

Association Between Medial Artery Calcification on Clinical Outcomes of Infrageniculate Revascularization with Diabetic Foot Tissue Loss

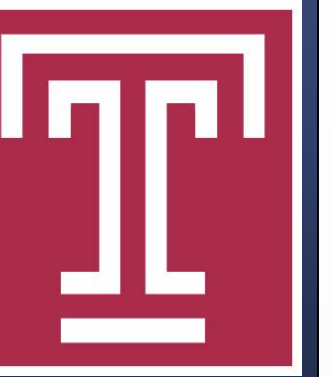
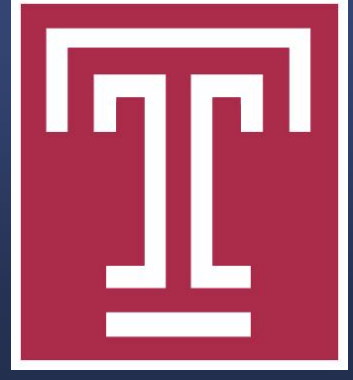
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Statement of Purpose and Literature Review

Diabetic foot tissue loss is a difficult to treat diagnostic spectrum owing to the complexity of underlying contributing factors including neuropathy, deformity, infection, and ischemia. Although ischemia might be addressed with revascularization procedures to optimize perfusion, the concomitant presence of medial artery calcification (MAC) has been demonstrated to occur at increased frequency in diabetics and has been associated with increased rates of amputation and death [1]. Despite the accepted recognition that MAC is one factor that might affect outcomes of lower extremity revascularization (LER) in patients with diabetic foot tissue loss, no studies have specifically examined the relationship between direct measures of MAC as noted on foot radiographs with outcomes of LER.

Therefore, the aim of this investigation was to evaluate the association between MAC and clinical outcomes following infrageniculate revascularization in the setting of relationship of diabetic foot tissue loss.

Methodology

Following IRB approval, a retrospective chart review was performed on patients with diabetes and lower extremity tissue loss who underwent tibial angioplasty over a 10-year period (2/2009-1/2019). Subjects were excluded if there was no evidence of tissue loss or ulceration at the time of angioplasty and/or if plain film radiographic images were not available for review.

Demographic information was collected including age, gender, ethnicity, history of tobacco usage, and other potentially confounding comorbidities. Wound characteristics were recorded by means of the Society for Vascular Surgery (SVS) wound grade and a frequency count of the presence of infection.

The presence and extent of MAC was scored on radiographs (Figure 1). Six specific anatomic locations were assessed with a score of 0-3 assigned. Other outcomes assessed included frequency counts of wound healing, recurrent ulceration, proximal amputation, and death.

Comparative and logistic regression analyses were performed to determine if measures of MAC were an independent predictor of clinical outcome.

Results

Figure 1
Medial Artery Calcification Scoring System



Medial Artery Calcification Scoring System

0 – Absent
1 – Mild and discontinuous
2 – Continuous
3 – Severe with obstruction

Assessed at 6 sites: 1. Anterior tibial, 2. Dorsalis pedis, 3. Posterior tibial, 4. Plantar, 5. Metatarsal, 6. Digital
-Up to 3 points possible at each site
-Minimum Score: 0; Maximum Score: 18

Ninety-six limbs in ninety-six patients met inclusion criteria and were included in the analysis. Of these 96, 31 (32.29%) went on to successful wound healing with limb preservation, while 30 (31.25%) went on to major amputation. Twenty-nine (30.21%) of the patients' wounds remained healed at their last follow-up.

The mean MAC score in those with proximal amputation was 8.67. A modest positive correlation was observed between MAC score and clinical outcome (0.136; p=0.238). Further, a statistically significant association was also observed with "severe" wound grades progressing to proximal amputation (p<0.035). An SVS wound grade 3 equates to a deep forefoot/midfoot ulcer, or full thickness calcaneal ulcer or heel necrosis and calcaneal involvement, or extensive gangrene involving forefoot/midfoot. A statistically significant association was also noted between age and proximal amputation (p<0.006) on univariate analysis. Age and wound grade remained significant predictors of amputation on multivariate analysis.

Table 1
Demographic characteristics of subjects

Patient Characteristics	
Age (mean)	66.61
Male (%)	68.75
Hypertension (%)	94.79
Hyperlipidemia (%)	53.12
Former or Current Tobacco Use (%)	56.25
Hemodialysis (%)	26.04
Coronary artery disease (%)	46.88
HbA1c (mean)	8.59
Insulin use (%)	69.79
Neuropathy (%)	62.50
Infection on clinical exam (%)	36.46
Osteomyelitis (X-ray) (%)	28.12
Local superficial infection (%)	6.25
Local extensive/deep infection (>2 cm) (%)	30.21
Local infection + SIRS (%)	7.29
Society for Vascular Surgery Wound Grade	
1 - Small Ulcer (%)	33.33
2 - Deep Ulcer/Gangrenous Digits (%)	55.21
3 - Extensive Ulcer/Gangrene (%)	11.46
Prior Revascularization (%)	37.50

Table 2
Frequency and Degree of Medial Artery Calcification

Arterial Location	Frequency (%)
Anterior tibial	
0	16 (16.67)
1	25 (26.04)
2	42 (43.75)
3	13 (13.54)
Dorsalis pedis	
0	18 (18.75)
1	30 (31.25)
2	40 (41.67)
3	8 (8.33)
Posterior tibial	
0	13 (13.54)
1	26 (27.08)
2	54 (56.25)
3	3 (3.12)
Plantar	
0	26 (27.08)
1	39 (40.62)
2	28 (29.17)
3	3 (3.12)
Metatarsal	
0	22 (22.92)
1	23 (23.96)
2	49 (51.04)
3	2 (2.08)
Digital	
0	47 (48.96)
1	27 (28.12)
2	21 (21.88)
3	1 (1.04)

Table 3
Mean MAC score divided into quartiles and univariate analysis of MAC score

MAC score (by quartile)	Frequency (%)	Mean MAC Score	Min	Max
1	27 (28.12)	2.185	0	5
2	22 (22.92)	6.909	6	8
3	29 (30.21)	9.862	9	11
4	18 (18.75)	12.833	12	18
MAC score (by quartile)	Odds Ratio	Std. Error	p Value	95% Conf. Int.
2	0.7177778	0.5607779	0.727	(0.189295, 3.1957)
3	3.266667	1.939148	0.046	(1.02051, 10.456)
4	1.75	1.192424	0.411	(0.460301, 6.6532)

Table 4
Multivariate Logistic Regression of Patient Age, SVS Wound Grade, and MAC score (by quartile) on Outcome of Amputation

	Odds Ratio	Standard Error	p Value	95% Conf. Interval
Age	0.944301	0.241147	0.009	(0.8883416, 0.98290)
SVS Wound Grade				
2	0.5244189	0.2851768	0.235	(0.1806336, 1.5225)
3	5.329008	4.481127	0.047	(1.02536, 27.695)
MAC Score (by quartile)				
2	0.8304621	0.655088	0.814	(0.1769588, 3.8973)
3	2.473745	1.645778	0.173	(0.6715093, 9.1129)
4	1.787886	1.344347	0.440	(0.4095477, 7.805)

Discussion

These results indicate a modest positive correlation between MAC scores and clinical outcome following infrageniculate lower extremity revascularization in the setting of diabetic foot tissue loss. Prior studies have demonstrated increased rates of major amputation in patients with MAC as well as those with peripheral artery disease (PAD) [1,2]. However, the relationship between MAC and PAD is still not completely understood. Guzman et al. attempted to determine whether increased MAC scores in patients with foot ulcers may be explained by underlying PAD and found that there is a correlation between MAC and diabetic foot tissue loss which remains independent of arterial occlusion [3]. Zettervall et al. noted that lower extremity arterial calcifications are independently correlated to increased categories of ischemia in patients with PAD [4]. Aragon-Sanchez and Lazaro-Martinez studied patients with pedal calcifications to determine if their presence played any role in short-term outcomes. They determined that differences in outcomes were secondary to the relationship of pedal calcification and PAD [5].

This study provides evidence that the presence of MAC might be associated with clinical outcomes after LER. Therefore this data might be beneficial in improving patient and procedure selection when considering limb preservation, and lead to future investigations of predictive clinical markers of successful limb preservation.

References

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