Mid-segment harvesting of right internal thoracic artery decreases sternal ischemia

Orta segment sağ internal torasik arter kullanılması sternum iskemisini azaltır

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ABSTRACT

Objective: We aimed to preserve sternal vascularity better by harvesting only midsegment of the right internal thoracic artery (RITA) than using conventional bilateral internal thoracic artery (BITA) harvesting method, and we evaluated the sternal vascularity with single photon emission computed tomography (SPECT).

Methods: In this prospective clinical randomized investigation, 135 patients undergoing coronary artery bypass surgery (CABG) were divided into three groups: Full-RITA group who had a full length of both ITA as a graft for CABG (n=45); mid-RITA group - a midsegment of RITA and left internal thoracic artery (LITA) (n=45); and non-RITA group who had only LITA (n=45). Before and after surgery, all patients underwent a bone scan with single photon emission computed tomography (SPECT) to evaluate the sternal vascular activity. Comparisons of variables were performed by Chi-square, ANOVA, Tukey HSD and paired t test as appropriate. The Bonferroni correction was applied for multiple comparisons.

Results: Postoperative early scans (6.9±0.9 days) showed a reduction of blood flow in the both sides of the sternum compared with the preoperative scans (p<0.001). In full-RITA group, there was no significant difference between left and right hemi-sternum (0.56±0.04 and 0.55±0.02 respectively). However, in mid-RITA and non-RITA groups, right hemi-sternum showed significantly better vascularity than left hemi-sternum in the early postoperative period (p<0.001). Three patients (6.6%) with diabetes mellitus in full-RITA group had sternal infection; one of them was deep sternal infection with dehiscence. In mid-RITA group, there was only two patients who had superficial infection (4.4%) and in non-RITA group there was no infection (p=0.234).

Conclusion: Mid-RITA harvesting technique can be preferred to preserve sternal vascularity better than conventional technique. By improving new techniques and methods, more acceptable sternal complications could be achieved than full-RITA technique.
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Key words: Internal thoracic artery, sternum, coronary artery bypass surgery, SPECT

ÖZET

Amaç: Konvansiyonel bilateral internal torasik arter (İTA) kullanımına göre sternum kanlanmasını daha iyi koruyabilmek amacıyla sadece orta segment sağ İTA kullanarak sternum kanlanmasına olan etkisini incelemeyi hedefledik.

Yöntemler: Prospektif randomize klinik bir araştırma ile koroner arter baypas cerrahisi uygulanacak olan 135 hastayı 3 grupta inceledik: İki taraflı tam uzunlukta İTA kullanılacak olan 45 hasta, sağ taraf İTA sadece orta segmenti kullanılacak olan 45 hasta ve tek taraflı İTA kullanılacak olan 45 hasta. Ameliyattan önce ve sonra bütün hastaların sternum kanlanması tek foton emisyon tomografisi ile değerlendirildi. Hastaların sternum komplikasyonları karşılaştırıldı. Sonuçların karşılaştırılmasında uygun durumlarda Ki-kare testi, ANOVA, Tukey HSD ve eşleştirilmiş "t" testleri kullanıldı. Çoklu değişkenlerin karşılaştırılmasında Bonferroni düzeltmesi uygulandı.

Bulgular: Tüm hastalarda postoperatif erken dönem kemik incelemelerinde (6.9 ±0.9 gün) preoperatif döneme göre belirgin sternum kanlanma azalması saptadık (p<0.001). İki taraflı tüm uzunlukta İTA kullanılan hastalarda sternumun her iki yarısında kanlanma eşit oranda azalırken (sırasıyla 0.56±0.04 ve 0.55±0.02) sadece orta segment sağ İTA kullanılan hastalarda sağ sternum yarısı belirgin olarak daha iyi kanlandığı gözlemlendi (p<0.001). Tam uzunlukta iki taraflı İTA kullanılan grupta 3 diyabetik hastada (%6.6) sternum enfeksiyonu gözlendi; bunlardan 1 tane-

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si sternum separasyonu ile seyreden derin sternum enfeksiyonu idi. Orta segment İTA kullanılan grupta sadece 2 hastada yüzeysel sternum enfeksiyonu gözlenirken tek taraflı İTA kullanılan grupta ise hiç enfeksiyon gözlenmedi (p=0.234).

Sonuç: Sternum kanlanmasını konvansiyonel tekniğe göre daha iyi koruyabilmek için orta segment İTA kullanılması tercih edilebilir. Yeni teknik ve yöntemlerin geliştirilmesiyle tam uzunlukta İTA tekniğine göre daha kabul edilebilir sternum komplikasyonları sağlanabilir.

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Anahtar kelimeler: İnternal torasik arter, sternum, koroner arter baypas cerrahisi, SPECT

Introduction

Use of bilateral internal thoracic artery (BITA) grafts is associated with improved long-term survival (1), reduced incidence of recurrent angina, and decreased cardiac events compared with patients receiving only left internal thoracic artery (LITA) graft (2, 3). However, BITA grafting is not preferred among the cardiovascular surgeons because of its disadvantages: the increased rate of deep sternal wound complications especially in diabetics (4), sternal dehiscence (5, 6), need for longer operation time for its preparation, the reduced length of right internal thoracic artery (RITA). First two are associated with devascularization of the sternum. Previous studies have shown that harvesting of a pedicled internal thoracic artery (ITA) results in acute sternal ischemia (5, 7). In a recent study, Medalion et al (8) have demonstrated that sternal ischemia after single pedicled LITA harvest is a temporary condition that resolves with time. However, most surgeons prefer skeletonized or semi-skeletonized harvesting technique to avoid or minimize sternal devascularization. Previous studies show that skeletonization results in increased sternal perfusion (9), and it has been suggested that all cardiac surgeons should be trained efficiently in using skeletonized BITA (10). The common aim of these all previous studies was to avoid sternal complications that caused by its devascularization.

In this prospective clinical randomized study, we aimed to better preserve sternal vascularity by harvesting only the midsegment of the RITA rather than use conventional BITA harvesting method by leaving the RITA's first and last branches untouched, and to evaluate the preoperative and postoperative sternal vascularity during acute and late periods after cardiac surgery with single photon emission computed tomography (SPECT).

Methods

Patients

Between January 2005 and November 2005, within 11-month period, 135 patients (between 45 and 55 years of age) undergoing elective primary coronary artery bypass surgery (CABG) for multivessel coronary artery disease including a diagonal artery or a proximal obtuse marginal artery as target vessels for RITA grafting were included in this prospective clinical randomized study. To avoid the effects of low cardiac output related tissue hypoperfusion that may affect the blood flow into the sternum; only the patients with ejection fraction ≥45% were enrolled in the study. Patients were not enrolled in the study if they had any of the following: 1) known pathology of sternum/chest wall, 2) previous history of trauma/surgery to sternum/chest wall, 3) previous history of sternotomy, 4) radiation to mediastinum/chest wall, 5) morbid obesity or cachexia, 6) chronic obstructive pulmonary disease, 7) dialysis dependent renal failure, 8) concomitant cardiac or extra-cardiac procedures, and 9) peripheral vascular disease. The study was approved by the institutional review board and all patients provided informed written consent pre-operatively.

Prior the patient selection, the primary surgeon evaluated the coronary angiographies for the suitability of diagonal artery or proximal obtuse marginal artery for RITA grafting. In the morning of the operation day, selected patients were randomly allocated into three groups by a nurse who was blinded to the study: Group 1 (full-RITA, n=45) included patients who had a full length RITA as a graft for CABG; Group 2 (mid-RITA, n=45)-patients having a midsegment of RITA as a graft for CABG; and Group 3 (non-RITA, n=45)-patients having a RITA for CABG as control group. In all groups, LITA was grafted to left anterior descending artery (LAD). All the RITAs were used for diagonal artery or circumflex system revascularization. To perform complete myocardial revascularization, radial artery and/or saphenous vein segments were used as additional bypass conduits as required. Preoperative demographic data and cardiac risk factors, bypass time, cross-clamp time, operation time, number of the grafts, sternal complications, duration of intensive care unit and hospital stay were recorded.

Surgical Technique

All the patients were pre-medicated with oral diazepam before anesthesia induction. Antibiotic prophylaxis was given intravenously (1.5 g cefuroxime) starting 30 min prior to incision at the induction of anesthesia and continued during 48 hours postoperatively. Anesthesia was induced with 0.04 mg/kg midazolam, 5-10 μg/kg fentanyl and 0.1 mg/kg pancuronium intravenously. Anesthesia maintenance consisted of 0.8 μg/kg/min of midazolam and 0.08 μg/kg/min of fentanyl by continuous infusion. Pancuronium was given as required to maintain neuromuscular blockade. All patients underwent cardiac surgery with non-pulsatile cardiopulmonary bypass (CPB) by using roller pumps and disposable membrane oxygenators. The pump was primed with 1000 mL of lactated Ringer solution with 100 mmol of sodium bicarbonate and 5000 IU of heparin. During CPB, the mean arterial pressure target was set at 60 mmHg, and the core temperature of the patients was cooled to 30-32^{o}C. Alpha-stat pH management was employed. Intermittent antegrade cold-blood cardioplegia (1:4 blood to crystalloid with maximal potassium concentration 22 mEq/L) was administered through the aortic root after cross-clamping. Cross clamp and total CPB times, and duration of the operation were recorded.

ITA preparation

A standard median sternotomy was performed and the use of bone wax was avoided in the patients for all groups. All the ITAs (RITA and LITA) were harvested in a semi-skeletonized fashion by using titanium clips and scissors to dissect collateral branches by the same surgeon. In mid-RITA group, dissection begun from the 3rd-4th intercostal space to avoid any damage to first or last branches of this vessel. So, proximal two branches and a few distal branches before the bifurcation were left untouched. Therefore, a minimum 7 cm length of free RITA segment was obtained. This graft was anastomozed to diagonal artery and to in situ LITA at its closer part to diagonal artery by forming arterial Y graft. In full-RITA group, a full length of RITA was harvested and used for diagonal or proximal circumflex artery system as an in situ or free graft. All RITAs were used as a graft for left coronary system. Free RITAs were anastomosed as a Y graft to in situ LITAs with continuous 7-0 polypropylene suture before initiation of CPB, but after the systemic heparinization.

To prevent kinking of LITA, the left pericardium was dissected. Electrocautery was only used to dissect fatty tissue in all groups. The sternum was closed with individual steel wires.

Bone SPECT

Before surgery, all patients underwent a bone scan with single photon emission computed tomography (SPECT) to evaluate the baseline sternal vascularity as described by Cohen et al (11)]. Same radiologist blinded to the study evaluated all scan results.

For quantitative analysis, sternum was divided into two parts through midline sternotomy incision, as shown in Figure 1. The coronal image in which the sternum showed the greatest activity was selected for the each side of sternum. The mean count per pixel on the each region of sternum was compared with the left humerus, and a sternum/humerus activity ratio was calculated for each region before and after surgical intervention. Humerus bone activity was selected because it is not traumatized or affected during the surgical intervention directly and for its being out of surgical area.

SPECT was repeated after surgery by using the same parameters of camera distance and bed height for each patient: The first postoperative scan was performed within 6th to 10th days (6.9±0.9) after surgery, and the second postoperative evaluation was performed in about 11 months (11.7±1.2) after surgical intervention.

Statistical analysis

Statistical analysis was done by SPSS statistical software package (SPSS 16.0 for Windows, Chicago, Illinois). Categorical variables were tested using the χ^2 test. Allocation of the variables was normal. Comparisons of variables were performed by one-way ANOVA, repeated measures of ANOVA, Tukey HSD test as a post hoc test, and paired t test as appropriate. Variables were presented as mean±SD. A p value less than 0.05 was considered statistically significant. The Bonferroni correction was applied for multiple comparisons.

Results

Preoperative and operative results

Preoperative variables in all groups were similar (Table 1). Except a shorter operation time in non-RITA group intraoperative variables were also similar (Table 2). The baseline preoperative bone SPECT demonstrated no significant differences between left to right sternal activity ratio, comparing the three groups (Table 3).

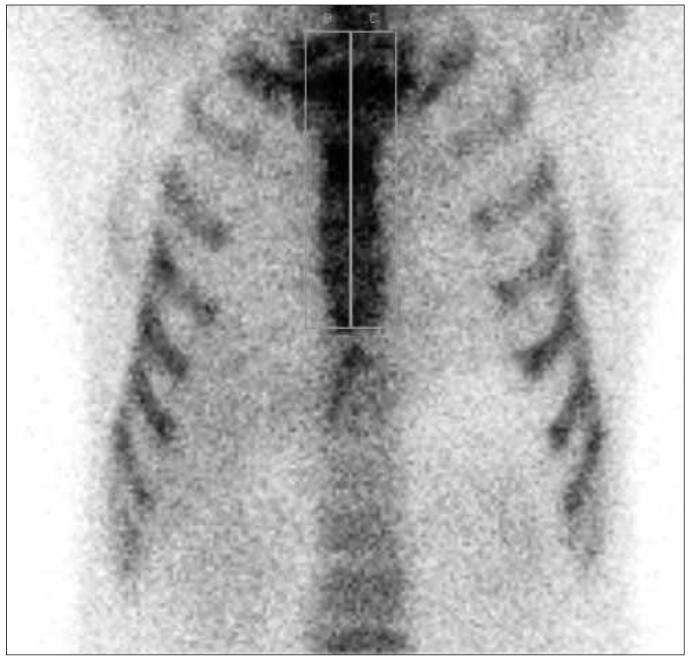

Figure 1. The demonstration of the sternal evaluation: the sternum was divided into two parts through midline sternotomy incision for quantitative analysis. The left hemi-sternum was compared with right hemi-sternum

Table 1. Preoperative demographic data of the patients

Parameters	full-RITA Group (n=45)	mid-RITA Group (n=45)	non-RITA Group (n=45)	p*
Age, years	61.7±7.5	61.6±7.8	61.9±8.3	0.930
Sex (F/M), n	12/33	12/33	11/34	0.962
BMI, kg/m^2	25.8±1.4	26.2±1.9	25.7±2.2	0.857
LVEF, %	53.1±6.0	52.6±5.5	52.7±5.6	0.806
Hypertension, n(%)	10 (22.2)	11 (24.4)	11 (24.4)	0.962
Diabetes, n(%)				
• IDDM	1 (2.2)	2 (4.4)	2 (4.4)	0.846$^+$
• NIDDM	8 (17.8)	9 (20.0)	9 (20.0)	

Data are represented as mean±SD and number/proportions

* - one-way ANOVA test and Chi-square test

BMI - body mass index, LVEF - left ventricle ejection fraction, IDDM - insulin dependent diabetes mellitus, NIDDM- non-insulin dependent diabetes mellitus

Table 2. Operative and early postoperative data of the patients

Variables	full-RITA Group (n=45)	mid-RITA Group (n=45)	non-RITA Group (n=45)	F*	p
CPB time, min	62.2±6.1	62.0±8.7	59.3±8.7	1.847[a]	0.251[b]
Cross-clamp time, min	35.4±6.4	36.0±6.5	32.7±5.9	4.052[a]	0.188[b]
Operation time, min	154.7±11.5	148.6±9.9	138.2±8.1	25.232[a]	< 0.001[b]
Number of grafts, n	3.0±0.5	3.2±0.6	3.0±0.5	1.576[a]	0.809[b]
ICU stay, days	2.0±0.2	2.1±03	2.0±0.2	0.183[a]	0.697[b]
Re-operation, n	2	1	0	-	0.360[c]
Sternal infection, n(%) • IDDM • NIDDM	 1 Deep (2.2) 2 Superficial (4.4)	 0 Deep (0) 2 Superficial (4.4)	None	-	0.234[c]

Data are represented as mean±SD and number/proportions

[a]-Degree of freedom 1 was =2 and degree of freedom 2 was = 132

[b]-One-way ANOVA test

[c]-Chi-square test

CPB - cardiopulmonary bypass, ICU - intensive care unit, IDDM - insulin dependent diabetes mellitus, NIDDM - non-insulin dependent diabetes mellitus

Table 3. SPECT sternal uptake data

Sternum		full-RITA Group (n=45)	mid-RITA Group (n=45)	non-RITA Group (n=45)	F *	p+
Preoperative	Left	0.92±0.03	0.92±0.03	0.92±0.02	0.111	n.s.
	Right	0.92±0.02	0.93±0.03	0.92±0.03	4.564	n.s.
Postoperative	Left	0.56±0.04	0.55±0.02	0.57±0.04	3.119	n.s.
(6.9±0.9 days)	Right	0.55±0.02	0.64±0.4	0.86±0.04	903.752	<0.001
Late	Left	0.78±0.02	0.84±0.02	0.88±0.02	203.912	<0.001
(11.7±1.2 months)	Right	0.79±0.02	0.87±0.01	0.90±0.02	266.586	<0.001

Data are represented as mean±SD
ANOVA for repeated measures test:
*-Degree of freedom 1 was=2 and degree of freedom 2 was=132
+-Bonferroni correction was applied for all comparisons
n.s.-not significant

Early postoperative results

In the early postoperative scans (6.9±0.9 days), all patients showed a dramatic decrease of blood flow in the both sides of the sternum compared with the preoperative scans (p<0.001). In full-RITA group there was no significant difference between left and right hemi-sternum activity rates (0.56±0.04 vs. 0.55±0.02, p>0.05). However, in mid-RITA and non-RITA groups right hemi-sternum showed a better vascularity than left hemi-sternum (p<0.001) (Table 3).

No cases of mediastinitis were observed. Three patients (6.6%) with diabetes mellitus in full-RITA group had sternal infection, one of them who had deep sternal infection with sternal dehiscence was re-operated, and one patient was re-operated for postoperative bleeding. In mid-RITA Group, there was no any deep sternal infection but 2 patients with diabetes mellitus had superficial sternal infection (4.4%), and both were treated medically with no further wound complication, and one patient was re-operated for postoperative bleeding. In non-RITA group, there was not any sternal complication and surgical revision (p=0.234). There was no any wound complication among the non-diabetic patients.

Late postoperative results

The late postoperative scans (11.7±1.2 months) also demonstrated significant decrease in blood flow at the both sides of the sternum in all groups (p<0.001). However, late postoperative blood flow at the both sides of the sternum was significantly higher than early postoperative blood flow (p<0.001). In full-RITA group, there was no significant difference between left and right side of sternum, but in mid-RITA and non-RITA groups, a higher sternal vascularity was detected on the right side of the sternum compared with the left side (p<0.05). At this period, sternum showed significantly higher vascularity in mid-RITA group than full-RITA group (p<0.001). Similarly, sternal vascularity was significantly higher in non-RITA group than in mid-RITA group (p<0.001).

Diabetic patients

There were 31 diabetic patients in the entire study population (22.9%). Of them, 5 patients had insulin dependent diabetes mellitus (IDDM) and the remaining had non-insulin dependent diabetes mellitus (NIDDM) (Table 1). Five of diabetic patients (16.2%) had sternal wound complications (4 superficial and 1 deep sternal infections) (Table 2). In full-RITA group, 9 patients were diabetic, and 3 of them had sternal infections (2 superficial and 1 deep sternal infections). In mid-RITA group 11 patients were diabetic, but only two had superficial sternal infection. Non-RITA group included 11 diabetic patients and they were free of sternal complications.

There was no any mortality in all groups during the hospital stay and follow up period. The mean follow-up period was 11.9±0.8 months, and all patients completed the study.

Discussion

In early postoperative period, there is absolute decrease in blood flow at the site of the sternum from which ITA is prepared as a graft. This ischemic period is prone to sternal complications. However, midsegment harvesting of RIMA prevents acute ischemia at that site of sternum, and therefore, we could minimize ischemia-dependent complications. Although in late postoperative period (about 11th month) sternal vascularity restored almost to preoperative level, the restoration is much better and quicker than full-RITA harvesting when we use mid-segment RITA.

Despite the presence of various arterial grafts, the first choice arterial conduit that can be added to the LITA is the RITA that, presents similar characteristics to the LITA (12, 13). Additionally, it has been clearly shown that BITA grafting has many benefits; improves survival, reduces need for revascularization, and reduces the incidence of recurrent angina when compared with the use of a single ITA (1, 3, 10, 14). On the other hand, sternal wound infection and dehiscence remain as a major problems after harvesting BITA because of decreased sternal vascularity especially in patients with diabetes mellitus and the other risk factors (chronic obstructive pulmonary disease, obesity, etc.). For this reason, many investigators tried different methods to improve their results. Some investigators showed that skeletonization of ITAs lowers the risk of sternal complications (15, 16), but De Paulis et al (17) advise not to use both ITA grafts in patients with multiple risk factors .

Zeitani et al. (18) used bilateral but partial RITA to avoid excessive devascularization of the sternum and performed a ultrasonographic plus radiographic study to show sternal vascular activity (19). They showed that preserving substantial vascular supply to middle and distal sternal tissues appears to prevent wound complications in selected high risk patients for this complication. They harvested the proximal part of the RITA in their study, but differently, we left the first two branches of RITA "untouched" because these branches are larger in diameter and stronger vessels for sternal vascularity.

Medalion et al. (8) have reported that sternal ischemia after single pedicled LITA harvest is a temporary condition, and it resolves with time. They found that there was a significant decrease of blood uptake in the left hemi-sternum in the early postoperative scan. However, it is well known that sternal complications mostly occur during early postoperative period. Therefore, if we preserve better vascular supply to sternum during acute postoperative period, it would likely heal earlier than any poorly vascular sternum, and probably, we can prevent sternal ischemic complications. Sternal dehiscence, deep or superficial infection may emerge during acute postoperative period due to surgical trauma, vascular damage and absence of ITAs. Reasonably, in this study, we aimed to preserve vascular supply for a larger area of sternum by leaving comparably larger proximal branches and distal vascular branches of RITA. So, we thought to narrow ischemic area during acute postoperative period, which the sternal complications tend to occur mostly. We observed that harvesting of either single or bilateral ITA results in acute devascularization of the sternum (Table 3). Our data showed that, during postoperative first week sternal uptake tends to decrease dramatically in left half of the sternum ($p<0.001$). However, in the right half of sternum, sternal blood uptake was higher in mid-RITA (0.64±0.4) and non-RITA (0.86±0.04) groups than in full-RITA group (0.55±0.02) ($p<0.001$). This finding made us thought that the first few branches of internal thoracic arteries have distinctive role for sternal blood supply. If we leave them untouched, the sternum will receive more blood to recover from ischemic stress after surgery. In the late postoperative period (11.7±1.2 months) measurements of sternal blood uptake, we observed the similar result as reported before (8); the ischemic condition of both half of the sternum were resolved with time.

Higami et al. (20) described a new method for skeletonization and harvesting of the ITA using an ultrasonic scalpel and they reported the early results of this technique (21). They showed that skeletonized harvesting of the ITA using the ultrasonic scalpel is simple, safe, and it reduces sternal infections. In an another comparative study between ultrasonic dissection and standard technique for harvesting arterial grafts, Sezgin et al (22) reported that the ultrasonic scalpel causes less spasm on arterial grafts and it may be an alternative method for harvesting arterial grafts in coronary bypass surgery. On the other hand, four years later, in a study performed using an electron microscope it was shown that skeletonization of the radial artery with an ultrasonic scalpel is associated with a higher risk of endothelial damage than those with the pedicled harvest (23). Matsumoto et al (24) also claimed that ultrasonic skeletonization may damage the endothelial function of ITAs. In present study, all the ITAs were harvested in a semi-skeletonized fashion by using titanium clips and scissors.

It is confirmed by many authors that two ITA grafts are better than one as Lytle et al. (1) have demonstrated before. Now, we should investigate how could we lower or avoid the sternal complications. Recently, some radiological studies evaluated sternal vascularity after ITA harvest. Lorberboym et al (25) investigated the effect of skeletonized and semi-skeletonized techniques of LITA harvesting on sternal vascularity with a prospective bone SPECT study. They demonstrated that postoperative sternal ischemia was minimal in patients where semi-skeletonized and skeletonized techniques were used, and was substantial in patients where the pedicled technique was used (25).

Mert et al. (26) studied BITA grafting in 25 diabetic patients and reported sternal wound infection in 12% of patients. On the other hand, they observed that 8% of non-diabetic patients had sternal wound infection ($p=0.45$) (26). They concluded that there was no statistically significant difference between diabetic and non-diabetic patients, whose single ITA and BITA were used. Moreover, they suggested diabetic patients should benefit advantages of BITA grafting, but some special measures must be taken perioperatively to prevent problems including sternal wound complications. Our study shows that BITA grafting should be performed in diabetic patient population as much as non-diabetic patients. However, sternal infection is still a problem during early postoperative period. Therefore, we aimed to resolve this problem by preventing sternal blood supply much better than conventional RITA harvesting method. Nevertheless, we did not design this study to investigate diabetic patients, and only 22.9% of our study population (31 patients) was diabetic, including five (3.7%) patients with IDDM. Nevertheless, the other risk factors such as obesity, low cardiac ejection fraction and renal failure were exclusion criteria in this study. Especially, insulin dependent and non-dependent diabetes mellitus would be the most valuable subject to be investigated.

Study Limitations

In this study, only a few patients with IDDM were included in the study, and the results are not enough to make a suggestion about these patients. This is the most important limitation of the study. In addition, we do not know if this method has any beneficial or deleterious effect on sternal vascularity in patients who has one or more additional risk factors for sternal complications including obesity, chronic obstructive lung disease and renal disease. To get a more accurate result of this technique in risky patients, a prospective randomized clinical study with larger number of patients with risk factors for sternal complications are warranted.

Conclusion

In present, it has been widely accepted that bilateral ITA grafting is better than one. Although many surgeons prefer using BITA, some hesitates to use BITA because of its disadvantages including longer operation time, increased sternal complications, and postoperative bleeding. The improvements on surgical instruments (such as ultrasonic scalpel) and surgical techniques (skeletonization of the ITAs) have decreased most of the complications of BITA harvesting. The most important complication of the BITA usage is associated with devascularization of the sternum. Thus, we aimed to develop a better technique to keep sternal vascularity where the BITA grafting is used. We observed that the mid-RITA harvesting technique shortens the operation time, and it preserves significantly better sternal blood supply.

In conclusion, mid-RITA harvesting technique has less hazardous effect on sternal vascularity during both early and late postoperative periods after cardiac surgery than when bilateral ITAs were used. Therefore, we can safely harvest RITA as an additional arterial free graft to LITA for coronary artery bypass grafting by using this technique, with more preserved sternal vascularity and more acceptable sternal complications than full-RITA technique.

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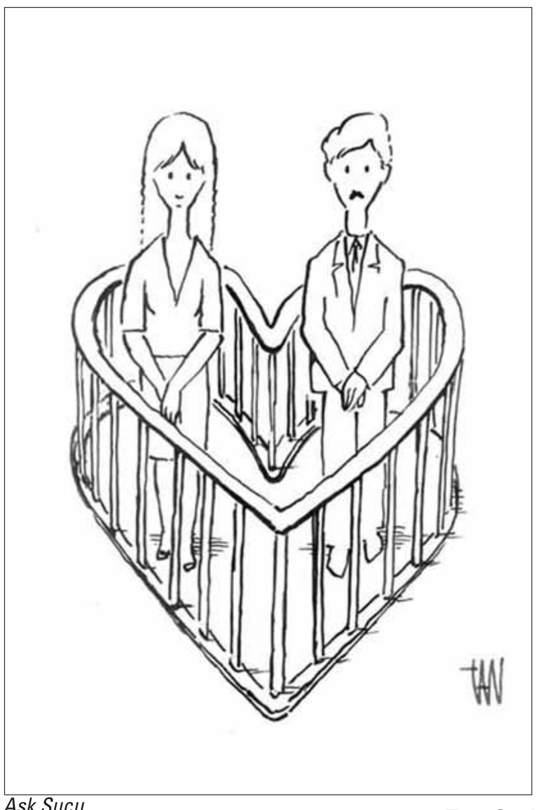

Aşk Suçu

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İnsan Hakları Haftası Karikatür Sergisi'nden