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Comparison of Endoscopic Saphenous Vein Harvesting with Open Saphenous Vein Harvesting in Coronary Artery Bypass Surgery

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Abstract

Aim: Recently minimally invasive approaches have been gathering more popularity in cardiac surgery. The aim of our study is to investigate the effects of endoscopic versus open harvesting of the great saphenous vein, the most commonly used grafting method in conventional coronary artery bypass surgery on early and long-term complications.

Methods: Included in the study were 60 patients who underwent coronary artery bypass grafting in our clinic using either endoscopic saphenous vein graft (n=30) or open saphenous vein graft (n=30) harvesting. Early follow-up data (wound site complications, pain, major cardiac and cerebrovascular events, etc.) and long-term data (major adverse cardiac and cerabral events (MACCE), recurrent angina pectoris, revascularization, tc.) were evaluated retrospectively.

Results: The rate of edema and pain was significantly lower in the EVH group (p=0.001), whereas MACCE, recurrent angina pectoris, reintervention and revascularization rates did not significantly differ between the groups in the long term follow-up (p>0.05).

Conclusion: The graft patency rate and the rates of MACCE and recurrent angina pectoris in the long term did not significantly differ between patients undergoing endoscopic saphenous vein harvesting and those undergoing open saphenous vein harvesting. The authors of the present study consider that endoscopic saphenous vein harvesting is an alternative less invasive method that is superior to standard surgical techniques, providing patient comfort and esthetic advantages without causing complications in the long term.

Keywords: coronary artery bypass surgery, saphenous vein, endoscopic vein harvesting and minimal invasive.

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Introduction

Coronary artery bypass grafting (CABG) is one of the most commonly performed surgical procedures worldwide (1). In patients undergoing CABG, the left internal mammary artery (LIMA) and great saphenous vein (GSV) have remained the most preferred conduits. The long-term patency of LIMA and GSV is shown to be satisfactory, over 95% and 50% at 10 years, respectively. Until now, many clinical studies have shown that CABG increases both quality of life and survival in patients with especially multi-vessel coronary artery disease (CAD), diabetes and left ventricular dysfunction (2).

After CABG, there are several factors preventing the convalescence of patients completely and, therefore, reducing the benefit of CABG in CAD. The wound healing has been documented to be the major issue in front of postoperative convalescence. It is adversely affected in patients with several risk factors such as obesity, diabetes, and peripheral vascular disease after undergoing harvesting of the saphenous vein. This prolongs the length of hospital stay and increases hospitalization costs. Hence, endoscopic techniques were developed in the 1990s (3). Endoscopic vein harvesting (EVH) was found to be cost-effective in terms of the occurrence of wound site complications in the early period, shortening of hospital stays, and optimizing patient satisfaction (4-6).

The present study aims to evaluate the effects of endoscopic harvesting of the GSV, the most commonly used grafting method in conventional coronary artery bypass surgery, on early and long term complications after CABG.

Material and Methods

After ethical approval and obtaining informed consent from all patients, 60 adult patients (18-80 years old) who underwent CABG between January 2013 and February 2014 were enrolled into the study. The clinical data related to the patients were retrospectively analyzed. The patients were grouped into 2 according to the technique of GSV harvesting during procedure; group 2: (n=30) endoscopic GSV harvesting and group 2: (n=30) open GSV harvesting The study evaluated early follow-up data and the long-term outcomes of patients who underwent either endoscopic or open harvesting of the saphenous vein for coronary artery bypass surgery.

Early follow-up data included infection, culture positivity and noninfectious complications, edema, pain, major cardiac or cerebrovascular events, mobilization times, and complications requiring readmission to the hospital. Noninfectious complications (hematoma, erythema) were evaluated as present or absent. Pain was evaluated by the visual analog scale (VAS). The patients were instructed to rate their current pain, considering that the highest pain level would correspond to 10 points, and to rate the leg pain accordingly. Leg pain was evaluated on postoperative days 1, 2, and 3. The edema was rated as +, ++, +++, ++++ pitting edema, and all patients underwent edema assessment before discharge.

Long-term data included the presence of recurrent angina, major cardiac (congestive heart failure, non-ST-elevation myocardial infarction, ST-elevation myocardial infarction), and cerebrovascular events, a recurrent need for coronary artery imaging, repeat intervention and revascularization attempts, and saphenous vein patency rates (in percentage). Patients were classified according to the cause of death: cardiac (acute myocardial infarction, congestive heart failure) events, cerebrovascular events, and other conditions were recorded.

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Surgical method

All patients received anesthesia using the standard protocol in our institution. After median sternotomy, cardiopulmonary bypass (CPB) was instituted via aortocaval cannulation. The left internal mammary artery (IMA) was prepared for the revascularization of the left descending artery (LAD) whereas the great saphenous vein (GSV) harvested synchronously from the right or left lower extremity was used for the revascularization of other vessels.

In the open surgical technique, the GSV was harvested from the right or left leg below the knee level in a desired length by starting from the level of the medial malleolus. Skin and subcutaneous tissues were closed in regular fashion. During endoscopic vein harvesting (EVH), the transverse incisions of few centimeters were made along the course of the GSV above the knee level. After dissecting the tissues above the saphenous vein, the bed was further expanded using balloon-tipped dilator. The endoscopic camera was then introduced into this bed. The GSV was dissected off from the surrounding fat and connective tissues by the help of the dissector of the endoscopic set. The branches were cauterized and ligated. The proximal and distal ends were ligated, and the vessel conduit was removed after the saphenous vein was sufficiently dissected off from the surrounding tissues. The incisions made on the femoral region and knee were closed with prolene sutures. After opening and suspending the pericardium, the systemic anticoagulation was performed using 300 IU/kg standard heparin. The activated clotting time (ACT) was maintained between 400 and 650 sec. The cardiopulmonary bypass (CPB) was initiated with the arterial and venous cannulation. The cardiopulmonary bypass flow was maintained in such a way as to keep the mean arterial blood pressure at 60 mmHg. The systemic body temperature was maintained between 20℃ and 32℃. The same roller pump (Sorin S5 roller pump, Sorin Group, Italy) and the oxygenator (Dideco compactflo Evo Physio, Sorin Group, Italy) were used for the CPB in all patients. The cross-clamp was removed after performing a distal anastomosis using 7/0-8/0 prolene, depending on the vessel structure. The normal sinus rhythm was restored spontaneously or by defibrillation. The proximal anastomosis was performed using 6/0 prolene under partial clamping of the ascending aorta. The CPB was terminated after esophageal temperature has reached 37℃, and cardiac parameters were optimized. Heparin was neutralized by the administration of protamine HCl. After achieving hemostasis, drains were inserted into the mediastinum and the thoracic cavity, after which the operation was ended upon the closure of the sternum using stainless steel wires and upon the closure of the skin and subcutaneous tissues using Vicryl sutures.

Postoperative follow-up

The mean duration of follow-up was 4.5 years. Patients with missing long-term data were excluded from the study.

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Statistical analysis

The Number Cruncher Statistical System 2007 (NCSS, Kaysville, Utah, USA) was used in the statistical analysis. Along with descriptive statistical method in the analysis of study data (mean, standard deviation, median, frequency, ratio, minimum, maximum), Student's t-test was used in the comparison of quantitative data with normal distribution whereas Mann-Whitney U test was used in the analysis of data without normal distribution. The Friedman test was used in the analysis of follow-up variables without normal distribution, and the Dunn's test was used in paired comparisons. Pearson's chi-square test, Fisher-Freeman-Halton test, and Fisher's Exact test were used in the comparison of qualitative data. The level of statistical significance was set at an alpha of 0.05.

Results

The study was conducted between January 2013 and February 2014 and preoperative variables related to the patients were given in Table 1. The body mass index (BMI) ranged between 19.8 and 37.5 kg/m^2 with a mean BMI of 27.57±3.53 kg/m^2; 20.0% (n=12) were normal weight, 60.0% (n=36) were overweight, and 20.0% (n=12) were obese (Table 1). Of the patients, 68.3% (n=41) were smokers, 50.0% (n=30) had diabetes, 36.7% (n=22) had hyperlipidemia, and 13.3% (n=8) had peripheral artery disease (table 1). The mean HbA1c was 6.80±1.84 with a range of 4.5 to 13.8, and the mean EF was 55.48±10.80% with a range of 25% to 71% (table 1). The descriptive characteristics of the two groups were evaluated, and the groups were then standardized according to the presence of significant differences (Table 2). There was no statistically significant difference between the groups in terms of the operation type, the graft number, and the graft length ($p>0.05$).

The graft harvest time was significantly different between the groups whereas the operation time was significantly higher in the EVH group than that in the open surgery group ($p=0.001$; $p<0.01$). There was no significant difference between the groups in terms of noninfectious complications, including hematoma and erythema at the wound site whereas the rate of edema and pain was significantly different between the groups ($p<0.01$). The rate of + pitting edema was higher in the EVH group, and the rate of +++ and ++++ edema was higher in the control group. The rate of pain was significantly different between thr groups ($p<0.01$) (Table 3). The mobilization time and the length of hospital stay did not differ between the patients significantly. There was no statistically significant difference between the groups in terms of the need for readmission, noninfectious complications after admission, and infections and treatments ($p>0.05$). One patient in the open surgery group underwent limb amputation within one month after readmission due to a wound site infection as a result of a lack of improvement despite debridement and antibiotic therapy.

MACCE occurred in the early period in 10.0% (n=6) of the patients (all sustained the CVA), and of these patients, three were in the EVH group, and the other three were in the open surgery group. There was no statistically significant difference between the groups in terms of the occurrence of MACCE in the early period ($p>0.05$).

When the occurrence of MACCE and recurrent angina in the long term was evaluated,

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58.3% of the patients were event-free, 26.7% (n=16) had recurrent angina, 8.3% (n=5) sustained NONSTEMI, 1.7% (n=1) sustained CVA, and 5.0% (n=3) sustained CHF. There was no significant difference between the groups in terms of the occurrence of MACCE in the long-term follow-up (p>0.05) (Table 4).

Table 1: Distribution of Descriptive Characteristics

Descriptive Characteristics		n (%)
Age (year)	***Min-Max (Median)***	**40-80 (66)**
	Mean±S.D.	**64.25±9.21**
Gender	**Male**	**46 (76.7)**
	Female	**14 (23.3)**
Height (cm)	***Min-Max (Median)***	**152-195 (167.5)**
	Mean±S.D.	**164.62±16.52**
Weight (kg)	***Min-Max (Median)***	**53-112 (76.5)**
	Mean±S.D.	**79.62±19.16**
BMI (kg/m^2)	***Min-Max (Median)***	**19.8-37.5 (27.5)**
	Mean±S.D.	**27.57±3.53**
	Normal	**12 (20.0)**
	Overweight	**36 (60.0)**
	Obese	**12 (20.0)**
Smoking	**No**	**19 (31.7)**
	Yes	**41 (68.3)**
Diabetes	**No**	**30 (50.0)**
	Yes	**30 (50.0)**
Hyperlidipemia	**No**	**38 (63.3)**
	Yes	**22 (36.7)**
Peripheral Artery Disease	**No**	**52 (86.7)**
	Yes	**8 (13.3)**
HbA1c	***Min-Max (Median)***	**4.5-13.8 (6)**
	Mean±S.D.	**6.80±1.84**
EF (%)	***Min-Max (Median)***	**25-71 (60)**
	Mean±S.D.	**55.48±10.80**

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Table 2: Evaluation of Descriptive Characteristics According to the Groups

		EVH group (n=30)	Open surgery group (n=30)	*p*
Age (year)	***Min-Max (Median)***	**40-80 (65.5)**	**45-77 (66)**	[a]*0.479*
	Mean±S.D.	**65.10±9.57**	**63.40±8.90**	
Gender*; n (%)*	**Male**	**27 (90.0)**	**19 (63.3)**	[c]*0.015**
	Female	**3 (10.0)**	**11 (36.7)**	
BMI (kg/m^2)	***Min-Max (Median)***	**22-37.5 (26.8)**	**19.8-36.3 (27.7)**	[a]*0.922*
	Mean±S.D.	**27.61±3.65**	**27.52±3.46**	
	Normal	**5 (16.7)**	**7 (23.3)**	
	Overweight	**18 (60.0)**	**18 (60.0)**	
	Obese	**7 (23.3)**	**5 (16.7)**	
Smoking*; n (%)*	**No**	**12 (40.0)**	**7 (23.3)**	[c]*0.165*
	Yes	**18 (60.0)**	**23 (76.7)**	
Diabetes*; n (%)*	**No**	**18 (60.0)**	**12 (40.0)**	[c]*0.121*
	Yes	**12 (40.0)**	**18 (60.0)**	
Hyperlipidemia*; n (%)*	**No**	**19 (63.3)**	**19 (63.3)**	[c]*1.000*
	Yes	**11 (36.7)**	**11 (36.7)**	
Peripheral Artery Disease*; n (%)*	**No**	**24 (80.0)**	**28 (93.3)**	[c]*0.129*
	Yes	**6 (20.0)**	**2 (6.7)**	
HbA1c	***Min-Max (Median)***	**4.5-13.8 (6)**	**5-11.6 (6.5)**	[b]*0.429*
	Mean±S.D.	**6.78±2.09**	**6.83±1.60**	
EF	***Min-Max (Median)***	**35-71 (60)**	**25-68 (60)**	[b]*0.433*
	Mean±S.D.	**56.87±9.90**	**54.10±11.63**	

*[a]Student's t-test [b]Mann-Whitney U Test [c]Pearson Chi-Square Test *p<0.05*

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Table 3: Pain Assessment in the Groups

		Total	EVH (n=30)	Open surgery group (n=30)	[b]p
Pain at day 1	Min-Max (Median)	3-9 (5)	3-5 (3)	7.10±1.27	0.001
	Mean±S.D.	5.22±2.16	3.33±0.76	4-7 (6)	
Pain at day 2	Min-Max (Median)	2-7 (4)	2-4 (3)	5.73±0.91	0.001
	Mean±S.D.	4.17±1.75	2.60±0.56	3-5 (4)	
				4.03±0.76	
Pain at day 3	Min-Max (Median)	1-5 (3)	1-3 (1)	3-5 (4)	
	Mean±S.D.	2.72±1.50	1.40±0.62	4.03±0.76	

[b]Mann-Whitney U Test

Table 4: Evaluation of MACCE and Mortality in the Groups

		Total	EVH group (n=30)	Open surgery group (n=30)	p
		n (%)	n (%)	n (%)	
Mortality in the Early Period	No	60 (100)	30 (100)	30 (100)	-
	Yes	0 (0)	0 (0)	0 (0)	
MACCE in the Early Period	No	54 (90.0)	27 (90.0)	27 (90.0)	*[e]1.000*
	Yes	6 (10.0)	3 (10.0)	3 (10.0)	
MACCE status in the follow-up	Normal	35 (58.3)	19 (63.3)	16 (53.3)	*[d]0.667*
	Angina	16 (26.7)	6 (20.0)	10 (33.3)	
	NONSTEMI	5 (8.3)	3 (10.1)	2 (6.7)	
	CVA	1 (1.7)	1 (3.3)	0 (0)	
	CHF	3 (5.0)	1 (3.3)	2 (6.7)	

[d]Fisher Freeman Halton Test *[e]Fisher's Exact Test*

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Discussion

Coronary artery bypass grafting is the most commonly performed major surgery in the developed countries, and approximately one million people around the world undergo this operation every year (2).

Coronary artery disease (CAD) is more commonly encountered in patients with advanced age, patients with diabetes, obese patients, and those with accompanying peripheral artery disease, which unfavorably affect wound healing. The complications related to the wound healing are more commonly observed in the early period in these patients. IMA, GSV, and radial artery are the most frequently used conduits for CABG surgery (7). Many complications such as pain, edema, hematoma, non-healing incision site, fat necrosis, and secondary surgical site infections can be encountered particularly after harvesting of the GSV. These complications still constitute a problem despite their decreased incidence rates. They also result in the need for repeat surgery, the prolongation of hospital stay, increased costs, and sometimes the loss of limb function (8). This affects the patient's quality of life and reduces the patient satisfaction.

The studies have demonstrated the superiority of endoscopic method to open surgery as this method is associated with a decreased rate of wound site complications, lesser pain, better cosmetic outcomes, and improvement in the patient satisfaction (9-14).

Lower pain scores associated with the EVH technique accelerates patient mobilization. Some studies have shown that the mobilization time and the length of hospital stay are lower in patients undergoing EVH than those undergoing open surgery (15-16). Although the present study identified no significant difference between the two groups in terms of the mobilization time and the length of hospital stay, the pain assessment showed lower pain scores and faster pain relief in the EVH group, suggesting an improved patient satisfaction. The preliminary studies, however, raised the suspicion that graft patency might be poor in mid- and long-term despite its superiority to open surgical technique considering a decrease in wound site complications, better esthetic outcomes and an improved patient satisfaction (17).

Lopes et al. conducted a study involving 3,000 patients in 2009. At the end of a 3-year follow-up period, they reported higher vein graft occlusion, myocardial infarction, and repeat revascularization rates in the EVH group than those in the open surgery group (18).

In the ROOBY study conducted by Zenati et al., the rate of graft patency one year after CABG surgery was lower (74.5% vs. 85.2%, $P<.0001$) and the need for repeat revascularization (6.7% vs. 3.4%, $P<0.05$) was higher in the EVH group than those in the other group (19).

However, it has been found that the harvesting of the saphenous vein by using the EVH technique increases endothelial damage at the histological level (20). It is considered that an increase in acute

endothelial damage may unfavorably affect graft patency by inducing thrombogenic events at the level of endothelium. The studies by Perrault et al. and Yu et al., on the other hand, have found no significant difference between the EVH and OVH groups in terms of graft patency in the short term (3-6 months) (21,22). On the contrary, there are also studies suggesting that endothelial damage is not aggravated further and that the integrity of endothelium is comparable to that observed in open surgery (23-26).

In a study involving 720 patients, Felisky et al. reported a lower rate of all wound site complications (seroma, erythema, hematoma, dehiscence, cellulitis, abscess, need for surgical debridement, use of antibiotics) in the EVH group than that in the open surgery group. No statistically significant difference was found in terms of early postoperative mortality, myocardial infarction, and the need for repeat cardiac catheterization (27).

In a study published in 2010 by Ouzounian et al. , the rate of wound site complications in the early period was found to be lower in the EVH group who were followed up for approximately 2.6 years, and no significant difference was found between the EVH group and OVH group in terms of the rate of MACCE (28).

In a study involving 1,988 patients with a mean follow-up duration of 22.1±10.5 months, Ad et al. found no increase in the rates of death, myocardial infarction, and recurrent revascularization in the EVH group than compared to the open surgery group (29). The present study also compared the rate of repeat revascularization in the long-term follow-up, and no significant difference was found.

In a study of 205 patients conducted by Zhang et al., no statistically significant difference was found between the EVH (n=66) and OVH (n=139) groups in terms of graft patency during a 2-year follow-up [83.59% in the OVH group and 82.22% in the EVH group (P=0.73)] (5). The present study has also found no significant difference in recurrent angina pectoris rates in the long-term follow-up between the two groups (p=0.667).

The present study compared wound site complications in the early period, the rates of MACCE and mortality, MACCE in the long-term (mean 54 months), recurrent angina pectoris, repeat intervention rates, and saphenous vein conduit occlusion rates detected by cardiac catheterization or coronary CT angiography between the EVH and OVH groups. Consistent with other studies in the literature, the rate of early complications such as pain and edema was lower in the EVH group. No significant difference was identified between the two groups in terms of noninfectious complications such as hematoma and erythema, and readmission and infections requiring antibiotherapy. There was no significant difference between the two groups in terms of MACCE and mortality. In the long-term follow-up of the patients, graft patency, MACCE and mortality did not significantly differ among patients who had recurrent angina and who required repeat revascularization. A comparison of graft patency rate in the long-term did not

show any significant difference between the two groups.

EVH is a safe technique reducing wound site complications, improving the life quality of the patients, preserving patient's comfort, providing satisfactory esthetic outcomes without causing complications in the long-term when compared to standard techniques (30).

In conclusion, the present study has found no significant increase in the saphenous vein patency rate and the associated MACCEE, recurrent angina, and repeat intervention rates in the long-term between patients undergoing endoscopic saphenous vein harvesting and those undergoing open surgical vein harvesting. These findings are consistent with literature data. On the other hand, this technique was shown to be superior to open surgical techniques in terms of pain and edema. The authors of the present study consider that endoscopic saphenous vein harvesting is an alternative method that is superior to standard surgical techniques, providing patient comfort and cosmetic advantages without causing complications in the long term.

References

1. Taggart DP, D'Amico R, Altman DG. Effect of arterial revascularisation on survival: a systematic review of studies comparing bilateral and single internal mammary arteries. Lancet, 2001; 358:870–875
2. Taglieri N, Bruno AG, Bacchi Reggiani ML. et all. Impact of coronary bypass or stenting on mortality and myocardial infarction in stable coronary artery disease. Int J Cardiol. 2020; 309:63-69.
3. Williams JB, Peterson ED, Brennan JM, et al. Association between endoscopic vs. open vein-graft harvesting and mortality, wound complications, and cardiovascular events in patients undergoing CABG surgery. JAMA. 2012; 308: 475–84.
4. Heyman Luckraz, Carly Cartwright, Kumaresan Nagarajan, Prabhjeet Kaur, and Alan Nevill· Original research article: Major adverse cardiac and cerebrovascular event and patients 'quality of life after endoscopic vein harvesting as compared with open vein harvest (MAQEH): a pilot study. Open Heart. 2018;5: e000694.
5. Zhang WH, Li J, Zhang X. et all. Mid-term outcome of endoscopic greater saphenous vein harvesting in coronary artery bypass grafting. Nan Fang Yi Ke Da Xue Xue Bao: 2016;36:829-32.
6. Greenland P, Knoll MD, Stamler J, et al. Major risk factors as antecedents of fatal and nonfatal coronary heart disease events. JAMA. 2003; 290:891–7.
7. Aldea GS, Bakaeen FG, Pal J. et all. Society of Thoracic Surgeons.The Society of Thoracic Surgeons Clinical Practice Guidelines on Arterial Conduits for Coronary Artery Bypass Grafting. Ann Thorac Surg. 2016; 101:801-9.

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Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2020; 9(1): 87-98 Demirbas E. et all.

8. Jonkers D, Elenbaas T, Terporten P, Nieman F, Stobberingh E. Prevalence of 90-days postoperative wound infections after cardiac surgery. European Journal of Cardio-Thoracic Surgery. 2003;23:97–102.
9. Andreasen JJ, Nekrasas V, Dethlefsen C. Endoscopic vs open saphenous vein harvest for coronary artery bypass grafting: a prospective randomized trial. Eur J Cardiothorac Surg. 2008;34:384-9.
10. Isgro F, Weisse U, Voss B, Kiessling AH, Saggau W. Minimally invasive saphenous vein harvesting: is there an improvement of the results with the endoscopic approach? Eur J Cardiothorac Surg. 1999;16 Suppl 2:S58-60.
11. Kyo S, Kaneko K, Nishikiori Y, Konou R, Hojo H, Omoto R. Endoscopic harvest of saphenous vein graft for coronary artery bypass grafting: Saitama-Olympus technique. Eur J Cardiothorac Surg. 1998;14 Suppl 1:S93-9.
12. Horvath KD, Gray D, Benton L, Hill J, Swanstrom LL. Operative outcomes of minimally invasive saphenous vein harvest. Am J Surg. 1998;175:391-5.
13. Marty B, von Segesser LK, Tozzi P, Guzmann J, Frascarolo P, Muller X, Hayoz D. Benefits of endoscopic vein harvesting. World J Surg. 2000;24:1104-7.
14. Au WK, Chiu SW, Sun MP, Lam KT, Lin MF, Chui WH, Yeung CL, Cheng LC. Improved leg wound healing
with endoscopic saphenous vein harvest in coronary artery bypass graft surgery: a prospective randomized study in Asian population. J Card Surg. 2008;23:633-7.
15. Patel AN, Hebeler RF, Hamman BL, Hunnicutt C, Williams M, Liu L, Wood RE. Prospective analysis of endoscopic vein harvesting. Am J Surg. 2001;182:716-9.
16. Ikram MU, Li WW, Segers P, Kloek JJ, de Mol BA. Endoscopic vein-graft harvesting for coronary bypass grafting: good results in patients at risk for surgical site infection. Ned Tijdschr Geneeskd. 2010;154:A1806.
17. Rousou LJ, Taylor KB, Lu XG. et all. Saphenous vein conduits harvested by endoscopic technique exhibit structural and functional damage. Ann Thorac Surg. 2009; 87:62-70.
18. Lopes RD, Hafley GE, Allen KB, et al. Endoscopic versus open vein-graft harvesting in coronary-artery bypass surgery. N Engl J Med. 2009;361:235–44.
19. Zenati MA, Shroyer AL, Collins JF, et al. Impact of endoscopic versus open saphenous graft harvest technique upon CABG patient outcomes in the randomized ROOBY trial. J Thorac Cardiovasc Surg. 2011;141:338–44.

20. Brat R, Horacek J, Sieja J. Endoscopic vs open saphenous vein harvest for coronary artery bypass grafting: a leg-related morbidity and histological comparison. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2013;157:70-4.
21. Perrault LP, Jeanmart H, Bilodeau L.et all. Early quantitative coronary angiography of saphenous vein grafts for coronary artery bypass grafting harvested by means of open versus endoscopic saphenectomy: a prospective randomized trial. J Thorac Cardiovasc Surg. 2004; 127:1402-7.
22. Yun KL, Wu Y, Aharonian V. et all. Randomized trial of endoscopic versus open vein harvest for coronary artery bypass grafting: six-month patency rates. J Thorac Cardiovasc Surg. 2005; 129:496-503.
23. Kiaii B, Moon BC, Massel D. et all. A prospective randomized trial of endoscopic versus conventional harvesting of the saphenous vein in coronary artery bypass surgery J Thorac Cardiovasc Surg. 2002; 123:204-12.
24. Bonde P, Graham AN, MacGowan SW. Endoscopic vein harvest: advantages and limitations. Ann Thorac Surg. 2004; 77:2076-82.
25. Crouch JD, O'Hair DP, Keuler JP Barragry TP, Werner PH, Kleinman LH. Open versus endoscopic saphenous vein harvesting: wound complications and vein quality. Ann Thorac Surg. 1999; 68:1513-
26. Alrawi SJ, Balaya F, Raju R, Cunningham JN Jr, Acinapura AJ. A comparative study of endothelial cell injury during open and endoscopic saphenectomy: an electron microscopic evaluation. Heart Surg Forum. 2001; 4:120-7.
27. Felisky CD, Paull DL, Hill ME, Hall RA, Ditkoff M, Campbell WG, Guyton SW. Endoscopic greater saphenous vein harvesting reduces the morbidity of coronary artery bypass surgery. Am J Surg. 2002;183:576-9.
28. Ouzounian M, Hassan A, Buth KJ, MacPherson C, Ali IM, Hirsch GM, Ali IS. Impact of endoscopic versus open saphenous vein harvest techniques on outcomes after coronary artery bypass grafting. Ann Thorac Surg. 2010;89:403-8.
29. Ad N, Henry L, Hunt S, Holmes S, Burton N, Massimiano P, Rhee J, Rongione A, Speir A, Collazo L. Endoscopic versus direct vision for saphenous vein graft harvesting in coronary artery bypass surgery. J Cardiovasc Surg. 2011;52:739-48.
30. Francis D. Ferdinand, MD, John K. MacDonald. Et all. Endoscopic Conduit Harvest in Coronary Artery Bypass Grafting Surgery An ISMICS Systematic Review and Consensus Conference Statements. Innovations: Technology and Techniques in Cardiothoracic and Vascular Surgery. 2017; 12:301–19.