more amputation, ٢ patients started with metatarsal amputation, ٢ patients started with major amputation (below or above knee) and ٦ patients started with vascular intervention operation while the final results of these ٥٠ patients were:١٣ patients ended with debridement, ٢٢ patients ended with toe or more amputation, ٦ patients ended with metatarsal amputation and ٩ patients ended with major amputation (below or above knee).

Fifty patients were submitted to the study ١١ of them were females and ٣٩ were males (Table ١).

Table (١): Comparative study between outcome and gender using Chi square Test (X^2).

			Category				X^2	P	Sig.
			Debridement	Toe(s) amputation	Metatarsal amputation	Major amputation			
Sex	Males	N.	١١	١٦	٦	٦	٣.٠٥٤	٠.٤٨٤	NS
		%	٨٤.٦٪	٧٢.٧٪	١٠٠.٠٪	٦٦.٧٪			
	Females	N.	٢	٦	٠	٣			
		%	١٥.٤٪	٢٧.٣٪	٠.٠٪	٣٣.٣٪			

The age ranges between ٤٠ and ٧٥ with main age of ٥٩.١ ± ٧.٦ years, patients Who underwent major amputations were older (Table ٢).

Table (٢): Comparative study between different outcomes and age using One way ANOVA Test (F).

		N	Mean	SD	F	P	Sig.
Age	Debridement	١٣	٥٨.١٥	٤.٩٩٧	٢.٤٧٩	٠.٠٢٧	S
	Toe(s) amputation	٢٢	٥٧.٠٩	٧.٨٤٩			
	Metatarsal amputation	٦	٦٠.١٧	٩.٦٠٠			
	Major amputation	٩	٦٤.٧٨	٧.١٠٢			

As regard special habits, there was a significantly higher number of smokers in the metatarsal and major amputation group (Table ٣).

Table (٣): Comparative study between outcome and special habit.

			Category			
			Debridement	Toe(s) amputation	Metatarsal amputation	Major amputation
Special H.	Non-smoker	N.	٧	١٣	٢	٤
		%	٥٣.٨٪	٥٩.١٪	٣٣.٣٪	٤٤.٤٪
	Ex-smoker	N.	٣	٥	١	١
		%	٢٣.١٪	٢٢.٧٪	١٦.٧٪	١١.١٪
	Smoker	N.	٣	٤	٣	٤
		%	٢٣.١٪	١٨.٢٪	٥٠.٠٪	٤٤.٤٪

As regard the character of the lesion:

١- Site: patients were classified into ٤ groups according to the site of the lesion (toe, forefoot, midfoot, hindfoot).
٢- Discharge.
٣- Ischemia and ABI.
٤- Osteomyelitis in foot X- rays.

There was a higher incidence of ischemia and osteomyelitis in major amputation groups (p=٠.٠١٦) and (p= ٠.٠٠٩) respectively (Table ٤ & ٥).

Table (٤): Lesions characteristics of studied patients

Lesion characteristics		N.	Percent (%)
Site of lesion	**Forefoot**	١٩	٣٨.٠
	Midfoot	٣	٦.٠
	Hindfoot	٥	١٠.٠
	Toe	٢٣	٤٦.٠
Discharge		٢٤	٤٨.٠
Ischemia		٨	١٦.٠
Vascular operations		٦	١٢.٠
Osteomyelitis		١٥	٣٠.٠

** N.B. ٦ of all patients underwent revascularization operations.*

Table (٥): Comparative study between outcome and lesion characteristics using Chi square Test (X^2)

			Category	X^2	P	Sig.			
			Debridement	Toe(s) amputation	Metatarsal amputation	Major amputation			
Discharge	Yes	N.	٤	١١	٤	٥			
		%	٣٠.٨٪	٥٠.٠٪	٦٦.٧٪	٥٥.٦٪	٢.٦٢٥	٠.٤٧٨	NS
Ischemia	Yes	N.	٠	٢	٢	٤			
		%	٠.٠٪	٩.١٪	٣٣.٣٪	٤٤.٤٪	١٠.٠١٧	٠.٠١٦	S
Vascular op.	Yes	N.	٠	٢	٢	٢			
		%	٠.٠٪	٩.١٪	٣٣.٣٪	٢٢.٢٪	٥.٤٢٥	٠.٠٨٧	NS
Osteomyelitis	Yes	N.	٠	٧	٣	٥			
		%	٠.٠٪	٣١.٨٪	٥٠.٠٪	٥٥.٦٪	٩.٥٤٨	٠.٠٠٩	HS
Site of lesion	Forefoot	N.	٥	٦	٤	٤			
		%	٣٨.٥٪	٢٧.٣٪	٦٦.٧٪	٤٤.٤٪			
	Midfoot	N.	١	١	٠	١			
		%	٧.٧٪	٤.٥٪	٠.٠٪	١١.١٪	١٣.٦٤٦	٠	NS
	Hindfoot	N.	٣	٠	٠	٢			
		%	٢٣.١٪	٠.٠٪	٠.٠٪	٢٢.٢٪			
	Toe	N.	٤	١٥	٢	٢			
		%	٣٠.٨٪	٦٨.٢٪	٣٣.٣٪	٢٢.٢٪			

Patients underwent major amputations had higher Wagner score and lower ABI than other patients with the p = ٠.٠٠٠ in both (Table ٦ & ٧).

Table (٦): ABI and Wagner score of studied patients

	Mean	SD	Range	
			Minimum	Maximum
ABI	٠.٩	٠.٢	٠.٣	١.١
Wagner score	٢.٧	١.١	١.٠	٥.٠

Table (٧): Comparative study between different outcomes and ABI and Wagner score using One way ANOVA Test (F)

		N	Mean	SD	F	P	Sig.
ABI	**Debridement**	١٣	٠.٩٨٥	٠.٠٨٠١			
	Toe(s) amputation	٢٢	٠.٩٠٠	٠.١٧١٨			
	Metatarsal amputation	٦	٠.٧١٧	٠.٢٨٥٨			
	Major amputation	٩	٠.٦٣٣	٠.٢٤٤٩	٧.٩٢٧	٠.٠٠٠	HS
Wagner score	**Debridement**	١٣	١.٦٩	٠.٩٤٧			
	Toe(s) amputation	٢٢	٢.٧٣	٠.٧٠٣			
	Metatarsal amputation	٦	٣.٦٧	٠.٨١٦			
	Major amputation	٩	٣.٤٤	١.٠١٤	١١.١٦٩	٠.٠٠٠	HS

As regard laboratory data obtained from the patients, all were significant except random blood sugar and bleeding profile(Table ٨ & ٩).

Table (٨): Baseline laboratory data of studied patients.

	Mean	SD	Range	
			Minimum	Maximum
Hemoglobin	١١.٦	١.٨	٧.٩	١٥.٦
WBC	١٣.٣	٥.٤	٤.٧	٢٧.٠
PNL	٧١.٨	١٢.٧	٣٣.٠	٩٠.٦
PLT	٣٦٣.٢	١٧٦.٤	١٦٧.٠	١٠٢٤.٠
Creatinine	١.٢	١.١	٠.٥	٨.٢
BUN	٤٧.٤	٢٦.١	١٢.٠	١٤٨.٠
Alt	١٩.٩	١٨.٤	٢.٠	١١٥.٠
Ast	٢٠.٨	١٤.٤	٣.٠	٦٦.٠
Albumin	٣.٤	٠.٥	٢.٤	٤.٥
RBS	٢٨٤.٧	١١٤.٧	١١٣.٠	٦١٤.٠
A١c (%)	١٠.٣	٢.٥	٦.٥	١٥.٠
INR	١.٣	٠.٣	١.٠	٢.٢
PT	١٦.٣	٣.٠	١٢.٥	٣١.٠

Table (٩): Comparative study between different outcomes and baseline laboratory data using One way ANOVA Test (F)

		N	Mean	SD	F	P	Sig.
Hemoglobin	**Debridement**	١٣	١٢.٦٣	١.٣٨٣			
	Toe(s) amputation	٢٢	١١.٥٣	١.٩٤٢			
	Metatarsal amputation	٦	١١.٠٠	١.٥٠١			
	Major amputation	٩	١٠.٤٦	١.٧٤٤	٣.٠٩١	٠.٠٣٦	S
WBC	**Debridement**	١٣	١٠.٤٢٣	٣.٣٦٧٥			
	Toe(s) amputation	٢٢	١٢.٦٥٩	٤.٢٣٥٩			
	Metatarsal amputation	٦	١٤.٦٢٠	٩.٦٨٤٠			
	Major amputation	٩	١٨.٣٥٩	٣.٣١٩٥	٥.١٢١	٠.٠٠٤	S
PNL	**Debridement**	١٣	٦٢.٩٣١	٧.٩٥٨٩			
	Toe(s) amputation	٢٢	٧٠.٩٩٥	١٣.٦٠٩٤			
	Metatarsal amputation	٦	٧٥.٤١٧	٩.٩٩٥٧			
	Major amputation	٩	٨٣.٩٢٢	٦.١٢٦٧	٦.٨٥٩	٠.٠٠١	HS
PLT	**Debridement**	١٣	٢٥٥.٣٨	٦١.١١١			
	Toe(s) amputation	٢٢	٣٧٧.٤٥	١٧٤.٦٨٩			
	Metatarsal amputation	٦	٣٠٤.٨٣	٤٨.٨٠٧			
	Major amputation	٩	٥٢٣.٠٠	٢٢٩.٦١٥	٥.٥٥٩	٠.٠٠٢	HS

Table (٩): Continued.

		N٠l	Mean	SD	F	P	Sig.
Creatinine	**Debridement**	١٣	٠.٨٨٤	٠.٢٢٣١			
	Toe(s) amputation	٢٢	١.٠٥٢	٠.٥٨٦٨			
	Metatarsal amputation	٦	١.٣٠٠	٠.٩٦٥٤			
	Major amputation	٩	٢.١٠٦	٢.٣١٦٠	٢.٥٤١	٠.٠١٢	HS
BUN	**Debridement**	١٣	٣٥.٠٨	٩.٢٧٨			
	Toe(s) amputation	٢٢	٤٠.٩١	١٨.٩٤٨			
	Metatarsal amputation	٦	٥٤.٣٣	٢٩.٠٩١			
	Major amputation	٩	٧٦.٦٧	٣٤.٩٣٩	٧.٤٠٤	٠.٠٠٠	HS
Alt	**Debridement**	١٣	١٧.٩٢	١١.٠٧٩			
	Toe(s) amputation	٢٢	١٤.٣٦	٦.٩٣٩			
	Metatarsal amputation	٦	٣٠.٣٣	٢٢.٦٧٧			
	Major amputation	٩	٢٩.١١	٣٤.٣٠٢	٤.٠٩٦	٠.٠٤٩	S
Ast	**Debridement**	١٣	١٨.٩٢	١٢.٨٧٤			
	Toe(s) amputation	٢٢	١٦.٠٩	٥.٨٣٠			
	Metatarsal amputation	٦	٣١.٠٠	٢١.٧١٦			
	Major amputation	٩	٢٨.٠٠	٢٠.٧٣٦	٥.٠٤٦	٠.٠٣٠	S
Albumin	**Debridement**	١٣	٣.٥١٥	٠.٥٣٩٨			
	Toe(s) amputation	٢٢	٣.٥٤٥	٠.٤٧٨٨			
	Metatarsal amputation	٦	٢.٨٥٠	٠.٤٢٧٨			
	Major amputation	٩	٣.١٦٧	٠.٥٢٩٢	٣.٩٢٣	٠.٠١٤	S

Table (٩): Continued.

		N	Mean	SD	F	P	Sig.
RBS	**Debridement**	١٣	٢٥٥.٣٨	١٠٢.٦٦٣			
	Toe(s) amputation	٢٢	٢٧١.٠٠	١١٤.٧٥٧			
	Metatarsal amputation	٦	٣١٩.٨٣	١٥٨.٨٣٦			
	Major amputation	٩	٣٣٧.٣٣	٩٢.١٢١	١.٢٢٣	٠.٣١٢	NS
A١c (%)	**Debridement**	١٣	٨.٩٧٧	١.٨١٨٥			
	Toe(s) amputation	٢٢	١٠.٢١٨	٢.٠٧٦٣			
	Metatarsal amputation	٦	١٠.٩١٧	٣.٤١٤٩			
	Major amputation	٩	١٢.٢٦٧	٢.٥٩١٣	١١.١٣٥	٠.٠٠٢	S
INR	**Debridement**	١٣	١.٢٨٤	٠.٣٠٢٩			
	Toe(s) amputation	٢٢	١.٣٤٠	٠.٢٤١١			
	Metatarsal amputation	٦	١.٣٧٣	٠.٣٣٣٤			
	Major amputation	٩	١.٤٢٠	٠.١٩٥٨	٠.٥٠٣	٠.٦٨٢	NS
PT	**Debridement**	١٣	١٥.٧٦٩	٢.٤٥٦٨			
	Toe(s) amputation	٢٢	١٦.١٩١	٢.١٥٧١			
	Metatarsal amputation	٦	١٧.٥١٧	٦.٨١١٠			
	Major amputation	٩	١٦.٤٨٩	١.٥٦٩٦	٠.٤٧٧	٠.٧٠٠	NS

All patients had culture and sensitivity test , the results had been classified into ٣ groups: Gram –ve organisms, Gram +ve organisms and mixed organisms (Table ١٠ & ١١).

Table (١٠): Culture findings of studied patients.

		N.	Percent (%)
Culture gram	**Gram +ve**	١٣	٢٦.٠
	Gram –ve	٣٠	٦٠.٠
	٢ growth (mixed)	٧	١٤.٠

Table (١١): Organism distribution in culture of studied patients.

		N.	Percent (%)
Culture organism	**bacilliklebs.**	٥	١٠.٠
	bacilliklebs. proteus	٢	٤.٠
	bacilliproteus, ecoli	١	٢.٠
	bacilliproteus ,psudo.	١	٢.٠
	bacilliecoli	٧	١٤.٠
	bacilliecoli, klebs	١	٢.٠
	bacilliecoli, psudo.	٣	٦.٠
	bacilliklebs.	٦	١٢.٠
	bacillipsudomonus	٣	٦.٠
	bacillipsudomonus, klebs.	١	٢.٠

	cocci	١٣	٢٦.٠

Discussion

In our study we found that debridement was the first and most important step in healing of diabetic foot infection by removal of all non-viable and infected tissue (including bone) in some cases from open wounds, also surrounding callosities, until a new border of healthy, bleeding soft tissue and this matches with Berm et al., who mentioned that extensive sharp excision debridement has five aims (removes local contaminated bacteria ,stimulates healing, documents the absence of hyper keratotic tissue and tumor, decreases local infection and assesses depth of infection in addition to any potential penetration into bones and joints and along tendon sheaths).[٩]

Cultures should be obtained not to diagnose the infection, but to determine which organism is causing the clinically diagnosed infection in order to aid in antibiotic selection. After removing overlying necrotic debris, specimens should be obtained from the wound base or deeper tissues for culture. Specimen for culture should not be taken from undebrided wounds or from wound drainage due to poor correlation with deep cultures. [١٠]

Our study examined whether or not certain baseline personal, clinical and laboratory features can predict the risk for overall and major amputations in a diabetic foot infection episode.

It was shown that limb ischemia, ABI, osteomyelitis, presence of gangrene (Wagner score) were major independent predictors of overall and major amputations. In concordance with our results, previous studies by Reiber et al.,[١١] Mayfield et al.,[١٢] and Flores et al.,[١٣] also showed that limb ischemia, ABI and osteomyelitis are associated with an increased risk for amputation.

Eneroth et al., found that limb ischemia was an independent risk factor for amputation.[١٤] Diamantopoulos et al., showed that limb ischemia was the major factor associated with worse outcome in diabetic foot infections. And the relationship between major amputation rate and the presence of limb ischemia was very strong.[١٥]

Our study show that low ABI is a major predictor factor associated with worse outcome in diabetic foot infections, similar to findings by and Hamalainen et al., [١٦] and Pittet et al., [١٧] which showed that patients with ABI <٠.٨ (indicating vasculo pathy) underwent major amputations more frequent, in comparison with patients with ABI ≥ ٠.٨. The ABI <٠.٨ was found to be highly significant in predicting limb loss (P= ٠.٠٠٠).

Eneroth et al., Similar to our study reported that a diabetic foot wound exposing the bone was more likely to be associated with amputation and shows that deep infections and osteomyelitis were reported to be associated with threefold increased risk for amputation.[١٤]

A high Wagner grade was another strong predictor of the foot infection management outcome. Oyibo et al., reported that the Wagner grade significantly correlated with the risk of amputation. [١٨] Also, Calhoun et al., reported that increased Wagner grade was associated with a higher treatment failure. Ulcers of Wagner grades ٤ and ٥ denote the presence of local or diffuse gangrene, which are usually due to a combination of ischemia and infection. It is thus not surprising that grade ٤ and ٥ ulcers were very strongly associated with amputation in our study. Wagner classification, was an independent predictor of amputation.[١٩]

Through our study we found that several other baseline personal characteristics such as older age, and smoking were found to be associated with either overall or major amputations. It show a significant association between the age of the patient and overall and major amputations, similar to findings by Leung et al.,[٢٠] and Santos et al., [٢١] Which show that, thirty-eight

percent of patients older than age ٦٠ suffered limb loss in comparison to ١٨.٠٪ of patients younger than age ٦٠ y. Patients older than age ٦٠ were found to be a significant predictive factor for limb loss (P= ٠.٠٢٦).
Gender in our study was not found to be an important predictive factor for limb loss (*P*= ٠.٤٨٤). This is similar to findings by Miyajima et al.,[٢٢] and Gurlek et al.,[٢٣] *(P*= ٠.٣١٠)., although Hamalainen et al.,[٢٤] showed otherwise, indicating that the male gender has a higher risk of undergoing lower extremity amputations.

Also our study shows that there is a significantly higher number of smokers in the metatarsal and major amputation group. J. Joseph Anderson et al., reported that smoker diabetic patients underwent more amputations, as well as more proximal amputations than those who did not smoke. The higher amount of smoking in pack years followed an increasing trend of more proximal amputations as well. (p_٠.٠٣٨).[٢٥]

Baseline laboratory predictors of overall and major amputation were evaluated by increased levels of WBC, PNL, PLT, creatinine, and glycosylated hemoglobin and decreased levels of hemoglobin and albumin were found to be associated with greater risk for overall amputations. We also found that baseline levels of WBC and PNL were related tooutcome. In a prospective study, Lipsky et al., showed that elevated baseline levels of (WBC), PNL was associated with clinical treatment failure in diabetic foot infections treated with broad spectrum antibiotics. [٢٦]

Leukocytosis was related to worse clinical outcomes in diabetic foot ulcer. A WBC count >١٢.٠ cells/μL was associated with increased risk for amputation. [٢٧]

We also found that decrease the level of blood hemoglobin, was related to outcome of the diabetic foot infection and it can strongly predicted major amputation with (p=٠.٠٣٦) Similarly, SenaYesil et al., found thatdecreased hemoglobin levels were associated with high amputation risk. [٢٨]

Our study shows that high level of glycosylated hemoglobin in diabetic patients associated with increase the risk for major and over all amputations with (p=٠.٠٠٢), Similar to our results, Andrea L.

et al., showed that diabetic foot wound outcome worse in patients with high blood glycosylated hemoglobin level more than in others with normal blood A١c. [٢٩]

In concordance with our results, previous studies also showed that low serum albumin was reported to be associated with increased amputation risk.[١٣]

We also found that high Creatinine is a major predictor factor associated with worse outcome in diabetic foot infections, similar to findings Pittet et al.,[٣٠] and Upchurch et al.,.[٣١] showed a significant association between high Creatinine level of the patient and overall and major amputations. Limb loss occurred in ٥١.٧٪ of patients with Cr ≥١٥٠ μmol/l. Cr ≥١٥٠ μmol/l was found, to be a highly significant predictive factor for limb loss (*P*= ٠.٠٠١ elevated CRP levels and elevated Cr levels were useful in signalling severe infection and predicting limb loss.

However, a study by Santos et al., did not find Cr, glucose and WBC levels to be significant risk factors for major amputations.[٣٢]

References

١. Larsson J, Apelqvist J: Toward less amputations in diabetic Patients: Incidence, causes, cost, treatment and prevention. Acta Orthopaedica Scand; ١٩٩٤, ١٥٤: ٢٦٧-٢٧٠.
٢. Aristidis Veves, MD, DSc John M. Giurini, Dpm Frank W. Logerfo, MD, The diabetic foot second Edition; ٢٠٠٦,٩. ١٢-١٣.
٣. Miller AD, Van Buskirk A,Verhoek-Oftedahl W, Miller ER. Diabetes-related lower extremity amputations,.J Med Soc N J; ١٩٩٥, ٥٢: ٢٢٣-٢٢٥.

٤. Lipsky BA, Berendt AR, Cornia PB, et al.,: Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. Clin Infect Dis. Jun ٢٠١٢; ٥٤(١٢):e١٣٢-٧٣.

٥. Nicholas Katsilambros MD, Elef-therios Dounis MD, FACS, Panagiotis Tsapogas MD, Atlas of the Diabetic Foot; ٢٠٠٣, ١٥٢: ٢٣-٥٥.

٦. Reiber GE, Lipsky BA, Gibbons GW. The burden of diabetic foot ulcers. Am J Surg; ١٩٩٨, ١٧٦:٥S–١٠S.

٧. Jean-Louis Richard, Albert Sotto, Jean-Philippe Lavigne New insights in diabetic foot infection world journal of diabetes; ٢٠١١, ١٢:٤٦-٥٢.

٨. Frykberg RG, Armstrong DG, Giurini J, Edwards A, Kravette M, Kravitz S, et al.,. Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons. J Foot Ankle Surg ٢٠٠٠; ٣٩(٥ suppl): S١–٦٠.

٩. Brem H, Sheehan P, Boulton AJM: Protocol for treatment of diabetic foot ulcers. Am J Surgery. ١٨٧ (Suppl., ٥A): ٢٠٠٤, ١ S-١٠S.

١٠. Lipsky BA, Berendt AR,Deery HG, et al.,; Infectious Diseases Society of America. Diagnosis and treatment of diabetic foot infections.Clin Infect Dis. ٢٠٠٤; ٣٩(٧):٨٨٥–٩١٠.

١١. Reiber GE, Pecoraro RE, Koepsell TD, Risk factors for amputation in patients with diabetes mellitus. A case-control study. Ann Intern Med; ١٩٩٢, ١١٧: ٩٧-١٠٥.

١٢. Mayfield JA, Reiber GE, Nelson RG, Greene T, A foot risk classification system to predict diabetic amputation in Pima Indians. Diabetes Care; ١٩٩٦ , ١٩: ٧٠٤-٧٠٩.

١٣. Flores Rivera AR, Risk factors for amputation in diabetic patients: a case-control study. Arch Med Res ٢٩: ١٧٩-١٨٤. J Am Podiatr Med Assoc. ٢٠١١ Jan-Feb; ١٠١(١):١-٦..

١٤. Eneroth M, Apelqvist J, Stenstrom A, Clinical characteristics and outcome in ٢٢٣ diabetic patients with deep foot infections. Foot Ankle Int; ١٩٩٧,١٨: ٧١٦-٧٢٢.

١٥. Diamantopoulos EJ, Haritos D, Yfandi G, et al.,.: Management and outcome of severe diabetic foot infections. Exp Clin Endocrinol Diabetes; ١٩٩٨, ١٠٦: ٣٤٦-٣٥٢.

١٦. Hamalainen H, Ronnemaa T, Halonen JP, Toikka T. Factors predicting lower extremity amputations in patients with Type ١ or Type ٢ diabetes mellitus: a population based ٧-year follow-up study. J Intern Med.١٩٩٩;٢٤٦:٩٧–١٠٣.

١٧. Pittet D, Wyssa B, Herter-Clavel C, Kursteiner K, Vaucher J, Lew PD. Outcome of diabetic foot infections treated conservatively. Arch Intern Med. ١٩٩٩; ١٥٩:٨٥١–٦.

١٨. Oyibo SO, Jude EB, Tarawneh I, et al.,: A comparison of two diabetic foot ulcer classification systems: the Wagner and the University of Texas wound classification systems. Diabetes Care; ٢٠٠١, ٢٤: ٨٤-٨٨.

١٩. Calhoun JH, Cantrell J, Cobos J, et al.,: Treatment of diabetic foot infections: Wagner classification, therapy, and outcome. Foot Ankle J.; ١٩٨٨, ٩: ١٠١-١٠٦.

٢٠. Leung HB, Ho YC, Carnett L, Lam PKW, Wong WC. Diabetic foot ulcers in the Hong Kong Chinese population: retrospective study. Hong Kong Med J. ٢٠٠١;٧:٣٥٠–٥.

٢١. Santos VP, Silveiria DR, Caffaro RA.Risk factors for primary major amputations in diabetic patients. Sao Paulo Med J. ٢٠٠٦;١٢٤:٦٦–٧٠

٢٢. Miyajima S, Shirai A, Yamamoto S, Okada N, Matsushita T. Risk factors for major limb amputations in diabetic foot gangrene patients. Diabetes Res ClinPract. ٢٠٠٦;٧١:٢٧٢–٩.

٢٣. Gurlek A, Bayraktar M, Savas C,Gedik O. Amputation rate in ١٤٧ Turkish patients with diabetic foot: the Hacettepe University Hospital experi-ence. Exp Clin Endocrinol Diabetes. ١٩٩٨;١٠٦:٤٠٤–٩.

٢٤. Hamalainen H, Ronnemaa T,Halonen JP, Toikka T. Factors predicting lower extremity amputations in patients with Type ١ or Type ٢ diabetes mellitus: a population based ٧-year follow-up

study. J Intern Med.١٩٩٩;٢٤٦:٩٧–١٠٣.

٢٥. J. Joseph Anderson, Joshua Boone, Myron Hansen, Loren Spencer, Zflan Fowler A comparison of diabetic smokers and non-smokers who undergo lower extremity amputation study. J Intern Med ٢٠٠٠, ٦٢٥X.

٢٦. Lipsky BA, Sheehan P, Armstrong DG, et al.,: Clinical predictors of treatment failure for diabetic foot infections: data from a prospective trial. Int Wound J; ٢٠٠٧, ٤: ٣٠-٣٨.

٢٧. Akanji AO, Famuyiwa OO, Adetuyibi A, Factors influencing the outcome of treatment of foot lesions in Nigerian patients with diabetes mellitus. Q J Med; ١٩٨٩, ٧٣: ١٠٠٥-١٠١٤.

٢٨. Sena Yesil, BarisAkinci, SerkanYener, Firat Bayraktar, OzalpKarabay, Hasan Havitcioglu, NurYapar, AtayAtabey Predictors of amputation in diabetics with foot ulcer: Single center experience in a large Turkish cohort HORMONES ٢٠٠٩, ٨(٤):٢٨٦-٢٩٥.

٢٩. Andrea L. Christman, Andrea L. Christman, et al.,: Hemoglobin A١c Predicts Healing Rate in Diabetic Wounds Journal of Investigative Dermatology advance June ٢٠١١; doi:١٠.١٠٣٨/jid.١٧٦.

٣٠. Pittet D, Wyssa B, Herter-Clavel C, Kursteiner K, Vaucher J, Lew PD. Outcome of diabetic foot infections treated conservatively. Arch Intern Med. ١٩٩٩; ١٥٩:٨٥١–٦.

٣١. Upchurch GR, Jr, Keagy BA, Johnson G., Jr An acute phase reaction in diabetic patients with foot ulcers. Cardiovasc Surg. ١٩٩٧;٥:٣٢–٦.

٣٢. Santos VP, Silveiria DR, Caffaro RA. Risk factors for primary major amputations in diabetic patients. Sao Paulo Med J. ٢٠٠٦;١٢٤:٦٦–٧٠.