Surgical Patch Angioplasty of the Left Main Coronary Artery and/or the Proximal Segment of the Right Coronary Artery

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Summary

Surgical patch angioplasty is procedure for lesions of the main coronary arteries but it is not performed frequently because of technical complexity and uncertainty about final results. We present experience of SPA for treatment of main coronary artery lesions and assess medium-term outcomes after this procedure. Since November 1998 13 patients have undergone SPA. There was an isolated left/right lesion in 9 cases (6/3), a combination with LAD stenosis in 3 cases. One patient had bilateral ostial lesion. Ten patients received a pulmonary artery autograft as angioplastic patch. The control angiography was performed in all patients. The mean follow-up was 33 months (2 to 80 months). There were no perioperative or late deaths. To date, patients are free of symptoms or have criteria for Grade 1 of CCS functional classification. Our limited experience with SPA of main coronary arteries proves the reliability and the efficiency of this procedure at a mean follow-up time of 33 months. SPA may be carried out with acceptable risk and mortality compared to conventional CABG.

Introduction

Surgical patch angioplasty (SPA) is procedure for the left main coronary artery (LMCA) and/or the proximal segment of the right coronary artery (RCA) lesions but it is not performed very frequently. There are several concerns about the application of SPA including the complexity of the procedure, which involves the risk of intraoperative complications and uncertainty about the final results. However, an alternative and more popular treat-

ment, the multi-vessel coronary bypass grafting, has disadvantages, including retrograde coronary blood flow, development of proximal coronary occlusion, excessive graft material consumption, etc.

In this paper we present our limited experience of the application of SPA for the treatment of main coronary artery lesions and assess the medium-term outcomes after this procedure.

Materials and Methods

Since November 1998 thirteen patients with lesions of the LMCA or the proximal segment of the RCA have undergone surgery. The general characteristics of the patients and the coronary artery disease (CAD) risk factors are shown in Table 1.

Intraoperative data is presented in Table 2.

Surgery was performed using standard balanced fentanil anesthesia and a standard middle sternotomy. Myocardial preservation included moderate hypothermic (30°C) cardiopulmonary bypass, aortic cross-clamping and cardiac arrest by cold blood antegrade intermittent cardioplegia in combination with topical pericardial cooling with ice cold saline. Recently, in cases where additional administration of cardioplegia was needed during aortic opening, it was performed in a retrograde fashion. The left ventricle was vented through the right

Table 1. Patient's characteristics and risk factors

Characteristics	Number of patients	(%)
Mean age (years)	**47.5**	**–**
Male gender	**11**	**(84.6)**
Female gender	**2**	**(15.4)**
The cause of coronary lesion:		
• **Atherosclerosis**	**10**	**(76.9)**
• **Aortitis**	**1**	**(7.7)**
• **Coronary spasm (variant angina)**	**2**	**(15.4)**
The type of the coronary lesion:		
• **Isolated main coronary lesion (left/right)**	**9 (6/3)**	**(69.2)**
• **Biostial lesion**	**1**	**(7.7)**
• **Main coronary lesion accompanied by LAD stenosis**	**3**	**(23.1)**
Clinical characteristics:		
• **Preoperative MI**	**2**	**(15.4)**
• **Angina at rest**	**7**	**(53.8)**
• **Unstable angina**	**3**	**(23.1)**
Risk factors:		
• **Hypercholesterolemia**	**8**	**(61.5)**
• **Systemic hypertension**	**9**	**(69.2)**
• **Smoking**	**9**	**(69.2)**

MI – myocardial infarction; LAD – left anterior descending artery;

Table 2. Intraoperative patients' data.
Localization of the narrowing anatomical structure (plaque, spastic segment of artery)

	LMCA	RCA
Ostium	**3**	**2**
Proximal third	**2**	**1**
Middle third	**3**	**–**
Distal third	**2**	**–**
Continuous lesion from ostial to middle segment	**–**	**1**
Combination of surgical patch angioplasty and LIMA-LAD anastomosis	**3**	**–**

superior pulmonary vein. The average time of aortic clamping was 56, 9 min (range 37 – 101 min); the cardiopulmonary bypass (CPB) time was 105 min (range 74 – 143 min).

SPA of LMCA was done only via anterior approach with complete cross-cutting of the main pulmonary artery in nine cases and without any in one case (Fig.1. Exposure of LMCA via anterior approach with complete cross-cutting of pulmonary artery). Pericardial, venous and radial artery autograft patches were each used in one case. The remaining patients received a pulmonary autograft patch (Fig. 2. General view of pulmonary autograft patch). The tailoring of the pulmonary autograft patch was performed predominantly from the anterior pulmonary artery wall or by a wider (up to circular) cutting in the case of a biostial lesion. In cases of SPA of the LMCA, we followed the methodology of Dion et al. [8], consisting of the creation of a "funnel-shaped" entrance into the LMCA with a wide angioplastic patch (Fig. 3. Final external view of patched LMCA). Enlargement of the initial segments of the

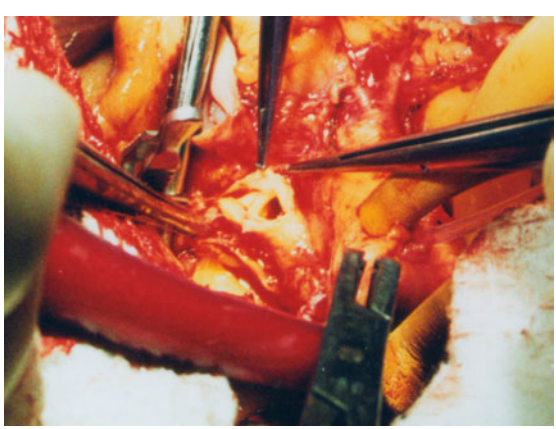
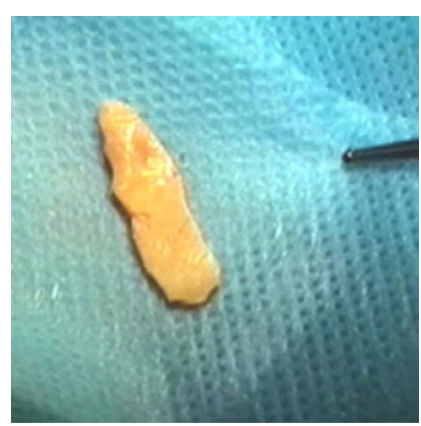


Figure 1.



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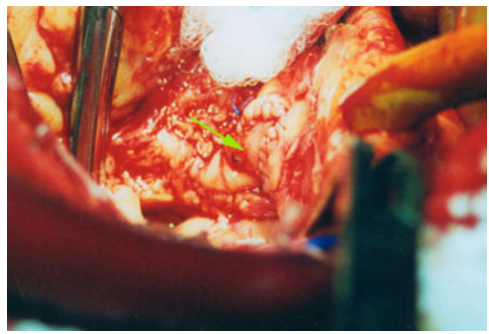

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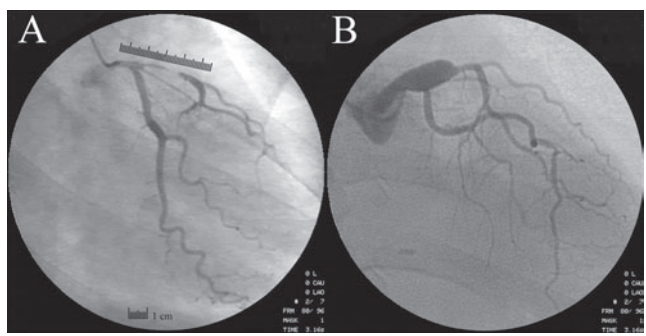

Figure 4.

LMCA branches was required in two cases, and in one of them it was necessary to execute enlargement of all three branches of left main coronary artery (LAD, circumflex and intermediate arteries).

There were three cases of SPA of the LMCA accompanied by LIMA-LAD anastomosis for treatment of concomitant LAD stenosis.

In cases of SPA of the proximal segment of the RCA, before the CPB, this part of the artery was dissected from its aortic origin through the fat of the epicardium. The procedure was performed by direct longitudinal opening of the RCA lumen by cutting far enough along the aortic wall. Although creation of a wide "funnel-shaped" entrance has less importance in cases of the angioplasty of the RCA in comparison with the LMCA, we try to do this regardless of whether we are performing right or left angioplasty. Endarterectomy was avoided in all cases.

Restoration of the pulmonary artery integrity was carried out in all cases by a simple double continuous prolene suture without any graft materials.

A control angiography was performed in all patients 2, 9 months after the operation on average (range 1-5 months). The mean follow-up time was 33 months (range 2 - 80 months).

Results

There were no perioperative or late deaths. At the control coronary angiography, the wide "funnel-shaped" entrance into the left or right coronary artery was demonstrated (Fig. 4. The angiographic view of LMCA before (A) and after (B) SPA). The length of the initial wide segment of the artery depended on the length of the pathological process narrowing the coronary artery segment (plaque or spastic segment) and in some cases was more than 4 cm length.

In one case, a relapse of symptoms occurred in 30 months after RCA angioplasty due to the appearance of a circumflex lesion. This patient underwent descending aorta- circumflex artery shunting with autovenous graft via left thoracotomy. To date, the remaining patients are free of symptoms or have criteria for Grade 1 of CCS functional classifications for stable angina pectoris.

Discussion

Critical isolated stenosis of the left main coronary artery (LMCA) is a special kind of coronary artery pathology, which has an adverse natural course [1,2,3]. The incidence of LMCA lesions amounts to 3-9% of the general number of CAD patients undergoing coronary angiography [3, 4]. Isolated lesions of the LMCA are diagnosed more rarely, according to different authors from 0, 13 up to 3 % [5, 6, 7, 8, 9]. Results of conservative treatment for this disease are not satisfactory; hence surgical intervention is a unique opportunity for the patient's recovery [1, 3].

Two surgical techniques for treatment for LMCA stenosis have been developed: surgical angioplasty of the LMCA and a conventional multi-vessel coronary artery bypass grafting (CABG). SPA was introduced at the early stages of cardiac surgery development [6,9] but after the introduction of CABG [10, 11], it was abandoned due to a high (44 - 65 %) intraoperative mortality rate[1,2, 4].

After clearing up the palliative essence of a conventional CABG, interest in SPA of the LMCA was revived by Hitchcock et al. in 1983 [1]. From the middle of 1980s an increasing number of surgeons have been carrying out this operation [4,5,6,9,12].

However, many surgeons still have a negative attitude to surgical angioplasty, [discussion in 1,4,13], preferring to carry out a conventional CABG for LMCA lesions.

Nevertheless, the advantages of SPA in comparison with CABG are obvious:

1. SPA restores the patency of the narrowing coronary artery segment and provides physio- logical antegrade coronary blood flow [5,8,9,12,14,15]. In contrast, conventional bypass surgery invariably leads to definitive occlusion of the LMCA [6,12] due to the retrograde blood supply of the coronary branches. In addition, the retrograde coronary circulation creates conditions whereby a progressive decrease in the blood flow volume takes place in the coronary branches derived from the main artery under the obtuse angle with

respect to the direction of the flow [1]. LMCA occlusion results with the patient's life completely dependent on the time-limited patency of the graft.

2. SPA reserves the opportunity for conventional bypass surgery or catheter intervention in cases of distal coronary lesions occurring during thepatient's life [6,9,12,15]. This is important given the younger age of patients with LMCA stenosis. For example, the mean age of our patients in the SPA group was 47,5 years and the mean age in the conventional CABG group was 53.7 years. It should be noted that the technical feasibility of conventional CABG following angioplasty is simpler than redo-CABG due to less pericardial adhesions [9].

3. In the case of a LMCA lesion, multi-vessel CABG requires harvesting of abundant shunt materials, which may limit the feasibility of redo-CABG if necessary [4,6,12,14,15].

4. If in the case of LMCA stenosis an intramyocardial arrangement of coronary arteries is present, SPA might be the only possible surgical treatment [16].

All the above items may be extrapolated to lesions of the proximal segment of the RCA with a greater or smaller degree of importance.

The technical elaboration of SPA led to a number of questions, which had to be answered in order to find an optimal surgical approach to LMCA.

Two basic methods are available: the right (or posterior) and the left (or anterior) approaches [9,12,17]. The right approach consists of LMCA dissection along the posterior aortic wall. Its advantage is a favorable (almost 180^0) angle between the axes of the LMCA and the aortic wall surface, which involves no danger of kinking of the onlay patch [1,12,17]. The disadvantage of this approach is limited visualization of the LMCA leading to unfeasibility of LMCA distal segment patching [12.17]. This approach was advocated by earlier authors because of the predominance of ostial LMCA lesion in their experience [1,12].

The single disadvantage of the anterior surgical approach is the unfavorable angle (much less than 180^0) between the axes of the LMCA and the aortic wall surface with the danger of kinking of the onlay patch [12,17]. The application of wide patches and the creation of the "funnel-shaped" entrance into the LMCA avoids this danger [6].

The frequently used addition for the anterior surgical approach is complete crossing of the main pulmonary artery resulting in excellent visualization of all parts of the LMCA including the site of its division into the LAD and the circumflex artery [4,6,9,14].

Devuaert et al. [12] suggested a surgical approach to the LMCA with complete crossing of both the aorta and the main pulmonary artery ("TGA approach"). Rotation of the face of the great vessels to the surgeon provides the opportunity to reach all the walls of the LMCA. The authors described a clinical case where it was the "TGA approach" that enable them to identify the LMCA wall uninvolved in the disease, resulting in uncomplicated execution of surgical patch angioplasty [12].

Eishi et al. [17], Liska et al. [2] used the approach of complete crossing of the ascending aorta alone and main pulmonary artery retraction to the left

("superior approach"). The authors believe that this maneuver provides the opportunity to gain a wide exposure of the LMCA for surgical manipulation.

The most experienced in surgical angioplasty of the LMCA, Dion, considers that the anterior approach with complete crossing of the main pulmonary trunk and use of a wide onlay patch is the approach of choice for surgical angioplasty of the LMCA apart from the anatomical features of lesion [6].

Our limited experience with SPA supports the universality of the anterior approach, with crossing of the main pulmonary trunk, for surgical manipulation of any parts of the LMCA.

Another subject for discussion is the patch material for SPA. Autovenous, autopericardial, radial artery and left internal mammary artery autografts are used for SPA as patch material [2,6,16,18]. Each material has positive and negative properties. For example, it was supposed that autovein has a tendency to specific proliferative degeneration as in the case of CABG [6, discussion in ref. [4] and may dilate because of its natural elasticity [14]. A fresh autopericardium does not have fibrinolitic properties [19], but may later shrink with an unpredictable behavior of the coronary entrance [8]. The autopericardium treated with glutaraldehyde tends to be subjected to calcification [discussion in ref. [4]. To accept Dion's pattern of SPA, autoarterial patches may not be sufficiently wide.

We consider that the material of choice for SPA to be the pulmonary autograft patch [18], which was used in our experience in most cases. This patch material seems to be "ideal" because of the viability of the tissue combined with excellent elastic properties and the ability to counteract the high pressure without development of dilatation, calcification and degradation in the course of time [18]. However, it should be noted that SPA with autoveinous or autopericardial patch material also leads to satisfactory follow-up results [6].

In summary, our limited experience with SPA of main coronary arteries proves the reliability and the efficiency of this procedure at a mean follow-up time of 33 months (2-80 months). SPA may be carried out with acceptable risk and mortality compared to conventional CABG. The obvious physiological advantages of SPA obligate us to consider this procedure instead of conventional CABG in individuals with lesions of the main coronary arteries, isolated or with limited involvement of distal coronary branches.

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