Razavi Int J Med. 2018 December; 6(4): e57107 doi: 10.30483/RIJM.2018.31

Published online 2018 December 30 **Original Article**

Use of Composite Graft in Patients with Coronary Artery Diseases Concomitant with Porcelain Aorta: A Safe Technique and case series in Severe Aortic Calcification

Mohamad Abbasi Tashnizi[1], Seyed Hamid Hoseinikhah[2], Shadi Sarafan[3], Arash Akhavan Rezayat[4], and Nahid Zirak[5,*]

[1] Associate Professor of Cardiac Surgery, Department of Cardiac Surgery, Emam Reza hospital, Mashhad University of Medical Science, Mashhad, Iran
[2] Assistant Professor of Cardiac Surgery, Department of Cardiac Surgery, Emam Reza hospital, Mashhad University of Medical Science, Mashhad, Iran
[3] Department of Medical Sciences, Mashhad Branch, Islamic Azad University, Mashhad, Iran
[4] Student Research Committee, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[5] lung Diseases Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

* ***Corresponding author:*** Nahid Zirak, lung Diseases Research Center, Mashhad University of Medical Sciences, Mashhad, Iran. Email: zirakn@mums.ac.ir

Received 2017 January 27**; Accepted** 2018 August 21.

Abstract

Background: Surgery in patients with severe calcification of the aorta, also known as "porcelain aorta", is challenging for cardiac surgeons. In this study, we evaluated the efficacy of composite grafts in avoidance of aortic manipulation among patients with porcelain aorta undergoing coronary artery bypass grafting (CABG).

Objectives: The aim of current study was to investigate of use of composite graft in patients with coronary artery diseases concomitant with porclain aorta.

Methods: Ten patients among admitted ones for CABG over 3 years showed severe calcification of the aorta. We used a composite graft for revascularization of the target vessel without manipulation of the aorta. In patients with CAD and porcelain aorta, off-pump CABG was applied to avoid cannulation of the aorta. Moreover, a composite graft was used for internal mammary artery (unilateral/bilateral) to avoid partial clamping of the aorta.

Results: Among ten patients with the mean age of 72.5 years seven patients were male and 3 were female. The most common risk factors were diabetes (6 patients), hypertension (5 patients), smoking (5 patients), and hyperlipidemia. Four patients had thetwo-vessel disease, while the remaining had thesix-vessel disease. In the intraoperative and postoperative periods, no hemodynamic instability was reported in any of the patients. Similarly, no ischemic complications due to femoral artery cannulation (lower limb ischemia) were reported. Based on the findings, no neurologic complications occurred in the early postoperative period and 12-month follow-up (causing no neurologic deficits). Postoperative evaluation of the grafts via computed tomography showed sufficient patency in all patients.

Conclusion: Coronary artery disease, concomitant with severe calcification of the aorta, is a challenging condition for cardiac surgeons, given the higher risk of atheroembolic events and serious morbidity. Although multiple techniques have been described for avoiding manipulation of the aorta in these patients, the composite graft technique may be a simple and safe procedure with reduced risk of cerebrovascular events due to atheroembolism.

Keywords: Aortic disease, Coronary artery bypass grafting (CABG), Porcelain aorta

1. Background

Porcelain aorta (PA) represents severe calcification of the ascending aorta. PA is associated with increased morbidity and mortality during coronary artery bypass grafting (CABG) due to the increased risk of perioperative atheroembolism. Imaging modalities for preoperative identification of PA include chest radiography, computed tomography (CT), and cardiac catheterization. However, in some cases, a severely calcified aorta may remain undetected until being palpated following sternotomy.

Conventional and classic CABG surgeries involve multiple manipulations of the ascending aorta during cannulation, as well as cross-clamping and partial clamping of the aorta, which can result in fatal strokes and profuse bleeding due to severe damage to the calcified aortic layers. In rare cases of severe calcification of the aorta, these procedures can increase the risk of embolic complications, especially in the central nervous system (CNS), thus leading to major morbidities. Embolization of a mobile atheromatous plaque in systemic circulation can also occur in CABG (1-3). In addition, a calcified aortic wall can cause uncontrollable bleeding, resulting in the rupture of the aortic wall and life-threatening complications (2).

Although there are controversies regarding the optimal preventive method for PA complications, all available techniques accentuate the importance of performing surgeries with no or minimal manipulation of the ascending aorta (4-6). The present study describes our efforts to prevent atheroembolic events in patients with severely calcified ascending aorta, who underwent CABG with the beating heart technique and composite graft for avoidance of aortic manipulations.

2. Objectives

The aim of current study was to investigate of use of composite graft in patients with coronary artery

diseases concomitant with porclain aorta.

3. Methods

A total of 870 CABG surgeries were performed by a surgical team at the Cardiovascular Surgery Department of Imam Reza Hospital, Mashhad, Iran during May 2010-2013. In the study population, 10 patients had severe calcification of the ascending aorta. The presence of PA was initially diagnosed by chest X-ray in 6 patients, which was later confirmed by transthoracic echocardiography (Figure 1). In 2 patients, severe calcification of the aorta was only detected via echocardiography. Moreover, in 2 patients, PA was diagnosed intraoperatively after sternotomy when the surgeon observed severe and complete calcification of the entire length of the ascending aorta.

The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences. An informed consent was obtained from each participant before inclusion in the study.

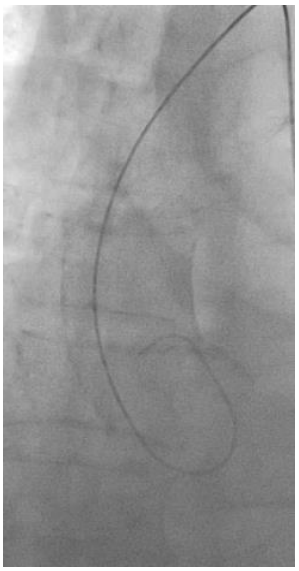

Figure 1. Porcelain Aorta was detected preoperatively on chest x-ray

Surgical technique

Following median sternotomy, the pericardium was opened. After harvesting the conduits, heparin (3 mg/kg) was administered. The surgery was conducted via beating heart technique (off-pump surgery) in 8 patients. In the remaining patients (n, 2), surgery was performed by the beating heart technique under supportive cardiopulmonary bypass (CPB). The heart was positioned with posterior pericardial retraction sutures, using a stabilizer (Medtronic).

The surgeon-harvested left internal mammary artery (LIMA) showed significant stenosis in 7 patients. The right internal mammary artery (RIMA) was also harvested after initiating cardiopulmonary bypass with femoral cannulation, but without cardiac arrest (beating heart technique). In some cases, significant stenosis of the right coronary artery (RCA) was observed; therefore, for bypass, RIMA was used as an in situ conduit. For bypassing the left coronary system, consisting of the left anterior descending (LAD) artery, diagonal branches, and obtuse marginal (OM) branches, a long segment of the saphenous vein graft (SVG) conduit was used for distal anastomosis of the target vessels (Figure 2).

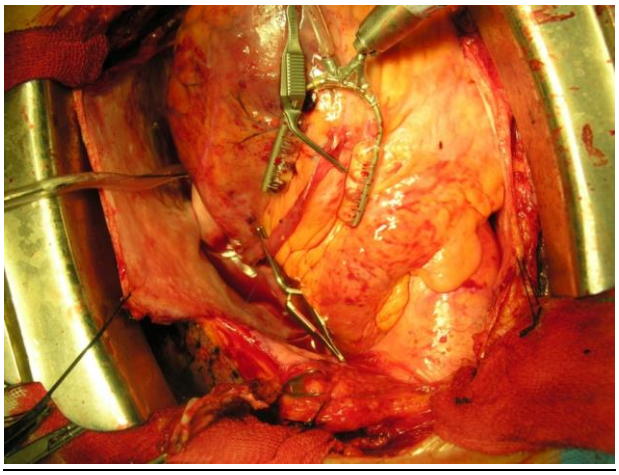

Figure 2. SVG was anastomosed to LAD and the OM branch with the off-pump technique

Afterwards, a distal segment of the in situ LIMA was grafted to an appropriate site of the SVG graft (Figure 3). By using this CABG strategy for patients with PA, any invasive manipulation of the diseased aorta can be avoided. It consists of aortic cannulation, cross-clamping, and partial clamping to reduce the risk of atheroembolic complications. The number of grafts used in our patients was 2 to 4. The conduits used for revascularization are shown in Table 1.

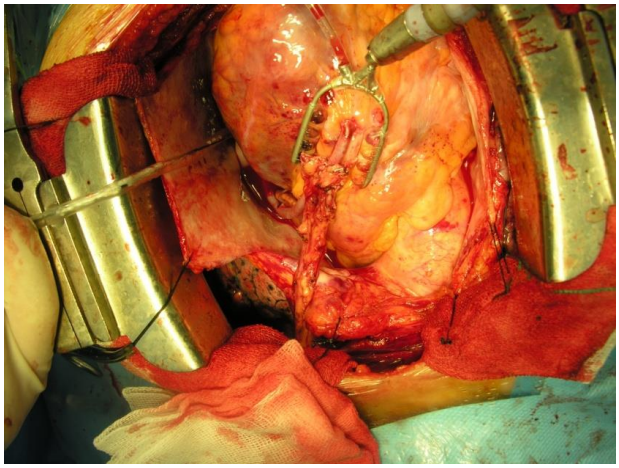

Figure 3. Lima was anastomosed as a composite graft to the SVG

Table 1. Operative data, including the surgical procedure and target vessels

patient	Number of vessels	Surgical procedure	Type of the surgery	Complications*
1	2	SVG[1] to LAD[2]& OM[3] Composite Graft to LIMA	OFF Pump CABG	No complication in all of cases
2	2	SVG to LAD & D[4] Composite Graft to LIMA[5]	OFF Pump CABG[6]	
3	3	SVG to LAD & D & OM Composite Graft to LIMA	OFF Pump CABG	
4	3	SVG to LAD & OM Composite Graft to LIMA RIMA to RCA	OFF Pump CABG	
5	2	SVG to LAD & OM Composite Graft to LIMA	OFF Pump CABG	
6	3	SVG to LAD & OM Composite Graft to LIMA RIMA[7] to RCA[8]	OFF Pump CABG	
7	3	SVG to LAD & D & OM Composite Graft to LIMA	OFF Pump CABG	
8	2	SVG to LAD & OM Composite Graft to LIMA	OFF Pump CABG	
9	3	SVG to LAD & D & OM Composite Graft to LIMA	Beating Heart on CPB[9]	
10	3	SVG to LAD & OM Composite Graft to LIMA RIMA to RCA	Beating Heart on CPB	

1. Saphenous vein graft
2. left anterior descending
3. Obtuse Marginal
4. Distal
5. left internal mammary artery
6. Coronary artery bypass graft
7. Right Internal Mammary Artery
8. right coronary artery
9. Cardiopulmonary bypass

* complications occurred in the early postoperative course and in the 12-month follow-up period

4. Results

In this study, 7 patients were male and 3 were female, with the mean age of 72.5 years. The most common risk factors were diabetes (6 patients), hypertension (5 patients), smoking (5 patients), and hyperlipidemia. Four patients had thetwo-vessel disease, while the rest (n, 6) had a three-vessel disease; also, 4 patients showed a recent history of myocardial infarction. Normal ejection fraction (EF> 45%) was found in 5 patients, while others had a low EF. CABG was completely performed using the off-pump technique in 8 patients, while the beating heart technique with CPB support and femoral cannulation was applied in the other 2 patients.

Total CPB duration in the mentioned subgroups was 48 and 56 minutes, respectively. In the intraoperative and postoperative periods, no hemodynamic instability was reported in any of the patients. Similarly, no ischemic complications due to femoral arterial cannulation (lower limb ischemia) were reported. Based on the findings, no neurologic complications occurred in the early postoperative period and 12-month follow-up. Postoperative evaluation of the grafts via CT scan showed sufficient patency in all patients.

5. Discussion

Today, CABG is recognized as the most common cardiac surgery. Conventional CABG with a CPB device and off-pump CABG can result in multiple manipulations of the ascending aorta, which mainly include cannulation, cross-clamping, and partial clamping of the aorta for establishing proximal anastomosis (5,6). Atherosclerotic disease of the ascending aorta should be suspected in all candidates for CABG, especially when significant carotid stenosis and left main coronary artery disease are present (5).

In rare cases of CAD with severe aortic calcification, off-pump CABG significantly increases the risk of cerebrovascular events in comparison with patients with a normal aorta (5,6). For many years, cardiac surgeons have been concerned about a safe CABG technique with minimal risk of atheroembolic complications. Accordingly, multiple techniques have been introduced by researchers (5,7,8). In general, all these techniques highlight the importance of performing CABG with no or minimal manipulation of the calcified aorta (8).

In patients undergoing CABG with CPB support, the most common site for arterial cannulation is the untouched distal segment of the aorta or femoral artery (3). Although surgeons can have access to the atheromatous plaque via intraoperative palpation of the aorta, epiaortic echocardiography is still the most accurate technique for finding a safe site of the aorta for cannulation(9,10). When the ascending aorta cannot be cannulated, the alternative option is peripheral cannulation, especially cannulation of the femoral and axillary arteries (3).

Introduction of a new CABG technique without CPB support, known as off-pump CABG, seems to be an interesting option for CABG patients with PA due to the minimal manipulation of the diseased aorta (11). For this reason, many researchers believe that CABG with the beating heart technique is the safest approach in patients with severe calcification of the aorta. However,similar to the procedures applied for 3 patients in this study, in certain patients requiring CPB support, revascularization with CPB can be performed through femoral cannulation(3).

Another technique has been also introduced for the management of patients with PA. This technique includes the insertion of the proximal site of the conduit on the innominate or axillary artery (1,12-14). Besides this site, the internal mammary artery can be used for proximal anastomosis, which

changes its thickness with respect to the physiological flow. This type of grafting, known as "composite graft", is a recognized approach in such cases and was used in this study for managing CAD patients with PA (3,9).

Complete arterial revascularization with in situ internal mammary artery (unilateral or bilateral) and gastroepiploic artery is a safe procedure (15,16). Despite its less common application, proximal anastomosis of the conduit to the ascending aorta is another option under hypothermic arrest with no need for aortic clamping (17). Aortic endarterectomy and coronary-to-coronary bypass with an SVG segment are among other options, which can be used in certain cases (3,17,18).

6. Conclusion

Management of coronary artery disease, concomitant with severe calcification of the aorta, is challenging for cardiac surgeons due to the higher risk of atheroembolic events and serious morbidity. Although multiple techniques have been described for avoiding the manipulation of the aorta in these patients, the composite graft technique can be introduced as a simple and safe procedure with reduced risk of cerebrovascular events due to atheroembolism.

Acknowledgments

We are thankful to the research council, Mashhad University of Medical Science for financial support.

Conflicts of interest

None.

Footnote

Funding support: This research was supported by the research deputy of Mashhad University of Medical Sciences.

Disclosure Statement: All Authors have no conflict of interests.

References

1. Demirsoy E, Unal M, Arbatli H, Yagan N, Tukenmez F, Sonmez B. Extra-anatomic coronary artery bypass graftings in patients with porcelain aorta. *J Cardiovasc Surg*. 2004;**45**(2):111. [PubMed:15179344].
2. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R,et al. Adverse cerebral outcomes after coronary bypass surgery.Multicenter study of perioperative ischemia research group and the ischemia research and education foundation investigators. *N Engl J Med*. 1996;**335**(25):1857-63. doi:10.1056/NEJM199612193352501. [PubMed:8948560].
3. Moeinipour A, Amouzeshi A, Hoseinikhah H. Coronary artery bypass surgery in coronary artery disease concomitant with porcelain aorta: great challenge for cardiac surgeon. *Iran Heart J*. 2014;**15**(1):29-31.
4. Sirin G,Sarkislali K,Konakci M,Demirsoy E. Extraanatomical coronary artery bypass grafting in patients with severely atherosclerotic (Porcelain) aorta. *J Cardiothorac Surg*. 2013;**8**:86.doi:10.1186/1749-8090-8-86. [PubMed:23587129].
5. Leyh RG, Bartels C, Nötzold A, Sievers HH. Management of porcelain aorta during coronary artery bypass grafting. *AnnThorac Surg*. 1999;**67**(4):986-8. doi:10.1016/s0003-4975(98)01370-8. [PubMed:10320239].
6. SadeghpourTabaee A, Rostami A, Soheila A, Khamoushi A. Coronary artery bypass graft in porcelain aorta. *Int Cardivasc Res J*. 2008;**1**(4):245-8.
7. Tamura K, Nomura F, Mukai S, Yoshitatsu M, Sakao J, Ihara K. Combined aortic valve replacement and coronary artery bypass grafting with in situ arterial grafts for porcelain aorta. *Ann Thorac Cardiovasc Surg*. 2003;**9**(3):206-8. [PubMed:12875646].
8. Bittner HB, Savitt MA. Management of porcelain aorta and calcified great vessels in coronary artery bypass grafting with off-pump and no-touch technology. *Ann Thorac Surg*. 2001;**72**(4):1378-80. doi:10.1016/s0003-4975(01)02568-1. [PubMed:11603471].
9. Yamaguchi A, Adachi H, Tanaka M, Ino T. Efficacy of intraoperative epiaortic ultrasound scanning for preventing stroke after coronary artery bypass surgery. *Ann Thorac Cardiovasc Surg*. 2009;**15**(2):98-104. [PubMed:19471223].
10. Davila-Roman VG, Barzilai B, Wareing TH, Murphy SF, Kouchoukos NT. Intraoperative ultrasonographic evaluation of the ascending aorta in 100 consecutive patients undergoing cardiac surgery. *Circulation*. 1991;**84**(5 Suppl):III47-53. [PubMed:1934441].
11. Lev-Ran O, Ben-Gal Y, Matsa M, Paz Y, Kramer A,Pevni D, et al. 'No touch'techniques for porcelain ascending aorta: comparison between cardiopulmonary bypass with femoral artery cannulation and off-pump myocardial revascularization. *J Card Surg*. 2001;**17**(5):370-6. [PubMed:12630532].
12. Weinstein G, Killen D. Innominate artery-coronary artery bypass graft in a patient with calcific aortitis. *J Thorac Cardiovasc Surg*. 1980;**79**(2):312-3.[PubMed:6986005].
13. Matsuda N, Kamihira S, Kanaoka Y, Ishiguro S, Ohgi S. Off-pump axillo-coronary artery bypass grafting with porcelain aorta. *J Card Surg*. 2005;**20**(6):586-8. doi:10.1111/j.1540-8191.2005.00125.x. [PubMed:16309420].
14. Kovačević P, Velicki L, Redžek A, Golubović M, Till V, Ivanović V. An unusual origin of proximal coronary bypass anastomosis in a patient with porcelain aorta: how we solved the problem. *Med Pregl*. 2011;**64**(3-4):215-8.[PubMed:21905604].
15. Akpinar B, Güden M, Sanisoğlu I, Konuralp C, Yilmaz O, Sönmez B. A no-touch technique for calcified ascending aorta during coronary artery surgery. *Texas Heart Inst J*. 1998;**25**(2):120-3. [PubMed:9654656].
16. Wu MY, Lin PJ, Haung YK, Tsai FC. A novel technique of coronary revascularization in porcelain aorta: report of two cases. *Surg Today*. 2008;**38**(2):157-60. doi:10.1007/s00595-007-3579-4. [PubMed:18239876].
17. Culliford AT, Colvin SB, Rohrer K, Baumann FG, Spencer FC. The atherosclerotic ascending aorta and transverse arch: a new technique to prevent cerebral injury during bypass: experience with 13 patients. *Ann Thorac Surg*. 1986;**41**(1):27-35. doi:10.1016/s0003-4975(10)64492-x. [PubMed:3942429].
18. Kudo M, Misumi T, Koizumi K. Aortotomy and endarterectomy of the ascending aorta for aortic valve replacement in a patient with porcelain aorta. *Surg Today*. 2005;**35**(11):1000-3. doi:10.1007/s00595-005-3058-8. [PubMed:16249862].