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Original Article

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Quantitative approach to radial artery patency

Abstract

Aim: Visual estimates of the severity of coronary stenosis are frequently very inaccurate. Angiography is inaccurate in assessing the functional significance of a coronary stenosis. Severity of stenosis in the native coronary artery is critical for both the short and long-term patency of the radial artery (RA), because of the potentially negative effects of competitive flow when the stenosis is below 70%.

Material and Methods: A one hundred patients were selected. Radial artery is used for all patients during off-pump surgery. After all distal anastomoses are done and the systolic blood pressure reached over 100 mmHg, we have made arterial pressure measurement from the proximal side of radial artery graft. Both radial artery pressure and aortic pressure were recorded instantaneously. Systemic arterial pressure measurements are done from ascending aorta.

Results: Serial postoperative coronary angiographies were performed at the first six postoperative months. We have detected ten radial artery graft occlusions and string sign. Five right coronary artery, four circumflex artery, and one diagonal artery radial artery grafts occluded. The percentage of systolic aortic and coronary pressure measurement (Ao/C-s%) on occluded graft patients was changed from 81 to 97. Percentage of diastolic aortic and coronary pressure measurement (Ao/C-d%) was changed from 83 to 90. Percentage of mean aortic and coronary pressure measurement (Ao/C-m%) was changed from 84 to 95.

Conclusion: We concluded that; we can predict of radial artery prognosis based on the severity degree of coronary artery stenosis. We have found ten radial artery grafts occluded. However the patients are completely asymptomatic because of functionally insignificant lesions despite these lesions are considered visually significant on coronary angiogram. Unfortunately ten radial artery measurements are not enough for establishing a reliable cut-off value. We need more studies for creating a cut-off value determination.

Keywords: Radial artery, FFR, coronary bypass

INTRODUCTION

Prone to spasm of Radial Artery (RA) was the primary concern for the use of arterial conduit for myocardial revascularization. Spasm of RA was overcome by calcium channel blockers. RA is being worldwide used as a second arterial conduit in (1). Severity of stenosis in the native coronary artery is critical to both the short and long-term patency of the RA, because of the potentially negative effects of competitive flow when the stenosis is below 70% (2,3). Visual estimates of the severity of coronary stenosis are frequently very inaccurate. Angiography is sometimes inaccurate in assessing the functional significance of a coronary stenosis. For this reason Fractional Flow Reserve (FFR) is being used for accurately assessing functional significance of a coronary stenosis (4). But currently, only 6% of patients has FFR measurement before revascularization procedure is carried out (5). Most surgeons are using RA for revascularization without having enough information about the functional significance of coronary stenosis. RA conduits have occluded in a low degree coronary stenosis. Therefore we have preferentially performed a prospective study by using distal coronary artery pressure and aortic pressure measurements and try to predict short-term patency of the RA.

MATERIAL AND METHODS

This study included 100 patients who received radial artery graft during beating heart surgery between the years of 2014 and 2023 years. Alife hospital ethical committe has approved our study in Agust 17,2014 (ALIFE 2017/44-EK). Redo coronary surgery,

patients with negative Allen test for radial artery, patients with compromised hemodynamia patients during off-pump surgery are excluded from our study. Patients with previous myocardial infarction were also excluded because of changed myocardial resistance which cannot be controlled because of not using adenosine administration. Perioperative MI patients were also excluded, due to may cause confounding results. Informed consent are obtained from all patients both distal pressure measurements and six months after control angiography. There were 37 female and 63 male patients. Thirty-one of patients have diabetes mellitus. Chronic obstructive pulmonary disease (COPD) found in 28 patients. Average left ventricule ejection fraction (EF) was 51%.

Definitions

To calculate the degree of coronary stenosis, the normal segment of the artery proximal to the lesion was used as a reference and the difference with the minimum luminal diameter of the stenotic lesion was considered the percent of stenosis. In the evaluation of the postoperative angiogram, Patent Graft was defined as the status of the grafted on highly stenosed coronary artery (Figure 1A) filled with angiographic contrast from the conduit without any irregularity (Figure 1B). String sign was a diffusely narrowed conduit filled with contrast but not seen to opacify the native coronary artery (Figure 1D). Postoperative coronary anjiogram was revealed that native coronary artery occlusion was not important (Figure 1C). When a conduit did not fill with contrast at all, it was considered occluded and was included with string sign for the purposes of this analysis. Both of these latter findings were considered together and referred to as occlusion in the analysis (6).

Surgical Technique

We have performed beating off-pump surgery to all patients. Left internal thoracic artery (LITA) is routinely used for 94 patients. Left radial artery is routinely used right radial artery is also used in younger patients (<50 years). Saphenous vein graft was used for additional coronary surgery. Heparinization was done just after LITA harvested. Pericardium is opened and stay sutures are placed. Firstly left side coronary vessels are anastomosed on beating off-pump surgery. Then LITA and right coronary system are bypassed. Radial artery graft is used for higher stenosed and larger coronary arteries. RA is used for LAD territory in six patients. After all distal anastomoses are done heart placed to pericardial cradle and waited for recovery of hemodynamic condition. During this time we have tried not to use inotropic agents. Warm saline solutions (>30ºC) spilled over the heart into the pericardial cradle. When the systolic blood pressure reaches over 100 mmHg, 20 gauge vessel catheter was advanced into proximal radial artery and coronary artery pressure was measured. Both radial artery and aortic pressures were recorded instantaneously. Aortic pressure is relatively similar to peripheral arterial pressure. We have prefer right radial artery (if it was not harvested) pressure for detecting aortic pressure. We have temporarily placed bulldog clamp to LITA graft to avoid collateral blood supplying effect during the pressure measurement. Systemic arterial pressure measurements were done from ascending aorta in seven patients. Both ascending aorta and radial artery distal pressure were simultaneously recorded. Systolic, diastolic and mean artery pressures are routinely recorded. Pressure differences are calculated. Bulldog clamp on LITA released just after measurements. All proximal anastomoses were done to the ascending aorta.

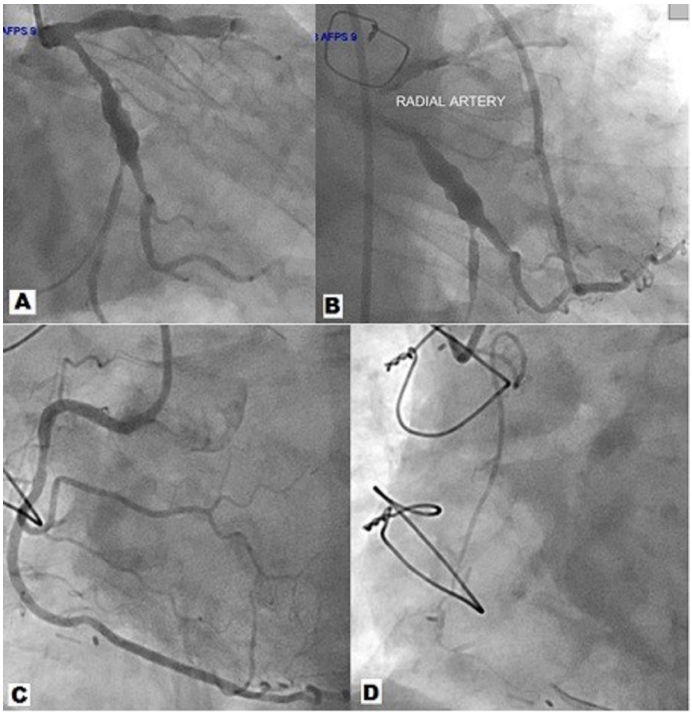

Figure 1A. Preoperative angiogram of highly stenosed (90%) obtuse marginal artery, **1B.** Postoperative angiogram of patent radial artery (measurements Ao/C-s%=32, Ao/C-d%=46, Ao/C-m%=61), **1C.** Postoperative angiogram of mildly stenosed (70%) right coronary artery, **1D.** Postoperative angiogram of string sign radial artery (measurements Ao/C-s%=93, Ao/C-d%=92, Ao/C-m%=88)

RESULTS

All patients were followed-up. Serial postoperative coronary angiographies were performed at first six postoperative months. There was not death with in the first postoperative six months follow-up. We have detected ten radial artery graft occlusions and string sign. Table 1 summarizes patient characteristics and measurements accordingly. Five right coronary artery, four circumflex artery and one diagonal artery radial artery grafts occluded. Six male and four female patients has occluded radial artery grafts. Percentage of systolic aortic and coronary pressure measurement (Ao/C-s%) on occluded graft patients was changed from 81 to 97. Percentage of diastolic aortic and coronary pressure measurement (Ao/C-d%) was changed from 83 to 90. Percentage of the mean aortic and coronary pressure measurement (Ao/C-m%) was changed from 84 to 95.

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Table 1. Patient characteristics and measurements

AGE	M/F	VESSEL	STENOSIS (%)	Ao/C-s%	Ao/C-d%	Ao/C-m%	STATUS
52	F	D1	75	85	90	86	OCCLUDED
71	M	OM	80	97	92	95	STRING SIGN
44	M	RCA	70	93	92	88	STRING SIGN
66	M	R-PDA	80	92	85	87	OCCLUDED
67	M	CxPL	75	97	89	95	STRING SIGN
72	M	OM	85	91	90	89	STRING SIGN
68	F	RCA	85	85	87	90	OCCLUDED
58	F	R-PDA	75	85	83	85	OCCLUDED
45	M	RCA	80	88	90	87	STRING SIGN
61	F	OM	80	81	85	84	STRING SIGN

Ao/C-s%: percentage of systolic aortic and coronary pressure measurement, Ao/C-d%: percentage of diastolic aortic and coronary pressure measurement, Ao/C-m%: percentage of mean aortic and coronary pressure measurement

DISCUSSION

Severity of stenosis in the native coronary artery is critical to both the short and long-term patency of the RA, because of the potentially negative effects of competitive flow when the stenosis is below 70-80% (2-7). Coronary angiography is limited in its ability to determine the physiologic significance of coronary stenosis. Especially in patients with intermediate stenosis, angiographic information does not correlate well with the functional significance of a lesion. This uncertainty may result in unnecessary revascularization of insignificant lesions or may cause early graft occlusion. It is also well recognized that angiographic grading of stenosis severity is at best an imperfect predictor of the physiological significance (i.e., flow-limiting status). Technical imperfections are related to patient morphology or vessel tortuousity can also limit visualization of specific coronary narrowing (8-10). Furthermore it needs to be recognized that visual estimates of the severity of coronary stenosis are frequently very inaccurate when compared to more objective measurements such as fractional flow reserve (FFR). FFR can be derived easily from the ratio of the mean distal coronary-artery pressure to the aortic pressure during maximal vasodilatation. This index is independent of changes in systemic blood pressure and heart rate and unaffected by conditions known to increase the base-line myocardial flow (8-11). But hyperemia is required to achieve the necessary resistance conditions and which is provided by adenosine administration. Most cardiologists avoiding use of adenosine and Sen et al. (12) present a novel concept, the instantaneous wave-free pressure ratio (iFR), using and expanding on the tenets of FFR. iFR, an index of stenosis severity, is based on the instantaneous ratio of translesional pressures acquired during a specific period of diastole in which the coronary microcirculatory resistance is constant and minimal, fulfilling the FFR resistance criteria without the need for adenosine hyperemia. iFR is basically translesional ratio of diastolic pressures. The first multicenter study, ADVISE (Adenosine Vasodilator Independent Stenosis Evaluation), compared iFR to FFR in 157 intermediate lesions and found the diagnostic accuracy of iFR to be 90%, with an optimal iFR cut-off of 0.90 (12). We have made comparison distal coronary pressure which is measured from radial artery that anastomosed coronary artery and aorta pressure which is obtained from ascending aorta cannula. We think that we can predict of radial artery prognosis based on severity of coronary artery stenosis. We have found ten radial artery grafts occluded. But patients are completely asymptomatic because of functionally insignificant lesions despite these lesions are considered visually significant on coronary angiogram. Lowest Ao/C-s% on occluded graft patients was 81 and lowest Ao/C-d% was 83 and lowest Ao/C-m% was 84. Unfortunately ten radial artery measurements are not enough for establish a cut-off value. We need more studies for creating a cut-off value determination.

CONCLUSION

Radial artery graft patency rate fully depend on the severity of stenosis on native coronary artery. Visual and mathematical estimation of native coronary artery stenosis could not be accurate in some vessels. FFR studies would be necessary but FFR studies always increased the cost. We have described relatively new technique for estimation native coronary artery stenosis via grafted with radial artery during off-pump surgery. Distal pressure measurement and compared with the systemic pressure would estimates radial artery patency during the coronary artery surgery.

Conflict of Interests: The authors declare that there are no conflict of interests.

Financial Disclosure: The authors declare that there is no financial support.

Ethics committee approval: Alife Ethical Commitee have approved this study (ALIFE 2017/44-EK).

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