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Forearm and Hand Function after Radial Artery Harvest for Coronary Artery Bypass Grafting: Subjective Patients' Assessment

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ABSTRACT

Background: As arterial myocardial revascularization is proved to provide great results, radial artery use as a graft and its consequences remain an important issue.

Objectives: The aim of the study was to evaluate how patients assess their forearm and hand function after radial artery harvest for coronary artery bypass grafting (CABG).

Methods: 50 patients (mean age 52.2 ± 7.4 years) who underwent CABG at least 6 months (median follow up 11.75 months) earlier filled in a questionnaire concerning hand and forearm efficiency and discomfort.

Results: The global efficiency of the operated upper extremity was scored mean 8.87 ± 1.26 points on a 10-point scale and it was worse in patients who noticed at least one sort of disorder than in patients with no problems (8.6 ± 1.4 versus 9.4 ± 0.7 points; $P = .04$). Paresthesias were the most often reported disorders; 21 patients felt some tingling and/or numbness, but in only 14 (28%) could the symptoms be considered as related to the operation. 20 patients (40%) declared that they felt some scar-related discomfort. Reduced grip strength and excessive hand fatigue were reported by 20% and 10% of patients, respectively. None of those interviewed answered that symptoms reported affected his or her life activity on any level.

Conclusion: The hand and forearm efficiency after radial artery harvest for CABG was highly evaluated by the majority of patients. Despite the fact that many patients reported some surgery-related problems, they did not notice extremity dysfunction that could limit their life activity.

INTRODUCTION

Radial artery as a graft in coronary artery surgery has its controversial history. It was first used in the early 1970s and was then abandoned for almost 20 years because of the initial unfavorable outcomes. Since 1992, when Acar et al published their late results, there has been a real revival of the radial artery for coronary artery bypass grafting [Acar 1992]. In the era of arterial myocardial revascularization, radial artery use perfectly fits to modern cardiac surgery.

Despite several tests estimating collateral hand circulation before radial artery harvest, there is still a risk of mild to moderate hand ischemia and its consequences, not to mentioned that surgical intervention in the forearm may jeopardize its function. Although severe complications after radial artery harvest are extremely rare (examples: acute hand ischemia [Fox 1999] or severe complex regional pain syndrome [Schmid 2002]), some patients notice various inconveniences, which could diminish their positive perception of the coronary surgery results.

In this paper, we focuses on subjective patient evaluation of hand and forearm function as well as the complications associated with harvesting the radial artery to coronary artery bypass grafting (CABG).

MATERIALS AND METHODS

Study Population

We evaluated 50 patients who underwent coronary artery bypass grafting in two cardiac surgery departments. All of them had the radial artery harvested as a vascular graft.

Table 1. Patients' Characteristics

Age, y, at time of surgery, mean ± SD	52.2 ± 7.4 (range 38-72)
Age, y, at time of evaluation, mean ± SD	53.4 ± 7.2
Sex, F/M, n (%)	3 (6) / 47 (94)
Hypertension, n (%)	30 (60)
Diabetes, n (%)	7 (14)
History of myocardial infarction, n (%)	35 (70)
Lower extremity atherosclerosis, n (%)	5 (10)
Carotid artery stenosis, n (%)	4 (8)
Chronic pulmonary obstructive disease, n (%)	2 (4)
BMI, kg/m^2, mean ± SD	28.1 ± 3.4

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Patient characteristics are show in Table 1. Most patients were relatively young men. Only 7 patients were operated at the age of greater than 60.

Surgical Technique

Before the operation all patients underwent Allen's test; none presented the return of skin blush longer than 10 seconds after radial artery closure, which would have been considered as abnormal. The radial artery was harvested using open technique with the concomitant veins from the non-dominant forearm (the left one in 48 cases). For tissue preparation low energy electrocautery was used.

The mean number of grafted coronary vessels was 2.56 ± 0.5. In 31 patients, additionally, saphenous vein was harvested. Three patients were operated with no use of cardiopulmonary bypass. One patient underwent a simultaneous mitral valve repair.

Follow Up and Questionnaire

After at least 6 months after surgery (median: 11.75 months; IQR: 7-15.5 months; range: 6-57 months) patients were invited to the hospital for a control visit. All patients were interviewed according to the same questionnaire.

Thirteen questions, briefly described below, were asked:

1. How do you score your global efficiency of the operated upper extremity on a scale from 0 to 10, assuming that the efficiency before operation could be scored 10?
2. Do you feel any pain in the operated upper extremity?
3. Do you feel any numbness in the operated upper extremity?
4. Do you feel any tingling in the operated upper extremity?
5. Do you observe any swelling of the operated upper extremity?
6. Do you feel that the grip strength of the operated hand is weaker than before operation?
7. Do you feel that the operated hand gets tired more quickly than before operation?
8. Do you feel that your operated upper extremity is very sensitive to cold?
9. Do you observe any touch sensation abnormalities? If yes, is the skin oversensitive or insensible?
10. Do you feel any discomfort related to the scar? If yes, please describe it.
11. Do you notice a general deterioration of the operated upper extremity function compared to the period before surgery? If yes, what is its cause (sensory symptoms, weakness, pain, etc)?
12. Is your life activity limited because of the symptoms related to the radial artery harvest?
13. In comparison to the symptoms related to the vein harvest, symptoms related to the radial artery harvest were: less burdensome, comparable, or more burdensome?

If the patient answered "yes" to the questions 2-9, further questions about the symptoms' frequency, intensity, and localization were asked. Moreover, patients were asked whether the symptoms were observed before operation and whether they are present in the non-operated extremity. As many of the symptoms were reported to be present on both sides or preoperatively, we considered "surgery-related" symptoms to be occurring in the operated extremity for the first time after surgery or exacerbated after surgery; or, if the symptoms were present on both sides, they had to be significantly more escalated on the operated side.

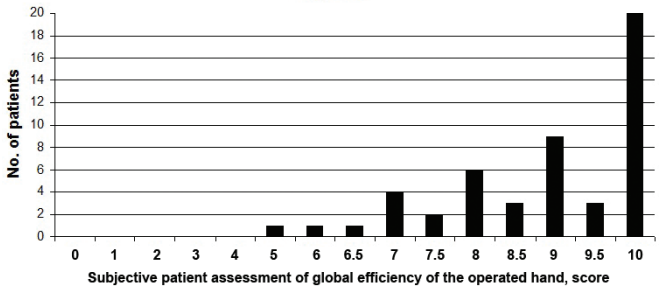

Figure 1. Subjective patient assessment of global efficiency of the operated hand.

Ethical Issues

The study was accepted by the local ethical committee and in all cases patients' informed consent was obtained.

Statistical Analysis

Statistical analyses were performed by the use of Statistica 6.0 package. *P* values lower than .05 were considered as significant.

RESULTS

The global efficiency of the operated upper extremity was scored mean 8.87 ± 1.26 points (range: 5-10). The Score distribution is shown in Figure 1.

Table 2 shows the prevalence of symptoms reported by the patients.

Out of four patients who reported some occasional pain in the operated forearm, only one considered it as tiresome (the pain was localized at the distal end of the scar). Mild pain of the anterior surface of the forearm was felt by two patients. The fourth patient reported pain to be localized in the shoulder and forearm.

Paresthesias were the most often reported disorders. All patients who complained about tingling also suffered from numbness. Two patients noticed nearly constant paresthesia of thenar and one of them considered it as tiresome. One patient reported occasional but tiresome paresthesia of both forearms; however, it was more escalated in the operated extremity. The other patients described paresthesias as occasional and mild and almost half of them (n = 5) declared that the symptoms were provoked by prolonged holding of the extremity in the same position. Paresthesias affected mostly fingers (in one case it was limited to the 4th and 5th finger), hand (n = 2), or forearm (n = 2).

Four patients reported both reduced grip strength and excessive hand fatigue. Two of them and one more patient,

Table 2. Symptoms Reported*

	Pain	Numbness	Tingling	Swelling	Reduced grip strength	Excessive hand fatigue	Hypersensivity to cold	Impairment of soft touch sensation	Oversensivity to soft touch
Symptoms reported in operated extremity, n (%)	4 (8)	21 (42)	15 (30)	3 (6)	13 (26)	8 (16)	11 (22)	4 (8)	4 (8)
Surgery-related symptoms, n (%)	4 (8)	14 (28)	9 (18)	0	10 (20)	5 (10)	5 (10)	4 (8)	4 (8)

*Definition of surgery-related symptoms is presented in the Material and Methods section.

who noticed isolated reduction of grip strength, described the symptoms as significant. One of them admitted that he "saved" the hand from extensive effort. The rest of the patients considered the symptoms as insignificant.

Oversensitivity to cold was observed by patients only in low temperatures and was not bothersome.

Localization of sensory abnormalities were as follows: thumb or thenar (n = 3); dorsal radial site of the hand (n = 2); anterior site of forearm (n = 2); and scar surroundings (n = 1). Only one patient (feeling the constant sensory impairment of the dorsal hand surface) claimed that the symptoms affect hand efficiency.

Twenty patients (40%) declared that they felt some scar-related discomfort. The reasons for the discomfort were: unaesthetic scar (n = 7); feeling of scar constriction (n = 6); paresthesia (n = 7); or sensory abnormalities (sensory impairment [n = 6]; or oversensivity [n = 5]). Ten patients complained about more than one symptom mentioned above. In one patient there was a small stitch abscess; the patient was referred to surgical debridement.

In summary, 18 (36%) patients did not report any inconvenience related to the radial artery harvest. 22 (44%) patients noticed more than one symptom mentioned in the questionnaire.

Nine (18%) patients declared that compared to the preoperative period, the global efficiency of the operated upper extremity worsened. The impairment of extremity function was thought to be due to muscular weakness (n = 6); paresthesia (n = 1); muscular weakness and soft touch sensation impairment (n = 1); and pain caused by extensive extremity effort (n = 1, pain was not ischemia-specific but claudication could not be excluded).

None of the interviewees answered that symptoms reported affected any level of his or her life activity.

Out of 18 patients who had both the radial artery and saphenous vein harvested to coronary surgery, 7 (39%) patients considered the symptoms related to the harvest site to be worse in the lower extremity, 4 (22%) to be worse in the upper extremity, and 6 (33%) assessed it as comparable. One patient did not suffer from any inconvenience because of vascular graft harvesting.

Patients who noticed at least one sort of disorder in the operated upper extremity scored its global efficiency lower than patients with no problems (8.6 ± 1.4 versus 9.4 ± 0.7 points; $P = .04$). Moreover there was a trend to statistical relation between lower grade and the number of symptoms ($P = .051$) (Figure 2).

DISCUSSION

A broad spectrum of procedures involves an intervention on the radial artery, and all are related to specific complications [Chim 2015]. The use of the radial artery as a graft to coronary artery surgery leads to the consequences not only resulting from hemodynamic changes in the forearm circulation, but also from extensive surgical intervention. Patients' comfort is one of the indicators of successful operation. However, it is difficult to assess properly the subjective patients' judgments. Allen et al [Allen 2004] used DASH Questionnaire (Disabilities of the Arm, Shoulder and Hand), and found that patients who had had the radial artery harvested for CABG estimated their forearm efficiency to be worse than the control group who underwent CABG with no radial artery harvest. Nevertheless, the author did not describe how long after surgery the examination was performed, and how many of these patients had both radial arteries harvested. Moreover, the DASH Questionnaire (http://www.dash.iwh.on.ca) has some limitations in this case; questions are usually concerned with activities that involve both arms, so the questionnaire is not the best tool to assess the efficiency of one arm – the operated one. The questionnaire most comparable to ours was used by Kowalczyk et al [Kowalczyk 2009]. Authors prepared a 10-score visual analogue scale of subjective estimation of forearm and arm function. Seventy-two percent of patients (42 out of 58) did not notice any difference between the extremity efficiency before surgery and at the time of examination. Only one patient described moderate trouble with the hand, which corresponded to the medium part of the scale. Better results presented by Kowalczyk et al [Kowalczyk 2009] may originate from the longer time of follow-up (mean 5.6 years). It could suggest that numerous problems related to the radial artery harvest are solved with time. In our observation, many patients reported that discomfort caused by surgical intervention disappeared or decreased after a few months. As we did not document the dynamics and history of symptoms, there are not certain numbers to prove this.

The most frequently reported symptoms were paresthesia.

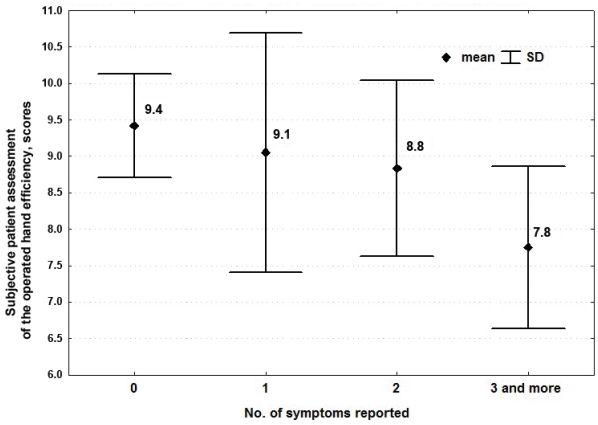

Figure 2. Relationship between numbers of symptoms reported and the subjective patient assessment of the hand efficiency.

Even after exclusion of patients who felt the paresthesia before surgery or postoperatively, both-sided there were 28% patients suffering from them. A similar prevalence was reported by Saeed et al [Saeed 2000] (26%); Reddy et al [Reddy 2002] (33%); and Siminelakis et al [Siminelakis 2004] (29.5%). However, some studies presented a lower percentage of patients with paresthesia: 3.7% [Budillon 2003]; 12.9% [Hata 2002]; 17.5% [Lee 2005]; and 18.1% [Denton 2001]. The higher rate of symptoms reported in our study may at least partially result from the way we conducted the medical interview. We literally asked the patients whether they felt some numbness or tingling. Moreover, all positive answers were noted even if the patients stressed that the paresthesia they observed were mild or rare. Five patients (10%) in our group reported that paresthesia occurred only in some particular positions, which is quite common in the general population. Finally, we could directly connect the symptoms with radial artery harvest in 18% of the patients.

The prevalence of sensation disorders is difficult to define, as many authors do not precisely identify the types of abnormalities, and other also include in the group paresthesia [Denton 2001; Allen 2004; Ikizler 2005; Saeed 2000]. In the study from Royse et al [Royse 1999] 15.5% of patients reported loss of sensation in the lateral cutaneous nerve area and 11.3% in the superficial branch of the radial nerve area. In our patients, the proportion was as follows: 8 and 6%, respectively. Moreover, in 2% of patients, sensation abnormalities were present in the innervation area of the medial cutaneous nerve. In those patients who reported sensation disorder in the thenar, an overlap of innervation of the median and lateral cutaneous nerve should be considered. The mechanism of neurological complication involves direct injury of radial nerve branches (lateral cutaneous nerve and the superficial branch) lying close to the radial artery [Denton 2001; Zembala 2002]. The other possible reason for neurological dysfunction is pressure caused by tissue oedema or hematoma, which is likely in case of median nerve disorders [Denton 2001; Siminelakis 2004]. Neurological dysfunction is also one possible explanation of motor abnormalities, however, less likely. The other is muscle ischemia. Symptoms such as reduced grip strength and excessive hand fatigue may suggest inadequate blood supply from the ulnar artery. Manabe et al [Manabe 2004], similar to our results, noted 12.5% of patients had symptoms indicating mild exercise hand ischemia. The observation about reduced tissue perfusion is supported by the studies using transcutaneous measurement of partial oxygen pressure [Manabe 2004; Serrichio 1999]. Researchers observed worsening of tissue oxygenation during exercise, which was directly proportional to exercise duration. Although clinically significant claudication is extremely rare, radial artery harvest should be carefully considered in patients who perform physical activity extensively involving upper extremities.

A significant number of patients were unsatisfied because of the scar discomfort. In our centers, surgeons performed "the lazy S incision" as described by Taggart et al [Taggart 1999] to minimize tension of the scar. However, some patients still complained about scar constriction. Taking into consideration that symptoms related to relative extensive scar are quite common (20% according to Royse et al [Royse 1999] and 33% acccording to Tatoulis et al [Tatoulis 1998]), an interesting alternative is seen in endoscopic technique which, as shown by Shapira et al [Shapira 2006], improved subjective assessment of the cosmetic effect by the patient.

The number of patients who assessed their operated forearm/hand efficiency as worse than before surgery was relatively high (18%). However, there were some inconsistencies observed. For example, three patients who primarily estimated postoperative weakness of the extremity as insignificant thereafter described it as the cause of extremity efficiency worsening. One patient declared that he purposely limited the activity of the operated forearm, and two patients reported similar weakness in the non-operated extremity. In fact, only two patients supported their opinion with an argument that could raise clinical concerns; one with permanent paresthesia, and the other with pain after greater effort, in whom the pain seemed to be at least partially related to the scar, though the ischemic background could not be excluded. What is worth stressing is that none of the patients considered the symptoms as limiting to his or her daily activity. This means that the inconveniences related to radial artery harvest are well tolerated by patients, and should not limit the use of this high-quality vascular graft.

Conclusion

The hand and forearm efficiency after radial artery harvest for coronary artery surgery was highly evaluated by the majority of patients. However, surgery-related symptoms were quite frequent. The most frequent disorders observed were paresthesia, which were usually described as mild and sporadic. As many patients reported some scar-related discomfort, an endoscopic harvest of the graft could be a good alternative. Despite the fact that many patients reported some postoperative problems, they did not notice extremity dysfunction causing limitations their daily life activities.

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