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3-month postoperative complications after below-knee amputation in peripheral arterial disease

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Abstract
Purpose: The aim of this study was to evaluate the frequency and types of complications that may occur after transtibial amputation in patients with peripheral arterial disease and the risk factors affecting them.
Methods: 87 patients who were diagnosed with fe included. Complications occurring within 3months after transtibial amputation were retrospectively reviewed. For statistical analysis, logistic regression analysis was used and significant factors in the univariate analysis were used for statistical verification using multivariate analysis.
Results: 60 patients were male and 27 patients were female and average age of patients was 71.1(±11.06) years. There were 11 superficial infection or wound dehiscence of the stump site (12.6%), 17 deep infection (19.5%), 20 stump revisions (22.9%) and above-knee amputation was performed in 9 cases (10.3%). High ESR ($P < 0.028$) and multiple occlusion sites in 3D CT angiography ($P < 0.011$) were significantly associated with the rate of stump revision and chronic renal disease ($P < 0.007$) was independent risk factor of mortality.
Conclusions: More attention should be paid to postoperative management for the patients with chronic renal failure, preoperative high ESR and multiple stenotic lesions in 3D CT angiography.

Keywords: peripheral arterial disease, chronic renal failure, amputation, complications

Introduction
Peripheral arterial disease is defined as chronic occlusion or narrowing of the vessels of the lower extremity arteries, which can range from asymptomatic to ulceration and gangrene of lower extremity [1]. Transtibial amputation has been used to treat necrosis and inflammation of the foot caused by trauma, tumor, peripheral vascular disease or diabetes complications [2]. In addition, due to the aging of the population and changes in eating habits, the incidence of vascular disease increases and the number of amputations are also increasing [2, 3]. Transtibial amputations require sufficient experience, and complications such as inflammation and necrosis of the stump site may occur, which may lead to a revision surgery. The incidence of complications after transtibial amputation is known to be higher than for transfemoral amputation [2, 3] and about 9%~19% of patients are reported to have a reamputation such as transfemoral amputation [3, 4].
The aim of this study was to evaluate the frequency and types of complications that may occur after transtibial amputation in patients with peripheral arterial disease and the risk factors affecting them.

Materials and Methods
87 patients who were diagnosed with peripheral vascular disease from January 2012 to January 2018 and underwent transtibial amputation were included. Ages, sex, regular alcohol use, smoking, complications of diabetes, chronic renal failure, laboratory data (WBC count, ESR, C-RP, HgA1c, albumin), level of necrosis and prior minor amputation were recorded. The extent of necrosis before index surgery was examined and divided into forefoot, midfoot, hindfoot and above the ankle.
Computed tomograph (CT) angiography was analyzed for lower extremity vascular status. The area of stenosis was divided into deep femoral artery, superficial femoral artery, popliteal artery, tibio-fibular trunk, anterior tibial artery, posterior tibial artery and peroneal artery. The

Upper part of the popliteal artery was classified as the proximal part and the lower part as the distal part. Each stenotic lesion was classified into single or multiple lesions. The degree of stenosis was categorized as partial and complete occlusion using the Bollinger scoring system and scored. And the complications after transtibial amputation were analyzed in relation to score [5].

Complications occurring within 3months after transtibial amputation were retrospectively reviewed. Wound dehiscence, superficial infection, hematoma formation, pneumonia, deep infection, surgical revision for stump problems, sepsis, pulmonary embolism and mortality were defined as complications. The association with the aforementioned variables was examined.

For statistical analysis, logistic regression analysis was used and significant factors in the univariate analysis were used for statistical verification using multivariate analysis. Statistical significance for analyses was 0.05. this study was approved by IRB committee of Samsung Medical Center.

Results

60 patients were male and 27 patients were female and average age of patients was 71.1(±11.06) years. There were 44 patients with diabetes, 19 patients with chronic renal failure and 38 patients who underwent vascular treatment such as vascular intervention or bypass surgery prior to operation (Table 1). In 3D CT angiography, proximal lesions were 47 cases and distal lesions were 40, single lesions 26, and multiple lesions were 61 cases. The average Bollinger scoring system was 26.3±16.3 (Table 2).

Table 1: Baseline patient demographics

Variables	Value
Age	71.09±11.06
Gender(M:F)	62:25
Preop laboratoty data	
HbA1c (%)	8.17±2.55
ESR (mm/h)	60.74±33.74
CRP (mm/h)	94.37±89.57
WBC (x10^3 cells/$\mu\ell$)	12.24±7.47
Albumin (g/dL)	2.79±0.66
Level of wound(gangrene)	
Toes	22
Midfoot	33
Including heel	10
Above ankle	22
Previous amputation (Yes:No)	33:54
Medical comorbidities	
Diabetes	43
Chronic renal failure	19
Smoking	36
Heart disease	15
Hypertension	39
Alcohol use	15
Vascular treatment (stents or bypass) (Yes:No)	38:49

Table 2: 3D-CT lower extremity angiographic findings

		N	%
Location of occlusion	Proximal	47	54.02
	Distal	40	45.98
Number of occlusion	Single lesion	26	29.89
	Multiple lesions	61	70.11
Bollinger score(mean)	26.3±16.34		

Stump complications were superficial wound infection or dehiscence (12.6%), deep infection (19.5%), surgical revision for stump problems (23%), and transfemoral amputation (10.3%). Post-operative complications were pneumonia (6%), urinary tract infection (13%), cardiovascular problems (3%), acute renal failure (6%), and mortality (14.9%) (Table 3).

For risk factors of overall complications, high ESR and C-RP, prior foot amputation, and patients who did not undergo vascular treatment such as thrombectomy, vascular intervention or bypass surgery were statistically significant in univariate analysis, but not in multivariate analysis.

For each complications, there were no risk factors associated with superficial wound infection or dehiscence. There was a statistically significant increase in the incidence of deep infection in multivariate analysis with high Bollinger scores or those who did not undergo vascular surgery, and surgical revision was significantly increased in 3D CT angiography with multiple lesions and with elevated ESR. There were no risk factors associated with pneumonia, urinary tract infection, cardiovascular disease, acute renal failure and sepsis. The mortality rate within 3 months after transtibial amputation was significantly increased in patients with chronic renal failure (Table 4).

Table 3: 3-month postoperative complications

Complications	Value(N)	%
Superficial infection	11	12.64
Deep infection	17	19.54
Stump revision	20	22.99
Above knee amputation	9	10.34
Urinary tract infection	11	12.64
Pneumonia	5	5.75
End stage renal disease	5	5.75
Carviovascular events	3	3.45
Sepsis	5	5.75
Mortality	13	14.94

Table 4: Statistically Significant risk factors for deep infection, stump revision and mortality

Complications	Variables (risk factors)	Univariable		Multivariable	
		OR(95% CI)	P-value	OR(95% CI)	P-value
Deep infection	Bollinger score	1.03(1.01-1.07)	0.044	1.04(0.99-1.08)	0.048
Stump revision	ESR	1.02(1.01-1.04)	0.017	1.03(1.01-1.05)	0.028
	3D CT angiography (multiple lesion)	11.31(1.43-89.71)	0.022	34.06 (2.26-513.94)	0.011
Mortality	hypertension	5.17(1.31-20.40)	0.019	2.89 (0.46-17.99)	0.255
	chronic renal failure	9.16(2.53-33.22)	0.001	10.30 (1.91-55.55)	0.007

Discussion

Peripheral vascular or arterial disease is a systemic vascular disease in a broad sense excluding the brain and cardio-pulmonary circulation, but in a narrow sense it is defined as chronic obstructive vascular disease caused by atherosclerosis of the lower extremities [6]. Symptoms such as acute or chronic lower limb ischemia may occur, and as the disease progresses, ulceration or necrosis of the lower limb may be aggravated. In addition, it is known that complications occur at high rate when lower limb amputation for those symptoms is perfomed [1, 6-8].

The aim of this study was to evaluate the complications and identify the risk factors within 3 months after transtibial amputation in patients who was diagnosed with peripheral arterial disease.

Complications after transtibial amputation occur in about 20~40 %, and various complications have been reported from wound problems to mortality [2, 4, 9-11]. Ciufo *et al*. [1] reported that major complications occurred in 12.8% and minor complications in 8.7% after transtibial amputation, and among the complications, additional surgery was most frequently performed due to wound problems, accounting for 9.6%. Belmont *et al*. [2] reported that complications occurred in 34.4% of patients within 30 days after amputation and additional unscheduled surgery was the most common at 15.6%. Analyzing studies on risk factors for wound complication, smoking, diabetes, renal disease, hypertension, bleeding tendency and short operation times were reported as risk factors [2, 9, 10-12]. In our study, the surgical revision was performed at the highest rate of 22.9% and the incidence of deep infection at the stump site was significantly increased in multivariate analysis when Bollinger score was high, and high preoperative ESR or multiple lesions on 3D CT angiography were identified as risk factors for surgical revision. In other words, the authors found that infection at the stump site and decreased blood flow play an unfavorable role in postoperative wound management. When additional surgery is performed after the transtibial amputation, infection or necrosis of the stump site is the most common cause, which may lead to transfemoral amputation [2]. So, the authors should be careful about controlling infection and improving blood flow before amputation.

Lower extremities amputation due to peripheral arterial disease is performed in about 15-20% [1] Im *et al*.[13] reported that the rate of lower extremities amputation was reduced by medication or vascular intervention in the early stages of peripheral arterial disease and pain reduction or improvement of blood flow were also observed and no additional surgery occurred during the follow up period. However, they showed that vascular intervention did not reduce the rate of additional surgery as the disease progresses chronically. In our study, vascular therapy such as thrombectomy, vascular intervention and bypass surgery did not significantly reduce complications in multivariate analysis. This is because our study involved patients with peripheral vascular disease that is indicative of lower extremities amputation and about 38% of them had already undergone minor amputation. So, vascular surgery may not have contributed significantly to reducing complications in our study.

Lower extremities amputation is associated with a high mortality rate, which is known to be mainly due to old age or comorbidities [14, 15]. The mortality rate within 1 month after amputation is reported to be 4~22%, and the mortality rate within 5 years is reported as 40~82% for transtibial amputation and 40~90% for transfemoral amputation [14-16]. In most, old age, renal failure, diabetes, vascular disease and more proximal lower extremities are known risk factors for mortality [2, 15]. The mortality rate within 3 months in our study was about 14.9%, similar to that in other studies. Univariate analysis showed that end-stage renal failure and hypertension increased mortality but in multivariate analysis, only end-stage renal failure was identified as a risk factor for independence.

Among the patients included in this study, 49% had diabetes and 22% had renal disease and all patients underwent transtibial amputation. That means patients in our study had already chronic disease, and if so, more study is needed to determine whether amputation itself is associated with mortality or mortality increases with comorbidities because transtibial amputation itself may be a clinical indication of an exacerbated chronic condition of the patient. So, care must be taken in interpreting the results of our study.

The authors hypothesized that the greater the degree of obstruction in 3D CT angiography at the time of surgery, the greater the incidence of postoperative complications. Although the lower extremities vessel status was evaluated by CT angiography in this study, in CT angiography the incidence of surgical revision was increased statistically as the stenotic lesion was multiple or the Bollinger score increased. Because 3D CT angiography rather than distal subtraction angiography, may result in inaccurate classification of the vessel stenosis and the results before and after vascular treatment were not compared, care must be taken in the interpretation of the statistical significance of the occlusion status and complications. Hardman *et al*. [8] insisted that Boilinger classification could be used for CT angiography or MR angiography and Akai *et al*. [17] reported that the Bollinger scores on CT angiography showed no statistically significant difference from the score on digital subtraction angiography in peripheral arterial disease. However, further study is needed because arterial obstruction has no reliable classification or scoring system on CT angiography.

Conclusions

Transtibial amputation in peripheral arterial disease has a high rate of complications. So, more attention should be paid to postoperative management for the patients with chronic renal failure, preoperative high ESR and multiple stenotic lesions in 3D CT angiography.

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