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Mobility Status Following Subtotal Calcanectomy in Diabetic Foot Related Hindfoot Infection

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Abstract

Diabetic foot related infections are the main causes of major amputations in diabetic patients [1]. In particular, hindfoot ulcers and infections are often harder to treat. A subtotal calcanectomy can be a viable alternative to major amputation in diabetic related hindfoot infections. We conducted a retrospective study of a cohort of diabetic patients undergoing a subtotal calcanectomy in our institution. All patients underwent an open subtotal calcanectomy for diabetic foot related hindfoot infections. From January 2011 to October 2021, a total of 13 patients were identified. The mean follow-up period was 20.2 months. Of the 13 patient analysed, 5 maintained their mobility status post subtotal calcanectomy.

A subtotal calcanectomy is a viable limb salvage alternative to major lower limb amputations in diabetic related hindfoot infections, with a significant proportion of patients maintaining their pre-operative mobility statuses, which is comparable to currently published data on major lower limb amputations.

Keywords: Diabetic Foot Ulcer; Calcanectomy; Ambulation; Limb Preservation

Introduction

Patients with diabetic foot related ulcers in the hindfoot are at particular risk of developing recalcitrant heel ulcers progressing to calcaneal osteomyelitis. The major pathologies of neuropathy, ischaemia, and infection often co-exist and exacerbate the condition. Healing of such hindfoot ulcers is also impaired by the limited amount of soft tissue coverage over the calcaneus. Major amputation rates and mortality of such hindfoot infections are higher compared to those in the forefoot or midfoot [2], with a study reporting a 52% rate of major amputation in heel osteomyelitis [3]. The prevalence of diabetes in the Singaporean adult population is estimated to be at 8.6% in 2017 [4], while global prevalence is estimated to be at 6.1% in 2023 [19]. Diabetic related complications, along their subsequent economical and healthcare associated costs, have been well documented [5,6]. Diabetic related foot infections can be a significant source of these costs as they often result in major lower limb amputation [7]. Locally in Singapore, diabetic related major lower limb amputation has been reported to be at a rate of 95 per 10,000 [8]. Major lower limb amputations have been proven to result in significant morbidity and mortality [9,10]. Of patients undergoing a below knee amputation, half are ambulant at 1 year post-amputation [9,11].

It has been established that a calcanectomy is a viable alternative to major amputation in diabetic related hindfoot infections, with preservation of ambulatory status in a higher proportion of patients [12-14,17,18] compared to patients undergoing major lower limb amputations [9,11,15]. Minor complication rates following a calcanectomy have been quoted at 24%, with approximately 10% of patients ultimately requiring a major lower limb amputation [14].

The aim of our study is to present the ambulatory outcomes of patients undergoing a subtotal calcanectomy for diabetic hindfoot infections.

Methods

Our study received approval from the Ethics Review Board of our Institution. We performed a retrospective review of the case notes of all patients admitted to our hospital from January 2012 to October 2021 who presented with diabetic hindfoot infections and underwent subtotal calcanectomies. All authors had no conflicts of interest to declare.

The inclusion criteria the study were diabetic patients with clinical evidence of hindfoot soft tissue infection, with or without clinical or radiological evidence of calcaneal osteomyelitis. They also were pre-morbidly ambulant with or without the use of walking aids.

Patients who met the following exclusion criteria were removed from the study population; patients who underwent a conversion to major lower limb amputation, or those who had follow-up data of less than 6 months post-operatively. Patients with less than 6 months of follow-up may not have had a sufficient postoperative runway for rehabilitation, and thus would likely not have fulfilled their ambulatory potential. Patients with significant comorbidities like end stage renal failure or peripheral arterial disease were not excluded, even though these patients were at a higher risk of wound healing complications.

The patient parameters that were collected included demographics (age, gender, ethnicity), medical comorbidities, pre--morbid and post-operative mobility statuses, time to wound healing, as well as details of their surgical procedures.

All details were obtained via screening of electronic medical records. Their pre-operative and post-operative ambulatory status, as assessed by a combination of allied health professionals (physiotherapists, occupational therapists) in our institution, was also compared. The assessment by the allied health professionals were performed both during their inpatient stay, as well as during outpatient therapy follow-ups. The assessment of each patient's ambulation status was collected at a minimum duration of 6 months post-operatively. Our primary outcome measures were ambulatory status post-operatively, and time to complete wound healing.

All calcanectomies were done via an open approach, usually incorporating any open wounds present. Definitive calcanectomies were usually performed after multiple debridements to remove dead and infected tissue to achieve initial source control. Patients were operated on under a general or regional anaesthetic, with no tourniquet control and were either positioned prone or lateral decubitus. All infected and non-viable tissue were removed. The amount of calcaneus resected depended on clinical evaluation of the soft tissue condition, or was based off the extent of calcaneal osteomyelitis as evaluated on advanced radiological imaging (MRI).

The primary outcome measure used was return to mobility as determined by reports from clinical review or from professional allied health assessments.

2 patients had a supplementary external circular frame applied after their subtotal calcanectomies. 3 patients underwent an anterolateral thigh (ALT) flap following their calcanectomies.

Results

A total of 28 patients underwent subtotal calcanectomies for diabetic related hindfoot infections in our hospital from January 2011 to October 2021. 15 patients were excluded from the study due to conversion to below knee amputation (6 patients), inadequate duration of follow-up (7 patients), and pre-morbidly non-ambulant patients (2 patients). A total of 13 patients were included in the final analysis. Patients were followed up for a minimum of 6 months post-operatively. The duration of follow-up ranged from 6 to 96 months, with a mean follow-up duration of 20.2 months. Table 1 shows the characteristics of the study population.

We classified the ambulatory statuses for the study population into 2 broad categories; ambulant and non-ambulant. Within the ambulant population, this was further sub-divided into 3 groups; those ambulant without a walking aid, those requiring a walking stick, and those requiring a walking frame. The non-ambulant group comprised of patients who were pre-operatively wheelchair or bedbound. Graph 1 showcases the distribution of ambulatory statuses pre and postoperatively.

Of the 13 patients analysed, 5 (38.5%) maintained their pre--operative mobility after a subtotal calcanectomy. There were no patients who experienced an improvement in their ambulatory status. Notably, 2 of the 8 patients whose ambulatory status declined post-operatively also had subsequent contralateral below knee amputations which significantly affected mobility. Another had an ipsilateral transmetatarsal amputation performed for a midfoot infection. Hence, the proportion of patients maintaining their ambulatory status with an isolated subtotal calcanectomy was 5 out of 10 patients (50%).

Of the 13 patients, 9 (69.2%) had documented full wound healing. The mean time for full wound healing was 8.33 months. Of the 4 patients whose wounds did not heal, 2 had undergone an ALT flap procedure, with documented flap complications at the time of data collection. 1 patient demised at 11 months postop, prior to documented wound healing.

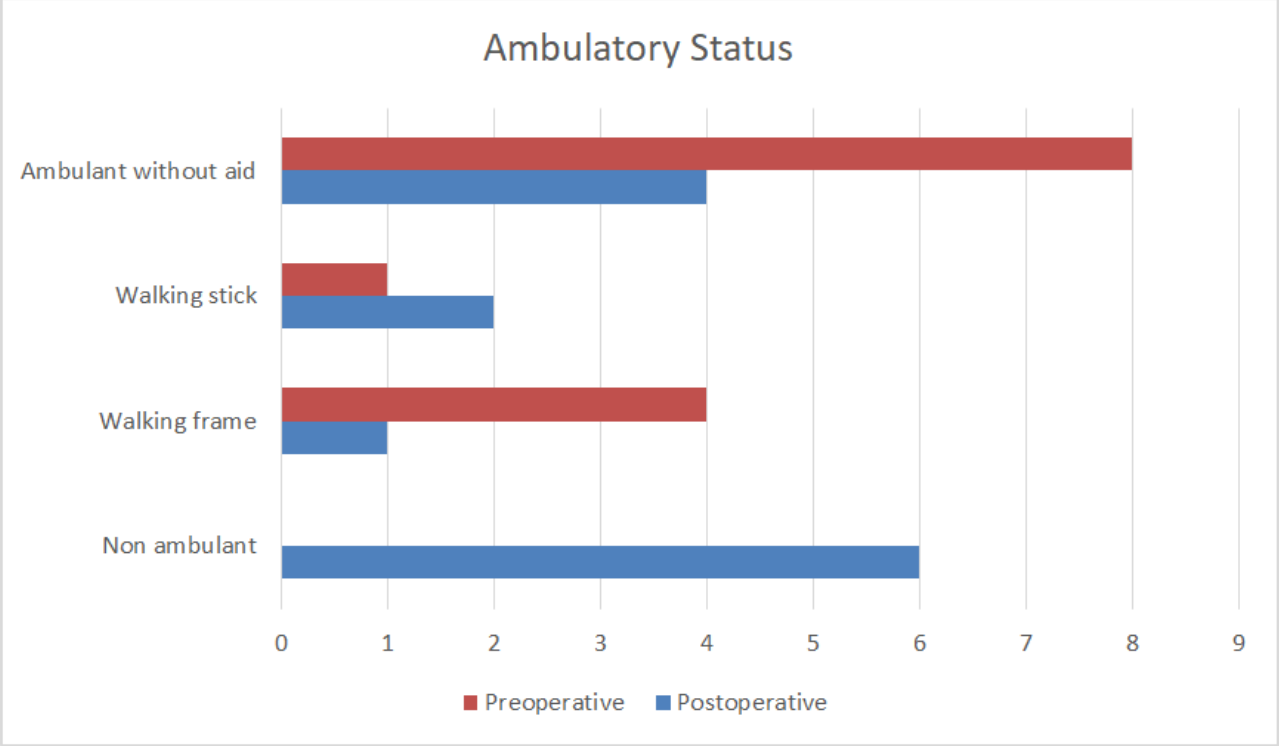
Table 1: Characteristics of Study Population (patients undergoing subtotal calcanectomy following diabetic hindfoot related infection)

Characteristics	Total Study Population (n=13)
Male	8
Female	5
Age (years), mean	57.2
Ethnicity	
- Chinese	9
- Malay	2
- Indian	2
- Others	0
Ethnicity (% breakdown)	
- Chinese	69.2
- Malay	15.4
- Indian	15.4
Co-morbidities	
Peripheral vascular disease	8

End stage renal failure	5
Ischaemic heart disease	5
Stroke	2

Table 2: Pre-operative and post-operative ambulatory statuses

Pre-operative ambulatory status	n=13	Post-operative ambulatory status	n=13
Ambulant	13	Ambulant	7
Without aid	8	Without aid	4
With walking stick	1	With walking stick	2
With walking frame	4	With walking frame	1
Non-ambulant	0	Non-ambulant	6



Graph 1: Pre and postoperative distribution of ambulatory statuses

6 out of 28 patients (21.4%) required conversion to a below knee amputation following their calcanectomy. Out of the 5 patients who maintained their ambulatory statuses, only 2 (40%) had documented peripheral vascular disease. In addition, only 1 out of 5 (20%) had end stage renal failure. Table 2 showcases the overall pre and post-operative ambulatory status for our study population. Table 3 showcases the breakdown of the change in ambulatory statuses for each category.

Table 3: Change in ambulatory status post subtotal calcanectomy

Maintained (n=5)	Ambulant without aid	4
	Walking stick	1
	Walking frame	0
Decreased (n=8)= Post-operative	Premorbid: Ambulant without aid (n=4)	
	Walking stick	1
	Walking frame	1
	Non-ambulant	2
	Pre-morbid: Ambulant with walking stick (n=0)	
	Walking frame	0
	Non-ambulant	0
	Premorbid: Ambulant with walking frame (n=4)	
	Non-ambulant	4

Discussion

Our study population is fairly representative of the overall Singaporean population in terms of the ethnic distribution. The 2020 Singapore Population Census is as such; the Singapore ethnic breakdown is 74.3% Chinese, 13.5% Malay, 9% Indian, with 3.2% classified as others. This is comparable to our study population distribution, with a slight increased representation in the Indian racial group.

There have been limited studies on the ambulatory outcomes following a calcanectomy for hindfoot related infections. These studies suggest that ambulatory outcomes following a calcanectomy are more favourable compared to currently published data on below knee amputations. In particular, a systematic review by Shade in 2012 revealed that 85% of post-calcanectomy patients either maintained or improved their ambulatory statuses post-operatively [14]. The studies that were included in the systematic review included patients with a fairly heterogenous surgical and postoperative regime. Inherently, the extent of the calcaneal involvement and amount of surgical debridement would also potentially vary widely between each case. Hence, we may not be able to accurately compare the results obtained. While our study results do not showcase such a similarly high proportion of patients maintaining their ambulatory statuses, a 50% proportion is comparable to currently published literature on post below knee amputees and their ambulatory statuses post-operatively with a prosthesis.

The healing rates showcased in our study is also comparable to locally published data on below knee amputations. In a prospective cohort study by Wong in 2013, 73.5% of below knee amputees had good stump healing within 6 months, and did not require more proximal amputations [9]. In comparison, 9 out of our 13 patients (69.2%) had documented full wound healing, with a mean healing time of 8.33 months. This further demonstrates that the subtotal calcanectomy has comparable wound healing rates compared to a below knee amputation, and is a viable limb salvage alternative to major lower limb amputations.

Our study also had a good representative cohort of patients, with good follow-up duration. We included patients with significant medical co-morbidities, and a spectrum of pre-operative ambulatory statuses. Patients with complex medical co--morbidities such as those with peripheral vascular disease or end stage renal failure were not excluded. This is highly reflective of the actual demographic of patients presenting with diabetic hindfoot related infections. The mean follow-up duration of 20.2 months also provided us with adequate data when it came to post-operative ambulatory as well as wound assessments.

However, our study is also limited due to the heterogeneity of our study population. As a retrospective study, we were unable to effectively control factors such as co-morbidities, wound size, surgical technique, and post-operative protocols

such as antibiotic therapy, offloading footwear/insoles, or weightbearing status. For example, the presence of peripheral vascular disease or end stage renal failure could negatively impact wound healing and therefore ambulatory status post-operatively. Poor pulses or a low ankle brachial pressure index have been shown to be associated with poor clinical outcomes following below knee amputations [9]. The lack of a standardised protocol following the subtotal calcanectomies in our series could have a potential impact on the interpretation of our results, as the escalation of the weightbearing status over the ipsilateral limb post-operatively would vary from case to case. This would undoubtedly affect the progress of physical therapy post-operatively and therefore the potential recovery of ambulation.

The low numbers in our study is also a limiting factor. Patients with diabetic related hindfoot infections are a difficult subset amongst those with diabetic foot infections, thus our institution saw a low volume of patients undergoing a subtotal calcanectomy who fit our inclusion and exclusion criteria. The necessary exclusion criteria significantly reduced the number of patients eligible for analysis. However, these criteria were necessary to accurately evaluate the effect that an isolated subtotal calcanectomy has on ambulatory status. A significant number of patients, 6 out of 28 (21.4%), were excluded due to conversion to below knee amputation, thus limiting the utility of evaluating their post-operative mobility for the purpose of this study. 2 out of 28 (7.1%), were also non-ambulant pre-operatively and were hence excluded from analysis.

A number of our patients also underwent subsequent coverage procedures, which included ALT flaps. Out of the 3 patients in our study who underwent ALT flap coverage procedures, only 1 had documented healing at 16 months post-calcanectomy. We propose that these additional coverage procedures may have delayed the weightbearing statuses for these patients, and may have made post-operative mobilisation more challenging. In addition, these coverage procedures are likely also associated with patients who have had a more extensive infection, and therefore a larger post-operative soft tissue defect.

Conclusion

A subtotal calcanectomy is a viable limb salvage alternative to major lower limb amputations in diabetic related hindfoot infections, with a significant proportion of patients (50 %) maintaining their pre-operative mobility statuses compared to currently published data on major lower limb amputations. Nearly 70% of our patients also had documented full wound healing, with a mean healing time of 8.33 months. Our case series also showed that approximately 21% of patients undergoing a subtotal calcanectomy eventually required a below knee amputation. Further studies may be needed on the rates of morbidity and mortality following a calcanectomy to further evaluate its role as an alternative to major lower limb amputations.

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