Limb Salvage in the Era of Endovascular Intervention: Observation Study

Abdulaziz Z Algaby,[1] Alaa A Marzouk,[1] Usama S Imam,[1] Safwat A Taha,[2] Mohamed H Abdelmawla[1]

[1]General and Vascular Surgery Department, Faculty of Medicine, Beni-Suef University, Egypt

[2]General and Vascular Surgery Department, Al-Agouza Police Hospital, Egypt

Objectives: Critical limb ischemia (CLI) occurs due to progressive obstructive nature of atherosclerosis disease. Nowadays, there is widespread use of endovascular revascularization procedures for restoration of blood flow in CLI. The aim of this study is evaluation of the efficacy of endovascular intervention in patients with critical limb ischemia.

Methodology: This is a prospective observation study. It included patients presenting with chronic atherosclerotic critical lower limb ischemia to the department of vascular surgery, in Beni-Suef University Hospital or Al-Agouza Police hospitals, during the period of October 2017 till April 2020. Patients included were patients with chronic critical limb ischemia eligible for endovascular intervention. Excluded ones were patients with severe tissue loss of the foot beyond salvage, orthopnea, and whose anatomical lesion was distributed to TASC II D classification. Study end points were limb salvage, procedural complications, and conversion to open surgery. A written consent was obtained from participants for data disclosure. Detail of the procedure (endovascular intervention), its indications, methods, risks, and outcome were explained for every patient.

Results: The current study included 220 patients. The mean age was 60.65 years ± 10.8 years, 143 males (65%) and 77 females (35%), 132 patients (60%) were smoker, 127 were hypertensive, 176 patients (80%) were diabetic, 55 cases (25%) had Coronary Artery Disease (CAD), 11 (5%) patients suffered from COPD, 11 cases (5%) had end stage renal disease (ESRD), and 44 cases (20%) had renal insufficiency. The mean follow up period was about 9 months. 36 (16.4%) patients were distributed into TASC II A, 76 (34.5%) were distributed to TASC II B, and 108 (49.1%) patients were distributed to TASC II C. 182 (82.7%) patients had their limb saved while 38 (17.3%) of cases had either their limbs lost (23 patients), suffered from peri-procedural mortality (5 patients) or open surgery conversion was decided (10 patients). Statistical correlation showed that predictors of limb loss were hypertension, CAD, and COPD patients.

Conclusion: Endovascular revascularization is effective for patients with critical limb ischemia, where it provides a high limb salvage rate (LSR). Some variables are associated with worse outcome like hypertension, COPD and CAD.

Key words: Critical limb ischemia, limb salvage, endovascular.

Introduction

Peripheral arterial disease (PAD) is now well known of its high risk with great morbidity and mortality. In addition, its burden on social, economic and psychological life of the patient as well as his family and society is well known. So, a great attention is paid to the proper management of this disease.[1] The sever form of PAD is called critical limb ischemia (CLI). It describes chronic ischemic pain of at least of 2 weeks duration, ischemic ulcer and/or ischemic gangrene. The diagnosis should be confirmed by hemodynamic studies.[2] CLI may be associated with coronary artery disease (25%) as atherosclerosis is a systemic disease. In addition the risk of major amputation in patients with CLI is quietly high ranging from 10% to 40%. Besides, treatment of CLI is quite expensive and quality of life may be affected.[3] Successful treatment of patient with CLI has been proved to affect the outcome of disease progression. Endovascular intervention and its evolution in treating those patients changed its morbidity and mortality to a great extent.[4] Moreover, its accepted safety made it the treat of choice in a lot of cases.[5] The current study was designed to show sequelae and limb salvage in patients with CLI in the era of endovascular intervention and detect variables that may affect outcome.

Patients and method

It was a prospective study that observed patients presenting with chronic atherosclerotic critical lower limb ischemia at the department of vascular surgery, in Beni-Suef University Hospital or Al-Agouza Police hospitals. Inclusion criteria: Patients with critical limb ischemia due to atherosclerosis were included. Chronic critical lower limb ischemia was defined according to the TransAtlantic Inter-Society Consensus (TASC) II guidelines as lower limb with more than 2 weeks of rest pain, ulcers, and/or tissue loss attributed to arterial occlusive disease.

Exclusion criteria

- Patients presenting with severe tissue loss or whole foot lost.
- Patients presenting with ejection fraction less than 35%.
- Patients presenting with orthopnea.
- Ischemia due to causes other than atherosclerosis.
- Patients whose lesions were not amenable for endovascular intervention (TASC II D patients' group).

Preprocedural Assessment: All patients were subjected to history taking, careful physical examination, and radiological imaging. As the procedure is considered the standard treatment of choice in the selected cases, it was explained for the patient and consent for data disclosure was taken. This study was approved by the institutional review board and ethics committee of Beni-Seuf University Hospital.

Procedure

- All endovascular procedures were done under local anesthesia.
- Arterial Access was accomplished using 6 F Introducer Sheath. Antegrade ipsilateral common femoral artery puncture was preferred for femoropopliteal lesion and for infrapopliteral artery lesions.
- Both contralateral femoral puncture and cross over technique and retrograde ipsilateral puncture of the popliteal artery were performed when the lesion was very close (less than 1 cm) to the SFA origin.
- The lesions were crossed using a hydrophilic guide wire over an angled-tip diagnostic catheter. For femoro-popliteal arterial lesions, 0.035 inch hydrophilic guide wires were used but, for infrapopliteal arterial lesions hydrophilic 0.018 inch guide wires were used. Angioplasty balloons length selected to match the length of the lesion and the diameter of the non-diseased artery adjacent to the lesion on CT or angiography. Balloon inflation pressures ranged from 4 to 16 atmospheres and maintained from 2 to 3 minutes. Stents in SFA lesions were placed for flow-limiting dissections or suboptimal angioplasty results (residual stenosis >30%).
- If a stent is indicated, a self-expanding stent was used apart from lesion of common iliac artery where balloon expandable stent was used.
- Post procedure angiography: Completion angiography was done immediately after the endovascular procedure.
- Debridement of all gangrenous and necrotic tissue if present was performed immediately after the end of the endovascular procedure. The patients were given dual oral antiplatelet therapy (clopidogrel 75-150 mg/day for at least 6 months and aspirin 75-150 mg/day for life-long).

Post-procedure follow up

The outcome was evaluated for every case immediately post-procedure, 3, 6 and 12 months later. On follow-up, clinical success was detected by improved patient symptomatology, clinically presence of distal pulse and healing of tissues. Duplex was done routinely.

Endpoint

Primary endpoints were technical success, clinical success represented by limb salvage, peri-procedural mortality, and conversion to open surgery. Secondary endpoints were procedural complications.

Definitions

- Technical success was diagnosed by patent completion angiography with less than 30% residual stenosis at the narrowest point of the arterial lumen and clinical retrieval of distal pulse.
- Clinical success which is improvement of the presenting symptoms represented mainly by limb salvage.
- Limb salvage with endovascular intervention was defined as prevention of major limb amputation (limb loss below or above the knee) and avoidance of conversion to open surgery or peri-procedural mortality.
- Peri-procedural mortality: that included procedural or early post-procedural mortality within 30 days.

Data collection and statistical analysis

Double data entry was performed in an electronic database to generate descriptive data summaries. Data were statistically described in terms of mean ± standard deviation (±SD), median and range, or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the studied groups was done using Student t test for independent samples. For comparing categorical data, Chi square (X2) test was performed. Exact test was used instead when the expected frequency is less than 5. P values

equal or less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows. All pre-procedural and post procedural complications were evaluated and documented.

Results

The current study included 220 patients from October 2017 till April 2020 suffering from CLI submitted to endovascular revascularization. The mean age was 60.65 years with a SD of 10.8 years. Studied cases were 143 males (65%) and 77 females (35%) with a male: female ratio near to 2:1. Smoking had been reported in 132 patients (60%). **Table 1** demonstrates the chronic diseases history of the studied cases; two-thirds (127) of the cases suffered from systemic hypertension (HTN). The majority of patients were diabetic (DM), 176 patients (80%). Coronary Artery Disease (CAD) was detected in 55 cases (25%). 11 patients (5%) suffered from chronic obstructive pulmonary disease (COPD). 11 cases (5%) had end stage renal disease (ESRD) on regular dialysis while 44 cases (20%) had renal insufficiency. According to Rutherford classification for chronic lower limb ischemia, 88 patients (40%) presented with rest pain and 132 patients (60%) with ulcer or tissue loss as shown in Table 2. The mean follow up period was about 9 months. 36 (16.4%) patients were distributed into TASC II A, 76 (34.5%) were distributed to TASCII B, and 108 (49.1%) patients were distributed to TASC II C. As demonstrated in **Table 3**; out of studied 220 cases, 182 (82.7%) patients had their limb saved while 38 (17.3%) of cases either submitted to major amputation (23 patients), suffered from peri-procedural mortality (5 patients), or open surgery conversion was decided (10 patients). The peri-procedural (30-day or in-hospital mortality) mortality was 5 patients (2.3%). **Table 4** illustrates no detected relation between limb salvage with endovascular intervention and basic characteristics of the studied cases; p-values > 0.05. But, there are detected relation between limb salvage and some variables of patient's comorbidities. Failure of limb salvage with endovascular intervention was significantly higher among cases suffered from hypertension, where about 30% of cases with high blood pressure suffered from limb loss (p value= 0.013). The presence of diabetes has not been found to be statistically significant in relation to limb salvage (p value= 0.108). Also, failure of limb salvage with endovascular intervention was significantly higher among cases with coronary artery disease; 60% of cases with CAD suffered from failure with a statistically significant difference (p-value= 0.030). All cases with COPD had limb loss with a statistically significant difference (p value= 0.027). Other chronic diseases were not related to the occurrence of limb salvage with endovascular intervention among the studied cases; p- values> 0.05. Sex distribution had no effect as shown by p value (p = 0.529). Also, smoking did not show influence on limb salvage with endovascular intervention (0.592). Neither ESRD nor renal insufficiency seems to have effect on limb salvage with endovascular intervention. P value respectively 0.677 and 0.569.

Table 1: General characteristics of the studied population; (n=220)

Variable		Frequency	Percent
Age (years)	Mean ±SD	60.65 ±10.8	
	Minimum	40	
	Maximum	85	
Sex	Male	143	65.0%
	Female	77	35.0%
Smoking		132	60.0%
HTN		127	58%
DM		176	80%
CAD		55	25%
COPD		11	5%
ESRD		11	5%
Renal insufficiency		44	20%

Table 2: Clinical presentation among the studied population; (n=220)

Manifestation	Number	Percent
Rest Pain	88	40.0%
Tissue loss	132	60.0%

Table 3: Limb salvage rate (LSR) with endovascular intervention

	Number	Percent
Amputation Free Survival		
Yes	182	82.7%
No	23	10.5%
Peri-procedural mortality	5	2.3%
Conversion to open surgery	10	4.5%

Table 4: Relation between limb salvage with endovascular intervetion, patients' characteristics and medical history variables of the studied cases

	Limb salvage		P-value
Patients' variable	**Yes**	**No**	
Sex			
Male	116 (63.7)	27 (71.1)	0.529
Female	66 (36.3)	11 (28.9)	
Age	60.45 ±10.8	61.57 ±11.6	0.807
Smoking			
(Yes)	110 (60.0)	22 (57.1)	0.592
(No)	72	16	
HTN			
(Yes)	88 (69.6)	39 (30.7)	0.013*
(No)	93 (100)	0 (0.0)	
DM			
(Yes)	138 (78.4)	38 (21.6)	0.108
(No)	44 (100)	0 (0.0)	
CAD			
(Yes)	22 (40.0)	33 (60.0)	0.030*
(No)	145 (87.8)	20 (12.2.)	
COPD			
(Yes)	0 (0.0)	11 (100.0)	0.027*
(No)	181 (86.6)	28 (13.4)	
ESRD			
(Yes)	11 (100.0)	0 (0.0)	0.677
(No)	171 (81.8)	38 (18.2)	
Renal insufficiency			
(Yes)	39 (88.6)	5 (12.4)	0.569
(No)	143 (81.2)	33 (18.8)	

* Indicates p value equal or less than 0.05.

Discussion

Critical limb ischemia (CLI) is the clinical end stage of peripheral artery disease. It develops within five years in 5–10% of patients older than 50 years of age diagnosed with PAD.[4] Revascularization strategies changed from traditional bypass surgery to endovascular intervention due to rapidly evolving equipment with less morbidity than open surgery.[6] Endovascular interventions have become the standard and preferred option in a lot of cases because it is performed under local anesthesia, suitable for patients at high anaesthetic risk, it has low mortality and it has acceptable results.[4]

So, current study aimed to assess the outcome of endovascular intervention in patients with CLI. It assesses the rate of limb salvage and detects variables correlated with the outcome.

This study included 220 patients suffered from CLI who underwent endovascular revascularization. The mean age was 60.65 ±10.8 years. In a line with the current study, Ghoneim et al. (2014) included 511 cases of CLI with the mean age was 64.5 years.[7] Screening for sex as risk factors for CLI has shown that 65% of the patients belonged to the male sex. The studied cases were a male: female ratio near to 2:1. Smoking had been reported by 60% of studied cases. That is in agree with most of the published literature.[8-10] The current study demonstrates the chronic diseases history of the studied cases; two-thirds (127) of the cases suffered from systemic hypertension. The majority 176 of patients (80%) were diabetics. Coronary Artery Disease (CAD) was detected in 55 (25%) of cases. About 11 cases (5%) suffered from COPD. 44 cases (20%) had renal insufficiency with about 11 cases (5%) were on regular renal dialysis. The current study results were coinciding with Lida et al., 2012 study, the main associated comorbidity was 69% diabetic, 52% cardiac, 3% COPD, 30% smokers, 29% stroke and 77% hypertensive and 60% renal insufficiency.[10] Engelhardt et al., (2012) found that, the main associated comorbidity was 54.8% diabetic, 69% cardiac, 15.4% COPD, 43% smokers, and 83.7% hypertensive and 8.7% renal insufficiency.[11] In Ghoneim et al. (2014) study, the main associated comorbidity was 87.9% diabetic, 61.3% smokers, and 67.3% hypertensive. Other associated diseases included 39.1% of cardiac patients.[7] The higher incidence of diabetes and smoker in the current study may be attributed to increased incidence of atherosclerosis with these risk factors. Also cardiac patients showed worse limb salvage and primary patency.

In current study, out of studied 220 cases only 182 cases had their limb with endovascular intervention (82.7%) at one year which is comparable to limb salvage rate (LSR) in other studies.[5,7,9,12-18] In a study done by Bakken et al., (2007) they reported 1- year limb salvage rates of 91% for endovascular therapy (EVT) compared with current study's 1-year limb salvage rates of 82.7% for CLI patients.[12] It was found by Dattilo and Casserly (2011) that it is apparent that endovascular therapy for CLI is associated with high rates of technical success (90%), low rates of peri-procedural mortality (2%), considerable complications (5%) and that intermediate term (1–2 years) limb salvage rates of more than 80%.[13] Another study was done by Conrad (2011) on 409 CLI patients. The patients underwent infra-inguinal PTA ± stent for CLI management. The LSR in that study was 88.4% at one year.[14] O'Brien Irr et al (2011) reported analysis of 106 infra-inguinal interventions for CLI with limb salvage rate of 83% at 2 years in patients with tissue loss.[15] Engelke et al. (2011) registered an overall limb salvage rate of 83% with a mean follow-up of 25 months (range nine to 48 months).[16] Several studies reported limb salvage rates of 57–79 % at one year.[19-21] Bae et al reported in a retrospective study on 189 limbs with CLI treated with multilevel endovascular revascularization that LSR was 94.8% at 1 year.[5] Okamoto et al., (2015) reported that wound healing was 87% in study included 211 patients with CLI caused by infra- inguinal disease treated by endovascular intervention.[17] Kanolkar et al., (2016) reported, in study included 34 patients underwent endovascular reconstruction of popliteal and infra-popliteal arteries for CLI, that the LSR was (97%) at 3- month.[23] Samir et al. (2018) found that the limb salvage rate (LSR) was 96.7, 90.3, and 80.6% at 3, 6, and 12 months, respectively.[24]

LSR with endovascular intervention was significantly lower among cases suffered from hypertension; where about only 70% of cases with high blood pressure had their limbs lost with a statistically significant difference (p-value= 0.013). Rabellino et al. (2010) achieved 58.6% limb salvage in patients with CLI in hypertensive during a mean follow-up period of 12.4 months.[25] Aulivola et al. (2005) reported 52.5% limb salvage rates after infrapopliteal endovascular treatment in hypertensive patients compared with 84.4% normotensive patients.[26]

The presence of diabetes has not been found to be statistically significant in relation to limb salvage with endovascular intervention (p value= 0.108). This may be attributed that more than 80% of our patients were diabetic and this may render statistical analysis invaluable. However, no one can deny the major effects of diabetes on vascular patients in term of morbidity and mortality. Cardiovascular events are the main reason for perioperative mortality and morbidity after vascular surgery, and it has been suggested that DM further increases the risk.[27] Hynes et al (2005) found that the incidence of diabetes, especially type 2, in population is increasing as population ages. Diabetes is known

to be associated with increased calcification, multilevel disease, and infrapopliteal lesions, as well as mortality rate up to 10 times higher than in nondiabetics.[28] It was mentioned by Bakken et al (2007) that in their study comparing the CLI in DM and non-DM among those with CLI, limb salvage rates are lowered for the diabetic groups (both diabetic types) despite equivalent patency and restenosis rates and the prevalence of these patients is increasing.[12] Also, Fernandez et al (2010) found that diabetes was not a negative predictor of wound healing or limb salvage.[29]

In the current study, all cases with chronic obstructive lung disease had failure of endovascular intervention with a statistically significant difference (p-value= 0.027). Because of common risk factors such as smoking and aging, COPD often coexists with cardiovascular diseases that have an important impact on prognosis. Atherosclerosis is the main driver in the pathogenesis of vascular diseases and can occur in various arterial vascular beds. In smokers, a strong association has been demonstrated between COPD and coronary artery disease, causing ischemic heart disease (encompassing angina pectoris and myocardial infarction).[30] In current study, low mortality rate (5 case %2.3) was recorded in endovascular patients. The 30-day or in-hospital mortality was also reported in several studies and ranged from zero to 10%.[20,21] This makes the endovascular treatment an attractive method of treatment of such patients with CLI who have multilevel disease with high burden of comorbidity.

Conclusion and recommendations

- Endovascular revascularization is effective for patients with critical limb ischemia, where it provides high LSR and wound healing rate.
- Some variables are associated with worse outcome like hypertension, COPD and CAD.
- The results of the present study were derived from a tow-center experience with a high work volume where certain techniques have been routinely adopted for many years as a first choice. It is therefore likely that the selection of techniques with its own limitations may differ largely from centers with another experience.
- The current study need to be potentiated by larger number of patients, multicenter observational study and longer period of follow up. Analysis of anatomical lesion and its correlation to limb salvage need to be assessed.

References

1. Uzun F, Erturk M, Cakmak HA, et al: Usefulness of the platelet-to-lymphocyte ratio in predicting long-term cardiovascular mortality in patients with peripheral arterial occlusive disease. ***Adv Interv Cardiol.*** 2017; 13(47): 32–38.
2. Mills JL Sr, Conte MS, Armstrong DG, et al: The Society for Vascular Surgery Lower Extremity Threatened Limb Classification System: Risk stratification based on wound, ischemia, and foot infection (WIfI). ***J Vasc Surg.*** 2014; 59(1): 220-234.
3. Teraa M, Conte MS, Moll FL, et al: Critical Limb Ischemia: Current trends and future directions. ***J Am Heart Assoc.*** 2016; 5:e002938; 1-9.
4. Lichtenberg M, Michiel A, Roberto F, et al: Surgical and endovascular venous arterialization for treatment of critical limb ischemia. ***Vasa.*** 2018; 47(1): 17–22.
5. Bae JI, Won JH, Han SH, et al: Endovascular revascularization for patients with critical limb ischemia: impact on wound healing and long term clinical results in 189 limbs. ***Korean J Radiol.*** 2013; 14: 430-438.
6. Goda AAEH: Endovascular revascularization of multilevel arterial disease in patients with critical limb ischemia. ***Int Surg J.*** 2018; 5: 2039-2044.
7. Ghoneim B, Elwan H, Eldaly W, et al: Management of critical lower limb ischemia in endovascular era. ***Int J Angiol.*** 2014; 23: 197–206.
8. Rueda CA, Nehler MR, Perry DJ, et al: Patterns of artery disease in 450 patients undergoing revascularization for critical limb ischemia: Implications for clinical trial design. ***J Vasc Surg.*** 2008; 47:995-9; discussion: 999-1000.
9. Faglia E, Clerici G, Losa S, et al: Limb revascularization feasibility in diabetic patients with critical limb ischemia: Results from a cohort of 344 consecutive unselected diabetic patients evaluated in 2009. ***Diabetes Res Clin Pract.*** 2012; 95(3): 364–371.
10. Lida O, Soga Y, Hirano K, et al: Midterm outcomes and risk stratification after endovascular therapy for patients with critical limb ischemia due to isolated below-the-knee lesions. ***Eur J Vasc Endovasc Surg.*** 2012; 43(3): 313–321.
11. Engelhardt M, Boos J, Bruijnen H, et al: Critical limb ischaemia: Initial treatment and predictors of amputation-free survival. Eur J Vasc Endovasc Surg. 2012; 43(1): 55-61. doi: 10.1016/j.ejvs.2011.09.010. ***Epub.*** 2011 Oct 15. PMID: 22001150.
12. Bakken AM, Palchik E, Hart JP, et al: Impact of diabetes mellitus on outcomes of superficial femoral artery endoluminal interventions. ***J Vasc Surg.*** 2007; 46(5): 946–958, discussion 958.

13. Dattilo PB, Casserly IP: Critical limb ischemia: endovascular strategies for limb salvage. ***Prog Cardiovasc Dis.*** 2011; 54(1): 47–60.

14. Conrad MF, Crawford RS, Hackney LA, et al: Endovascular management of patients with critical limb ischemia. ***J Vasc Surg.*** 2011; 53: 1020-1025.

15. O'Brien-Irr MS, Dosluoglu HH, Harris LM: Outcomes after endovascular intervention for chronic critical limb ischemia. ***J Vasc Surg.*** 2011; 53: 1575-1581.

16. Engelke C, Morgan RA, Quarmby JW, et al: Distal venous arterialization for lower limb salvage: Angiographic appearances and interventional procedures. ***Radiographics.*** 2011; 21(5): 1239–48.

17. Okamoto S, Iida O, Nakamura M, et al: Postprocedural skin perfusion pressure correlates with clinical outcomes 1 year after endovascular therapy for patients with critical limb ischemia. ***Angiology.*** 2015; 66: 862-6.

18. Khanolkar UB, Ephrem B: Endovascular reconstruction of popliteal and infrapopliteal arteries for limb salvage and wound healing in patients with critical limb ischemia: a retrospective analysis. ***Indian Heart J.*** 2016; 68: 77-82.

19. Gavrilenko AV, Skrylev SI: Long-term results of venous blood flow arterialization of the leg and foot in patients with critical lower limb ischemia. ***Angiol Sosud Khir.*** 2007; 13(2): 95–103.

20. Alexandrescu V, Ngongang C, Vincent G, et al: Deep calf veins arterialization for inferior limb preservation in diabetic patients with extended ischaemic wounds, unfit for direct arterial reconstruction: Preliminary results according to an angiosome model of perfusion. ***Cardiovasc Revasc Med.*** 2011; 12(1): 10–19.

21. Mutirangura P, Ruangsetakit C, Wongwanit C, et al: Pedal bypass with deep venous arterialization: The therapeutic option in critical limb ischemia and unreconstructable distal arteries. ***Vascular.*** 2011; 19(6): 313–319.

22. Khanolkar UB, Ephrem B: Endovascular reconstruction of popliteal and infrapopliteal arteries for limb salvage and wound healing in patients with critical limb ischemia - A retrospective analysis. Indian Heart J. 2016; 68(1): 77-82.

23. Khanolkar UB, Ephrem B: Endovascular reconstruction of popliteal and infrapopliteal arteries for limb salvage and wound healing in patients with critical limb ischemia - A retrospective analysis. ***Indian Heart J.*** 2016; 68(1): 77-82.

24. Samir AM, Elboushi A, Soliman M, et al: Efficacy of multiple arterial levels of percutaneous transluminal angioplasty on limb salvage. ***The Egyptian Journal of Surgery.*** 2018; 37: 569–574.

25. Rabellino M, Aragón-Sánchez J, González G, et al: Is endovascular revascularisation worthwhile in diabetic patients with critical limb ischemia who also have endstage renal disease? ***Diabetes Res Clin Pract.*** 2010; 90(3): e79–e81.

26. Aulivola B, Gargiulo M, Bessoni M, et al: Infrapopliteal angioplasty for limb salvage in the setting of renal failure: do results justify its use? ***Ann Vasc Surg.*** 2005; 19(6): 762–768.

27. Virkkunen J, Heikkinen M, Lepäntalo M, et al: Finnvasc Study Group. Diabetes as an independent risk factor for early postoperative complications in critical limb ischemia. ***J Vasc Surg.*** 2004; 40(4): 761–767.

28. Hynes N, Mahendran B, Manning B, et al: The influence of subintimal angioplasty on level of amputation and limb salvage rates in lower limb critical ischemia: A 15-year experience. ***Eur J Vasc Endovasc Surg.*** 2005; 30(3): 291–299.

29. Fernandez N, McEnaney R, Marone LK, et al: Predictors of failure and success of tibial interventions for critical limb ischemia. ***J Vasc Surg.*** 2010; 52(4): 834–842.

30. Roversi S, Roversi P, Spadafora G, et al: Coronary artery disease concomitant with chronic obstructive pulmonary disease. ***Eur J Clin Invest.*** 2014; 44: 93–102.