

A Comparative Analysis on Surgical Outcomes and Complications of Endoscopic and Open Vein Harvesting Techniques

Mohammed Fawzy Eltaweel¹, Ismail N. El-Sokkary², Ahmed Alherazi³, Mohamed Wael Badawi², Mohammed G. Abdellatif¹, Bahaa A. Elkhonezy², Ibrahim K. Gamil², Haytham Mohamed Abd El Moaty², Sarra Sadmi⁴, Mahmoud Khalil⁵

¹Department of Cardiothoracic Surgery, Faculty of Medicine, Menoufia University, Shibin El Kom, Egypt

²Department of Cardiovascular & Thoracic Surgery, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

³Department of Cardiothoracic Surgery, Faculty of Medicine, Alexandria University, Alexandria, Egypt

⁴Faculty of Medicine, University of Algiers, Algiers, Algeria

⁵Department of Cardiac Surgery, Sabah Al-Ahmed Cardiac Center, Al-Amiri Hospital, Kuwait City, Kuwait

Email: mfawzy_cts@yahoo.com

How to cite this paper: Eltaweel, M.F., El-Sokkary, I.N., Alherazi, A., Badawi, M.W., Abdellatif, M.G., Elkhonezy, B.A., Gamil, I.K., El Moaty, H.M.A., Sadmi, S. and Khalil, M. (2024) A Comparative Analysis on Surgical Outcomes and Complications of Endoscopic and Open Vein Harvesting Techniques. *Open Journal of Thoracic Surgery*, **14**, 29-39.

<https://doi.org/10.4236/ojts.2024.142003>

Received: May 13, 2024

Accepted: June 22, 2024

Published: June 25, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Objective: The great saphenous vein (GSV) is commonly used as a conduit for grafting during CABG surgery, and open GSV harvesting (OVH), commonly used with long incision to expose the vein. However, endoscopic vein harvesting (EVH) is an alternative approach, utilizing specialized instruments and small incisions to harvest the vein. **Methods:** A retrospective analysis was conducted on a cohort of patients who underwent Coronary artery bypass graft (CABG) requiring great saphenous vein (GSV) harvesting which was done by EVH or OVH procedures. Demographic variables, including age and gender, were assessed for both groups. Intraoperative variables such as the number of grafts, cardiopulmonary bypass time, X clamp time, and type of procedure were analyzed. Postoperative variables, including infection and bleeding rates, were also evaluated. **Results:** The study included 30 patients each undergoing Coronary artery bypass graft (CABG) with need of great saphenous vein harvesting which was done by EVH and OVH. Demographic variables were well-matched between the two groups in terms of age, while a significant difference in gender distribution was observed. Obesity and smoking were more prevalent in the OVH group, and EVH was associated with a higher mean number of grafts compared to OVH. Conversion to an open technique occurred in a portion of the EVH cases, and infection rates did not significantly differ between the EVH and OVH groups. However, the incidence of postoperative bleeding was significantly higher in the EVH group.

Conclusion: This study provides valuable insights into the demographic, intraoperative, and postoperative variables associated with EVH and OVH techniques. EVH demonstrated advantages in terms of reduced infection rates compared to OVH. However, the higher incidence of postoperative bleeding associated with EVH raises concerns about potential risks.

Keywords

Endoscopic Vein Harvesting (EVH), Open Vein Harvesting (OVH), Coronary Artery Bypass Grafting (CABG), Great Saphenous Vein (GSV), Surgical Outcomes

1. Introduction

Coronary artery bypass grafting (CABG) is a widely performed surgical procedure to improve blood flow to the heart in patients with coronary artery disease [1]. The great saphenous vein (GSV) is commonly used as a conduit for grafting during CABG surgery. Traditionally, open GSV harvesting (OVH) has been the gold standard technique, involving a long incision to expose and remove the vein. However, advancements in surgical techniques have introduced endoscopic vein harvesting (EVH) as an alternative approach, utilizing specialized instruments and small incisions to visualize and harvest the vein [2] [3].

EVH has gained popularity in recent years due to several potential benefits, including reduced postoperative pain, shorter hospital stays, faster recovery, and improved cosmetic outcomes [1] [2] [3]. These advantages have led to increased interest in comparing EVH with the conventional OVH technique. By evaluating the comparative effectiveness and safety of these two approaches, healthcare professionals can make informed decisions about the optimal method for GSV harvesting in CABG procedures.

The aim of this study is to present an analysis and comparison of EVH and OVH techniques in terms of procedural outcomes, including patient-related factors, intraoperative variables, and postoperative complications. Previous studies have explored the differences between EVH and OVH related postoperative pain, wound infections, graft patency, and long-term outcomes [4] [5] [6]. However, the results have been mixed, and further research is needed to clarify the relative merits and limitations of each technique [6] [7] [8]. Understanding the advantages, limitations, and potential risks associated with EVH and OVH will help guide surgeons in selecting the most appropriate method for GSV harvesting, ultimately leading to improved patient outcomes [9].

Considering the ongoing debate and the limited consensus regarding the superiority of EVH or OVH, it is crucial to conduct a comprehensive comparative analysis to provide evidence-based recommendations. This study aims to examine a range of clinical variables and outcomes associated with EVH and OVH. By elucidating the benefits, drawbacks, and overall efficacy of each technique,

this research can facilitate the development of guidelines and protocols that optimize patient care and surgical outcomes in CABG procedures.

2. Patients and Methods

This study aims to conduct a comparative analysis of patients who have undergone CABG and require GSV Harvesting. The data for this analysis was collected from Sabah Al-Ahmed Cardiac Center in Al-Amiri Hospital in Kuwait. The study involved two distinct groups: one consisted of 30 patients who underwent EVH, while the other group comprised 30 patients who underwent the OVH technique. The patients' demographics and comorbid conditions were noted, which are associated with postoperative complications and morbidity.

A subcutaneous dissector with a C ring (Maquet) was employed for vein dissection. This dissector featured an internal 7 mm wide lens and camera, which were conveniently introduced through a 35-cm trocar, facilitating visualization during the procedure. Vein harvesting was performed using a specially designed Hemopro 2 device. This device, equipped with a mechanism for cauterization of branches, was controlled by a bottom mechanism. The entire process was conducted within a closed gas system, utilizing CO₂ insufflation. A comparable approach, utilizing an open gas system (Terumo) for enhanced safety and efficiency was employed. However, the cauterization of branches during vein harvesting was executed using a bipolar cautery, which was skillfully controlled by a control pedal. This ensured precise control and accuracy throughout the procedure. The LigaSure system (Storz's) offered an alternative method for efficient and effective cauterization during the study.

3. The EVH Procedure

Prior to surgery, patients were positioned supine with their leg externally rotated, knee flexed, and supported on the operating table. Appropriate general anesthesia was administered to ensure the patient's comfort and safety. To maintain aseptic conditions, thorough cleansing and sterilization were performed on the entire body, including the neck, chest, abdomen, and lower limbs. This meticulous approach aimed to minimize the risk of infection and maintain a sterile surgical environment. At the site of the saphenous vein, a small longitudinal incision was made using anatomical landmarks as guidance. In some cases, an ultrasonic doppler device was employed to aid in locating the vein with precision. The endoscopic equipment, including a high-definition endoscope equipped with a light source and a camera at its tip was used. This setup provided optimal visualization of the surgical site. Additionally, dissectors and vein C rings were utilized to facilitate accurate dissection and isolation of the GSV. To control bleeding and ensure optimal hemostasis, a Haemopro 2 device was employed for the cauterization of branches. With utmost care, the endoscope was inserted through the incision, allowing real-time visualization of the GSV and the surrounding tissues. The images captured by the camera were displayed on a SONY

monitor, enabling the surgical team to closely monitor the progress of the procedure and ensure precise dissection and harvesting of the GSV.

The endoscope, equipped with an attachable dissection tip was used to dissect the subcutaneous and connective tissue surrounding the saphenous vein, as well as to isolate and dissect the branches. The dissection tip, designed to minimize trauma, facilitated blunt dissection, ensuring the preservation of delicate structures. CO₂ insufflation was employed to aid in the dissection process. By constantly visualizing the surgical site, CO₂ insufflation reduced bleeding and maintained a clear working space, enhancing the precision of the procedure. The Vaso-view Hemopro Endoscopic Vessel Harvesting System was utilized to seal and transect vessel branches in a single step, ensuring efficient hemostasis. The C-Ring played a vital role in protecting the main vessel and exposing the branches for optimal access. The Hemopro Harvesting Tool, inserted through the Tool Adapter Port on the Vaso-view Hemopro Harvesting Cannula, allowed control over the jaws of the tool and activation of the power supply through the Activation Toggle. Opening the jaws required pushing the Activation Toggle forward. To separate the GSV from adjacent structures, advanced techniques were employed, ensuring meticulous preservation and visualization of the vein. Throughout the procedure, bipolar electrocautery and precise ligation of any bleeding vessels were employed to maintain meticulous hemostasis. Once the vein harvesting was completed, the incision was closed using standard surgical techniques such as absorbable sutures or surgical staples. Additionally, a Redivac drain was inserted to facilitate post-operative drainage. Patients were closely monitored during the post-operative period to evaluate their recovery progress and promptly identify any potential complications that might arise.

4. The OVH Procedure

For OGSV harvesting, the patients were positioned supine on the operating table and administered the appropriate general anesthesia, as determined by the surgical team. The surgical site was meticulously prepared through thorough cleansing and sterilization to maintain strict aseptic conditions (as described earlier). A longitudinal incision is carefully made along the course of the GSV, typically in the thigh, to gain access to the vein. Subsequently, meticulous dissection technique was employed to expose the GSV and separate it from the surrounding tissues. Specialized surgical instruments, including a scalpel, scissors, and retractors, were utilized to aid in the dissection process, ensuring careful preservation of the GSV. Hemostasis is maintained throughout the procedure using electrocautery, ligatures, or sutures as necessary to control any bleeding vessels. Once the GSV was exposed, it was meticulously dissected and mobilized for subsequent use. After completion of the harvesting, the wound was closed using absorbable sutures or surgical staples, followed by appropriate wound care. Post-operatively, patients were closely monitored for signs of infection, hematoma, or other complications, and follow-up care was provided to support their

recovery.

5. Statistical Analysis

The data were subjected to rigorous statistical analysis to compare the outcomes between the two groups (EVH and OVH). The independent samples t-tests were employed to compare the mean average age between the EVH and OVH groups. Chi-square tests were utilized to examine the proportions of male participants, obesity, smoking, Diabetes Mellitus (DM), dyslipidemia, peripheral vascular disease, and the urgency of the surgical procedure. Furthermore, Fisher's exact and Chi-square test was applied to determine the proportions of post-operative variables including bleeding, wound and infection between the two groups.

6. Results

In this study outcomes of GSVH techniques (EVH and OVH) were compared in terms of demographic and intra- and postoperative variables. A total of 30 patients were included in each group, and the statistical analysis was performed using independent samples t-tests, chi square and Fisher's exact test to assess the differences between the two groups.

EVH (group1) and OVH (group2) comprised of 30 participants each were included in this study. The mean average age of group 1 was noted to be 58.96 ± 7.62 , and group 2 was 56.16 ± 7.30 . Group1 found with a higher percentage of male participants (96.67%) compared to the group 2 (23.33%). The prevalence of obesity was noted to be 30% in group 1, whereas it was slightly higher in group 2 at 36.66%. Additionally, a higher percentage of smokers was observed in group 1 (43.33%) in comparison to group 2 (60%). The prevalence of Diabetes Mellitus (DM) was also higher in group 1 (46.66%) as compared to group 2 (60%). Dyslipidemia was observed to be higher in both groups (83.33% and 100% in group 1 and 2, respectively). None of the patients in group 1 were found with peripheral vascular disease (PVD), while 20% of patients in group 2 presented with this condition. The urgency of the surgical procedure was not observed in any patient in group 1, whereas it was reported in 56.66% of cases in group 2. The average HbA1c level was 7.10 ± 1.53 , and 6.29 ± 1.78 in group 1 and 2, respectively (**Table 1**).

Regarding the intraoperative variables, the ejection fraction showed no statistically significant difference between group 1 (48.63 ± 10.56), and group 2 (52 ± 6.10), ($p = 0.136$). However, significant differences were observed in other variables. The group 1 had a higher mean number of grafts (3.03 ± 0.66) compared to the group 2 (2.66 ± 0.66), ($p = 0.036$). Cardiopulmonary bypass time was significantly longer in the group 1 (161.06 ± 63.68 min) compared to the group 2 (112.93 ± 17.08 minutes), ($p < 0.001$). Similarly, X clamp time was also significantly higher in the group 1 (92.23 ± 37.94 minutes) than the group 2 (71.73 ± 7.54 minutes), ($p = 0.001$). A higher proportion of patients in the group 2 underwent a one or two-leg procedure (10 ± 0.305) compared to the group 1 ($1 \pm$

0.00), ($p < 0.001$). However, harvest time for the group 1 (36.79 ± 6.06 minutes) was significantly longer than that for the group 2 (29.66 ± 8.99 minutes), ($p < 0.001$). Moreover, the total operation time was significantly greater in the group 1 (296.5 ± 57.97 minutes) compared to the group 2 (189.66 ± 20.54 minutes), ($p < 0.001$). Conversion to an open technique occurred in 13.33% of the cases in group 1 (**Table 2**).

In the present study, we investigated the occurrence of post-operative complications, including post-operative infection, bleeding, pain, and mortality in EVH and OVH groups of patients. Regarding the variable “Infection,” we compared the proportions between the two groups using a chi-square test. The analysis revealed 8 cases of infection (26.66%) and 22 cases without infection (73.33%) in group 1, while Group 2 had 10 cases of infection (33.33%) and 20 cases without infection (66.66%). The chi-square test did not show a statistically significant difference in the proportions of infection between Group 1 and Group 2 ($p = 0.667$).

For “post-op bleeding,” the proportions between the groups were assessed using Fisher’s exact test, as the frequency of post-operative bleeding was low. Notably, no cases of post-operative bleeding were observed in group 2, while group 1 had 3 cases (10%). The Fisher’s exact test indicated a significant difference in the proportions of post-operative bleeding between group 1 and group 2 ($p = 0.047$) (**Table 3**).

It is worth mentioning that no cases of mortality or post-operative pain were reported in either group during this study.

Table 1. Demographic variable of both groups.

Groups	Age	Sex %	Obesity %	Smoking %	DM %	Dyslipidemia %	Peripheral vascular disease %	Urgency %	HbA1c
EVH (n = 30)	58.96 ± 7.62	3.33	30	43.33	46.66	83.33	0	0	7.10 ± 1.53
OVH (n = 30)	56.16 ± 7.30	23.33	36.66	60	60	100	20	56.66	6.29 ± 1.78

Table 2. Analysis of intra-operative variables among EVH and OVH techniques.

Intra-operative variables	EVH (Mean \pm SD)	OVH (Mean \pm SD)	P value
Ejection fraction	48.63 ± 10.56	52 ± 6.10	0.136
No. of graft	3.03 ± 0.66	2.66 ± 0.66	0.036
Cardiopulmonary bypass	161.06 ± 63.68	112.93 ± 17.08	<0.001
X clamp	92.23 ± 37.94	71.73 ± 7.54	0.001
One or two leg	1 ± 0.00	10 ± 0.305	<0.001
Harvest time (min)	36.79 ± 6.06	29.66 ± 8.99	<0.001
Total op. time (min)	296.5 ± 57.97	189.66 ± 20.54	<0.001
Conversion to open technique	13.33%	-	-

Table 3. Analysis of post-operative variables among EVH and OVH techniques.

Post-operative variables	EGSVH%	OGSVH%	P value
Post op. bleeding	10	0	0.047
Post op. pain	-	-	-
Post op. infection	20	26.66	0.66
Mortality	-	-	-

7. Discussion

The present study aimed to compare the outcomes of two surgical techniques, EVH and OVH, in terms of demographic, intraoperative, and postoperative variables. Understanding the significance and role of these variables is crucial for evaluating the effectiveness and safety of these surgical procedures.

Demographic variables play a fundamental role in determining patient characteristics and can influence surgical outcomes. In this study, both groups were well-matched in terms of age, with group 1 having a mean age of 58.96 ± 7.62 years, and group 2 with a mean age of 56.16 ± 7.30 years. Age can impact surgical outcomes; as older patients may have a higher risk of complications [10]. Additionally, gender distribution differed significantly between the groups, with a higher percentage of male participants in group 1 (96.67%) compared to group 2 (76.67%). Gender differences can influence surgical outcomes due to variations in anatomical and physiological factors (need to be revised) [11].

Obesity can increase the complexity of surgery and predispose patients to postoperative complications including risk of wound infection, prolonged operative time, poorer outcomes, and other adverse effects [12]. In this study, we found the prevalence of obesity slightly higher in group 2 (36.66%) compared to group 1 (30%). Likewise, smoking was more prevalent in group 2 (60%), which is associated with impaired wound healing and increased risk of infections (need to be revised) [13]. These findings highlight the importance of considering the risk factors during preoperative evaluation and management.

Additionally, the presence of comorbidities, such as diabetes mellitus (DM) and dyslipidemia can significantly affect surgical outcomes. Group 2 had a higher prevalence of DM (60%) compared to group 1 (46.66%). While dyslipidemia, observed in both groups (83.33% and 100% in group 1 and 2, respectively) which can contribute to the development of atherosclerosis and impact graft patency [14]. DM is associated with impaired wound healing, increased risk of infections, and cardiovascular complications [15]. Studies reported a higher incidence of endoscopic vein harvesting in DM patients. Therefore, it is crucial to optimize the management of comorbidities before and after surgery to improve outcomes [16].

Peripheral vascular disease (PVD) is a condition that can affect graft selection and wound healing [17]. None of the patients in group 1 had PVD, while 20% of patients in group 2 presented with this condition. PVD can influence the choice of surgical techniques and affect long-term outcomes. The urgency

of the surgical procedure was reported in 56.66% of cases in group 2, which indicated that large number of patients required immediate intervention due to the severity of their condition. These factors highlight the need for individualized treatment approaches and careful consideration of patient characteristics.

Intraoperative variables provide insights into the technical aspects of surgical procedures and their impact on outcomes. The ejection fraction, a measure of cardiac function, did not show a statistically significant difference between the two groups. However, other variables exhibited notable differences. Group 1 had a higher mean number of grafts (3.03 ± 0.66) compared to group 2 (2.66 ± 0.66). Our finding is in agreement with Gaudino *et al.* (2016), who reported a higher mean number of grafts in the endoscopic group compared to the open group [18]. While another study reported less frequency of grafts associated with EVH technique [19]. Though the number of grafts can influence the complexity and duration of the procedure. This may be attributed to the better visualization and accessibility provided by endoscopic techniques.

Cardiopulmonary bypass time and X clamp time were significantly longer in group 1, indicating that the endoscopic technique may require more extensive operative manipulation. Our findings are in align with previous studies indicating that EVH require additional time for the setup of endoscopic instruments and the learning curve associated with the technique [9]. Additionally, the type of procedure differed significantly between the groups, with a higher proportion of patients in group 2 undergoing a one or two-leg procedure. The choice of procedure may depend on the individual patient's condition and surgeon's preference. Harvest time and total operation time were significantly longer in group 1, reflecting the additional time required for endoscopic vein harvesting [9]. The conversion to an open technique occurred in 13.33% of cases in group 1, suggesting that the endoscopic approach may have technical limitations or unforeseen complexities.

Postoperative outcomes are critical for evaluating the success of surgical interventions. Infection is a common postoperative complication that can lead to morbidity and graft failure. Previous studies indicated several potential benefits while comparing EVH with OVH, including reduced wound-related complications, improved patient satisfaction, shorter hospital stays, and decreased postoperative pain at the harvest site [20] [21]. However, despite these advantages, there are concerns about the risk of injury during the harvesting process, which could potentially affect vein graft patency and clinical outcomes. These concerns have hindered the universal adoption of EVH.

In this study, the proportions of infection did not differ significantly between group 1 (20%) and group 2 (26.66%) which indicate that both techniques have similar infection rates. Though the number of infections is not significant, but still notable in group 2. These findings aligns with the previous research by Lai *et al.* (2006) who reported less frequency of infection with EVH technique as compared to OVH [21]. The similarity in infection rates between group 1 and group

2 suggests that both techniques have comparable effectiveness in preventing post-operative infections. The study's findings contribute to the existing body of research on the comparison of EVH and OVH techniques, providing support for the notion that EVH may offer advantages in terms of reducing the risk of post-operative infections.

Additionally, postoperative bleeding is another crucial variable that was examined in this study. Surprisingly, the incidence of postoperative bleeding was significantly higher in group 1 (10%), compared to group 2, where no cases of bleeding were reported. This finding contradicts previous researches which reported decreased less wound complications associated with EVH at the site of vein harvest [22] [23]. The unexpected result of higher bleeding rates in the EVH group raises questions about the potential risks associated with this minimally invasive technique. It is possible that the use of endoscopic instruments during EVH may increase the likelihood of bleeding complications. The precise mechanisms underlying this higher risk of bleeding in EVH require further investigation. Notably, no cases of mortality or significant postoperative pain were reported in either group during the study.

Overall, this study provides valuable insights into the demographic, intra-operative, and postoperative variables associated with EVH and OVH techniques. It highlights the importance of patient characteristics, such as age, gender, obesity, smoking, and comorbidities, in surgical outcomes. Furthermore, the study demonstrates differences in operative techniques and their impact on graft numbers, procedural times, and postoperative complications. These findings emphasize the need for individualized patient care, meticulous technique selection, and optimization of patient factors to achieve optimal surgical outcomes. Further research with larger sample sizes is warranted to validate these results and explore additional variables that may influence the outcomes of these surgical techniques.

8. Conclusion

In conclusion, the findings of this study suggest that EVH may offer advantages over OVH in terms of reduced postoperative complications. However, the higher incidence of postoperative bleeding with EVH raises concerns about potential risks. Further research is needed to fully assess the benefits and limitations of each technique and determine the better approach in terms of surgical outcomes. Individualized patient care, consideration of patient characteristics, and meticulous technique selection remain crucial factors in optimizing surgical outcomes.

Limitations of the Study

The results contribute to our understanding of the complications associated with the EVH and OVH techniques. Further investigations with larger sample sizes are warranted to validate and explore these findings in more detail.

Acknowledgements

Thanks for Dr. Mohammed Al-Jarallah head of cardiology department, Sabah Al-Ahmed Cardiac Center in Kuwait for his continuous support and unlimited help. And thanks to all cardiac surgery, Anesthesia, and cardiology team.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Collins, P., Webb, C.M., Chong, C.F. and Moat, N.E. (2008) Radial Artery versus Saphenous Vein Patency Randomized Trial: Five-Year Angiographic Follow-Up. *Circulation*, **117**, 2859-2864. <https://doi.org/10.1161/circulationaha.107.736215>
- [2] Lopes, R.D., Hafley, G.E., Allen, K.B., Ferguson, T.B., Peterson, E.D., Harrington, R.A., *et al.* (2009) Endoscopic versus Open Vein-Graft Harvesting in Coronary-Artery Bypass Surgery. *New England Journal of Medicine*, **361**, 235-244. <https://doi.org/10.1056/nejmoa0900708>
- [3] Allen, K.B., Griffith, G.L., Heimansohn, D.A., Robison, R.J., Matheny, R.G., Schier, J.J., *et al.* (1998) Endoscopic versus Traditional Saphenous Vein Harvesting: A Prospective, Randomized Trial. *The Annals of Thoracic Surgery*, **66**, 26-31. [https://doi.org/10.1016/s0003-4975\(98\)00392-0](https://doi.org/10.1016/s0003-4975(98)00392-0)
- [4] Deppe, A., Liakopoulos, O.J., Choi, Y., Slottosch, I., Kuhn, E.W., Scherner, M., *et al.* (2013) Endoscopic Vein Harvesting for Coronary Artery Bypass Grafting: A Systematic Review with Meta-Analysis of 27,789 Patients. *Journal of Surgical Research*, **180**, 114-124. <https://doi.org/10.1016/j.jss.2012.11.013>
- [5] Sá, M.P.B.O., *et al.* (2019) Coronary Artery Bypass Graft Surgery Improves Survival without Increasing the Risk of Stroke in Patients with Ischemic Heart Failure in Comparison to Percutaneous Coronary Intervention: A Meta-Analysis with 54,173 Patients. *Brazilian Journal of Cardiovascular Surgery*, **34**, 396-405.
- [6] Ouzounian, M., Hassan, A., Buth, K.J., MacPherson, C., Ali, I.M., Hirsch, G.M., *et al.* (2010) Impact of Endoscopic versus Open Saphenous Vein Harvest Techniques on Outcomes after Coronary Artery Bypass Grafting. *The Annals of Thoracic Surgery*, **89**, 403-408. <https://doi.org/10.1016/j.athoracsur.2009.09.061>
- [7] Andreasen, J.J., Nekrasas, V. and Dethlefsen, C. (2008) Endoscopic vs Open Saphenous Vein Harvest for Coronary Artery Bypass Grafting: A Prospective Randomized Trial. *European Journal of Cardio-Thoracic Surgery*, **34**, 384-389. <https://doi.org/10.1016/j.ejcts.2008.04.028>
- [8] Brat, R., Horacek, J. and Sieja, J. (2013) Endoscopic vs Open Saphenous Vein Harvest for Coronary Artery Bypass Grafting: A Leg-Related Morbidity and Histological Comparison. *Biomedical Papers*, **157**, 70-74. <https://doi.org/10.5507/bp.2012.011>
- [9] Krishnamoorthy, B., Critchley, W.R., Venkateswaran, R.V., Barnard, J., Caress, A., Fildes, J.E., *et al.* (2016) A Comprehensive Review on Learning Curve Associated Problems in Endoscopic Vein Harvesting and the Requirement for a Standardised Training Programme. *Journal of Cardiothoracic Surgery*, **11**, Article No. 45. <https://doi.org/10.1186/s13019-016-0442-y>
- [10] Deiner, S. and Silverstein, J.H. (2012) Long-Term Outcomes in Elderly Surgical Patients. *Mount Sinai Journal of Medicine: A Journal of Translational and Personal*

- lized Medicine*, **79**, 95-106. <https://doi.org/10.1002/msj.21288>
- [11] Kodia, K., *et al.* (2018) Graft Patency after Open versus Endoscopic Saphenous Vein Harvest in Coronary Artery Bypass Grafting Surgery: A Systematic Review and Meta-Analysis. *Annals of Cardiothoracic Surgery*, **7**, 586-597.
- [12] Al-Mulhim, A.S., *et al.* (2014) Obesity Disease and Surgery. *International Journal of Chronic Diseases*, **2014**, Article ID: 652341.
- [13] Fan Chiang, Y., Lee, Y., Lam, F., Liao, C., Chang, C. and Lin, C. (2022) Smoking Increases the Risk of Postoperative Wound Complications: A Propensity Score-Matched Cohort Study. *International Wound Journal*, **20**, 391-402. <https://doi.org/10.1111/iwj.13887>
- [14] Kulik, A., Voisine, P., Mathieu, P., Masters, R.G., Mesana, T.G., Le May, M.R., *et al.* (2011) Statin Therapy and Saphenous Vein Graft Disease after Coronary Bypass Surgery: Analysis from the CASCADE Randomized Trial. *The Annals of Thoracic Surgery*, **92**, 1284-1291. <https://doi.org/10.1016/j.athoracsur.2011.04.107>
- [15] Spampinato, S.F., *et al.* (2020) The Treatment of Impaired Wound Healing in Diabetes: Looking among Old Drugs. *Pharmaceuticals*, **13**, Article No. 60.
- [16] Carpino, P.A., Khabbaz, K.R., Bojar, R.M., Rastegar, H., Warner, K.G., Murphy, R.E., *et al.* (2000) Clinical Benefits of Endoscopic Vein Harvesting in Patients with Risk Factors for Saphenectomy Wound Infections Undergoing Coronary Artery Bypass Grafting. *The Journal of Thoracic and Cardiovascular Surgery*, **119**, 69-76. [https://doi.org/10.1016/s0022-5223\(00\)70219-4](https://doi.org/10.1016/s0022-5223(00)70219-4)
- [17] Provenzano, D.A., Jarzabek, G. and Georgevich, P. (2008) The Utilization of Transcutaneous Oxygen Pressures to Guide Decision-Making for Spinal Cord Stimulation Implantation for Inoperable Peripheral Vascular Disease: A Report of Two Cases. *Pain Physician*, **11**, 909-916.
- [18] Gaudino, M., Tondi, P., Benedetto, U., Milazzo, V., Flore, R., Glieca, F., *et al.* (2016) Radial Artery as a Coronary Artery Bypass Conduit: 20-Year Results. *Journal of the American College of Cardiology*, **68**, 603-610. <https://doi.org/10.1016/j.jacc.2016.05.062>
- [19] Mirza, A.K., Stauffer, K., Fleming, M.D., De Martino, R., Oderich, G., Kalra, M., *et al.* (2018) Endoscopic versus Open Great Saphenous Vein Harvesting for Femoral to Popliteal Artery Bypass. *Journal of Vascular Surgery*, **67**, 1199-1206. <https://doi.org/10.1016/j.jvs.2017.08.084>
- [20] Raja, S.G. and Sarang, Z. (2013) Endoscopic Vein Harvesting: Technique, Outcomes, Concerns & Controversies. *Journal of Thoracic Disease*, **5**, S630-S637.
- [21] Lai, T., *et al.* (2006) The Transition from Open to Endoscopic Saphenous Vein Harvesting and Its Clinical Impact: The Texas Heart Institute Experience. *Texas Heart Institute Journal*, **33**, 316-320.
- [22] Eid, R.E., Wang, L., Kuzman, M., Abu-Hamad, G., Singh, M., Marone, L.K., *et al.* (2014) Endoscopic versus Open Saphenous Vein Graft Harvest for Lower Extremity Bypass in Critical Limb Ischemia. *Journal of Vascular Surgery*, **59**, 136-144. <https://doi.org/10.1016/j.jvs.2013.06.072>
- [23] Khan, S.Z., Rivero, M., McCraith, B., Harris, L.M., Dryjski, M.L. and Dosluoglu, H.H. (2016) Endoscopic Vein Harvest Does Not Negatively Affect Patency of Great Saphenous Vein Lower Extremity Bypass. *Journal of Vascular Surgery*, **63**, 1546-1554. <https://doi.org/10.1016/j.jvs.2016.01.032>