

# The Impact of Offloading Footwear in Prevention and Healing of Viral Foot Ulcers (Verruca Plantaris)

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## ABSTRACT

**Objectives:** The aim of the present study was to assess the healing time of ulcers in patients with chronic foot ulcers and determining its correlation with various factors such as addiction history, operation of foot and use of offloading footwear.

**Methods:** It was a prospective observational study conducted at Shree Vijay Vachhrajani memorial diabetic foot and wound management centre between 2016 to 2019. A total of 98 patients were included in the study. For each patient, clinical profile like age, gender, location of foot ulcer, site of ulcer, healing status, length of time the ulcer has been healed; amputation history, surgical history; family history; tobacco use; alcohol abuse and use of offloading footwear etc were studied.

**Results:** The average age was 55.4 and patients between 9 to 90 years of age. Out of total 98 patients, 54 were males (55.10%) and 44 were females (44.90%) and male preponderance was observed in comparison to females. Among ulcer healed patients, we observed negative correlation (correlation coefficient= - 0.10823) between addiction history of patients and length of healing time. Positive correlation (correlation coefficient= 0.27787) was seen between operation of foot and healing time. A significant association ( $p < 0.0166$ ) was seen between offloading footwear use and healing of foot ulcers.

**Conclusion:** Offloading footwear was associated with shorter healing time when compared with patients who are not on any offloading footwear and positive correlation was noticed between operation of foot and healing time of ulcers.

**Key words:** Verruca plantaris, operation of foot and offloading-footwear.

## INTRODUCTION

Skin diseases are common contributors to disease morbidity worldwide and affect approximately 10% of the population. <sup>[1]</sup> Warts are the third most common skin disease encountered in routine clinical practice, <sup>[2]</sup> affects about 7 to 12 percent of the world population. <sup>[3]</sup> Warts can affect person of any age, although rare in infancy and early childhood, prevalence increases among school-aged children and peaks at 12 to 16 years. <sup>[3]</sup> A plantar wart also known as Verruca plantaris, are cutaneous lesions on the plantar aspect of the foot that are caused by Human papilloma virus (HPV). <sup>[4]</sup> Which enters the human body through tiny cuts and breaks through the skin, occurring on soles or toes of the feet. The most common location for plantar warts includes a) Soles of the feet, especially the weight bearing areas like heels and balls of the feet. b) Undersides of the toes. Plantar warts may occur singly or in cluster in the form of mosaic warts. <sup>[5]</sup>

The prognosis of warts cannot be predicted. In some patients they may spontaneously disappear, whereas others show persistence and progression with spreading to other body sites, leading to physical and emotional distress to the patients. <sup>[6]</sup> There are many possible ways to treat foot ulcers including topical medications, intralesional immunotherapy,

cryotherapy, laser, and photodynamic therapy. [7] But the standard care of treatment includes the following: local wound care with surgical debridement, dressings promoting a moist wound environment, wound off-loading, vascular assessment, treatment of active infection, and glycemic control. [8] Warts with short-term duration are more likely to be cleared than those with long-term duration. [9] Footwear and offloading techniques are commonly used in the prevention and treatment of viral foot ulcers. [10] But the evidences are not well known to support these techniques in clinical setting. Therefore, the aim of the present study was to assess the healing time of ulcers in patients with chronic foot ulcers and determining its correlation with various factors such as addiction history, operation of foot and use of offloading footwear

## MATERIALS AND METHODS

Ninety-eight consecutive clinically diagnosed patients of chronic foot ulcers attending the outpatient department of our tertiary care hospital (Shree Vijay Vachhrajani memorial diabetic foot and wound management centre) between 2016 to 2019 were included in this prospective and observational study after obtaining their consent. This study included both male and female inpatients of all age groups with or without history of diabetes. All patients were subjected for ulcer margin biopsy. Biopsy samples were sent to the Department of Pathology for histopathological examination for diagnosis and pathology of viruses. Data collection comprised factors thought to be associated with viral foot ulcers as suggested by previous studies. [11] For each patient, the following information were collected: age, gender, location of foot ulcer, site of ulcer, healing status, length of time the ulcer has healed, amputation history, surgical history; family history; tobacco use; alcohol abuse and use of offloading footwear in prevention and healing of viral foot ulcer.

## STATISTICAL METHODS:

All the statistical analysis was done using the software SAS Version 9.4. Descriptive statistics like percentages and frequencies were calculated for viral foot ulcers and healing time. Relationship between two variables was done using Pearson correlation test. The Correlation coefficient value ranges from -1 to +1, the negative value represents that the parameters are inversely proportional to each other and the positive value represents that the parameters are directly proportional to each other. The extent to which this correlation coefficient can show a significance was given in terms of p-value. P value of <0.05 was taken as statistically significant and the data was represented in the form of tables.

## RESULTS

### Patient Characteristics:

Over 3-year study period (2016 to 2019), a total of 98 chronic foot ulcer patients were included in this study. Out of total 98 patients, 54 were males (55.10%) and 44 were females (44.90%) and male preponderance was observed in comparison to females. Table 1 presents the demographic characteristics of the patients. In present study, for age 1 patient data is missing and we have done analysis for 97 patients. Mean age of patients at the time of diagnosis was 55.4 years ranging from 9 to 90 years. In majority of patients, foot ulcers were noticed on left side location (50.00%) followed by right side (43.88 %) and bilateral location (6.12%). Of the 98 patients, 32 (32.65 %) had foot ulcers only on their Forefoot, 28 patients (28.57%) had foot ulcers only on their Great Toe, 26 patients (26.53%) had ulcers on Heel, 7 patients (7.14%) had foot ulcers on midfoot and 2 patients (2.04%) had foot ulcers on both their forefeet and midfoot respectively.

### Viral Foot Ulcer healing time and its relation to associated factors:

As shown in Table 2, of the 98 treated patients, 43 (43.88%) healed and the treatment failed to work for 55 (56.12 %) patients. The average healing time of the

foot ulcers was found to be about 12.38 months with adequate footwear offloading and surgical treatment.

**Table 1: Summary of patients Demographics**

PARAMETER	RESULT
<b>AGE</b>	
N	97
Mean	55.40
Median	55.00
Standard Deviation	12.10
Minimum	9.00
Maximum	90.00
<b>SEX</b>	
Male N (%)	54 (55.10 %)
Female N (%)	44 (44.90 %)
<b>FOOT ULCER LOCATION</b>	
Right N (%)	43 (43.88 %)
Left N (%)	49 (50.00 %)
Bilateral N (%)	6 (6.12 %)
<b>SITE OF ULCER</b>	
Forefoot	32 (32.65 %)
Great Toe	28 (28.57 %)
Heel	26 (26.53 %)
Midfoot	7 (7.14 %)
Forefoot; Midfoot	2 (2.04 %)
LT Malleois	1 (1.02 %)
2nd Toe	1 (1.02 %)
4th and 5th Toes	1 (1.02 %)

**Table 2: Summary statistics of Foot Ulcer Healing Status of Subjects**

HEALING STATUS	RESULT
Healed N (%)	43 (43.88 %)
Not Healed N (%)	55 (56.12 %)

Table 3 presents the summary statistics of addiction history with healing time of the ulcers. Out of total 43 healed patients, 15 patients (34.89%) had presented with addiction history, and 5 patients (11.62%) were ex-users. Most patients (23, 53.49%) had no history of tobacco use, alcohol abuse and smoking. As shown in Table 3, healing time of foot ulcers was not dependent on the social status of the patients.

**Table 3: Summary statistics of Addiction History with Healing Time (Months)**

ADDICTION HISTORY WITH HEALING TIME	FREQUENCY N (%)
Alcohol; 8 months	1 (1.02 %)
Bajar; 18 months	1 (1.02 %)
Bajar; 2 months	1 (1.02 %)
Bajar; 24 months	1 (1.02 %)
Ex user; 0.49 months	1 (1.02 %)
Ex user; 1 month	1 (1.02 %)
Ex user; 24 months	1 (1.02 %)
Ex user; 36 months	1 (1.02 %)
Ex user; 4 months	1 (1.02 %)
No; 0.23 months	1 (1.02 %)
No; 1 month	1 (1.02 %)
No; 1.5 months	1 (1.02 %)
No; 12 months	4 (4.08 %)
No; 15 months	1 (1.02 %)
No; 18 months	1 (1.02 %)
No; 2 months	1 (1.02 %)
No; 24 months	3 (3.06 %)
No; 3 months	3 (3.06 %)
No; 36 months	2 (2.04 %)
No; 4 months	2 (2.04 %)
No; 48 months	1 (1.02 %)
No; 8 months	1 (1.02 %)
No; 9 months	1 (1.02 %)
Smoking; 5 months	1 (1.02 %)
Tobacco, Alcohol; 13 months	1 (1.02 %)
Tobacco, Smoking; 6 months	1 (1.02 %)
Tobacco; 0.66 months	1 (1.02 %)
Tobacco; 1.5 months	1 (1.02 %)
Tobacco; 18 months	2 (2.04 %)
Tobacco; 2 months	1 (1.02 %)
Tobacco; 24 months	1 (1.02 %)
Tobacco; 6 months	1 (1.02 %)
Tobacco; 9 months	1 (1.02 %)
Total	43 (100 %)

Table 4 shows the summary statistics of surgical treatment with respect to healing time of foot ulcers. Out of total 43 healed patients, 23 patients (53.49%) had underwent surgical treatment and remaining patients didn't undergo any surgery. In present study, we noticed that surgical patients had shown better improvements than non-surgical patients.

**Table 4: Summary statistics of Operation of Foot with Healing Time (Months)**

OPERATION OF FOOT WITH HEALING TIME	FREQUENCY N (%)
2 <sup>nd</sup> , 3 <sup>rd</sup> toe amputation done; 9 months	1 (1.02 %)
Below knee amputation done before 2 years;8 months	1 (1.02 %)
Debridement; 24 months	1 (1.02 %)
Debridement; 3 months	1 (1.02 %)
Debridement done; 4 months	1 (1.02 %)
Debridement done on great toe; 15 months	1 (1.02 %)
Debridement done Left great toe; 8 months	1 (1.02 %)
Left 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> toes amputation done; 24 months	1 (1.02 %)
Left 2 <sup>nd</sup> , 3 <sup>rd</sup> , 4 <sup>th</sup> toe amputation; 9 months	1 (1.02 %)
Left ankle surgery; 18 months	1 (1.02 %)
Left great toe amputation before 2years;18 months	1 (1.02 %)
Left leg surgery, CABG*; 24 months	1 (1.02 %)
Left toe amputation done in 2015, 3 <sup>rd</sup> toe in 2017; 24months	1 (1.02 %)
No; 0.23 months	1 (1.02 %)

No; 0.49 months	1 (1.02 %)
No; 0.66 months	1 (1.02 %)
No; 1.5 months	2(2.04 %)
No; 12 months	3 (3.06 %)
No; 13 months	1 (1.02 %)
No; 18 months	2(2.04 %)
No; 2 months	1 (1.02 %)
No; 24 months	1 (1.02 %)
No; 3 months	2(2.04 %)
No; 36 months	1 (1.02 %)
No; 4 months	1 (1.02 %)
No; 5 months	1 (1.02 %)
No; 6 months	2(2.04 %)
Right 2 <sup>nd</sup> , 3 <sup>rd</sup> toes amputation done; 12 months	1 (1.02 %)
Right midfoot debridement; 48 months	1 (1.02 %)
Toe amputation-left below knee amputation;36 months	1 (1.02 %)
Toe amputation Right; 1 months	1 (1.02 %)
Toe amputation; 1 months	1 (1.02 %)
Toe amputation; 2 months	2 (2.04 %)
Toe amputation; 4 months	1 (1.02 %)
Toe amputation; 36 months	1 (1.02 %)
Debridement, CABG* done; 24 months	1 (1.02 %)
<b>Total</b>	<b>43 (100 %)</b>
*CABG = Coronary artery bypass graft	

**Table 5: Summary statistics of Offloading Footwear use with Healing Time (Months)**

<b>OFFLOADING FOOTWEAR USE WITH HEALING TIME</b>	<b>FREQUENCY N (%)</b>
NO; 0.66 months	1 (1.02 %)
NO; 1 months	1 (1.02 %)
NO; 12 months	2 (2.04 %)
NO; 18 months	3 (3.06 %)
NO; 2 months	2 (2.04 %)
NO; 24 months	5 (5.10 %)
NO; 36 months	3 (3.06 %)
NO; 4 months	2 (2.04 %)
NO; 48 months	1 (1.02 %)
NO; 5 months	1 (1.02 %)
NO; 6 months	2 (2.04 %)
NO; 8 months	1 (1.02 %)
NO; 9 months	2 (2.04 %)
YES; 0.23 months	1 (1.02 %)
YES; 0.49 months	1 (1.02 %)
YES; 1 months	1 (1.02 %)
YES; 1.5 months	2 (2.04 %)
YES; 12 months	2 (2.04 %)
YES; 13 months	1 (1.02 %)
YES; 15 months	1 (1.02 %)
YES; 18 months	1 (1.02 %)
YES; 2 months	1 (1.02 %)
YES; 24 months	1 (1.02 %)
YES; 3 months	3 (3.06 %)
YES; 4 months	1 (1.02 %)
YES; 8 months	1 (1.02 %)
Total	43 (100 %)

Table 5 presents the distribution of patients according to the offloading footwear use in ulcer healing. Footwear offloading treatment were found to be more effective in the prevention and healing of foot ulcers.

As shown in Table 6, correlation coefficient was derived to estimate the impact of addiction history, operation of foot and role of offloading footwear in prevention and healing of ulcers in patients with chronic foot ulcer. Among all patients, no significant association was found with addiction history ( $p < 0.9659$ ), operation of foot ( $p < 0.1773$ ) and role of offloading footwear ( $p < 0.9386$ ). As shown in Table 7, among all ulcer healed patients, significant association was seen between offloading footwear use and healing of foot ulcers ( $p < 0.0166$ ), showing that ulcer healing is dependent on use of offloading footwear in patients with chronic foot ulcers.

**Table 6: Correlation Coefficients of Various factors affecting Healing Time in All Patients (N = 98)**

<b>FACTORS AFFECTING HEALING TIME</b>	<b>HEALING TIME (CORRELATION COEFFICIENT)</b>	<b>p-value</b>
Addiction History (Tobacco and Alcohol)	- 0.00437	0.9659
Operation of Foot	0.13741	0.1773
Role of Offloading Footwear	-0.00789	0.9386

**Table 7: Correlation Coefficients of Various factors affecting Healing Time in Ulcer Healed Patients (N = 43)**

<b>FACTORS AFFECTING HEALING TIME</b>	<b>HEALING TIME (CORRELATION COEFFICIENT)</b>	<b>p-value</b>
Addiction History (Tobacco and Alcohol)	- 0.10823	0.4897
Operation of Foot	0.27787	0.0712
Role of Offloading Footwear	-0.36338	0.0166

## DISCUSSION

### Patient Characteristics:

The study has prospectively evaluated the associations between healing time of foot ulcers with various factors such as addiction history, operation of foot and offloading footwear use in patients with chronic foot ulcers. Data collected of these three years clearly shows that there is male preponderance in this study. Out of 98 patients, 54 were males (55.10%) and 44 were females (44.90%). A study conducted by Chandrasekhar *et al* [12] noticed that out of total 144 patients, 97 were males (67.36%) and 47 were females (32.64%). A study done by Sudhakar *et al* [13] observed that, out of 90 patients, 67 were males (74.44%) and 23 were females (25.55%). Based on these studies we estimated that males were more susceptible to foot ulcers in comparison to the females. In our study, mean age of patients at the time of diagnosis was 55.4 ranging from 9 to 90 years. Chandrashekhar *et al* [12] in their study on 144 patients of warts found 41.9% patients in the age group of 10-14 years. Chaung *et al* [14] noticed a peak incidence between 12 and 16 years of age. These studies represent that warts were commonly seen in the younger age group than older age group.

During 3-year study period, sites of involvement were observed in this study. Total of 98 patients, 32 (32.65 %) had foot ulcers only on their Forefoot, 28 patients (28.57%) had foot ulcers only on their Great Toe, 26 patients (26.53%) had ulcers on Heel, 7 patients (7.14%) had foot ulcers on midfoot and 2 patients (2.04%) had foot ulcers on both their forefeet and midfoot. A retrospective descriptive study of patients with diabetic foot ulcer observed that 48.8% were toe ulcers, 21.8% plantar ulcers, 17.8% heel ulcers, and 8.9% were found to be dorsal/lateral foot ulcers. [15] The study has found that the commonest site of involvement in adults was the feet. The findings of the present study were similar to above study.

### Viral Foot Ulcer healing time and its relation to associated factors:

Over 3-year study period, the average healing time of the foot ulcers was found to be about 12.38 months. Out of total 98 treated patients, 43 (43.88%) were healed of their ulcers; the treatment failed to work for 55 (56.12 %) patients. A study conducted by sorenson *et al* [15] determine the differences in healing time of diabetic foot ulcers patients between years 1999/2000 and 2011/2012 and noticed that average healing time was 6 months in 1999/2000 and 6.6 months in 2011/2012. About 33% of ulcers were healed, 17% were minor or major amputated, and 1.5% were dead within one year in 1999/2000, whereas 30% of ulcers were healed ( $p = 0.6$ ), 14% were amputated ( $p = 0.2$ ), and 12.8% were dead within one year in 2011/2012. [15]

Out of total 43 healed patients, 15 patients (34.89%) had presented with social history, and 5 patients (11.62%) were ex-users. Most patients (23, 53.49%) had no history of tobacco use, alcohol abuse and smoking. A study by Bikramjit Pal [16] evaluated the impact of lifestyle factors like smoking and chronic alcoholism with prognosis and outcome of the diabetic foot ulcers. Out of 79 patients, 53 (67.09%) of the patients were addicted to either smoking, alcohol or both and 26 (32.91%) had no addiction. The study found that addiction history was positively related to ulcer healing and both smoking, and alcoholism are strong determinant factors in the development of severe grades of diabetic foot ulcers which ultimately leads to amputation. [16] Sorensen *et al* [15] noticed that smoking was positively related to a longer healing time and is associated with a higher risk of amputation. Both studies revealed that addiction history was positively related to healing time. In our study, we observed negative relation between addiction history and healing time.

In present study we evaluated the associations between operation of foot and length of healing time. The findings show that operation of foot is positively correlated to the length of healing time. This is in equivalent other studies like Finestone *et al*

[17] Piaggese et al [18] in which length of healing time is dependent on operation foot in chronic foot ulcers patients. Surgical patients have shown better improvements in ulcer healing than non-surgical patients.

Over 3-year study period, we observed that offloading footwear treatment was found to be more effective in the prevention and healing of foot ulcers. Offloading footwear treatment was negatively correlated to length of healing time. Our study findings were correlating with study conducted by SA Bus et al [19] revealed that ulcers can heal within 6 to 8 weeks with adequate offloading.

In our study we established the correlation between length of healing time and various factors such as addiction history, operation of foot and use of offloading footwear. Among ulcer healed patients, we observed negative correlation (correlation coefficient= - 0.10823) between addiction history of patients and length of healing time. Positive correlation (correlation coefficient= 0.27787) was seen between operation of foot and healing time. As shown in Table 7, a significant association was seen between offloading footwear use and healing of foot ulcers ( $p < 0.0166$ ), showing that ulcer healing is dependent on use of offloading footwear in patients with chronic foot ulcers.

## CONCLUSION

Foot ulcers are the most frequent presentation of all viral skin infections. The common site of involvement was feet as seen in the present study. Our study showed that the mean time to healing of a foot ulcer was long, around 12.38 months with adequate offloading footwear. This study has shown that length of healing time is associated with various factors.

In conclusion, our findings suggest that offloading footwear use in patients with chronic foot ulcers was associated with shorter healing time as compared to patients who are not on any offloading footwear and positive correlation was noticed between operation of foot and healing time of ulcers.

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