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Multisite Atherosclerotic Disease: State of Art and Review of Literature

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Abstract

Multisite artery disease, defined by the simultaneous presence of atherosclerotic lesions in at least two major vascular territories, denotes an aggressive manifestation of the diseaseand leads to a deterioration of cardiac prognosis. The therapeutical strategy of multisite artery disease is not standardized and it is influenced by increased risk for both vascular and coronary surgery.

Percutaneous treatmentshould be considered as analternative to surgical revascularization in patients at high surgical risk.Simultaneous percutaneous intervention involving coronary and peripheral arteries seems to represent a promising strategy of treatment.

Keywords: Atherosclerosis; Carotid; Concomitant coronary artery disease (CAD)

Introduction

Atherosclerosis is a progressive disease with a multifactorial pathogenesis, which involves both large and mid-size arteries of different districts, causing stenosis of some vessels and ectasia in others. The clinical manifestations of the disease are different depending on the affected district (ischemic heart disease, ischemic stroke, peripheral artery diseases).

Atherosclerosis represents the leading cause of death and disability in Europe and USA (about 52%) [1] and it is predicted to become the main cause of mortality and disability worldwide [2,3].

The simultaneous presence of atherosclerotic lesions in at least two major vascular territories is defined "multisite" artery disease [4]. The prevalence in the population of atherosclerotic multisite disease is very high, because of common pathophysiology and risk factors (smoking, diabetes, hyperlipidemia, hypertension, and elevated C-reactive protein).

The presence of atherosclerosis in multiple vascular districts denotes an aggressive manifestation of the disease and leads to a deterioration of cardiac prognosis.The concomitant coronary artery disease (CAD) in patients with peripheral artery disease (PAD) influences the treatment and the risk associated with the surgical treatment and general anaesthesia is greater in the presence of ischemic heart disease.

So, the therapeutical strategy (conservative, surgical or endovascular) of combined CAD and PAD is not standardized and depends on the opinion of attending physicians and the preference of patients, due to lack of randomized trials.

Epidemiology of Multi-Site Atherosclerotic Disease

The prevalence of combined CAD and PAD (cerebrovascular disease, CVD and lower extremity vascular disease, LEAD) has been confirmed in two international studies: CAPRIE (Clopidogrel Versus Aspirin in Patients at Risk of Ischemic Events) trial [5] and Aronow & Ahn trial [6].

Relevant CAD was demonstrated in 16-35% of patients with atherosclerosis or three or more risk factors [7].

As shown by the Reduction of Atherothrombosis for Continued Health (REACH) Registry [8], a substantial percentage of patients with chronic CAD have associated CVD, LEAD, or both. In particular 60% of patients affected by LEAD, 25% of patients affected by CAD and 40% of patients with CVD had multisite disease.

Coronary artery disease in at least one vessel was diagnosed in 40% of patients with extracranial carotid arteries disease [9-11] and 60% of patients with severe lower limb disease [12,13].

Prognostic Implications

Peripheral artery disease and cardiac prognosis

The presence of atherosclerosis in peripheral districts suggests an aggressive manifestation of disease, increases risk of recurrent symptoms and complications and worsens cardiac and global prognosis. Clinical manifestations of non-coronary forms of atherosclerotic disease (peripheral arterial disease and carotid artery disease with transient ischemic attacks or stroke of carotid origin or >50% obstruction of a carotid artery), are considered as a coronary heart disease (CHD) risk equivalent by the guidelines of the Adult Treatment Panel III (ATP III) [14].

Carotid disease and cardiovascular events: The presence of severe carotid stenosis correlates with the severity of coronary artery disease [15]. In particular, the values of carotid artery intima-media (IMT) wall thickness was associated with a high rate of cerebrovascular and cardiovascular events, as confirmed in Cardiovascular Health Study (CHS) [16], the Rotterdam Study [17] and the Atherosclerosis Risk in Communities (ARIC) [18]. The Global Registry of Acute Coronary Events (GRACE) [19] showed that patients with acute coronary syndrome (ACS) and previous stroke had higherin-hospital mortality than patients with CAD alone.

Lower limb disease and cardiovascular events: LEAD is associated with higher risk of multivessel coronary disease and it's an important predictor of mortality: patients with peripheral arterial disease had

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a higher rate of multi-vessel coronary artery disease and a higher concentration of C-reactive protein, a marker of systemic inflammation [20].

The risk of death from all causes increases threefold in patients with stable coronary artery disease and peripheral vascular disease,while the risk of cardiac death increases six-fold, compared to patients without vascular disease [21].

In the REACH registry [8], 1-year risk of cardiovascular death, myocardial infarction (MI), stroke or hospitalization for atherothrombosis was 23.1% in presence of combined CAD and PAD and 13-17% in either disease alone; this risk increased with the number of districts affected by symptomatic disease.

Data from Global Registry of Acute Coronary Events (GRACE) [19] showed an increase of in-hospital mortality from 4.5 to 7.2% and 6-month mortality from 3.9 to 8.8% in patients with LEAD.

Ankle-brachial index (ABI), which correlates with LEAD severity, is a strong marker of cardiovascular disease and it is predictive of cardiovascular events and mortality [22,23].

Multisite artery disease and myocardial revascularization: Several trials have shown that patients with LEAD or cerebrovascular disease undergoing percutaneous coronary interventions (PCI) or coronary artery bypass grafting (CABG) for CAD had higherprocedural failure rates, in-hospital systemiccomplication rates and long term rates of MI, target vessel revascularization and cardiac mortality [24-30].

The extra cardiac arteriopathy (any or more of the following: claudication, carotid occlusion or > 50% stenosis, previous or planned intervention on the abdominal aorta, limb arteries, or carotids) is one of parameters considered in the EuroScorerisk model to predict in-hospital mortality for patients undergoing open-heart surgery: extra cardiac arteriopathy is significantly associated with the occurrence of operative mortality (Odds ratio 1.9, P value 0.001) [31].

The important relationship between carotid artery disease and coronary artery disease (CAD) is expressed by the high incidence of stroke following CABG [4,32].

Coronary Artery Disease In Patients Undergoing Vascular Surgery

Coronary artery disease is the leading cause of death in patients with peripheral artery disease.

Postoperative and long-term prognosis of vascular surgery is strongly influenced by the presence of ischemic heart disease. Cardiovascular death is the major cause of peri-operative and long-term mortality among vascular surgical patients with PAD [33-35]: cardiac risk is more than 5% [36].

The risk of perioperative complications is related to patient's conditions before surgery, presence of comorbidity and the nature, duration and urgency of surgery. In severe cases, the presence of CAD prevents surgery, due to this risk.

Guidelines on the diagnosis and treatment of peripheral artery diseases [4] and guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery [36] recommend a careful evaluation of the patient according to clinical risk factors, results of imaging studies and the surgical stress, to obtain a preoperative cardiac risk assessment and to select the most appropriate intervention. Prophylactic coronary revascularization before surgery shows no advantage in terms of all-cause death or MI [37,38]. However, Monaco et al. suggestthat systematic prophylactic coronary angiography and myocardial revascularization in medium-high-risk patients improves long-term outcome after major vascular surgery [39].

Treatment of Patients with Multi-Site Atherosclerotic Disease

The best management of patients with multisite artery disease is not standardized, due to lack of randomized trials.

A global evaluation not only of the specific treatment options for the management of lesion sites, but also of the clinical status of the patient is mandatory. So, the treatment strategy suggested by current guidelines for the management of atherosclerotic disease involving specific districts should be adapted on an individual basis.

Treatment of carotid disease in patients with coronary artery disease

The benefits of surgical carotid artery revascularization (carotid endarterectomy, CEA) over medical management have been clearly established in several randomized trials, including the NorthAmerican Symptomatic Carotid Endarterectomy Trial (NASCET) [40], Asymptomatic Carotid Atherosclerosis Study (ACAS) [41], Asymptomatic Carotid Surgery Trial (ACST) [42] and European Carotid Surgery Trial (ECST) [43]. Nevertheless, the risks of CEA (stroke, TIA, MI, cranial nerve palsy, hypertension, hypotension, haemorrhage, venous thromboembolism, restenosis, infection, death) are higher in patients with CAD.

The Stenting and Angioplasty with Protection in Patients at HIgh Risk for Endarterectomy (SAPPHIRE) study [44] and the randomized multicentre Carotid Revascularization Endarterectomy vs Stenting Trial (CREST) trial [45] demonstrated that carotid artery stenting (CAS) with use of embolic protection devices (distal filters and proximal protection) should be considered as an alternative to surgical revascularization in symptomatic patients at high surgical risk [46,47].

Treatment of Lower Limb Disease in Patients with Coronary Artery Disease

While revascularization is mandatory in patients with critical limb ischemia (CLI) [4], the evidence of long-term benefit of prophylactic revascularization over supervised exercise and best medical treatment is inconclusive [48]. Revascularization is indicated in patients with lifestyle-limiting claudication when clinical features suggest a reasonable likelihood of symptomatic improvement and there has been an inadequate response to conservative therapy.

The selection of the most appropriate revascularization strategy is based on comorbidities, anatomical suitability, according to the Trans-Atlantic Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II) [49].

A primary endovascular approach may be considered in complex lesions (TASC D) in patients with severe comorbidities, if done by an experienced team [49]. Endovascular treatment offers several advantages: lesser invasivity, local anesthesia, short hospitalization time, no preclusion to subsequent surgery and possibility to repeat intervention if necessary.

Multi-Site Percutaneous Revascularization

It's important to consider a global therapeutic approach of

atherosclerotic disease, involving revascularization of each district affected, to improve symptoms and overall prognosis.

Simultaneous percutaneous intervention involving coronary and peripheral arteries is feasible and safe, but few experiences havebeen reported in literature [50-53].

Endovascular treatment of coronary and carotid disease

In 2001, Kiesz et al. [50] published the first case of treatment with PCI and bilateral internal carotid artery stenting.

In the recent clinical trial FRIENDS [54], patients with ACS (ST Elevation Myocardial Infarction STEMI, Non-ST elevation myocardial infarction NSTEMI, unstable angina) and symptomatic (with previous transient ischemic attack TIA or stroke) or asymptomatic carotid disease were divided into three groups of treatment: surgical (CABG and CEA), endovascular (PCI and carotid Percutaneous Transluminal Angioplasty, PTA) and hybrid (CABG and carotid PTA or PCI e TEA).

The trial showed lower incidence of primary endpoints (death, MI, ischemic stroke) in patients treated by combined PCI and carotid PTA, compared to patients treated with surgical coronary and carotid revascularization: in particular, the endovascular group had a lower incidence of mortality and myocardial infarction, but higher of stroke and bleeding.

In May 2011, a prospective study [55], enrolling 239 patients affected by carotid obstructive disease and concomitant coronary disease undergoing PCI and carotid artery stenting, was published. The primary endpoints (major adverse cardiac and cerebrovascular events, MACCE) within 30 days occurred in 4.2% of patients, the mortality rate was 4.2%, the incidence of MI and stroke was 2.1% and 3.8% respectively.

According to these data, a combined percutaneous treatment seems to be comparable to previous surgical experiences, in terms of cardiac and cerebrovascular events, especially for patients considered at high surgical risk.

Endovascular treatment of coronary and lower limb disease

The first cases of combined PCI and PTA for LEAD were described by Baruah et al. [51] and Movahed et al. [53].

Bartuś et al. coordinated the most significant studies. In patients with non-ST elevation ACS and chronic LEAD, treated by PCI and PTA, this group documented apromising long-term follow-up [56]. In another trial, Bartuś et al. assessed long-term (12-month) safety and efficacy of coronary and peripheral endovascular procedures in patients with multi-vessel CAD, in comparison to patients with a single-vessel CAD [57]. Generally, patients with multi-vessel CAD had a worse cardiovascular prognosis due to comorbidity and risk factors of atherosclerosis. These patients, when treated by PCI and PTA for LEAD, had a similar prognosis compared to those with single-vessel CAD.

According to a recent study [58], a combined "global" revascularization of coronary and lower extremities districts could be associated to a better outcome. A total number of 245 patients with NSTEMI or unstable angina and LEAD (intermittent claudication for at least 3 months prior to the event) were enrolled; 125 patients underwent PCI and PTA procedures, 120 patients PCI alone. Primary endpoints (MACCE: death, MI, ischemic stroke/TIA, urgent PCI or CABG) occurred in 3.2% of patients treated with PCI and PTA and in 15% of patients treated with PCI alone ($p = 0.029$); secondary endpoints (major adverse peripheral events: rePTA, ischemic stroke/TIA, lower limb amputation) were more frequently in the group of patients treated with PCI and PTA (6.4% vs 3.3%, $p = 0.19$).

Conclusions

The prevalence of multisite vascular disease is increasing and influences the prognosis and the possible strategies of treatment.

Endovascular techniques have rapidly developed as an alternative to surgery for patients at high cardiac risk and offerpromising long-term outcome.

References

1. The world health report 2000 – Health systems: improving performance, WHO, Geneva.
2. Russell LB, Gold MR, Siegel JE, Daniels N, Weinstein MC (1996) The role of cost-effectiveness analysis in health and medicine. Panel on Cost-Effectiveness in Health and Medicine. JAMA 276: 1172-1177.
3. Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB (1996) Recommendations of the Panel on Cost-effectiveness in Health and Medicine. JAMA 276: 1253-1258.
4. European Stroke Organisation, Tendera M, Aboyans V, Bartelink ML, Baumgartner I, et al. (2011) ESC Guidelines on the diagnosis and treatment of peripheral artery diseases: Document covering atherosclerotic disease of extracranial carotid and vertebral, mesenteric, renal, upper and lower extremity arteries: the Task Force on the Diagnosis and Treatment of Peripheral Artery Diseases of the European Society of Cardiology (ESC). Eur Heart J 32: 2851-2906.
5. CAPRIE Steering Committee (1996) A randomised, blinded, trial of clopidogrel versus aspirin in patients at risk of ischaemic events (CAPRIE). CAPRIE Steering Committee. Lancet 348: 1329-1339.
6. Aronow WS, Ahn C (1994) Prevalence of coexistence of coronary artery disease, peripheral arterial disease, and atherothrombotic brain infarction in men and women > or = 62 years of age. Am J Cardiol 74: 64-65.
7. Fowkes FG, Low LP, Tuta S, Kozak J; AGATHA Investigators (2006) Ankle-brachial index and extent of atherothrombosis in 8891 patients with or at risk of vascular disease: results of the international AGATHA study. Eur Heart J 27: 1861-1867.
8. Alberts MJ, Bhatt DL, Mas JL, Ohman EM, Hirsch AT, et al. (2009) Three-year follow-up and event rates in the international REduction of Atherothrombosis for Continued Health Registry. Eur Heart J 30: 2318-2326.
9. Rokey R, Rolak LA, Harati Y, Kutka N, Verani MS (1984) Coronary artery disease in patients with cerebrovascular disease: a prospective study. Ann Neurol 16: 50-53.
10. Chimowitz MI, Mancini GB (1992) Asymptomatic coronary artery disease in patients with stroke. Prevalence, prognosis, diagnosis, and treatment. Stroke 23: 433-436.
11. Hertzer NR, Young JR, Beven EG, Graor RA, O'Hara PJ, et al. (1985) Coronary angiography in 506 patients with extracranial cerebrovascular disease. Arch Intern Med 145: 849-852.
12. Hertzer NR, Beven EG, Young JR, O'Hara PJ, Ruschhaupt WF 3rd, et al. (1984) Coronary artery disease in peripheral vascular patients. A classification of 1000 coronary angiograms and results of surgical management. Ann Surg 199: 223-233.
13. Mohler ER 3rd (2003) Peripheral arterial disease: identification and implications. Arch Intern Med 163: 2306-2314.
14. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (2001) Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Jama 285: 2486-2496.
15. Kuller LH, Arnold AM, Psaty BM, Robbins JA, O'Leary DH, et al. (2006) 10-year follow-up of subclinical cardiovascular disease and risk of coronary heart disease in the Cardiovascular Health Study. Arch Intern Med 166: 71-78.

16. O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, et al. (1999) Carotid-artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults. Cardiovascular Health Study Collaborative Research Group. N Engl J Med 340: 14-22.

17. Hollander M, Bots ML, Del Sol AI, Koudstaal PJ, Witteman JC, et al. (2002) Carotid plaques increase the risk of stroke and subtypes of cerebral infarction in asymptomatic elderly: the Rotterdam study. Circulation 105: 2872-2877.

18. Chambless LE, Heiss G, Folsom AR, Rosamond W, Szklo M, et al. (1997) Association of coronary heart disease incidence with carotid arterial wall thickness and major risk factors: the Atherosclerosis Risk in Communities (ARIC) Study, 1987-1993. Am J Epidemiol 146: 483-494.

19. Mukherjee D, Eagle KA, Kline-Rogers E, Feldman LJ, Juliard JM, et al. (2007) Impact of prior peripheral arterial disease and stroke on outcomes of acute coronary syndromes and effect of evidence-based therapies (from the Global Registry of Acute Coronary Events). Am J Cardiol 100: 1-6.

20. Brevetti G, Oliva G, Silvestro A, Scopacasa F, Chiariello M; Peripheral Arteriopathy and Cardiovascular Events (PACE) Study Group (2004) Prevalence, risk factors and cardiovascular comorbidity of symptomatic peripheral arterial disease in Italy. Atherosclerosis 175: 131-138.

21. Eagle KA, Rihal CS, Foster ED, Mickel MC, Gersh BJ (1994) Long-term survival in patients with coronary artery disease: importance of peripheral vascular disease. The Coronary Artery Surgery Study (CASS) Investigators. J Am Coll Cardiol 23: 1091-1095.

22. Mehler PS, Coll JR, Estacio R, Esler A, Schrier RW, et al. (2003) Intensive blood pressure control reduces the risk of cardiovascular events in patients with peripheral arterial disease and type 2 diabetes. Circulation 107: 753-756.

23. Leng GC, Fowkes FG, Lee AJ, Dunbar J, Housley E, et al. (1996) Use of ankle brachial pressure index to predict cardiovascular events and death: a cohort study. BMJ 313: 1440-1444.

24. Singh M, Lennon RJ, Darbar D, Gersh BJ, Holmes DR Jr, et al. (2004) Effect of peripheral arterial disease in patients undergoing percutaneous coronary intervention with intracoronary stents. Mayo Clin Proc 79: 1113-1118.

25. Saw J, Bhatt DL, Moliterno DJ, Brener SJ, Steinhubl SR, et al. (2006) The influence of peripheral arterial disease on outcomes: a pooled analysis of mortality in eight large randomized percutaneous coronary intervention trials. J Am Coll Cardiol 48: 1567-1572.

26. Novo G, Maniglia D, Corrado E, Muratori I, Sutera F, et al. (2007) Peripheral atherosclerosis is associated with the occurrence of restenosis after percutaneous coronary intervention. Coron Artery Dis 18: 627-631.

27. Nikolsky E, Mehran R, Dangas GD, Lasic Z, Mintz GS, et al. (2004) Prognostic significance of cerebrovascular and peripheral arterial disease in patients having percutaneous coronary interventions. Am J Cardiol 93: 1536-1539.

28. Timaran CH, Rosero EB, Smith ST, Valentine RJ, Modrall JG, et al. (2008) Trends and outcomes of concurrent carotid revascularization and coronary bypass. J Vasc Surg 48: 355-360.

29. Bosch JL, Hunink MG (1997) Meta-analysis of the results of percutaneous transluminal angioplasty and stent placement for aortoiliac occlusive disease. Radiology 204: 87-96.

30. Midwall S, Swaminathan RV, Charitakis K, Kim LK, Gordin J, et al. (2013) Impact of peripheral vascular disease on short- and long-term outcomes in patients undergoing non-emergent percutaneous coronary intervention in the drug-eluting stent era. J Invasive Cardiol 25: 132-136.

31. Roques F, Nashef SA, Michel P, Gauducheau E, de Vincentiis C, et al. (1999) Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. Eur J Cardiothorac Surg 15: 816-822.

32. Aboyans V, Lacroix P, Guilloux J, Rollé F, Le Guyader A, et al. (2005) A predictive model for screening cerebrovascular disease in patient undergoing coronary artery bypass grafting. Interact Cardiovasc Thorac Surg 4: 90-95.

33. Jamieson WR, Janusz MT, Miyagishima RT, Gerein AN (1982) Influence of ischemic heart disease on early and late mortality after surgery for peripheral occlusive vascular disease. Circulation 66: I92-97.

34. McFalls EO, Ward HB, Santilli S, Scheftel M, Chesler E, et al. (1998) The influence of perioperative myocardial infarction on long-term prognosis following elective vascular surgery. Chest 113: 681-686.

35. Etchells E, Meade M, Tomlinson G, Cook D (2002) Semiquantitative dipyridamole myocardial stress perfusion imaging for cardiac risk assessment before noncardiac vascular surgery: a meta-analysis. J Vasc Surg 36: 534-540.

36. Poldermans D, Bax JJ, Boersma E,De Hert S, Eeckhout E, et al. (2009) Guidelines for preoperative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery: the Task Force for Preoperative Cardiac Risk Assessment and Perioperative Cardiac Management in Non-cardiac Surgery of the European Society of Cardiology (ESC) and European Society of Anesthesiology (ESA). Eur Heart J 30: 2769-2812.

37. McFalls EO, Ward HB, Moritz TE, Goldman S, Krupski WC, et al. (2004) Coronary-artery revascularization before elective major vascular surgery. N Engl J Med 351: 2795-2804.

38. Poldermans D, Schouten O, Vidakovic R, Bax JJ, Thomson IR, et al. (2007) A clinical randomized trial to evaluate the safety of a noninvasive approach in high-risk patients undergoing major vascular surgery: the DECREASE-V Pilot Study. J Am Coll Cardiol 49: 1763-1769.

39. Monaco M, Stassano P, Di Tommaso L, Pepino P, Giordano A, et al. (2009) Systematic strategy of prophylactic coronary angiography improves long-term outcome after major vascular surgery in medium- to high-risk patients: a prospective, randomized study. J Am Coll Cardiol 54: 989-996.

40. Barnett HJ, Taylor DW, Eliasziw M, Fox AJ, Ferguson GG, et al. (1998) Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med 339: 1415-1425.

41. [No authors listed] (1995) Endarterectomy for asymptomatic carotid artery stenosis. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. JAMA 273: 1421-1428.

42. Halliday AW, Thomas D, Mansfield A (1994) The Asymptomatic Carotid Surgery Trial (ACST). Rationale and design. Steering Committee. Eur J Vasc Surg 8: 703-710.

43. [No authors listed] (1998) Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST) Lancet 351: 1379-1387.

44. Massop D, Dave R, Metzger C, Bachinsky W, Solis M, et al. (2009) Stenting and angioplasty with protection in patients at high-risk for endarterectomy: SAPPHIRE Worldwide Registry first 2,001 patients. Catheter Cardiovasc Interv 73: 129-136.

45. Brott TG, Hobson RW 2nd, Howard G, Roubin GS, Clark WM, et al. (2010) Stenting versus endarterectomy for treatment of carotid-artery stenosis. N Engl J Med 363: 11-23.

46. Murad MH, Shahrour A, Shah ND, Montori VM, Ricotta JJ (2011) A systematic review and meta-analysis of randomized trials of carotid endarterectomy vs stenting. J Vasc Surg 53: 792-797.

47. Roffi M, Mukherjee D, Clair DG (2009) Carotid artery stenting vs. endarterectomy. Eur Heart J 30: 2693-2704.

48. Spronk S, Bosch JL, den Hoed PT, Veen HF, Pattynama PM, et al. (2009) Intermittent claudication: clinical effectiveness of endovascular revascularization versus supervised hospital-based exercise training--randomized controlled trial. Radiology 250: 586-595.

49. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, et al. (2007) TASC II Working Group. Inter-society consensus for the management of peripheral arterial disease (TASC II). J Vasc Surg 45: S5–S67.

50. Kiesz RS, Rozek MM, Bouknight D (2001) Bilateral carotid stenting combined with three-vessel percutaneous coronary intervention in single setting. Catheter Cardiovasc Interv 52: 100-104.

51. Baruah DK, Panigrahi NK, Srinivas AN (2003) Concurrent coronary, bilateral iliac and left renal artery direct stenting. Indian Heart J 55: 71-74.

52. Yaneza LO, Sun LL, Bagsit NL, Baysa AN, Torres RN, et al. (2004) Angioplasty of an asymptomatic total occlusion of the left subclavian artery to provide access for coronary angiography and intervention: a case report. Catheter Cardiovasc Interv 61: 310-313.

53. Movahed MR, Amani F, Stinis C, Kubaska SM 3rd (2006) Combined peripheral and coronary artery percutaneous intervention in patients with significant coronary and peripheral vascular disease. Case reports and review. J Invasive Cardiol 18: E157-E161.

54. Ribichini F, Tomai F, Reimers B, Russo P, Borioni R, et al. (2010) Clinical outcome after endovascular, surgical or hybrid revascularisation in patients with combined carotid and coronary artery disease: the Finalised Research In ENDovascular Strategies Study Group (FRIENDS). EuroIntervention 6: 328-335.

55. Tomai F, Pesarini G, Castriota F, Reimers B, De Luca L, et al. (2011) Early and long-term outcomes after combined percutaneous revascularization in patients with carotid and coronary artery stenoses. JACC Cardiovasc Interv 4: 560-568.

56. Bartus S, Siudak Z, Brzezinski M,Rakowski T, Dziewierz A, et al. (2008) Percutaneous peripheral interventions in patients with non-ST elevation acute coronary syndromes performed by interventional cardiologists: rationale and results. Kardiologia Polska 66: 135-141.

57. BartuÅ› S, Siudak Z, BrzeziÅ„ski M, Dziewierz A, Chyrchel M, et al. (2010) Percutaneous peripheral interventions in patients with multivessel coronary artery disease. Kardiol Pol 68: 1115-1121.

58. BartuÅ› S, Siudak Z, BrzeziÅ„ski M, Rakowski T, Dziewierz A, et al. (2008) Percutaneous peripheral interventions in patients with non-ST elevation acute coronary syndromes performed by interventional cardiologists: rationale and results. Kardiol Pol 66: 135-141.

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