Risk Factors Analysis in Complicated Leg Wound after Saphenous Vein Harvesting for Myocardial Revascularization

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Abstract: It is often painful to both the surgeon and the patient when wound complication develops or when the wound outcome post coronary artery bypass grafting (CABG) is suboptimal. Our aim in this study was to analyze anatomical variations and perioperative risk factors leading to leg wound infection post CABG at the graft harvesting site. A retrospective study was carried out on 1251 patients who underwent CABG surgery. They were classified into 2 groups: The demographic, operative and postoperative data were collected and statistical analysis was performed to assess risk factors predisposed to leg wound infection post CABG in both groups. The study included 2 groups, group I: who had infected leg wound: (n= 76, 6.1%) and group II: non infected cases post CABG: (n=1175, 93.9%). Multivariate analysis for risk factors showed that high lipid profile was significantly associated with leg wound infection (p-value= 0.005), Odds ratio 3.769 (95% CI 1.5-9.45). Peripheral arterial disease also was significant finding (P-value=0.021), Odds ratio 1.98(95% CI 1.34 -3.45) as well as hypoalbuminemia (p-value=0.043), Odds ratio 1.32 (95%CI 1.02-2.32). The highest correlation was documented in the presence of unusual course of saphenous vein (p-value= 0.004), Odds ratio 5.44 (95% CI 3.21-6.85). On the other hand the demographic data as age, sex and BMI were not significant risk factors for leg wound infection in multivariate analysis model. The knowledge and identification of anatomical variations of GSV play an important role in increasing the success and improving outcome post-surgical intervention.
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Keywords: Saphenous vein, anatomical variation, CABG, infection, leg wound.

1. Introduction

The conventional open technique for dissection to harvest the vein in coronary artery bypass grafting (CABG) surgery still widely used in most of the centers all over the world specially in developing countries [Gelape, 2007]. There are other methods as interrupted or endoscopic vein harvesting (EVH), but still need more training and still costly. The approach used is important to get a good quality graft without intimal injury. This improves the survival of the graft with short and long term course post operatively in ischemic heart disease (IHD) cases.

Complications related to the surgical technique, occur in 30% of the patients subjected to a saphenectomy. Many morbidities as seroma, suture dehiscence increase hospital stay and delay patient recovery. One study reported prolonged hospital stay up to 12 days due to complications affecting the leg. This incurred an increase of US$ 9900 per patient in hospital costs linked to these patients [*DeLaria et al*., 1981].

Sometimes bad scenario can lead to amputation, septicemia or other systems affection. They may spend weeks to manage unnecessary complication after successful coronary artery surgery [Kleber et al., 2016 and Mohammad et al., 2011]. Surgical team experience, believes regarding the method used in harvesting SV (saphenous vein) and awareness about its anatomical variation are essential to minimize tissue handling during dissection, skin flaps formation and difficult closure.

The precise anatomy of the great saphenous venous system (GSV) should be well known preoperatively, clinically and radiologically to lower the incidence of excessive dissection. The GSV originates anterior to the medial malleolus then continues on medial aspect of the thigh till it joins the femoral vein at the saphenofemoral junction. The GSV is easily identified especially in the proximal to mid-

thigh region due to its typical ultrasound appearance known as the saphenous eye "Egyptian eye"(Figure 1) that helps the GSV to be distinguished from other tributaries [Bailly, 1993]. Its anatomical variations were documented by many studies since long time as venous anatomy not fixed as arterial system. Variations may be for its tributaries, presence of large bifurcating vein or deviation of its course either in the leg or in the thigh.

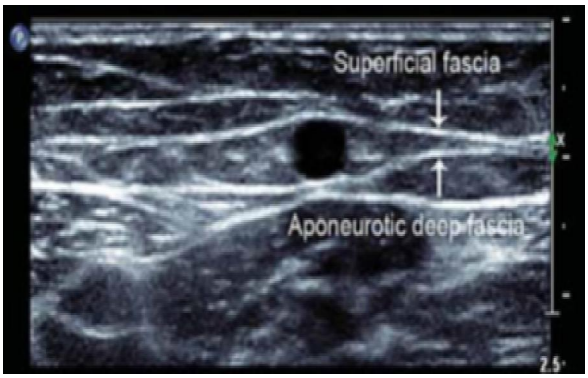

Figure 1: Ultrasound appearance of saphenous vein in the thigh.

Our aim in this study was to analyze anatomical variations and perioperative risk factors leading to leg wound infection post CABG at the graft harvesting site.

2. Patient and Methodology

A retrospective study was carried out in 3 tertiary centers in the period from 2014 to 2017 and was approved by ethical committee of these centers. The study included all cases that underwent CABG surgery and saphenous veins were harvested as a conduit by open approach. 76 infected cases (28 male and 48 female) were included in our study from total number of 1251 patients that underwent CABG surgery in this period. These cases were divided into two groups, group I: 76 cases with leg wound infection and group II: 1175 cases with non-infected leg wound cases following vein harvesting.

Inclusion criteria: any age group of patients who underwent SVG harvesting in isolated CABG cases and acquired leg wound infection after removal of the conduit by open technique.

Exclusion criteria: any case of CABG associated with other cardiac lesions either acquired or congenital, cases that underwent endoscopy or interrupted techniques for vein harvesting and cases with leg wound secondary to varicose veins or lower limb ischemia were excluded.

Venous duplex data were collected. Demographic, intraoperative findings and post-operative data were analyzed. Consents were taken from the patients to utilize these data and use images in our research.

Surgical techniques

Patients included in our study underwent CABG surgery. Prophylactic antibiotic was given to all cases. After sterilization and draping, harvesting SVG were done by conventional open technique. Longitudinal skin incision was done above and in front of the medial malleolus by 2 inches then the saphenous vein was exposed. The dissection for the vein within the superficial layer were performed then the incision was extended proximally along the vein course. Ligation of vein tributaries a long SV course were done either using vascular clip or silk suture. Tributaries were variable in diameter, direction and location. After harvesting the length needed from the vein, it was placed in normal saline. Its proximal and distal ends were ligated with silk suture or vascular clip. Hemostasis was done followed by wound closure in double layer versus single layer technique. Suction drains were inserted if needed especially in high BMI with deep fatty wounds. Creep bandage was used for all cases. Pre-operative ultrasound findings, intra operative data and post-operative outcome were documented and analyzed.

Statistical analysis

Statistical analysis using SPSS version 24.0 was done. Continuous variables were compared using Student's unpaired *t*-test or the Mann–Whitney *U*-test. Categorical variables were compared using the χ^2 and Fisher's exact tests. The risk factors for wound infection were determined after multivariate analyses. A value of $P < 0.05$ was considered statistically significant.

3. Results

1251 cases were included in our study according to inclusion and exclusion criteria. The study included cases with major infected leg wound stage III and IV post SV harvesting using open technique (n= 76, 6.1 %) from total CABG cases (n=1251). The number of non-infected cases was (n=1175, 93.9 %).

These patients were divided into 2 groups, group I: who had infected leg wound: (n= 76, 6.1%) and group II: non infected cases post CABG: (n=1175, 93.9%). In group I female to male ratio was 1.71: 1. Mean age of infected cases was (56.65±8.28) years and in non-infected group (56.78±7.8) years with no significant age related difference between both groups (p-value= 0.8944) (Table-1).

Table-1: Patients demographic data in both groups.

Demographic data	Group I (76 cases)	Group II (1175 cases)	*p*-value
	mean± SD	Mean± SD	
Age	56.65±8.28	56.78±7.80	0.8944
BMI (Kg/m²)	31±4	29.3±5.2	0.2158
	N= (%)	**N= (%)**	
Female gender	N=48, (63.1%)	N=369, (32.2%)	< 0.0001*
Diabetes	N=49, (64.6%)	N=311, (26.5%)	< 0.0001*
Chronic kidney disease	N=6, (7.9%)	N=84, (7.1%)	0.7931
Smoking habit	N=29, (38.5%)	N=482, (41%)	0.6675
Peripheral limb ischemia	N=50, (66.2%)	N=154, (13.1%)	<0.0001*
High lipid profile	N=56, (73.5%)	N=508, (43.2%)	< 0.0001*

* P < 0.05 statistically significant

The mean body weight was 87.5±12.3 Kg and the height was 169.9±3.6, mean BMI was 31±4Kg/m² for group I. The majority of cases were obese and overweight categories. BMI in group II was 29.3±5.2Kg/m² with insignificant difference between both groups (p-value= 0.2158). Female gender was 63.1% in group I and 32.2% in group II (p-value < 0.0001) (Table-1) (Figure 2).

Regarding the baseline characteristics of the patients, the most prominent risk factors in both groups were diabetes in 64.6% in group I and 26.5% in group II (p-value <0.0001), peripheral limb ischemia 66.2% in group I versus 13.1% in group II (p-value<0.0001), and high lipid profile 73.5% in group I and 43.2% in group II (p-value <0.0001). There were no significant differences between both groups regarding smoking habit and the presence of chronic kidney disease as risk factors, with minimal numerical differences that were found (Table-1).

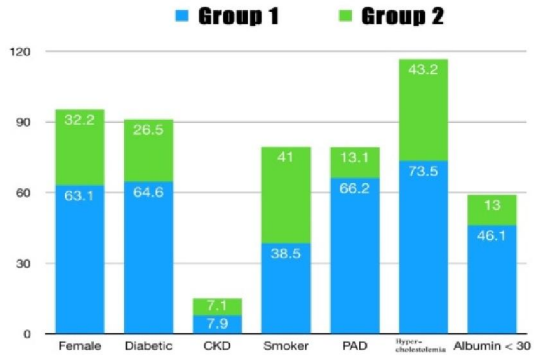

Figure 2: Demographic data for both groups.

Table -2: Analysis of risk factors in both groups.

Risk factors	Group I (76 cases)		Group II (1175 cases)		*p*-value
	%	N	%	N	
IABP	38.2%	29	9.4%	110	< 0.0001*
Inotropes	59.2%	45	14.8%	174	< 0.0001*
Diathermy	22.4%	17	3.5%	41	< 0.0001*
Single layer closure	23.5%	18	21.3%	250	0.6507
Double layer closure	76.5%	58	78.7	925	0.6507
Use of creep bandage	19.9%	15	74.5%	875	< 0.0001*
Use of suction drain	13%	10	48.3%	568	< 0.0001*
Blood transfusion> 4 units PRBCs	50%	38	2.21%	26	< 0.0001*
Reopening	39.3%	30	11.5%	135	< 0.0001*
Coagulopathy or use of anticoagulation	77.7%	59	13.8%	162	< 0.0001*
Bypass time (long) >120 min	66.9%	51	17.8%	209	< 0.0001*
Serum Albumin level (low) <30 m.mol /l	46.1%	35	13%	153	< 0.0001*
Unusual SV course	46.05%	35	28.4%	334	< 0.0001*
-course below knee	15.8%	12	11%	129	0.2002
- course above knee	30.3%	23	17.4%	205	< 0.0001*

* P < 0.05 statistically significant

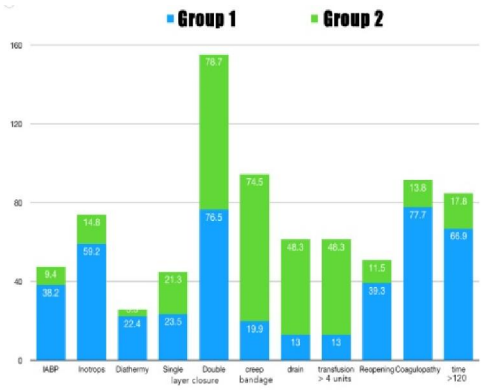

Figure 3: Intra-operative and post-operative risk factors for both groups.

There were significant differences between both groups regarding risk factors predisposed to leg wound infection. Incidence of use of IABP (Intra-aortic balloon pump) was higher in group I (n=29, 38.2%) and (n=110, 9.4%) in group II (p-value <0.0001). The need for blood transfusion either due to coagulopathy or surgical bleeding was significant in group 1, as well as reopening of the leg for homeostasis (p-value <0.0001). The use of diathermy and inotropes post-operative increased the risk of infection significantly in group I (p-value <0.0001). Serum albumin level and long bypass time (p-value <0.0001) were significantly higher in infected cases more than the non-infected group. The use of suction drain and creep bandage after harvesting the SV decreased the incidence of infection in group II (p-value < 0.0001). There was no significant difference in-between both groups regarding method of closure either single layer or double layer technique (p value= 0.6507) (Table-2) (Figure 3).

In this study, we noticed that long bypass time (>120 minutes) was documented in (n=51, 66.9%) in group I and in (n=209, 17.8%) cases in group II (Table-2).

Regarding location of the wounds in group I either above or below the knee, the higher percentages of infected wounds were observed above the knee as (n=64,84.2%) in group I, while below the knee infection was documented in (n=12, 15.8%). There was significant difference between infection in the thigh and leg in group I (p-value <0.0001). The wounds in stage III were documented in (n= 56, 73.7%) (Figure 4,5).

Unusual course of GSV was found in (n=35, 46.05%) in group I and in (n=334, 28.4%) in group II. It was found that unusual anatomy documented in group I cases in (n=12, 15.8%) below the knee and above the knee in (n=23, 30.3%). On the other hand in group II unusual anatomy were in (n=205, 17.4%) above the knee and in (n=129, 11%) below knee. There was significant difference of unusual anatomy above the knee (p-value < 0.0001) and insignificant below the knee (p value= 0.2002) (Table- 2).

Figure 4: Collection of pus under healed skin closed with interrupted technique.

Figure 5: Deep infected wound stage IV in the thigh.

By analysis of data of 365 cases did Doppler ultrasound pre-operative and compared to intraoperative findings, we found that all cases had patent GSV. There was insignificant difference between the diameter at the beginning of SV above the malleolus either by Doppler study or during harvesting (p value= 1). The diameter of SV above and below the knee showed significant difference after Doppler assessment in comparison to intraoperative findings. (P value= 0.0012 and 0.035 respectively) (Table-3) (Figure 6).

There was significant difference between ultrasound assessment of the SV course and intraoperative findings. Doppler assessment showed large tributaries or bifurcating SV in (n=37, 20%) cases, in comparison to intraoperative finding in (n=177, 48.5%) cases (P value= 0.0123). Also there was significant difference regarding the deviation of its course or changing of its diameter or side draining vein misleading to the proper course (p-value

<0.0001). The classic courses were found in (n=303, 83.01%) of cases who did Doppler preoperative, while the classic courses were only in (n=94, 25.75%) intraoperative (Table-3).

Table-3: Anatomical difference between ultrasound and intraoperative findings in 365 cases.

Anatomical variables	U/S findings (n= %)	Intra-operative findings (n= %)	P-value
The beginning	5±1.3mm	5±2mm	1
Diameter below the knee	6 ±2.3mm	7±1.5mm	0.035
Diameter above the knee	9±1.4 mm	10.5±2.2mm	0.0012
Presence of large tributaries	37(20%)	177(48.5%)	0.0123
Classic course	303(83.01 %)	94(25.75%)	< 0.0001*
Abnormal course	63(17.2%)	271(74.2%)	< 0.0001*

* P < 0.05 statistically significant

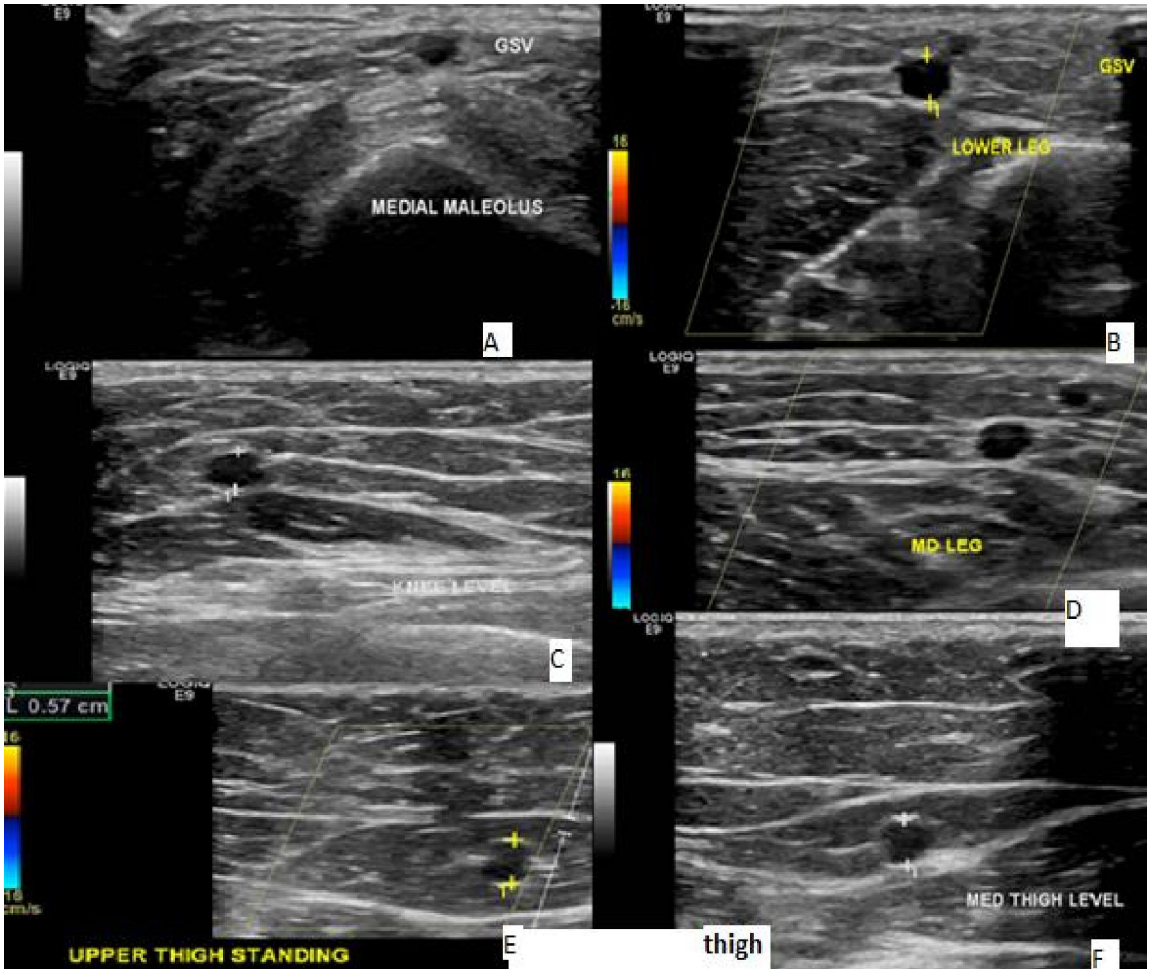

Figure 6: Doppler study for Saphenous vein course at: A) The malleolus, B) lower leg, C) Knee level, D) Mid-leg, E) Upper thigh with bifurcating vein, F) Mid-thigh.

Multivariate analysis for risk factors showed that high lipid profile was significantly associated with leg wound infection (p-value= 0.005), Odds ratio 3.769 (95% CI 1.5-9.45). Peripheral arterial disease also was significant finding (P-value=0.021), Odd s ratio 1.98(95% CI 1.34 -3.45) as well as hypoalbuminemia (p- value=0.043), Odd s ratio 1.32 (95%CI 1.02-2.32). The highest correlation was documented in the presence of unusual course of SV (p-value= 0.004), Odd s ratio 5.44 (95% CI 3.21-6.85). On the other hand the demographic data as age, sex and BMI were not significant risk factors for leg wound infection in multivariate analysis model (Table-4).

Table-4: Multivariate analysis in both groups

Risk factors	p-value	Odd s ratio	95% CI
BMI	0.445	0.966	0.885-1.055
Gender (female)	0.309	1.535	0.673-3.501
High lipid profile	0.005*	3.769	1.502-9.459
Peripheral arterial disease	0.021*	1.986	1.342-3.451
Hypoalbuminemia	0.043*	1.324	1.022-2.324
Age	0.743	1.011	0.342-1.251
Unusual SV course	0.004*	5.443	3.214-6.859

* $P < 0.05$ statistically significant

4. Discussion

Ischemic heart disease is a major illness affects more than 13 million American today and had resulted in more than 573000 coronary artery bypass graft (CABG) operations [DeLaria, et al., 1981].

Our study was concerned with the analysis of risk factors leaded to complicated leg wounds post CABG at the vein harvest site, that lead to long hospital stay, unsatisfactory results post CABG distressing the patients and limiting their activities. Even this may lead to undesired results as amputation and increase total surgical coast. The hospital course was variable according to the grade of wound and related complication.

In our study, the percentage of infected cases was 5.6% and this was acceptable than *Delaria* who reported leg wound complications after myocardial revascularization range from 1% to as high as 44% in 1981 [DeLaria, et al., 1981].

By analysis of both groups, the predisposing factors showed significant differences in-between. Also there was no significant difference in the causative organism in both groups of patients. Still there were few published papers concerned with leg wounds. Up to 20% of CABG procedures in the United States are complicated by surgical site infections, either at the sternal site or conduit harvested site collectively [Roy, 1998]. Most attention has focused on deep chest infections and mediastinitis due to their potential serious morbidity and mortality. Despite the presence of many cases with complicated graft harvest site infection, increase the number of CABG cases with different experience and concepts in many centers, the great saphenous vein harvested by traditional techniques is still widely used and caries a high incidence of wound infection [Mohammad et al., 2011].

There are different techniques for SVG harvesting as classic open, interrupted technique with skin bridging and endoscopic vein harvesting. Till now many surgeons believe in open technique with skilled harvester to preserve the intima of the vein as there is no traction or gas insufflation during EVH. So the incidence of vein thrombosis will be less with better longevity of the graft and satisfactory short and long term operative results. On the other hand there are different studies which encouraging to use other techniques compared to the conventional method. They are aiming to be less invasive to decrease the incidence of complications [Kleber, 2016] and others considered the use of Endoscopic saphenectomy should be the standard of care [Allen, et al., 2000].

In this study, risk factors analysis showed significant correlation between DM and the increased risk of leg harvest site infections especially in female cases. This is correlated with previous findings in other studies and may be due to gender differences in fat distribution or to more impaired peripheral circulation in women than in men [Vuorisalo, et al., 1998]. High BMI may increase the risk of leg infections, this can be explained by different mechanisms in obese cases: poor penetration of prophylactic antibiotics into adipose tissue, and this increase bacterial colonization upon the skin associated with difficulty in skin antisepsis during surgery and post-surgical procedure. Obesity is a risk factor for infection secondary to more dissection during harvesting, hematomas, difficult ambulation, and tissue edema that increase the likelihood of infections that occurred post CABG [Moulton, et al., 1996].

The site of skin incisions and their length increased the risk of infection in our cases as infections were more documented in longer incisions specially if reaching above the knee joint with unusual course of SVG. This is correlated with others, who reported that the location, the length of the leg incision and the duration taken in harvesting SV are associated with leg wound infections or complications [Wong, et al., 1997]. This may be due to more dissection within the adipose tissue which leading to fat necrosis, hematoma formation and long duration with increase the incidence of bacterial colonization.

In this study there were (n=365, 29.2%) of cases from both groups did Doppler preoperative, either due to the presence of varicosity or SV wasn't clear clinically or previous varicose vein surgery was done. Despite that this tool of investigation wasn't routinely

used, it proved significant difference with intraoperative findings.

The course of GSV may show different variations. Five anatomical GSV variations had been reported in the thigh [Ricci & Caggiati,1999]. The unique "Egyptian eye" appearance of the saphenous compartment allows the identification and differentiation of these patterns as follow: a) Single GSV without large parallel tributary. b) Single GSV with a large subcutaneous tributary that penetrates the superficial fascia at variable levels. c) GSV lies within the proximal saphenous compartment while large subcutaneous tributary is found distally without other substantial veins visible in the saphenous compartment. d) The GSV is found with the anterior accessory saphenous vein, distally located in separate saphenous compartments, these two veins join and lie within one saphenous compartment before reaching to femoral vein.e) A rare anatomical variation which consists of duplication of the GSV which is so rare that it only exists in about 1% of the population [Zamboni, et al., 1997] (Figure 7).

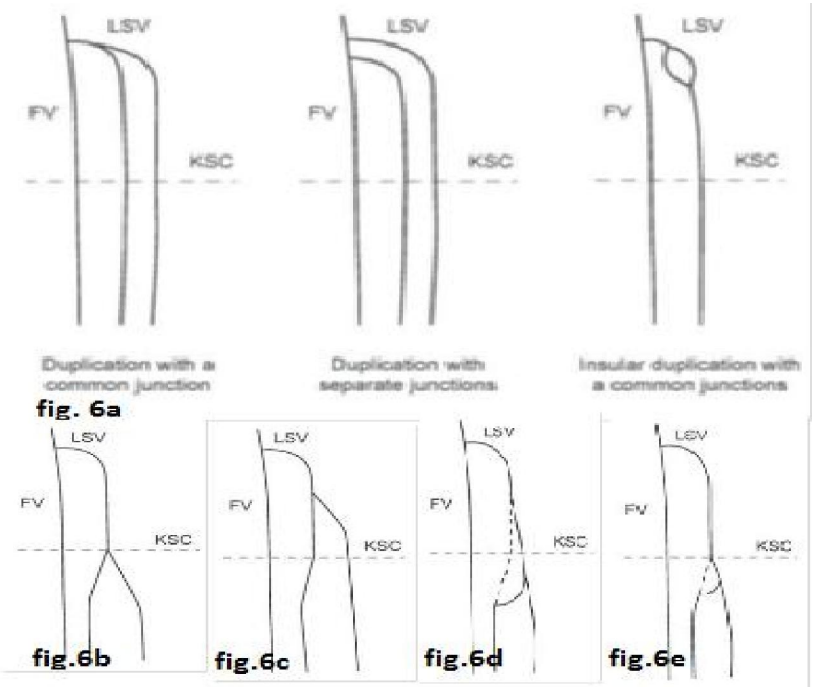

Figure 7: Anatomical variations of the GSV: (a) Duplication of the GSV and its confluences. (b) below the knee. (c) above the knee. (d) The missing portion of the GSV above the knee. (e) The missing portion of the GSV below the knee. *(Ricci & Caggiati,1999)*

According to *Ricci and Caavezzi*, there are five GSV patterns seen at the knee region [Ricci and Caavezzi, 2002] as follow: a) The GSV without any large tributaries at the level of the knee. b) The GSV with one or more tributaries below the knee. c) The GSV with a large tributary above the knee. d) A portion of the GSV is not visible above or below the knee. The GSV then returns by piercing the saphenous fascia at the level of mid-calf to become a subcutaneous tributary. The tributary then courses upwardly and crosses the knee before joining the GSV in its compartment at the distal thigh. e) In this pattern the non-visible portion of the GSV is very short. In the leg region, the GSV duplication is rare (1%), with one or more subcutaneous tributaries parallel to it in the distal calf. Sometimes, the tributaries are large and can be mistaken as the GSV itself or its duplication. [Zamboni, et al., 1997]

Based on the GSV direct tributaries, 5 types of draining pattern were identified. Type 1, GSV with 3 direct collaterals is 47.8%. [Janowski & Topol 2004]

In our study, the technique of closure and the use of suction drain decreased the occurrence of infection, while other studies reported that wound closure with subcuticular single layer closure over suction drain improve wound outcome with less pain compared to double layer suture technique [Mohammad et al., 2011].

Other study reported that, closure with subcuticular technique improves post-operative outcomes than closure with skin clips. This may be due to multiple skin punctures which affect the integrity of the skin especially in ischemic cases that

are mostly diabetic with affected limb vascularity [Chughtai, et al.,2000]. Also the use of creep bandage minimized the incidence of infection significantly, especially if applied before starting extra corporeal circulation in on pump cases. It decreases the liability of accumulation of hematomas subcutaneously especially if there was abnormal coagulation profile [Chughtai, et al., 2000].

Peripheral limb ischemia was found as a predisposing factor for leg infection post CABG as reported by other authors. Selected leg for harvesting with ABI≤ 0.5 is not recommended to be the site of conduit [Paletta, et al., 2000].

The use of IABP and high inotropic support increase significantly the incidence of leg wound infection in CABG cases. This impair the blood supply of the limb leading to prolongation of period of healing directly through vasoconstriction, impaired blood flow to the affected limb or indirectly by impairing blood to the tissue for healing. The incidence of infection was reported in other studies to be 20-30% after IABP use [Mackenzie, et al., 1992]. Because of this reason, it is better to harvest the saphenous vein from the contralateral limb if possible.

Hospital course and length of stay were significantly better for group II compared to group I. Meticulous care during vein harvesting with proper care during wound closure will decrease the likelihood of infection. More training upon other techniques in vein harvesting also will improve the results of leg wounds and will reduce the possibilities of infection especially in high risk patients. Some studies showed that, there are lower rate of leg harvest site infections or wound complications in patients whose saphenous vein (s) are harvested endoscopically rather than conventional methods [Carpino, et al., 2000].

Themodality of EVH was done in our centers since short period and need more practice and training. Other studies regarding EVH reported that, this technique may reduce saphenous vein harvest wound problems, but when a complication occurs, it may be more difficult to be identified and treated [Allen, et al., 2000].

Analysis of patients' risk factors will modify the hospital course and surgical outcome with low possibilities for amputation, major morbidities, mortality, as well as the total coast.

Limitations:

Cases that underwent endoscopic vein harvesting not included as most of the cases operated on through traditional technique.

Conclusion

Evaluation of risk factors predisposing to leg infection encourage the use of less invasive approaches with meticulous surgical technique during harvesting and closure. The knowledge and identification of anatomical variations of GSV play an important role in increasing the success outcome post-surgical intervention. It is recommended to do routine Doppler for CABG cases for SVG mapping.

Abbreviations

CABG: Coronary Artery Bypass Grafting surgery.
IHD: Ischemic Heart Disease.
EVH: Endoscopic Vein Harvesting.
SVG: Saphenous Vein Graft.
GSV: Great Saphenous Vein.
IABP: Intra-Aortic Balloon Pump.
BMI: Body Mass Index.
DM: Diabetes Mellitus
ABI: Ankle brachial index.

Declarations

Acknowledgment

For Dr. Mahmoud Katnanifor his support. Surgical team and wound care team for their efforts in following complicated cases.

Availability of data and materials

The data sets during the current study are available from the corresponding author on reasonable request**.**

Conflict of interest

The authors declare that they have no competing interests.

Consent for publication

Written informed consents were obtained from the patients for publication of this study.

The consents are available for review by the Editor-in-Chief of this journal.

Ethics approval and consent to participate

Prior the study, consent from all patients and approval from the Ethical Committee of the Tertiary Centers were obtained.

References

1. Allen KB, Heimansohn DA, Robison RJ, Schier JJ., Griffith GL, Fitzqerald EB, Isch JH, Shaar CJ.: Risk factors for leg wound complications following endoscopic versus traditional saphenous vein harvesting. Heart surg. Forum;2000, 3(4):325-30.
2. Bailly M, Cartographie CHIVA. Enclyclopedie Medico-Chirurgicale. Paris; 1993: 43–161-B:1–4.
3. Carpino PA, Khabbaz KR, Bojar RM, Rastegar H, Warner KG, Murphy RE: Clinical benefits of endoscopic vein harvesting in patients with risk factors for saphenectomy wound infections undergoing coronary artery bypass grafting. J Thorac Cardiovasc Surg, 119 (2000), pp. 69–75.

4. Chughtai T, Chen LQ, Salasidis G, Nguyen D, Tchervenkov C, Morin JF.: Clips versus suture technique: is there a difference? Cardiol J.2000, 1403,7-16.
5. DeLaria GA, Hunter JA, Goldin MD, Serry C, Javid H, Najaf H.: Leg wound complications associated with coronary re-vascularization. J Thorac Cardiovasc Surg 1981;81:403–7
6. Gelape, C. L.: Surgical wound infection following heart surgery. Arq. Bras. Cardiol. J.2007; 89: p3–9.
7. Janowski K, Topol M. Types of outlet of the major saphenous vein tributaries in patients with chronic vein insufficiency of the lower limbs. Folia Morphol 2004; 63: 473-479.
8. Kleber G, Augusto D and Paulo C: A randomised controlled trial of mini incision or conventional incision for saphenous vein harvesting in patients undergoing myocardial revascularization. Annals of medicine and surgery; 2016, vol.7, p 1-6.
9. Mackenzie DJ, Wagner WH, Kulber DA.: Vascular complications of the intra-aortic balloon pump. Am J Surg 1992; 164:517-21.
10. Mohammad Salman Siddiqi, Hilal Al Sabti, Mirdavron Mukaddirov, and Ashok Kumar Sharma: Prospective comparative study of single-layer versus double-layer closure of leg wounds after saphenous vein harvest in coronary artery bypass graft operations. J Thorac Dis 2011; 3:171-176.
11. Moulton MJ, Creswell LL, Mackey ME, Cox JL, Rosenbloom M: Obesity is not a risk factor for significant adverse outcomes after cardiac surgery. Circulation, 94 (Suppl II) (1996), pp. 87–92.-Wong SW, Fernando D, Grant P: Leg wound infections associated with coronary revascularization. Aust N Z J Surg, 67 (1997), pp. 689–691.
12. Paletta CE, Huang DB, Fiore AC.: Major leg wound complications after saphenous vein harvest for coronary revascularization. Ann Thorac Surg 2000; 70(2):492-7.
13. Ricci S, Caggiati A. Echoanatomical patterns of the long saphenous vein in patients with primary varices and in healthy subjects. *Phlebology* 1999; 14: 54–8.
14. Ricci S, Cavezzi A. Echo-anatomy of long saphenous vein in the knee region: proposal for a classification in five anatomical patterns. *Phlebology* 2002; 16: 111–16.
15. Roy MC: Surgical-site infections after coronary artery bypass graft surgery: discriminating site-specific risk factors to improve prevention efforts. Infect Control Hosp Epidemiol, 19 (1998), pp. 229–233.
16. Vuorisalo S, Haukipuro K, Pokela R, Syrjala H: Risk features for surgical-site infections in coronary artery bypass surgery. Infect Control Hosp Epidemiol, 19 (1998), pp. 240–247.
17. Wong SW, Fernando D, Grant P: Leg wound infections associated with coronary revascularization. Aust N Z J Surg, 67 (1997), pp. 689–691.
18. Zamboni P, Cappelli M, Marcellino MG, Murgia AP, Pisano L, Fabi P. Does a varicose saphenous vein exist? *Phlebology* 1997; 12: 74–7.

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