CHAPTER **29**

SUCCESS RATE AND COST ANALYSIS OF THE TRANSMETATARSAL AMPUTATION IN PERIPHERAL ARTERIAL DISEASE

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INTRODUCTION

It is estimated that the number of individuals in North America and Europe affected by peripheral arterial disease (PAD) is approximately 27 million.[1-3] The 3 major risk factors associated with PAD are diabetes mellitus, cigarette smoking, and individuals older than 40 years of age.[4] With a large percentage of the population older than 65 and the increase of incidence of diabetes, the number of individuals affected by atherosclerosis syndrome will progressively increase. Atherosclerosis is one of the most common causes of PAD. As a result of the atherosclerotic process, the artery narrows and becomes blocked reducing the amount of blood flow to the lower extremity at rest or during activity, which can be symptomatic or asymptomatic.[2-3]

As PAD progresses, individuals can develop ischemic rest pain, ulcerations, and gangrene which ultimately leads to amputation. One form of amputation that is indicated for gangrene of the digits[5] and nonreconstructible vascular disease[6] is the transmetatarsal amputation (TMA). This procedure has been advocated because it preserves the length of the limb and it allows for a functional weight-bearing extremity.[16,18-20] It is a relatively common procedure. In 2000, the number of procedures performed exceeded 12,000.[15] As the number of individuals diagnosed with PAD increases so will the number of TMAs.

In this era of fiscal restraints it has become increasingly important to consider the cost of medical care. As the number of individuals with PAD rises it is advantageous to evaluate the costs associated with the medical treatment of this disease. The literature reports on the cost of treating PAD with arterial revascularization[21-25] but there is a lack of cost information on the treating of PAD with TMA.

We will evaluate the success rate and the cost analysis of the TMA in PAD. We defined a successful TMA as a procedure resulting in complete healing leading to a remaining functioning limb. The cost analysis section evaluates the in-hospitalization and physical therapy/rehabilitation costs associated with the TMA.

METHODS

Patient Data

The inpatient and outpatient medical records of 42 patients who underwent a TMA from July 1998 to April 2005 were reviewed. Data collected on patients included age at time of surgery, sex, race, medical history, and smoking history. Additional information included previous contralateral extremity amputation and revascularization procedures either through bypass or stenting.

The inclusion criteria in this study, was dependent upon circulatory status. The circulatory status was determined by a thorough history and physical examination that included a history of intermittent claudication and rest pain, and objective findings of nonpalpable pedal pulses, ischemic ulcerations, and/or gangrene. PAD was defined as an ankle brachial index (ABI) of <0.9.[2,3] Confirmation of PAD was also performed by the Vascular Surgery Service. In this study, following the inclusion criteria of an ABI <0.9.[11] patients were excluded leaving 31 patients for evaluation.

A successful TMA was defined as complete healing with the patient retaining a functional weightbearing extremity. A failed TMA was defined as any nonfunctional extremity or any requiring a more proximal amputation. Reason for failure, time interval before a more proximal amputation, length of hospital stay, mortality, and followup were recorded.

Treatment followed simple guidelines and the surgical technique was similar to the technique described

by Sanders.[20] Treatment guidelines included debriding all necrotic tissue, preserving viable tissue, infected wounds being left open and appropriate antibiotic therapy were determined by wound fluid cultures and Gram stain results.

Cost Analysis

Hospital cost information was obtained, including charges for routine room and board and intensive care room and board, clinical laboratory services (i.e., chemistry), diagnostic radiology (i.e., angiography), operating room services (including nonprofessional anesthesia services), pharmacy, and all other inpatient services related to the admission. Rehabilitation (i.e., physical therapy) and prosthetic fees were included. Physical therapy fees were based on the National APC Fee Schedule for reimbursement. The prosthetic fees were based on the least expensive prosthesis available, a toe-filler with an arch support. Professional costs of the surgeon and the anesthesiologist were not included.

All costs were based on the fiscal year of 10/01/03 to 09/30/04. The costs were averaged solely on 8 patients who underwent TMAs for that fiscal year. Because these costs were determined based on one year, we opted not to adjust the costs based on the annual consumer price index.

To identify and quantify each cost associated with the TMA would be time consuming and labor intensive. Administrative and accounting services of the hospital record charges to costs as a cost to charge ratio. Costs are categorized into 2 groupings; direct and indirect. Direct costs refer to the costs associated with direct patient care (i.e., nursing, laboratory, pharmacy, etc.). Indirect costs refer to the costs associated with non-direct patient care (i.e., overhead, administrative fees, help provided by the computing department, cooling the building, etc.). This cost to charge ratio is based on the diagnosis-related groups (DRGs). DRGs are a classification of hospital case types into groups expected to have similar hospital resource use. The groups are based on diagnoses, procedures, age, sex, and the presence of complications or comorbidities (27). Medicare uses this classification (DRGs) to pay for inpatient hospital care.

RESULTS

A total of 31 patients were evaluated in this study (2 patients were unavailable at time of final followup, which left a total of 29 patients). Of the 29 patients, 4 patients underwent bilateral TMAs for a total of 33 extremities.

The average age at the time of surgery was 69 years with a range of 41 to 88 years. There were 7 (24%) females and 22 (76%) males. Four (14%) patients were African Americans, 11 (38%) were Mexican Americans, and 14 (48%) were Caucasian. Associated systemic diagnoses included diabetes mellitus (n = 20), coronary artery disease (n=10), end stage renal disease/nephropathy (n = 10), neuropathy (n = 9), hypertension (n = 16), hypercholesterolemia (n = 4), and retinopathy (n = 3). Eighteen (62%) patients either had a history of smoking or currently smoked during the time of the TMA, and 11 (38%) were nonsmokers. Demographic data can be found on Table 1. Table 2 provides data on the etiology of the TMA in the 33 extremities involved in this study.

Contralateral extremity or distal foot amputation had been previously carried out on 6 patients prior to their TMA. Revascularization procedures performed prior to the time of the TMA included superficial femoral-peroneal bypass (n = 5), femoral-tibial (n = 2), femoral-dorsalis pedis (n = 2), femoral-popliteal (n = 4), femoral-posterior tibial (n = 1), femoral-anterior tibial (n = 2), popliteal-dorsalis pedis (n = 1), popliteal-posterior tibial (n = 1), angioplasty (n = 3), 3 patients were nonbypassable, and the remaining extremities did not warrant any revascularization attempts prior to their TMA.

Of the 33 TMAs, 21 (64%) healed and returned to a functional limb. Only 1 required revisional surgery at the TMA level but ultimately healed. The average length

Table 1

DEMOGRAPHIC DATA OF PATIENTS WITH TMA

Age, years average (range)	69 (41 – 88)
Female/Male, no.	7/22
Race, no.	
African American	4
Mexican American	11
Caucasian	14
Systemic diagnoses, no.	
Diabetes mellitus	20
Coronary artery disease	10
ESRD/Nephropathy	10
Neuropathy	9
Hypertension	16
Hypercholesterolemia	4
Retinopathy	3
Smokers/nonsmokers, no.	18/11
Prior revascularization, no.	21
Bypass/stent	18/3

of hospital stay was 12 days (range, 4-30 days), and the average length of time to completely heal with a functioning limb after the TMA was 3 months (range, 21-10 months). At final followup (range 5 months to 6 years), all TMAs that healed continue to be without complications and optimally functioning.

Prior revascularization procedures occurred in 21 extremities (n = 18 with bypass and n = 3 with stents) and were associated with successful TMAs in 12 that were bypassed and 2 that were stented.

Of the 33 TMAs 20 extremities were of patients with diabetes mellitus and 15 of these 20 healed. There were a total of 12 extremities of patients that had diabetes mellitus and underwent vascular bypass or stenting, of the 12, 9 healed. Of the 18 patients who smoked or had a history of smoking, 13 healed. There were a total of 14 extremities of patients that had diabetes and a smoking history, of the 14, 9 healed. Of these 9: 4 had bypasses, 3 did not require vascular bypass or stenting, 1 was non-bypassable, and 1 had a stent. 15 patients had palpable pedal pulses and 13 of these 15 patients healed. Refer to Table 3 for healing rates.

Three individuals had previous below knee amputations (BKA) on their contralateral limb, 1 individual had a contralateral Lisfranc amputation prior to their TMA, and 2 had TMAs on their opposite limb. Eight patients (9 extremities) failed their TMAs and required an ipsilateral BKA and 2 patients (2 extremities) underwent above knee amputations (AKAs). Following the original TMA, 2 patients underwent contralateral TMAs and 2 pateints had a BKA on the contralateral side. One patient failed the TMA but was in terminal condition and was transferred to hospice care. The average time to having an ipsilateral amputation following the TMA was 6 months (range, 8 days to 4 years). Only 1 pateint was treated with progressively higher amputation solely as a result of attempted TMA.

No deaths followed the TMA, however 1 patient subsequently underwent an ipsilateral BKA and developed systemic sepsis during his hospitalization and died. One patient had bilateral TMAs and then an AKA on the left side following the TMA, but due to his terminal condition as a result of his multiple diagnoses he was transferred to hospice, as mentioned above.

The costs of the TMA associated with an average 12 day hospitalization, not including the surgeon or anesthesiologist fees totaled $17,133. The rehabilitation and prosthetic fees averaged $1,175. The total cost of the TMA for PAD is $18,308.

DISCUSSION

The survival rate of the transmetatarsal amputee varies widely from 40% to greater than 90%.[7-11,13,14] Prior revascularization procedures as well as the previously discussed major risk factors associated with PAD play a major role in the patient's final outcome. This study reported an overall TMA success rate of 64% in patients with PAD.

One of the most challenging and frustrating conditions a surgeon must face is infections of the forefoot combined with peripheral arterial disease. The goal of treating these problematic cases (ischemia with infection) is to preserve the limb function without endangering the patient. LaFontaine et al[14] indicated that early revascularization played an important role in limb salvage. This study reported that 14 of 21 patients (64%) who had revascularization prior to their TMA had a successful outcome.

Diabetes mellitus can also affect the overall success rate of a TMA. Twenty of the patients had diabetes mellitus and 15 of these healed having a 75% success rate. McKittrick and coworkers[5] reviewed 43 amputations in 40 patients, 30 of these patients had diabetes mellitus. They reported that 63.3% of the patients with diabetes

Table 2

HEALING RATES OF THE TMA

	No.	No. healed, (%)
Total TMAs	33	21 (64)
Prior Revascularization	21	14 (67)
Diabetes mellitus	20	15 (75)
Diabetes mellitus with revascularization	12	9 (75)
Smokers	18	13 (72)
Smokers with diabetes mellitus	14	9 (64)
Palpable pedal pulses	15	13 (87)

Table 3

DIAGNOSIS FOR TMA

Patient Diagnosis	Extremity No.	No. (%) healed
Ischemia	16	8 (50)
Ischemia with infection	17	13 (77)

had a successful healing rate. Hosch et al (13) reported having a 68.6% success rate of the TMA in diabetic patients with a 1 year followup. Our study findings correlate with these other researcher's findings in regard to success rates of healing in diabetic patients.

As mentioned earlier, smoking is another major risk factor associated with PAD. Medical problems largely caused by smoking include peripheral vascular disease, gastric and duodenal ulcers, and osteopenia with an increased risk of fracturing bones. In the last several years, there has been an interest in the adverse effects of smoking on soft tissue healing. Studies have shown that smoking causes vasoconstriction,[31] tissue hypoxia,[32] hypercoagulability,[33] decrease in collagen production,[34] and a delay in revascularization.[35] Despite the significant amount of studies showing the detrimental effects of smoking on healing, we found a high success rate among our patients with a smoking history. During the investigation, we divided the patients into two categories: those who smoked and those who did not. All patients that had a history of smoking but had quit were placed into the category of "smokers." Reviewing the "smoking" category revealed 11 of the 18 smokers had stopped smoking at least one year prior to their TMA, and of these that stopped, 8 patients (73%) went on to a successful outcome following their TMA. Our smoking category also contained six patients who were currently smoking at the time of their surgery. Of these 6, five (83%) healed their TMA, and so far have not needed any further amputations. Four of these 6 had some type of revascularization procedure prior to their TMA. Overall, 13 (72%) of those in the smoking category healed with a successful outcome following their TMA. We are unable to account for this high success rate amongst the smokers in comparison with other studies. Further study with a larger smoker patient population is warranted.

The third major risk factor linked with PAD is being over the age of 40. All of our patients were over 40, corroborating this mark as a significant factor.

Ankle brachial index, distal pulse pressure measurements, and transcutaneous oxygen mapping have all been advocated to determine the proper level of amputation.[11,28,29] There has been controversy over these diagnostic studies as to their reliability.[30] However, the physical examination is readily available to the surgeon. Palpable pulses distal to the femoral pulse have been shown to correlate with healing of distal amputation sites.[28] In this study, of the patients with a palpable pedal pulse 87% healed their amputation. Hodge and coworkers[7] found that over 60% of their cases healed their TMA site with palpable posterior tibial pulses and Efird et al[36] related that "patients without a popliteal pulse healed their amputation infrequently."

The advent of hospital reimbursement based on DRGs, mandates that surgeons evaluate treatment plans in terms of both effectiveness and cost-effectiveness. Our current costs of approximately $18,000 for the TMA allows for the anticipated Medicare DRG reimbursement of $20,000 for this category. This indicates the TMA to be a cost effective treatment.

CONCLUSION

The overall success rate for TMA reported by this study was 64%. Notable success rates were also found among those patients affected by diabetes mellitus, those patients that were smokers, and those patients who had previously undergone revascularization procedures. 75% of patients with diabetes mellitus, and 67% of patients with a previous stent or bypass procedure healed and retained a functioning limb. TMA also met cost effectiveness goals by not exceeding the allotted DRG amount for reimbursement. Due to our findings, this study concludes the TMA to be a physically as well as financially successful treatment option for the patient with peripheral arterial disease.

ACKNOWLEDGMENTS.

We would like to thank Nina Galvan and Lisa Laux in the financial department at Scripps Mercy Hospital for their help with the cost analysis.

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