

# Revascularization of the Circumflex Artery Using Pedicled Right Internal Mammary Artery Graft via the Transverse Sinus

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## SİRKUMFLEKS ARTERİN TRANSVERS SİNÜSTEN GEÇİRİLEN PEDİKÜLLÜ SAĞ İNTERNAL MAMMARYAN ARTER KULLANILARAK REVASKÜLARİZASYONU

Sol ventrikülün tam arteriyel revaskülarizasyonunun gerçekleştirilmesi için sağ internal mammaryan arterin (RIMA) aortanın arkasından geçirilerek circumfleks (Cx) arter ve dallarına anastomozu alternatif bir yöntem olarak ilgi çekmektedir.

**Hastalar ve metodlar:** Nisan 1995 ile Aralık 1997 tarihleri arasında 115 elektif hastaya (98 erkek, 17 kadın, 34-75 yaş arası, ortalama yaş: 56.3) bu teknik uygulandı. Yirmi üç hasta diabetik olup, 10 hastada kronik obstrüktif akciğer hastalığı mevcut idi. On üç hastanın sol ventrikül ejeksiyon fraksiyonu %40 dan azdı. RIMA kalbin arka yan yüzünün revaskülarizasyonunu sağlamak için transvers sinüsten geçirildi. RIMA 21 hastada Intermediar (IM) artere, 84 hastada Obtus marginal (OM) artere ve 10 hastada posterolateral Cx (PLCx) artere anastomoz edildi. Sol internal mammaryan arter (LIMA) 63 hastada sol ön inen dala (LAD), 51 hastada LAD ve diagonal artere, bir hastada da LAD proksimal distaline anastomoz edildi. Sekiz hastada ise sağ gastroepiploik arter sağ koroner arter veya dallarına anastomoz edildi. Kırk iki hastada tam arteriyel revaskülarizasyon sağlandı. Her hastada 2.52 arteriyel anastomoz yapılırken ortalama distal anastomoz sayısı 3.2 idi.

**Sonuçlar:** Erken ya da geç mortalite gözlenmedi. Perioperatif miyokard infarktüsü elektrokardiografide yeni Q dalgası beraberinde kreatin kinaz MB fraksiyonunda artış ile tanımlandı. Dört hastada perioperatif miyokard infarktüsü gelişti ve bu hastaların hiç birinde intra aortik balon pompası kullanılmadı. Kronik obstrüktif akciğer hastalığı olan 3 hasta sternal dehisens nedeniyle reopere edildi. İki hasta ise kanama nedeniyle erken reoperasyona alındı. Postoperatif angiografiyi kabul eden otuz beş hastaya 1-12 ay arasında prospektif angiografi yapıldı RIMA anastomozları otuz beş hastada otuz üçünde açıkken tüm hastalardaki LIMA anastomozları açıktı. Treadmill testi RIMA anastomozları tıkalı olan hastalar da dahil olmak üzere 93 hastada da negatifti.

**Yorum:** RIMA nın transvers sinüsten geçirilerek circumfleks bölgesinde kullanılmasının mükemmel patensi ve iyi klinik sonuçlar sağladığı düşünülmektedir.

**Anahtar kelimeler:** RIMA, transvers sinus, arteriyel revaskülarizasyon.

Internal mammary artery (IMA) conduits are known to provide long term patency and increased patient survival with low morbidity after coronary artery bypass grafting (CABG). IMA has demonstrated its resistance to atherosclerosis and intimal hyperplasia (1,2). Currently, the IMA is considered the conduit of first choice for CABG, and bilateral IMA grafts were expected to improve survival. In our institution, when bilateral IMA grafts are used for coronary revascularization the right internal mammary artery (RIMA) is brought through the transverse sinus to the posterior wall of the left ventricle (Figure 1) and the left internal mammary artery (LIMA) is anastomosed to the left anterior descending (LAD) coronary artery. This report presents a retrospective analysis of the early and intermediate results of 115 elective patients who underwent revascularization of the myocardium with bilateral IMA grafts using right internal mammary artery (RIMA) via the transverse sinus.

## MATERIAL AND METHODS

### Patient selection

There was no strict contraindication to use this technique. However, old patients (more than 80 years), hemodynamically unstable patients, chronic obstructive pulmonary disease (COPD) and also insulin dependent diabetes were decided as relative contraindication for this kind of surgical procedure. This study also excluded emergency cases, reoperations, and patients who had concomitant valve procedures, carotid endarterectomy or aneurysmectomy.

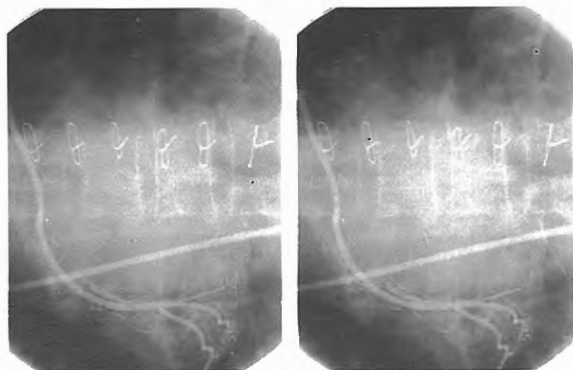


Figure 1. Postoperative control angiogram showing patent RIMA-Cx anastomoses

### Patient population

Between April 1995 and December 1997, this technique was applied to 115 elective patients (98 males, 17 females; age: 56.3 years, range 34-75 years). Twenty-three patients were diabetics and 10 patients had suffered from the COPD. Ejection fraction determination by left ventriculography was available for all patients in the series; this was < 40% in thirteen patients. Preoperative symptoms for angina were defined by the Canadian Cardiovascular Society (CCS) classification (3). Immediately before the operation, 37 patients (32.2%) were in class I, 19 (16.5%) in class II, 52 (45.2%) in class III, and 7 (6.1%) in class IV. Clinical profile of the patients is shown in table 1.

Table 1. Clinical profile of 115 patients

|                                   |              |
|-----------------------------------|--------------|
| Mean age (yr)                     | 56.3 (34-75) |
| Male/female                       | 98:17        |
| COPD                              | 10           |
| LVEF <40 %                        | 13           |
| <b>Risk factors</b>               |              |
| Hypertension                      | 38           |
| Diabetes mellitus                 | 23           |
| Hyperlipidemia                    | 41           |
| Previous myocardial infarction    | 54           |
| Previous cerebrovascular accident | 2            |

### Operative data

Both IMAs were harvested and used in all patients. Besides bilateral IMA grafting, in eight patients the right gastroepiploic artery (RGEA) was prepared and anastomosed to the right coronary artery (RCA) or its branches. In 42 patients, complete arterial revascularization had been obtained. RIMA grafts were passed through the transverse sinus to revascularize the lateral back side of the myocardium. RIMA grafts were anastomosed to the the intermediar artery (IM) in 21, the obtuse marginal artery (OM) in 84, an the posterolateral Cx (PLCx) in 10 patients. Left internal mammary artery (LIMA) was anastomosed to the LAD in 63, LAD and diagonal in 51 and LAD proximal-distal in

one patient. Patients received, on average, 2.52 arterial anastomoses.

### Operative technique

Chest was entered through the standard midline sternotomy approach. LIMA and RIMA were dissected in standard fashion beginning at the bifurcation of the artery and ending at the level of the subclavian vein. Low-current electrocautery and metallic Ligaclips (Ethicon, Inc., Summerville, N.J.) were used and both pleural cavities opened. Then pedicle was transected and injected with 30 mg of papaverine solution. The IMA is exposed by incising the pectoralis fascia through the length of the pedicle. The free cut-end flow through the IMAs are then evaluated. If there is no concern regarding flow, patients were heparinized and the routine cannulation and cardiopulmonary bypass were instituted. Two oval-shaped windows were made in the left and right lateral pericardium anterior to the phrenic nerves. RIMA was passed through a wide pericardial incision anterolateral to the superior vena cava and behind the aorta, through the transverse sinus. Mobilization of the pedicle with adjacent tissues, veins, and fascia can give some extra length-and avoid possible stretching of the RIMA. In this way, circumflex artery, its braches and diagonals could be reached easily.

LIMA was grafted to the left anterior descending, diagonals or sequentially to the diagonal and left anterior descending arteries. When necessary for revascularization of additional coronary braches, saphenous vein graft or RGEA was also used. Systemic mild hypothermia (32°C) and cold crystalloid+blood cardioplegia were used either antegrade or retrograde, or both. The IMA-coronary anastomoses were performed with continuous 7-0 polypropylene sutures (prolene, Ethicon) with optical magnification.

### Postoperative angiography and treadmill test

Thirty-five patients enrolled in prospective angiographic study agreed to undergo postoperative angiography (range 1 to 12 months after operation). Treadmill tests have done in 93 patients.

### Clinical Follow-up

Perioperative data were obtained from patients' hospital records. Follow-up information was collected directly with patient contact, from patients' personal physicians, or by telephone interview with the surviving patients or family members. The follow-up period ranged from 5 to 25 months (mean 17.6 months).

## RESULTS

There was no early or late mortality. Perioperative myocardial infarction was defined as new electrocardiographic Q waves combined with cardiac enzyme elevation (creatin kinase MB fraction concentration > 100 units). Eventhough-it was documented in 4 of our patients (3.5%) an intra aortic balloon pump (IABP) was never used in these patients. On the postoperative angiography of these patients it was

shown 2 RIMA and 2 saphenous vein occlusions. In the present group, three patients were reoperated for sternal dehiscence who had also COPD. Mediastinitis with positive cultures has occurred in two of these three patients and were treated with debridement, open irrigation and antibiotics. Two patients underwent early reoperation for excessive bleeding. Arrhythmias were rare and they were generally supraventricular in origin and benign in nature. On the control angiograms thirty three of the 35 RIMA anastomoses were patent and all the LIMA anastomoses were patent in postoperative. Treadmill tests were negative in all patients including patients who had occluded RIMA and saphenous grafts.

## DISCUSSION

Advantages of the IMA over the reversed saphenous vein as conduit for coronary bypass grafting have been extensively recorded in the literature. Comparative analysis of patency rates for saphenous vein and IMA grafts to the LAD reveal that over time the latter is a significantly more viable conduit (4). Then bilateral IMAs are harvested almost routinely if angiograms suggest that the location of the coronary lesions are amenable to in situ bilateral IMA grafts and no obvious contraindication exist. Our current contraindications for bilateral IMA grafting include the followings: old patients (more than 80 years), patients with atherosclerotic peripheral arterial disease, hemodynamically unstable patients and patients suffered from COPD and also insulin dependent diabetics. Pick and associates (5) who evaluated 10-year outcome of patients with bilateral versus single IMA grafts demonstrated that patients receiving bilateral IMA grafts had better long term survival. This study has not covered the diabetic patients.

Rankin and associates (6) have reported occlusion in two of 20 patients and flow in three others in postoperative control angiographic studies (1-32 week after operation) and recently, Gerola and associates (7) have reported patency of the transverse right IMA as 93.7% in 75 patients at the early postoperative period and 91.6% in 33 patients at the late postoperative period. Ueyama and associates (8) have found more encouraging patency rates of the right IMA to the circumflex branches was 97.2%, and in only one of 109 cases was it found to be totally occluded. Re-

cently, our study's results showed two occlusions in 68 patients. Eventhough, RIMA graft was never used in coronary lesions were less than 60%, probably the reason for occlusions was flow competition. In our institution, when both IMA grafts are prepared-RIMA is brought through the transverse sinus for grafting the circumflex area, as described by Pugig and associates (9) and the LIMA is anastomosed to LAD artery.

This method of bringing RIMA via the transverse sinus is indeed more demanding technically; however, the most crucial points are careful assessment of the length prior to anastomosis and obtaining adequate homeostasis of the pedicle before passing it through the transverse sinus. This technique has two main advantages: 1. no necessity to cross the midline anterior to the aorta, thus avoiding risks in case reoperations required; 2. size matching, that is, the LIMA graft reaches the generally largest coronary artery, the LAD, at a level where is still of good caliber, and the RIMA brought through the transverse sinus matches the circumflex branches. On the other hand, some authors had pointed out to the risks of overstretching and twisting the RIMA and the difficulties in bleeding control (6,10). None of our patients required reexploration for pedicle bleeding and problem as overstretching or twisting the RIMA were not seen in any of them.

Kouchoukos and associates (11) had reported that 6.9% sternal infection rate in the bilateral IMA group although %1.3 in single IMA group. In our series this was %2.6. Wound complications were more frequent in patients with diabetes and COPD. Because of this reason, this type of patient was never enrolled that study. In conclusion, complete arterial revascularization of the left ventricle by means of both pedicled IMAs could be performed with excellent graft patency and good results. For this purpose that bringing the RIMA via the transverse sinus to the circumflex area provides excellent early patency and good clinical results.

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