Does harvesting of radial artery in the early postoperative period perturb the palmar blood supply and functions?

Radiyal arterin çıkarılması erken postoperatif dönemde palmar kanlanmayı ve fonksiyonları bozar mı?

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ABSTRACT

Objective: The aim of this prospective study was to assess whether the removal of the radial artery (RA) caused any alteration in the function or power of hand on postoperative 15th day.

Methods: The study group included 25 patients with objective or subjective complaints on postoperative 15th day regarding harvest site following coronary bypass surgery by using RA. Patients were examined for bilateral forearm function (soft touch and pin-prick neural sensation, handgrip power). The ulnar artery and palmar arcus Doppler measurements such as peak systolic and end-diastolic velocity, and radius of the arteries have been measured both at rest and following handgrip test. The operated arm was evaluated and compared with the opposite arm. Wilcoxon test was used to compare continuous variables.

Results: Among 18 patients complained a loss of sense in the RA excised arm, the sensory defects were documented in 5. Among 7 patients presented with a feel of strength loss, handgrip power revealed a nonsignificant decrease of strength in the harvested arm. After squeezing test, ipsilateral ulnar artery peak systolic velocity increased from 86±15 to 105±15 cm/sec ($p<0.001$), end-diastolic flow velocity from 28±5 to 36±8 cm/sec ($p<0.001$) without any change in the ulnar artery radius. In contrast, no significant change in the flow velocity and the diameter of palmar arcus was noted before and after squeezing test. The comparison of the ulnar artery radius and blood flow velocity parameters in the RA excised arm to those of contralateral one after exercise test demonstrated no difference.

Conclusions: With an assumption of appropriate selection, removal of RA does not change the forearm blood supply and functions with little sensory disturbances in the early postoperative period. *(Anadolu Kardiyol Derg 2009; 9: 128-31)*

Key words: Coronary bypass surgery, radial artery graft, forearm function, hand ischemia

ÖZET

Amaç: Bu prospektif çalışmanın amacı radiyal arterin (RA) çıkarılmasının, operasyondan 15 gün sonra elin fonksiyon ve gücünde değişmeye neden olup olmadığının değerlendirilmesidir.

Yöntemler: Çalışma grubu RA'in kullanıldığı koroner arter baypas cerrahisini takip eden 15. günde çıkarılan taraftaki el ile ilgili objektif veya subjektif şikâyetleri olan 25 hastayı içermektedir. Hastalarda iki taraflı ön kol fonksiyonları değerlendirildi (hafif dokunma, iğne batması hissi, el kavrama gücü). Pik sistolik ve diyastol sonu akım hızı ve arterlerin çapı gibi Doppler ve ultrason ölçümleri hem istirahatte, hem de el sıkma testinden sonra tekrarlandı. Opere edilen kol değerlendirildi ve karşı taraftaki ile karşılaştırıldı. Devamlı değişkenlerin karşılaştırılması için Wilcoxon testi kullanıldı.

Bulgular: Radiyal arterin çıkarıldığı kolda şikayetleri olan 18 hasta arasından 5'inde duyu defekti dokümante edildi. Güç kaybı hissi ile müracaat eden 7 hastada el sıkma gücü opere edilen kolda anlamlı olmayan bir güç kaybı ortaya koydu. Sıkma testinden sonra, ulnar arter pik sistolik hız 86±15'den 105±15 cm/sn'ye ($p<0.001$), diyastol sonu akım hızı 28±5'den 36±8 cm/sn'ye ($p<0.001$) artış gösterdi. Bu dönemde ulnar arter çapında anlamlı bir değişme olmadı. Tam aksine, sıkma testi öncesi ve sonrasında palmar ark çap ve akım hızında anlamlı bir değişme olmadı. Sıkma testinden sonra RA çıkarılan koldaki ulnar arter çapı ve kan akımı hız parametrelerinin karşı taraf koldaki ile karşılaştırılmasında fark bulunmadı.

Sonuç: Uygun seçilen kişilerde RA'in çıkarılması erken postoperatif dönemde önkola olan kan akımını değiştirmemekte, ayrıca hafif bir duyu bozukluğu dışında fonksiyon bozulmasına neden olmamaktadır. *(Anadolu Kardiyol Derg 2009; 9: 128-31)*

Anahtar kelimeler: Koroner baypas cerrahisi, radiyal arter grefti, önkol fonksiyonu, el iskemisi

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Introduction

The use of radial artery (RA) as an alternative to saphenous vein graft for the purpose of revascularization has been gradually increasing in all age groups because of the high patency rates in long follow-up period (1-3). It is of vital importance to have a good and sufficient ulnar collateral artery circulation at the RA excised extremity. The RA excision from the dominant RA arm can result in ischemia in the same hand and fingers when the ulnar collateral flow is not adequate. The Allen test is still standard examination to test the patency of ulnar artery (4-6). Doppler ultrasonographic (USG) evaluation of the antebrachial artery and its collateral circulation, and oxygen saturation measurements via digital pulse oxymetry following application of one-minute pressure over RA have been used in decision-making process (4). Numbness and loss of soft touch sensation at the fingers ipsilateral to the arm with the excised RA are frequently reported, mostly secondary to frequent and improper use of electrocautery (2). A thorough evaluation of the extremity is frequently necessary in patients with objective or subjective complaints regarding the harvested graft side in the arm, since some of the complaints are only due to psychological stress.

In this study, pre-and postexercise Doppler USG examination of the extremity to detect the forearm arterial flow, tests of feeling and physical power of handgrip have been evaluated in a group of patients with complaints of neural sense loss, decrease in hand grip power and numbness at the RA excised extremity in the early postoperative period (15th day). This study is designed to reveal the relationship between the complaints, and the symptoms and signs in this category of patients.

Methods

Study population

This prospective study population included the last 25 consecutive patients with complaints of sense loss, decrease in hand grip power and numbness at the RA excised extremity in the early postoperative period (15th day) after coronary bypass surgery. All of the patients gave informed consent.

Radial artery harvesting

Preoperatively, all patients underwent Allen test with pulse oxymetry to determine the flow through the brachial, radial, and ulnar arteries. The appropriate RA was harvested between the recurrent RA and the segment 3 cm to the styloid process of radius. The method of harvesting of RA has been published before (7). Briefly, a curvilinear skin incision starting 2-3 cm distal to the elbow and ending 2-3 cm proximal of the wrist was performed. Electrocautery with low-voltage diathermy was used where RA is far from the fascia. Distal part of the deep fascia was incised using scissors to avoid thermal injury. When visible, the superficial radial and antebrachial cutaneous nerves were protected. A mixture of 1% papaverine and diltiazem cocktail was applied externally with a soaked sponge. An atraumatic vascular clamp was placed temporarily across to trunk of the artery to observe retrograde pulsation indicating adequate ulnar artery collateral flow after mobilization of RA. After homeostasis was assured using electrocautery and small clips, the harvesting site was closed with 3-0 absorbable sutures.

Definition and methods of detection of neurological defects

Detection of sense loss: Sense loss in the RA harvested extremity was evaluated with the soft touch and the needle of the pin by comparing with the contralateral extremity. The results were reported and scored as (+) or (-) based on the examination of the cardiovascular surgeon.

Examination of handgrip power: The cuff of a sphygmomanometer was folded, locked and inflated up to 150 mmHg. The patient was asked to squeeze the folded cuff between the thumb and the other fingers equally. The manometer pressure recordings of the patient from RA excised and non-excised arms were obtained during squeezing.

The forearm blood flow assessment with Doppler USG: Arterial blood flow in both arms was assessed comparatively by using Doppler USG (GE Logic, USA, 12 MHz linear probe) in each patient. All vasodilators (calcium channel blockers, nitrates etc.) were withdrawn 24-48 hours before the Doppler USG recordings. Both arms were examined by Doppler USG after 20 minutes of rest and 20 seconds of stress ball squeezing, and both the ulnar artery and palmar arcus peak systolic velocity (cm/sec), enddiastolic velocity (cm/sec) and arterial radius (mm) measurements were obtained.

Statistical analysis

The SPSS 11.5 program for Windows was used for the entire statistical work-up (SPSS Inc., Chicago, Il, USA). Values of selected variables were summarized by standard descriptive statistics and expressed as mean±SD, median and minimum- maximum values. Wilcoxon test was used to compare continuous variables. Statistical significance was defined by a p value < 0.05.

Results

Radial artery grafting has been used in a total of 178 patients undergoing coronary artery bypass graft (CABG) in our cardiovascular surgery department between January 1998 and December 2003. The study group consists of the last 25 consecutive patients, who were admitted with objective or subjective complaints regarding the graft side in the arm on postoperative 15th day. The patient demographics are presented in Table 1. Among 18 patients complained a loss of sense in the RA excised arm, the sensory defects were documented in only 5 patients by tests of soft touch feeling and the touch of the needle of the pin. Among 7 patients presented with a feel of strength loss, handgrip power revealed a nonsignificant decrease of strength in the harvested arm in comparison to those of contralateral arm (Table 2).

The comparison of the Doppler USG blood flow recordings of the ulnar artery in the excised arm demonstrated that the ulnar artery peak systolic and end-diastolic flow velocity after exercise

were increased significantly (p<0.001 for both) without any change in the ulnar artery radius (Table 3). In contrast, the Doppler USG blood flow recordings of the palmar arcus before and after exercise did not reveal any significant change in the flow velocity and the diameter of palmar arcus (>0.05) (Table 3).

The comparison of the ulnar artery radius and blood flow velocity parameters in the RA excised arm to those of contralateral ulnar artery after exercise test demonstrated no difference (Table 4).

Discussion

This study reveals that substantial percent of patients (72%) with a feeling of lost of sense in the RA excised arm did not reveal an objective sensory loss. Moreover, patients with a feel of strength loss do not present an objective power loss in the ipsilateral arm. Additionally, increased blood flow demand to the hand can be compensated by ulnar artery, probably via small arteries other than palmar arcus, since the blood flow velocity of the palmar arcus does not increase significantly although the flow through ulnar artery increases after exercise. Following RA harvesting, blood flow disturbance in the forearm, loss of function, sensorial disorder and paresthesia especially in the thenar part of the hand caused by nervus cutaneous antebrachialis and superficial part of the radial nerve lesion were reported in some cases (11%) (8). Neural complications decreased with the reduced use of electrocautery during the RA excision. Zile et al. (9) reported that 98.8% of these paresthesia and sensory disorders disappeared within three or six months following the RA excision. This is consistent with our low incidence of objective demonstration of sensory loss (28%) among the patients with subjective feeling of sensory loss.

One of the most important predictors of decreased complication regarding the blood supply of the ipsilateral hand is the selection of the side of harvesting arm. Allen test is rapid, easy and reliable for this purpose (4). Additionally, the use of finger pulse oxymetry during Allen test increases quantitative evaluation of the test. When there is a disagreement about the Allen test, the use of the Doppler USG examination of the forearm vascular supply is highly recommended (4). Manabe et al. (10) reported that preoperative Doppler USG assessment of the ulnar artery flow reserve and radius during manual compression on RA is the most valuable test to predict the postoperative exercise intolerance. The RA harvesting should be avoided when Allen test is over 10 seconds. In our clinic, we did not excise RA if this test is over 5 seconds. Although above precautions might contribute to the results, the study has not been designed to test the effect of those methods. In contrast, in spite of these selective methods, Tatoulis J. et al. (11) reported significant hand ischemia although the incidence was low (0.03%). William et al. (8) also reported that there is no relationship

Table 1. Patient demographics

Parameters	n (%)
Female/Male	19/6
Age, years	45-72
Obesity, BMI≥23 kg/m^2	18 (72)
Ejection Fraction, <40%	4 (16)
Diabetes mellitus controlled by oral antidiabetics	10 (10)
Diabetes mellitus controlled by insulin	1 (4)
Hormone drugs	2 (8)
COPD	6 (24)
Smoking	5 (20)

Data are presented as proportions/percentages and minimum maximum values
BMI - body mass index, COPD - chronic obstructive pulmonary disease

Table 2. Comparison of the handgrip power between the harvested arm and the contralateral arm in patients with a feel of strength loss (n=7)

Variables	Ipsilateral arm	Contralateral arm	p*
Handgrip power, mmHg	23±8 (17-29)	25±10 (18-32)	0.414

Data are presented as mean±SD (min-max) values
*-Wilcoxon test

Table 3. Comparison of the ulnar artery and palmar arcus Doppler USG parameters in the RA excised arm before (preexercise) and after (postexercise) squeezing test

Variables	Preexercise	Postexercise	p*
Ulnar artery			
Peak systolic velocity, cm/sec	86±15 (63-110)	105±15 (92-132)	<0.001
Enddiastolic velocity, cm/sec	28±5 (20-35)	36±8 (23-52)	<0.001
Radius, mm	3.3±0.6 (2.1-4.3)	3.3±0.6 (2.2-4.4)	0.960
Palmar arcus			
Peak systolic velocity, cm/sec	52±12 (34-72)	52±12 (33-75)	0.911
Enddiastolic velocity, cm/sec	21±4 (14-27)	21±4 (13-26)	0.900
Radius, mm	1.5±0.2 (1.0-1.9)	1.5±0.1 (1.2-1.8)	0.525

Data are presented as mean±SD (min-max) values
*-Wilcoxon test.
RA- radial artery, USG - ultrasonography

Table 4. Comparison of the ulnar artery Doppler USG parameters in the ipsilateral and contralateral RA-excised arm following squeezing test

Parameters	Ipsilateral arm	Contralateral arm	p*
Peak systolic velocity, cm/sec	105±15 (92-132)	107±14 (90-139)	0.627
Enddiastolic velocity, cm/sec	36±8 (23-52)	39±4 (30-49)	0.099
Radius, mm	3.30±0.63 (2.2-4.4)	3.41±0.38 2.56-4.3)	0.456

Data are presented as mean±SD (min-max) values
*-Wilcoxon test.
RA- radial artery, USG - ultrasonography

between the cyclic exercise fatigue and RA excision; furthermore improvement occurs stage by stage at the postoperative period, without any disturbance at the RA excised arm in the early postoperative period.

Subjective weakness of the forearm reported by patients mostly originates from psychological circumstances, since the loss of handgrip power during the objective assessment does not demonstrate a significant decrease. The patient avoids using the extremity because of the physiological defense mechanisms and describes this situation as the loss of power both in arm and hand. Gregory et al. (6) reported only minimal changes in the arm and hand functions ipsilateral to RA excised arm in 42 patients.

Study Limitations

The major limitation of the study is the limited number of the cases. Additionally, long-term repeat of Doppler examination would be valuable, since most of the subjective symptoms have been reported to wane in 6 months.

Conclusion

In conclusion, with the appropriate selection and removal of RA, harvesting of RA graft does not change the forearm blood supply and functions except minor sensory disturbances in the early postoperative period.

References

1. Acar C, Jebara VA, Portoghese M, Beyssen B, Pagny JY, Grare P, et al. Revival of the radial artery for coronary artery bypass grafting. Ann Thorac Surg 1992; 54: 652-9.
2. Demirkılıç U, Bolcal C, Küçükarslan N, Bingöl H, Oz BS, Kuralay E, et al. Middle and late-term results of coronary artery bypass graft surgery in very young (20-29 years) patients. Anadolu Kardiyol Derg 2004; 4: 25-9.
3. Küçükarslan N, Ulusoy E, Oz BS, Baysan O, Ozal E, Tatar H. The early and mid term results of radial artery graft use in coronary artery bypass surgery in female patients over 60 years old. MN Cardiology 2004; 11: 443-7.
4. Abu-Omar Y, Mussa S, Anastasiadis K, Steel S, Hands L, Taggart DP. Duplex ultrasonography predicts safety of radial artery harvest in the presence of an abnormal Allen test. Ann Thorac Surg 2004; 77: 116-9.
5. Allen EV. Thromboangiitis obliterans: methods of diagnosis of chronic occlusive arterial lesions distal to the wrist with illustrative cases. Am J Med Sci 1929; 178: 237.
6. Dumanian GA, Segalman K, Mispireta LA, Walsh JA, Hendrickson MF, Wilgis EF. Radial artery use in bypass grafting does not change digital blood flow or hand function. Ann Thorac Surg 1998; 65:1284-7.
7. İkizler M, Özkan S, Dernek S, Özdemir C, Erdinc O. O, Sevin B, et al. Does radial artery harvesting for coronary revascularization cause neurological injury in the forearm and hand? Eur J Cardiothorac Surg 2005; 28: 420-4.
8. Chong WC, Ong PJ, Hayward CS, Collins P, Moat NE. Effects of radial artery harvesting on forearm function and blood flow. Ann Thorac Surg 2003; 75: 1171-4.
9. Meharwal ZS, Trehan N. Functional status of the hand after radial artery harvesting: results in 3,977 cases. Ann Thorac Surg 2001; 72: 1557-61.
10. Manabe S, Tabuchi N, Toyama M, Yoshizaki T, Kato M, Wu H, et al. Oxygen pressure measurement during grip exercise reveals exercise intolerance after radial harvest. Ann Thorac Surg 2004; 77: 2066-70.
11. Tatoulis J, Royse AG, Buxton BF, Fuller JA, Skillington PD, Goldblatt JC, et al. The radial artery in coronary surgery: a 5-year experience-clinical and angiographic results. Ann Thorac Surg 2002; 73: 143-7.