Does Radial Artery Harvesting Cause Any Changes in the Forehand Circulation During the Postoperative Period? An Angiographic Study

Radiyal Arter Çıkarılması Postoperatif Önkol Kollateral Sisteminde Değişiklik Oluşturur mu? Anjiyografik Çalışma

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Abstract

Objective: The aim of this study was to evaluate angiographic changes in the ulnar and interosseous arteries, and the collateral circulation of forehand after harvesting radial artery.
Methods: Forty patients were studied between June 1998 and June 2001. Study group consisted of 30 patients who received radial artery as a conduit for coronary artery bypass operation, and control group consisted of 10 patients who did not undergo any cardiac or vascular operation before. Preoperative risk factors were similar between the two groups. All patients underwent angiographic evaluation to detect coronary artery and left forehand arterial circulation.
Results: Angiographic evaluation was performed 25.5 ± 2.0 months after the initial operation in the study group. Mean diameter of ulnar artery was 2.9 ± 0.59 mm (range 2.1 - 4.8) in the study group and 3.2 ± 0.8 mm (range 1.5 t- 4.7) in the control group ($p > 0.05$). Mean diameter of interosseous artery was significantly higher in the study group than in control one: 2.06 ± 0.57 mm (range 1.2 t- 4.2) versus 1.46 ± 0.79 mm (range 0.8 t- 3.6); ($p = 0.003$).
Conclusion: Although angiography was performed in a limited number of patients, interosseous artery rather than ulnar artery enlarged to compensate blood supply of forehand 25 months after harvesting the radial artery for coronary artery bypass grafting. *(Anadolu Kardiyol Derg 2004; 4: 149-52)*
Key words: Radial artery, coronary artery bypass grafting, hand ischemia.

Özet

Amaç: Bu çalışmada radiyal arter kullandığımız hastalarda ulnar arter ve interosseöz arterde anatomik veya çap değişikliği olup olmadığını araştırmayı amaçladık.
Yöntem: Haziran 1998-2001 yılları arasında çalışmaya 40 hasta dahil edildi. Bu hastaların 30'unda sadece radiyal arter çıkarılan sol kol anjiyografileri yapıldı (Çalışma grubu). Kontrol grubu olarak ise, demografik bulguları aynı olan preoperatif koroner arter hastalığı araştırılmak üzere anjiyografi yapılan 10 hastanın sol kol anjiyografisi yapıldı. Hastaların hepsinin koroner arterleri ve önkolun kollateral sirkülasyonu anjiyografik olarak değerlendirildi.
Bulgular: Anjiyografik değerlendirme çalışma grubunda operasyondan 25.5 ± 2.0 ay sonra yapıldı. Çalışma grubunda ulnar arter ortalama 2.9 ± 0.59 (2.1-4.8) mm iken kontrol grubunda ulnar arter ortalama çapı 3.2 ± 0.8 (1.1-5.4) mm ($p > 0.05$) bulundu. Ortalama interosseöz arter çapı çalışma grubunda 2.06 ± 0.57 (1.2-4.2) mm kontrol grubunda göre 1.46 ± 0.79 mm (0.8-3.6) yüksek bulundu ($p = 0.003$).
Sonuç: Çalışmaya dahil edilen hasta sayısı az olmasına rağmen radiyal arter kullanımından 25 ay sonra interosseöz arter ön kol sirkulasyonunu kompanse etmek amacıyla ulnar artere göre daha fazla genişlediği saptandı. *(Anadolu Kardiyol Derg 2004; 4: 149-52)*
Anahtar Kelimeler: Radiyal arter, koroner arter baypas greftleme, kol iskemisi

Introduction

After a short time period of using radial artery for coronary artery bypass grafting (CABG) operations, it was completely abandoned because of early graft failure. By the introduction of the new antispasmotic regimens in the early 90's, early graft failure problem was solved and using arterial grafts has become more popular. Nowadays radial artery is believed to be the second choice after internal mammary artery

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(IMA) as a graft for CABG by most authors (1,2). Hand ischemia after harvesting of the radial artery was reported in only two cases in the literature (3,4).

In this study, we examined left forehand circulation and compared it between patients that received radial artery as a conduit for bypass and non-operated patients.

Material and Methods

Data were collected from 40 patients between June 1998 and June 2001. Control coronary artery and left forehand angiographies were performed in 30 patients who received a radial artery graft as one of the conduits for coronary revascularization (Study group). The control group consisted of 10 patients who had not undergone any cardiac or vascular operation before, and their angiographies were performed to detect coronary artery disease and evaluate left forehand circulation. Preoperative risk factors were similar between the two groups (Table 1). Preharvesting Allen test was performed in all patients. It was negative (less than 10 seconds) in all cases. All patients in study group had left IMA graft for the first choice of conduit except one who had a dissection of left IMA, and one patient received bilateral IMA grafts. Operations of 4 patients were done on the beating heart and the remainders were performed using extracorporeal circulation. All proximal anastomoses of radial arteries were performed to the ascending aorta and no patient needed inotropic or mechanical support after the operation. Control angiographies were performed 25.5 ± 2 months after the initial operation using the classical Seldinger method. The catheter was introduced through the left femoral artery into the left subclavian artery to visualize IMA graft. After then, ulnar collateral circulation was examined and diameters of ulnar and interosseous arteries were calculated just below the elbow. All angiographic examinations were done with 6 F diagnostic catheter. Mean diameter of ulnar and ventral interosseous arteries were measured by Vepro angiographic quantification system (Vepro, Munich, Germany) after calibrating with diagnostic catheter seen in the same imaging plane. Measurements were done by the same person. The results were compared with control group. There were no complications due to the angiographic interventions.

Statistical Analysis

A commercial statistical software package (SPSS for Windows, version 10.0, SPSS Inc, Chicago) was used for data analysis. Data are presented as mean ± standard deviation. Differences between categorical variables were tested using a Chi-square test, and differences in ulnar and intermediar artery diameters between both groups were tested using ANOVA and t test. A p value of less than 0.05 was considered as statistically significant.

Results

There was no congenital vascular anomaly in both groups. One patient had a steal syndrome due to serious subclavian artery stenosis, therefore angiographic assessment of ulnar and interosseous arteries was not performed. This patient was evaluated by the Allen's test preoperatively and it was found to be negative (less than 10 seconds). Left IMA and left radial artery were used in this patient and he was asymptomatic in the postoperative period possibly due to the well-developed collaterals. In the study group, mean diameter of ulnar artery was 2.9 ± 0.59 mm (range 2.1 - 4.8) and interosseous artery was 2.06 ± 0.57 mm (range 1.2 - 4.2). In the control group, mean diameter of the ulnar artery was 3.2 ± 0.8 mm (range 1.5 - 4.7) and interosseous artery was 1.46 ± 0.79 mm (range 0.8 - 3.6). The diameter of the interosseous artery was significantly higher in the study group (p = 0.003) (Table 2).

Table 1. Demographic characteristics of patients

	Study Group	Control Group
Age, years	48.83 ± 9.9	37.8 ± 15.8
Male, n%	30 (100)	10 (100)
Body surface area kg/m^2	23.86 ± 6.08	24.2 ± 5.63
Diabetes Mellitus, n%	16 (53.33)	5 (50)
Family history, n%	8 (26.67)	3 (30)
Hypertension, n%	9 (30)	3 (30)
Smoking, n%	25 (83.33)	8 (80)
Hypercholesterolemia, n%	8 (26.67)	3 (30)

Table 2. Angiographic findings

	Study group	Control group	p
Mean diameter of ulnar artery, mm	2.9 ± 0.59	3.2 ± 0.8	ns
Mean diameter of interosseous artery, mm	2.06 ± 0.57	1.46 ± 0.79	0.003

Discussion

Mid-term patency rates of radial artery used in coronary artery bypass surgery are satisfactory (over 90%) and they are superior to saphenous vein grafts (1,2). In our experience mid-term patency rate of radial artery is 80% with 46 angiograms of 183 patients within a mean time of 1.7 years (5).

Due to postoperative risk of hand ischemia, collateral circulation of the hand must be evaluated carefully in preoperative period. However, many surgeons are still worried about the risk of hand ischemia following the harvesting of the radial artery. Allen's test and its modifications are used to examine collateral circulation because it is simple and cost effective, and also has high sensitivity. Other tests such as Doppler ultrasound and pulse oxymetry tests have some advantages and disadvantages in contrast to the Allen's test. Although additional data about collateral circulation, ulnar and radial artery agenesis can be detected using the Doppler ultrasound, angiographic examination is still the gold standard. The main concern with the Allen's test is that it may provide a false negative result, thus allowing the surgeon to harvest the artery in a situation where the ulnar collateral circulation is inadequate. It is recommended to perform Doppler ultrasound in all patients who have a positive Allen's test to prevent hand ischemia in such patients (6,7).

Tatoulis et al. (2) reported 2 cases of finger tip ischemia that had Raynaud's phenomenon and scleroderma. Serious motor deficiency was reported in two cases, ulnar artery agenesis was detected in these 2 patients and both of them required surgical reintervention (3,4). Dumanian et al. (8) measured digital flow in both left and right forehands of the patients in whom radial artery harvesting had been performed for CABG and found that there was not any change in flow and function between two forehands. In a different study, there was an increase in flow of the ulnar artery, flow redistribution in digital arteries, flow reduction in superior palmar branch of radial artery and also an increase in the flow velocity in the first three fingers in forehands with harvested radial arteries (9). In a radioisotope perfusion study, authors compared forehands perfusion with and without harvested radial arteries, and they found a decrease in flow characteristics in harvested hands, but there was no functional deterioration (10). In a cadaver study, forehand and hand collateral circulations were examined in 50 patients. Dorsal palmar branch of radial artery makes an anastomosis with deep palmar arcus that is formed by the ulnar artery in 90% of individuals. Ulnar artery continues with a complete superficial palmar arcus in 66% and incomplete in 44% of individuals. This study shows that if an ulnar artery anomaly does not exist, radial artery can be harvested safely (11).

In our study we found that the mean diameter of interosseous artery is wider in patients with harvested radial artery. It seems to be a compensatory change. The increase in the diameter of interosseous arteries was statistically significant ($p = 0.003$), while mean diameter of ulnar artery was similar in both groups ($p > 0.05$). Although angiography was performed in a limited number of patients, we believe that interosseous artery plays an important role besides the ulnar artery to compensate the absence of the radial artery in the mid-term postoperative period.

References

1. Acar C, Ramsheyi A, Pagny JY, et al. The radial artery for coronary artery bypass grafting: clinical and angiographic results five years. J Thorac Cardiovasc Surg 1998; 116: 981-9.
2. Tatoulis J, Royse AG, Buxton BF, et al. Radial artery in coronary surgery: a 5-year experience clinic and angiographic results. Ann Thorac Surg 2002; 73: 143-8.
3. Mensah JN. An unexpected complication after harvesting of the radial artery for coronary artery bypass grafting. Ann Thorac Surg 1998; 66: 929-31.
4. Fox AD, Whiteley MS, Hughes JP, Roake J. Acute upper limb ischemia: a complication of coronary artery bypass grafting. Ann Thorac Surg 1999; 67: 535-7.

5. Yakut N, Kırali K, Güler M et al. The use of radial artery for coronary bypass grafting and early term results. Turkish J Thorac Cardiovasc Surg 1999; 7: 362-6.
6. Jarvis MA, Jarvis CL, Jones PRM, Spyt TJ. Reliability of Allen's test in selection of patients for radial artery harvest. Ann Thorac Surg 2000; 70: 1362-5.
7. Baxter BT, Blackburn D, Payne K, Pearce W, Yao JS. Non-invasive evaluation of the upper extremity. Surg Clin N Am 1990; 70: 87-97.
8. Dumanian GA, Segelman K, Mispireta LA, Walsh JA, Hendrickson MF, Wilgis EFS. Radial artery use in bypass grafting does not change digital blood flow or hand function. Ann Thorac Surg 1998; 65: 1284-7.
9. Pola P, Serricchio M, Flore R, Manasse E, Favuzzi A, Possati GF. Safe removal of the radial artery for myocardial revascularization: a Doppler study to prevent ischemic complications to the hand. J Thorac Cardiovasc Surg 1996; 112: 737-44.
10. Sadaba RJ, Conroy JL, Burniston M, Maughan J, Munsch C. Effect of radial artery harvesting on tissue perfusion and function of the hand. Cardiovasc Surg 2001; 9: 378-82.
11. Ruengsakulrach P, Eizenberg N, Fahrer C, Fahrer M, Buxton BF. Surgical implications of variations in hand collateral circulation: anatomy revised. J Thorac Cardiovasc Surg 2001; 122: 682-6.