

COMPARISON OF DIABETIC SMOKERS AND DIABETIC NONSMOKERS WHO UNDERGO LOWER EXTREMITY AMPUTATION

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INTRODUCTION

Cigarette smoking is well known for the numerous harmful effects on the human body. These negative effects also extend to the realm of foot and ankle surgery. Cigarette smoking is known to increase risk of diabetes, peripheral arterial disease (PAD), and delay surgical healing in both elective and emergent diabetic foot surgery. The complications in bone healing are well documented in the smoking populations (1). Lower extremity amputations are often an unfortunate outcome for someone who develops a foot ulcer (2). Despite public health efforts the incidence of amputations in the diabetic population continues to increase. The 5 year mortality in diabetics who undergo lower extremity amputations in specific below knee amputations has been reported to be as high as 50% (3). There is also a significant increased functional disability in those who undergo lower extremity amputation when compared to diabetics who do not undergo any type of lower extremity amputation (4).

Tobacco use is well known to increase the risk of amputation in patients in general. Liedberg demonstrated out of 188 lower limb amputees in Sweden only 23 were not either a diabetic, smoker, or older than 80 years of age (5). Smoking has been shown to delay healing in patients undergoing transmetatarsal amputations (TMA). A smoking history of >20 years was one key factor that was shown to lead to a more proximal amputation in 40% of those who underwent a TMA (6). There are several ways in which cigarette smoking inhibits tissue healing. Tissue perfusion and oxygenation is decreased by harmful by-products such as carbon monoxide and hydrogen cyanide that inhibit the normal metabolism of healing (7). Perfusion is further decreased as nicotine stimulated epinephrine and norepinephrine release that also limits tissue perfusion (8).

In our study we explored the relationship between smoking and amputations in a diabetic cohort. First we investigated if there were more amputations in diabetics

who smoked versus those who did not. In addition we investigated if diabetics who smoke undergo amputation at a younger age than those who do not smoke. We also examined the postoperative smoking habits in diabetics that underwent lower extremity amputations. Lastly, we examined the effect that the level of the lower extremity amputation has on diabetic patients' smoking habits postoperatively

METHODS

A total of 112 diabetic patients underwent lower extremity amputation from July 2002 to July 2010 in the practice of the primary author. Inclusion criteria included patients with a follow up longer than 3 months after the amputation and a history of diabetes. Exclusion criteria consisted of death within the perioperative course and less than 3 months of follow up. Information was obtained on current smoking history including pack years. Patients were followed in their postoperative course for at least 3 months and asked at each subsequent office visit what their current smoking status was at the time of the visit. The level of the amputation was also noted

Patients were divided into two groups based on their smoking history. Patients were defined as smokers if they had ≥ 5 pack years of smoking history and/or were smoking at the time of the amputation. Nonsmokers were defined as patients who had never smoked or had a smoking history of ≤ 5 years and were not currently smoking at the time of the surgery. Patients were also divided into 3 groups based on the level of amputation. The 3 levels of amputations were defined as follows. The first group was called distal, which included all amputations distal to the midshaft of the metatarsals. Second, the midfoot/rearfoot group included transmetatarsal amputations, amputations through Lis Franc's, Chopart's, or ankle joint. The final group was defined as proximal to include all below knee and above knee amputations.

There were 66 smokers and 46 nonsmokers in our study (68 male and 44 female). There were 69 distal amputations, 32 midfoot/rearfoot amputations, and 11 proximal amputations for a total of 112 amputations. The number of diabetic smokers who underwent lower extremity amputation were compared to their nonsmoker counterparts in regard to incidence and age at time of amputation

The smoking habits of the diabetic smokers (defined in our study as ≥ 5 pack years of smoking) were examined during the perioperative course. Smoking habits during the peri-operative course were broken down into 3 categories. First, those who never stopped smoking, second those who stopped smoking initially but resumed within 3 months of their amputation and lastly those who never stopped smoking. We also looked to see if the level of amputation had any influence on the smoking habits of diabetic smokers.

Table 1

DEMOGRAPHIC DESCRIPTION OF COHORT (N=112)

Age at time of operation, years (range)	61.5 (23-92)
No. (%) male/female	68 (61)/ 44 (39)
No. (%), smoker/nonsmokers	66 (59%) /46 (41%)*
Average pack years of smokers (range)	34.0 (5-100)

* $P = 0.038$

Table 3

NUMBER OF PACK YEARS IN DIABETIC SMOKERS IN RELATIONSHIP TO LEVEL OF AMPUTATION

Amputation Level	Number	Pack Years
Distal	35	32.5
Midfoot/rearfoot	19	33.3
Proximal (below knee)	10	40.3

 $P = 0.492^*$

*By ANOVA.

RESULTS

A total of 112 patients fit our inclusion criteria. The average age of the patients was 61.5 years old. There were 66 smokers and 48 nonsmokers. The average number of pack years in our smoker group was 34.0 (Table 1). There was a greater number diabetics who smoked that underwent amputation when compared to diabetics who did not smoke, which was statistically significant ($P = 0.038$).

The 66 smokers with diabetes who underwent lower extremity amputation were then further examined. Of the smokers there were 35, 19, and 10 patients who underwent distal, midfoot/rearfoot, and proximal amputations, respectively. This is compared to nonsmokers where there were 34, 13, and 1 distal, midfoot/rearfoot, and proximal amputations, respectively (Table 2). There was no statistical difference in levels of amputation between smokers and nonsmokers ($P = 0.100$), but it is worth mentioning that of

Table 2

COMPARISON OF THE LEVEL OF AMPUTATION IN SMOKERS AND NONSMOKERS

	Smokers	Nonsmokers
Amputation Level		
Distal	38	31
Midfoot/Rearfoot	19	13
Proximal (BKA)	10	1

 $P = 0.100^*$

*By Mann-Whitney test.

Table 4

EFFECT OF LOWER EXTREMITY AMPUTATIONS ON DIABETIC SMOKERS SMOKING HABITS

Amputation level	Never Stopped	Stop & Start	Stop >3 months
Distal	15	11	9
Midfoot/rearfoot	9	8	2
Proximal (below knee)	5	2	3

 $P = 0.455^*$

• By Kruskal-Wallis test.

the 11 proximal amputations 10 were in patients who were smokers while only 1 was in a nonsmoker. Table 3 shows the number of pack years for smokers who underwent the 3 levels of amputation and although not statistically significant ($P = 0.492$), it should be noted that the number of pack years on average increases as the amputation becomes more proximal.

We then evaluated if our smoking patients were likely to change their smoking habits after lower extremity amputation. Furthermore we looked to see if there was any correlation between level of amputation and change in smoking habits (Table 4). Of the smokers who had a distal amputation 15 never stopped smoking, 11 stopped but restarted within 3 months, and 9 stopped for > 3 months. In those with midfoot/rearfoot amputations it was 2, 8, and 9, respectively. For proximal amputations the numbers were 3, 2, and 5, respectively ($P = 0.594$, not statistically significant). The data suggest there is very little change in smoking habits despite undergoing a lower extremity amputation.

DISCUSSION

Lower extremity amputation continues to be an unfortunate complication in patients with diabetes. In addition to functional limitations that amputees experience there is also a significant psychological impact (9). Major depression has been shown to increase the number of macrovascular and microvascular complications from diabetes (10). Even when excluding death due to cardiovascular causes, depression has recently been shown to increase mortality in diabetics with comorbid depression (11).

One finding from our data show that diabetics who smoke are more likely to undergo amputation than those that do not smoke ($P = 0.038$). This information is important to note and to relay to patients who continue to smoke while having diabetes. This may be several reasons, however the most likely is the increased risk of PAD. Also of note were patients who underwent a below knee amputation (BKA). There were 11 total (BKAs) performed and of those, 10 were in smokers. Given our small sample size this was not significant but is worth noting. There is a trend towards diabetic smokers requiring a more proximal amputation.

Our research demonstrates that an amputation does not appear to influence a diabetic smoker's smoking

habits. As seen in Table 1, the average number of pack years for the smoking diabetic amputation population is 34.0. This is somewhat surprisingly high and our sample size may be biased to those with a high pack year history. As most smokers have tried numerous times to quit it does not appear that amputation helps them do this any faster than they would normally.

There are several limitations in our study, such as the fact that we did not include other variables such as PAD, neuropathy, hemoglobin A1C, body mass index, etc. This was done however to look at one particular factor, smoking and amputations. It is unknown how these other variables would affect our results. Weaknesses include the retrospective nature of the study and short follow up of 3 months, therefore it is unclear if those who were able to stop smoking were able to continue this long term. Also our information on patient's smoking habits was based on patient response. If there was reason for doubt i.e., the patient smelled strongly of tobacco smoke, family members were also questioned and patients asked again, therefore the information we received may be fairly accurate although it is difficult to know for sure.

Aiding patients in smoking cessation is a challenge faced by all medical practitioners. While the primary medical provider typically coordinates smoking cessation efforts, foot and ankle surgeons can play an important role in the process. Reviewing and explaining individualized patient- and diagnosis-specific information is one way that has been shown to be effective in aiding in smoking cessation (12). It is difficult to predict which smokers will have adverse outcomes if they continue to smoke before and after the procedure. However specific examples of the negative impact on bone, wound healing, and the possibility of more proximal amputation if smoking continues may be helpful (1).

The overall conclusion in our study is that diabetic patients who smoke are more likely to undergo a lower extremity amputation when compared to diabetics who do not smoke. Also, while not statistically significant, there is a trend towards diabetic smokers receiving a more proximal amputation when compared to their nonsmoking diabetic counterparts. Educating patients on the increased risk of amputations with continued smoking and diabetes may play a role in smoking cessation.

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