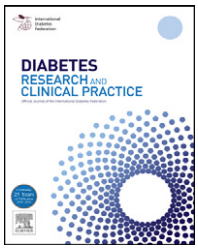
Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation



C-reactive protein as an outcome predictor for percutaneous transluminal angioplasty in diabetic patients with peripheral arterial disease and infected foot ulcers

Cheng-Wei Lin [a], *Lung-An Hsu* [b], *Chun-Chi Chen* [c], *Jiun-Ting Yeh* [d], *Jui-Hung Sun* [a], *Chia-Hung Lin* [a], *Szu-Tah Chen* [a], *Brend Ray-Sea Hsu* [a], *Yu-Yao Huang* [a,*]

[a] *Division of Endocrinology and Metabolism, Department of Internal Medicine, Chang Gung Memorial Hospital, Chang Gung University, 5 Fusing St., Gueishan Township, Taoyuan County 333, Taiwan, ROC*

[b] *The First Division of Cardiology, Department of Internal Medicine, Chang Gung Memorial Hospital, Chang Gung University, Taiwan, ROC*

[c] *The Second Division of Cardiology, Department of Internal Medicine, Chang Gung Memorial Hospital, Chang Gung University, Taiwan, ROC*

[d] *Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Chang Gung University, Taiwan, ROC*

ARTICLE INFO

Article history:
Received 14 March 2010
Received in revised form
1 August 2010
Accepted 1 August 2010
Published on line 6 September 2010

Keywords:
Percutaneous transluminal angioplasty (PTA)
Peripheral arterial disease (PAD)
Infected foot ulcer
Lower-extremity amputation (LEA)
C-reactive protein (CRP)

ABSTRACT

Aim: Although percutaneous transluminal angioplasty (PTA) is an effective therapeutic procedure for critical limb ischemia, several clinical factors can influence the outcome of PTA for peripheral arterial disease (PAD). The aim of this study is to identify the outcome predictors of PTA in infected diabetic foot patients with PAD.

Methods: Eighty-five diabetic patients with a total of 90 infected limbs treated by PTA participated in this study. Patients were initially admitted for infected foot ulcers and were later diagnosed with PAD. Even though all patients underwent successful PTA within 15 days of admission, limb salvage was successful in 66 cases while 24 underwent subsequent amputation. The clinical characteristics and laboratory variables of both groups before PTA were compared and analyzed.

Results: Significantly higher level of C-reactive protein (CRP) was observed in the major amputation group before PTA. The cutoff value via receiver operating characteristic curve was 50 mg/L (81.8% specificity, 70.7% sensitivity). Multivariate logistic regression analysis revealed that CRP levels may serve as valuable marker in determining a successful outcome.

Conclusion: Reduced CRP levels (<50 mg/L), which indicates a low infection severity, may serve as a major predictor of successful PTA outcome in diabetic patients with infected foot ulcers.

1. Introduction

Unlike most vascular complications of diabetes, such as myocardial infarction or cerebral vascular accidents, the mortality rates associated with peripheral arterial disease (PAD) are relatively low, except when it coexists with severe sepsis. However, PAD is associated with considerable morbidity as a result of lower-extremity amputation (LEA) [1].

Most vascular guidelines recommend revascularization, which includes percutaneous transluminal angioplasty (PTA) procedures when treating diabetic patients with PAD—especially when patients present signs of critical limb

* *Corresponding author*. Tel.: +886 3 3281200x8491; fax: +886 3 2115386.
E-mail addresses: yyh@adm.cgmh.org.tw, yyh@cgmh.org.tw (Y.-Y. Huang).

0168-8227/$ – see front matter
doi:10.1016/j.diabres.2010.08.002

ischemia (resting pain or progressive tissue loss) refractory to conservative therapy [2–6].

Although limb ischemia is considered to be a major independent factor of LEA; other factors such as foot infection, glycemic control, neuropathy, and impaired renal function may also combine to affect outcomes [1,3,7,8]. Thus, successful revascularization does not assure a satisfactory outcome of an infected diabetic foot.

The aim of this study was to identify the predictors of clinical outcomes of PTA in diabetic patients with both infected foot ulcers and PAD.

2. Subjects

From January 2004 to September 2009, type 2 diabetic patients admitted to Chang Gung Memorial Hospital in Taiwan for treatment of infected foot lesions were retrospectively reviewed. A total of 85 subjects who were diagnosed with PAD and had successfully undergone PTA for 90 lower limb ulcers were enrolled in this study. Of the 90 infected limbs, 66 responded well to PTA and patients were discharged without LEA—these cases were categorized in the limb salvage group (LSG); the 24 cases of subsequent amputation were categorized in the major amputation group (MAG).

3. Methods

The patients were cared for by a comprehensive interdisciplinary team of health professionals that included diabetologists, cardiologists, vascular, plastic and orthopedic surgeons, dietitians, educators, and nurse practitioners. The patients were promptly administered empirical systemic antibiotics based on their clinical presentations and their wounds were debrided and dressed; the antibiotic regimens were adjusted after the susceptibility test results were available. Surgical interventions, such as debridement, drainage, and digital or foot amputation, were scheduled after the interdisciplinary team reached a consensus. Our definition of major amputation was amputation of the foot above the ankle whenever overwhelming infection threatened the patient's life, or the existence of extensive foot necrosis in accordance with the recommendations of the American Diabetes Association in 2003 [6].

The existence of PAD was confirmed by color duplex imaging and ankle–brachial index (ABI). PTA was scheduled immediately after PAD diagnosis and after the interdisciplinary team reached a consensus, and were performed by cardiologists; all patients underwent PTA within 15 days of admission (Table 1). Preliminary angiographic studies were performed using six or seven French gauge sheaths. Superficial femoral and popliteal artery lesions were recanalized using 0.014 or 0.035-in. wires and dilated using 3.5–6 mm diameter balloon catheters while infrapopliteal artery lesions were recanalized using 0.014-in. coronary wires and dilated using 1.5–3.0 mm diameter balloon catheters. The diameters of balloon catheters were between 20 and 30 mm, and the dilation duration was approximately 60–90 s. Stents were not used because of potential infection risks. During the procedure, 5000 IU sodium heparin infusion was administered. If vessel spasms occurred, 0.1–0.2 mg nitroglycerine was infused as an intra-arterial bolus. In this study, a successful PTA dilation was defined as when residual stenosis was <40%.

The study protocol was approved by the institutional review board of Chang Gung Memorial Hospital. We collected patient histories, including age, sex, body height, body weight, duration of diabetes, co-morbidities of cardiovascular diseases, hypertension, and cigarette smoking history. Laboratory variables were measured by performing hemograms, investigating blood

Table 1 – Comparison of clinical characteristics between limb salvage and major amputation groups.

Variables	Limb salvage (n = 66)	Major amputation (n = 24)	P-value
Age (years)	70.45 ± 10.77 (n = 66)	67.46 ± 10.17 (n = 24)	0.240
Body weight (kg)	60.17 ± 10.26 (n = 50)	61.36 ± 9.27 (n = 20)	0.655
Body height (cm)	159.36 ± 8.28 (n = 39)	159.85 ± 6.78 (n = 20)	0.820
Gender			0.824
Male	51.5% (n = 34)	54.2% (n = 13)	
Female	48.5% (n = 32)	45.8% (n = 11)	
DM[a] duration (years)	15.32 ± 8.96 (n = 66)	14.38 ± 7.89 (n = 24)	0.925
Smoking	33.3% (n = 22)	45.8% (n = 11)	0.277
Hypertension	68.2% (n = 45)	70.8% (n = 17)	0.810
CAD[b] or IHD[c]	16.7% (n = 11)	20.8% (n = 5)	0.648
CVA[d]	28.8% (n = 19)	37.5% (n = 9)	0.430
Dialysis	21.2% (n = 14)	37.5% (n = 9)	0.117
Wagner grade			0.144
2	33.3% (n = 22)	16.7% (n = 4)	
3	30.3% (n = 20)	25.0% (n = 6)	
4	36.4% (n = 24)	58.3% (n = 14)	

[a] DM: diabetes mellitus.
[b] CAD: coronary artery disease, confirmed by coronary angiography.
[c] IHD: ischemic heart disease, confirmed by echocardiography, electrocardiography, treadmill, thallium heart scan, or history of acute coronary syndrome.
[d] CVA: cerebral vascular accident, including embolic, ischemic, or hemorrhagic stroke.