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Review Article

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Comparison of the Outcomes after Endoscopic Vein Harvesting Versus Open Vein Harvesting for Coronary Bypass Surgery

*Al Malki Afnan and Arifi AA**

Division of Cardiac Surgery, Department of Cardiac Sciences, King Abdulaziz Medical City, National Guard Health Affairs, Saudi Arabia

Abstract

Minimally invasive endoscopic vein harvesting (EVH) was first reported in 1996 as an alternative to open vein harvesting (OVH). Making coronary artery bypass surgery a less invasive procedure, shortly after its introduction, it became the standard of care for conduit harvesting. When compared to the conventional technique, the incidence of site infections wound dehiscence, delayed healing, duration of hospitalization, and postoperative pain were markedly reduced. However, the long-term outcomes, safety, and graft patency remain uncertain. Herein is an extensive literature review discussing the outcomes following endoscopic vein harvesting for Coronary Artery Bypass Surgery (CABG) as well as its advantages and disadvantages.

Method: A comprehensive literature search was performed using MEDLINE, Embase, language restricted to English only. Original papers, review articles, and meta-analysis published in the past five years were included. Reports investigating radial artery harvest, noncardiac use conduits, non-endoscopic techniques were excluded; no other filters used to restrict the study design.

Keywords

Endoscopic Vein Harvesting (EVH), Coronary Artery Bypass Grafting (CABG), Open Vein, Conduit, Graft Patency, Clinical Outcome

Introduction

Reported first in 1996, endoscopic vein harvesting (EVH) emerged as an alternative approach to the open vein harvesting method (OVH) [1]. It was rendering coronary artery bypass grafting (CABG) a less invasiveprocedure. Shortly after its introduction, it became the standard of care for conduit harvesting (Class I, Level B) according to a consensus statement by the International Society of Minimally Invasive Cardiothoracic Surgery (ISMICS) [2]. When compared to the conventional technique, the incidence of surgical site infections wound dehiscence and delayed wound healing were markedly reduced. The updatefrom (ISMICS) in 2017 [3] recommended endoscopic-vein harvesting to reduce wound-related complications, including wound infection or cellulitis (class I, level A).

Furthermore, EVH is shown to improve patient satisfaction and postoperative pain when compared with the OVH technique (class I, level A). Also, the EVH technique reduces the postoperative length of hospitalstay (class I, level A). However, Two major trials, PREVENT IV trial and the ROOBY trial [4,5] associated the increase of major adverse cardiac events and reduced graft patency rates with the endoscopic-vein harvesting technique. It is important to note that several questions remain unanswered concerning endoscopic vein harvesting long-term outcomes, safety, graft patency, and harvesting injuries. The objective of this review is to discuss endoscopic vein harvesting outcomes and its advantages and disadvantages in light of the recent literature.

***Corresponding author:** Ahmed A Arifi, MD, FCRCS, FCSHK, FHKAM, FACC, MBA, Division of Cardiac Surgery, Department of Cardiac Sciences, King Abdulaziz Medical City, Mail Code 1400, P.O. Box 22490, Riyadh 11426, Kingdom of Saudi Arabia, Tel: 801-1111 Ext 16783

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Method

Clinical data search strategy

This review was conducted with limitation to 5 original articles, five review articles, two systematic reviews with meta-analysis, published in the last five years. Eligible studies were from an online database of Pubmed. The articles were searched in "Title/Abstract" using the keywords: Endoscopic vein harvesting (EVH); coronary artery bypass grafting (CABG); open vein; conduit; graft patency; clinical outcome.

Study inclusion and exclusion

Inclusion criteria:

i. Articles are comparing EVH to OVH, discussing at least one of the outcomes related to our interest.

ii. All randomized controlled trials (RCTs) and comparative studies available in the recent literature.

Exclusion criteria:

i. Articles are investigating radial artery harvest, non cardiac use conduits, non-endoscopic techniques.

Results

Characteristics of the included studies

The inclusion and exclusion criteria were applied to PubMed, eleven studies met the criteria and were included for the analysis, including 47968 patients (21622 for EVH, and 26346 OVH). Of the eleven studies, six were randomized controlled trials; three were retrospective cohort studies, one comparative study. (**ERROR! REFERENCE SOURCE NOT FOUND.**) displays the characteristics of the included studies (Table 1).

Table 1: Characteristics of the included studies.

First author	Year	EVH	OVH	Follow up	Study design
Kopjar, et al. [15]	2015	N/A	N/A	N/A	Comparative
Kim, et al. [10]	2015	31	44	Six months	Retrospective
Chernyavskiy, et al. [11]	2015	113	115	N/A	RCT
Moeinipour, et al.	2016	87	86	Six weeks	Retrospective
Krishnamoorthy, et al. [12]	2017	200	100	48 months	RCT
Harky, et al. [17]	2017	N/A	N/A	N/A	RCT
Ferdinand, et al. [3]	2017	N/A	N/A	N/A	RCT
Kodia, et al. [6]	2018	7,258	10,873	2.6-years	Retrospective
Zenati, et al. [7]	2019	576	574	2.78-years	RCT
Li,et al. [14]	2019	13357	14554	Five-years	RCT
Mahmood, et al.	2019	N/A	N/A	N/A	N/A

Abbreviations: EVH: Endoscopic venous harvesting; OVH: Open venous harvesting; RCT: Randomized controlled trial, NRCT: Non-randomized controlled trial; N/A: Not available.

Table 2: Summary of the Clinical Outcomes (EVH vs. OVH).

First author Year	Wound complications	30 days of mortality	Endothelial integrity preservation	Early graft patency	Midterm graft patency	Long-term graft patency
Kopjar, et al. 2015 [15]	OVH > EVH	OVH ≤ EVH	OVH > EVH	OVH = EVH	OVH = EVH	OVH = EVH
Kim, et al. 2015 [10]	OVH ≥ EVH	OVH = EVH	N/A	OVH = EVH	N/A	N/A
Chernyavskiy, et al. 2015 [11]	OVH ≥ EVH	N/A	OVH > EVH	N/A	N/A	N/A
Moeinipour, et al. 2016	OVH > EVH	OVH = EVH	OVH = EVH	N/A	N/A	N/A
Krishnamoorthy, et al. 2017 [12]	OVH > EVH	OVH = EVH	OVH > EVH	N/A	N/A	NA/
Harky, et al. 2017 [17]	N/A	N/A	OVH > EVH	OVH = EVH	OVH > EVH	OVH > EVH
Ferdinand, et al. 2017 [3]	OVH > EVH	OVH = EVH	OVH = EVH	OVH = EVH	OVH = EVH	OVH = EVH
Kodia, et al. 2018 [6]	OVH > EVH	OVH > EVH	OVH < EVH	OVH > EVH	OVH > EVH	OVH > EVH
Zenati, et al. 2019 [7]	OVH > EVH	OVH = EVH	N/A	N/A	N/A	N/A
Li, et al. 2019 [14]	OVH > EVH	OVH = EVH	N/A	N/A	OVH > EVH	OVH > EVH
Mahmood et al. 2019	OVH > EVH	N/A	N/A	N/A	N/A	N/A

Abbreviations: EVH: Endoscopic venous harvesting; OVH: Open venous harvesting; N/A: Not available.

Outcomes

There is ample evidence in the literature today that advocates the use of endoscopic vein harvesting to achieve remarkable advantages over the conventional technique, in terms of reducing the incidence of wound-related complications, pain and improving cosmetic appearance. A summary of the clinical outcomes between the two methods of harvesting is given in (**ERROR! REFERENCE SOURCE NOT FOUND.**) (Table 2).

Wound related complications

The goal of endoscopic-vein harvesting is to reduce the prevalence of surgical site infection and decrease the trauma to the surrounding tissue. A recent meta-analysis study by Ferdinand, et al. analyzed 29 studies, including 11,919 patients, showed that the odds of wound complications were significantly reduced by 71%with endoscopic-vein harvesting compared to open-vein harvesting. Reaching a recommendation that endoscopic-vein harvesting reduces wound-related complications, including wound infection or cellulitis (class I, level A) [5]. A similar pattern of results was obtained from another meta-analysis of eleven studiesby Kodia, et al. [6] in which 7,258 patients who underwent endoscopic vein harvesting reported that the endoscopic-vein harvesting technique was associated with less infectious-wound complications in the immediate postoperative period compared to open-vein harvesting technique [endoscopic 1.0% vs. open 3.5%]. And less use of postoperative treatment with antibiotics was reported with the endoscopic-vein harvesting compared to the open-vein harvesting [endoscopic 0.0% vs. open 10.5%]. It has been explored that non-infectious wound complications were observed more frequently among patients who underwent open-vein harvesting compared to endoscopic-vein harvesting.

Moreover, 3.8% of the wound drainage complications were observed with the open-vein harvesting vs. only 0.2% was observed with endoscopic-vein harvesting. The altered sensation was reported to be 2.0% with the endoscopic harvesting technique vs. 13.5% with the open technique [6]. Similar outcomes were published in a recent randomized trial by Zenati and his colleagues in 2019 [7], that leg-wound infection occurred in 18 patients (3.1%) in the open-harvest group, while only in 8 patients (1.4%) in the endoscopic- harvest group. During the follow-up period, antibiotics were administered to 14.4% of the patients in the open-harvest group compared to only 4.6% of the patients in the endoscopic-harvest group. The prior investigation by Moeinipour, et al. in 2016 studied 87 patients who underwent endoscopic-vein harvesting, have implemented that the reason of the zero-infection rate observed with the endoscopic-vein harvesting patients is due to the smaller incisions and preserved tissue perfusion with this approach [8]. A study by Nezafati, et al. concluded that in order to decrease wound related complications associated with the extensiveincisions, endoscopic vein harvesting is recommended to reduce wound complications, leg wound infection and hematoma. In a study of 30 patients underwent endoscopic-vein harvesting [9]. Few studies reported that leg wound complications were more common post open vein harvesting techniques. However, the difference was not statistically significant between the two techniques [10,11]. Furthermore, Chernyavskiy, et al. reported that the length of the incision during open-vein harvesting has an impact on the lymphatic and the nervous system; lymphorrhea was reported less with the endoscopic harvesting technique (0.9%) compared to (6.1%) with the open harvesting technique. Lower incidences of paresthesia were reported with the endoscopic harvesting technique (3.5%) vs. (14.8%) with the open harvesting technique [11].

Patient's satisfaction with appearance and post-operative pain

Two of the essential aspects of the surgical intervention are the intensity of pain experienced by the patient after the surgery and the satisfaction of the surgical outcome. Ferdinand, et al. demonstrated patient's satisfaction with the cosmetic results of surgery as endoscopic-vein harvesting patients were significantly more likely to be satisfied with the cosmetic results compared to open-vein harvesting patients [3]. Zenati, et al. followed up with his patients for six weeks after the surgery, reported that incisional leg pain had little to no effect in 79.1% of the patients in the endoscopic-harvest group when compared to 62.2% of the patients in the open-harvest group [7]. Moeinipour, et al. also supported this finding. In a study showing that patients in the endoscopic-vein harvesting group have experienced less pain than patients in the open-vein harvesting group and pain scores during the 6-week follow-up were significantly reduced [8].

Reduced post-surgical pain is the best predictor of satisfaction with the surgery, according to Chernyavskiy's, et al. The study showed significantly lower intensities of the post-surgical pain observed with the endoscopic-vein harvesting group compared to the open-vein harvesting group [11]. In 2017 Krishnamoorthy, et al. demonstrated that difficulties in mobility, self-care, usual activities, pain, and discomfort over three months of follow up were more likely reported with the open-vein harvesting group compared with the endoscopic-vein harvesting group [12]. Further support is given by Luckraz, et al. as 48 patients in the endoscopic-vein harvesting group and 49 patients in the open-vein harvesting group were followed up over (28-43) months and (28-42) months for the endoscopic-vein harvesting and open-vein harvesting groups, respectively. The study generally asserts that harvest-site pain, numbness and dysesthesia were reported only with the open-vein harvesting technique [13].

MACE (within 30 days of CABG)

Major adverse cardiac events (MACE) including death from any cause and nonfatal myocardial infarction.

Mortality: The mortality rate is a significant concern to patients and surgeons. Kodiak, et al. in 2018 reported that in the 30-day postoperative period, the mortality rate was significantly higher in patients who underwent CABG through an open harvesting technique (3.4%) compared to (2.1%) through an endoscopic harvesting technique [6]. A study done by Zenati, et al. defined cardiac death as death related to a cardiovascular cause including death by acute myocardial infarction, sudden unwitnessed cardiac arrest, or as a result of cardiovascular bleeding and heart failure or a stroke. Non-cardiovascular deaths were defined as death resulting from related pulmonary causes, infection (includes sepsis), accident/trauma, and non-cardiovascular organ failure. The undetermined cause of death was defined as death due to any other cause not listed previously. The study reported that death occurred in 83 patients, out of which 46 patients (8.0%) were in the open-harvest group and 37 patients (6.4%) in the endoscopic-harvest group [7]. Observation in short periods revealed that death rates in many studies were statistically comparable between the two methods of vein harvesting. Moeinipour, et al. in 2016 reported comparable results of death as 3.5% death occurred with patients in the open-vein harvesting technique, and 2.2% death occurred with patients in the endoscopic-vein harvesting technique during the intensive care unit period [8]. The one-month mortality rate was not significantly different between the two methods of harvesting reported by Kim, et al. as the study showed (0%) mortality rate in the endoscopic-vein harvesting group and (5.66%) in the open-vein harvesting group [10]. According to many studies with longer follow up periods, significant differences were absent between the two groups in terms of major adverse cardiac events [12,14].

Myocardial infarction: The other component of the MACE is Myocardial infarction. Kodiak, et al. outlined in a meta-analysis of eleven studies with a total of 18131 patients who underwent CABG that in the 30-day postoperative period,myocardial infarction occurred in 0.5% of the patients who underwent endoscopic-vein harvesting technique compared to 1.0% of the patients who underwent open-vein harvesting technique [6]. In line with the previous study, a randomized trial by a Zenati, et al. in 2019 confirming that lower incidences of myocardial infarction were associated with endoscopic-vein harvesting technique, as it occurred in 27 patients (4.7%) in the endoscopic-harvesting group compared to 34 patients (5.9%) in the open-harvesting group [7]. Additionally, Krishnamoorthy, et al. reported in a randomized clinical trial of 300 patients, where 200 patients were randomly selected for EVH. Out of the 200 patients, 16 symptomatic patients underwent magnetic resonance imaging and angiogram. Concluding that Angina occurrence did not relate to the method of harvesting, instead, it was caused by the progression of the disease to the native vein graft, left internal mammary artery insertional site stenosis, vein graft blockage and previous patent stent blockage [12]. The findings of a study by Luckraz, et al. reinforced the general belief that MACE occurrence doesn't relate to the harvesting method, as the study reported a small percentage of patients post-CABG developedeither an ischemic event or an evidence of graft blockage on angiography: 2.4% (1/41) for endoscopic-veinharvesting and 2.8% (1/36) for open-vein harvesting. The overall MACCE rates were similar, 12.2% for endoscopic-vein harvesting vs. 13.9% for open-vein harvesting [13].

Quality and durability of the conduit

The goal of the minimally invasive harvesting technique is to reduce the morbidity, shorten the recovery time, and preserve the quality of the harvested vein. In contrast, the quality and durability of the harvested conduit have been a controversial point widely discussed in the literature. Extensive data showed that suture repairs of saphenous vein grafts were observed more with the endoscopic-vein harvested grafts compared to the open-vein harvested grafts. Ferdinand, et al. in 2017 reported that the mean number of venous graft repair stitches was increased by a mean of 1.09 stitches per patient with the endoscopic-vein harvesting technique. However, based on the quality of the graft the study reported that endoscopic-vein harvested grafts were noninferior to the open-vein harvested grafts [3]. Such findings were also demonstrated previously by Kopjar, et al. in 2016 as the study reported that endoscopic-vein harvesting technique subjects the grafts to a greater vascular trauma than those harvested with the open-vein harvesting. And that suture repairs of the vein grafts were significantly detected by the endoscopic-vein harvesting technique rather than the open harvesting technique [15].

Histological evaluation: Maintaining the endothelial integrity of the conduits is the backbone for graft patency, which can ensure successful revascularization. At a histologic level, Kodiak, et al. analyzed 11 studies, including 7258 patients who underwent endoscopic-vein harvesting. It outlined that manipulation of the vein during harvesting was associated with increased endothelial injury and reduced viability of the graft. These findings were verified with immunofluorescence and biochemical techniques [6]. In contrast to the previous study, several studies in the broader literature have examined endothelial integrity post-harvesting. Moeinipour, et al. in 2016 reported that endothelial injury of the grafts showed no meaningful difference between the two harvesting techniques [OVH 2.3% vs. EVH: 0.0%] [8]. Similarly, a study by Nezafati, et al. enrolled 47 patients, 30 patients underwent endoscopic-vein harvesting and 17 patients underwent open-vein harvesting. The study reported that eNOS, E-cadherin, Caveolin, and vWF immunohistochemistry staining in distal, medial and proximal segments of the vein samples in the two harvesting techniques had no significant statistical difference ($P > 0.05$) [9]. Furthermore, the histopathological analysis conducted by Chernyavskiy's, et al. suggested that vein vascular wall disturbances are unlikely to occur alone and were often accompanied by other damages such as rupture or dissection. Wall dissection was reported in 41% inthe endoscopic-vein harvesting group compared to 44.6% in the open-vein harvesting group. Under the light microscopy, the study identified other structural manifestations associated with endoscopic-vein harvesting. The most frequent one was corpuscle adhesion to the deendothelialized surface, which may have resulted from damage to the endothelial layer that led to the development of high thrombogenicity ofthe subendothelial tissue to the circulating platelets [11]. Additionally, Krishnamoorthy, et al. studied the vein structure post-harvesting on a histological level using (CD34) an endothelial marker.

The study reported that endothelial integrity was better preserved with the open-vein harvesting technique in the proximal samples compared to the proximal segments obtained by the endoscopic techniques [CT-EVH 91.50% vs. OT-

EVH 91.63% vs. OVH 95.75%]. Similarly, the random samples obtained by the open-vein harvest technique displayed the greatest endothelial integrity compared to the random segments obtained by the endoscopic technique [CT-EVH 85.25% vs. OT-EVH 87.50% vs. OVH 92.71%]. However, the distal samples obtained by both techniques showed no statistical difference in the endothelialintegrity [CT-EVH 92.25% vs. OT-EVH 91.75% vs. OVH, 95.38%] [12]. Consistent with the previous data, a study by Kopjar, et al. (2016) showed that endothelial damage was observed less with the open-vein harvested grafts compared to the endoscopic-vein harvested grafts. Using the optical coherence tomography, marked damage to the adventitia as well as abnormalities in the intima and endothelial denudation were observed with the endoscopically harvested veins [15]. However, Milutinović, et al. studied the endothelial loss of the grafts post-harvesting on a histological level using (CD31). As the study reportedthat at the time of implantation of the distal segment of the vein graft, no differences in endothelial loss were observed between the endoscopic-vein harvested grafts and open-vein harvested grafts. As the endoscopic-vein harvested distal segments were implanted 52 min ± 19 after harvesting and 72 min ± 44 after harvesting with the open-vein harvesting technique. At the time of implantation of the proximal segments, it was observed that a significant loss of endothelial cells in the veins harvested with the open technique compared to the endoscopic technique. The time of implantation was not statistically significant; the proximal segments were implanted 57 min and 41 min after the implantation of the distal segments in the endoscopic-vein harvesting and the open-vein harvesting group, respectively. A significant loss of endothelial cells at the time of implantation of the proximal segments compared to the distal segments was observed in the open-vein harvesting group [16].

Graft patency: Multiple studies answered the question of whether the graft patency after CABG is compromised by endoscopic vein harvesting as they significantly favored the open harvesting technique over the endoscopictechnique. In a meta-analysis conducted by Kodiak, et al. over a follow-up period of 2.6-years. Graft patency rate of 75.1% was reported following endoscopic-vein harvesting vs. 82.3% following open-vein harvesting [6]. However, it has been previously reported in the literature by Kim, et al. that the patency rate did not show a statistically significant difference between the two methods of harvesting, in the immediate postoperative period and six months post-harvesting [10]. Also Li, et al. in a meta-analysis of 22 studies, including 27911 patients, where 13357 patients underwent endoscopic vein harvesting. The resultsshowed that early graft patency rates were markedly reduced with the endoscopic harvested vein grafts compared to open harvested vein grafts. Over one-year results showed an inferior graft patency rate associated with the endoscopic harvested vein grafts [81.04% in the EVH vs. 86.58% in OVH]. Similarly, Data on the mid-term (1-5- years) reported that graft patency rates were significantly lower with the endoscopically harvested grafts [73.37% in the EVH Vs. 77.81% in the OVH] [14]. Kopjar, et al. drew attention to the graft patency concerns associated with endoscopic-vein harvesting, by raising the question' is wound healing and the cosmetic outcome more important than graft performance and potentially the survival of patients undergoing CABG?'. It was concluded that the endoscopic-vein harvesting technique offers grafts with inferior patency rates compared to those harvested conventionally [15]. In this regard, Harky, et al. provided the best evidence analyzing four articles reported on graft patency. The reduction of vein graft patency from twelve months onward was reported significantly with the endoscopic harvesting technique [17]. However, a recent study by Harky, et al. in demonstrated that EVH will offer patencyrates similar to the OVH when the grafts are harvested by highly experienced harvesters [18]. Many studies consistently reported a close and strong association between graft patency and target vessel status, to justify this claim, Gaudino, et al. reported that a crucial factor affecting the long-term patency of the graft, which is the target vessel diameter. Concluding that a target vessel diameter ≥ 2.0 mm significantly increased the graft patency rate (OR, 4.7; CI, 1.4-15.4; P = 0.011) [19]. A series of previous studies has indicated that a target vessel ≤ 1.5 mm was associated with both arterial and venous graft occlusion, providing an evidence that excellent patency rate of 88% for SVGs anastomosed to coronary arteries with a diameter > 2 mm compared to 55% patency rate for SVGs anastomosed to ≤ 2 mm target vessels [20,21].

Conversion to OVH and revascularization: The uncertainty of endoscopic vein harvesting clinical outcomes was associated with the incidence of conversion and repeated revascularization.

Two articles reported on the conversion rates. Zenati, et al. published the results of 32 endoscopic cases converted to open (5.6%). Repeat revascularization occurred in 35 patients in the open-vein harvesting group vs. 31 patients in the endoscopic-vein harvesting group (6.1% vs. 5.4%), respectively [7]. Chernyavskiy's, et al., in a prospective, parallel-group trial of 228 patients diagnosed with ischemic heart disease who underwent coronary artery bypass surgery. Reported that 113 patients underwent successful endoscopic vein harvesting with no incidence of conversion to the open technique [11].

Graft failure: Ferdinand, et al. declared that endoscopic-vein harvesting was not associated with an increase in angiographic graft failure or occlusion. During six months up to one-year follow-up, reports showed that the angiographic occlusions of the endoscopically harvested grafts were not significantly higher than the open harvested grafts [3]. A series of recent studies have emphasized that the lack of proficiency and expertise of the harvesters have been described as factors contributing to the graft failure [6,7,10,14]. The results obtained by Kopjar, et al. confirmed that during a 12-month to 18-month period of follow-up, angiographic reports of endoscopic-vein grafts were associated with higher failure rates compared to open-vein grafts. Moreover, at three years post CABG, high revascularization rates were observed more with the endoscopic harvested grafts [15]. Harky, et al. have proposed the most exciting approach to this issue. In 2017 demonstrated that 1096 vein grafts have failed out of 4343 grafts. Confirmed by coronary angiographic studies at 12 to 18 months follow up period. The endoscopic vein harvesting technique was found to be a factor associated with vein graft failure. However, other factors have attracted much attention contributing to graft failure such as prolonged surgical time, poor target artery quality, and the administration of clopidogrel or ticlopidine postoperatively. This did not impair that the study strongly suggested that endoscopic vein harvesting is a safe alternative to open vein harvesting [17]. Although previous reports in the literature suggested that greater rates of graft failure were associated with endoscopic-vein harvesting technique, it remains a controversial territory according to Gaudino, et al., the study reported significantly higher incidence of graft stenosis and occlusion with the endoscopically harvested saphenous vein grafts. However, the study has demonstrated a strong and consistent association between the graft failure and the structural characteristics of the venous conduit, andthe target vessel characteristics [19]. This has also been explored in a prior study by McKavanagh, et al. reporting other surgical factors predispose to the graft failure including graft kinking, size mismatch between the graft and artery, poor distal run-off and small target vessel diameter [22]. Furthermore, distension was found to be an important factor contributing to the graft failure according to a recently published study in (2020), which enrolled 100 patients, 50 patients underwent endoscopic-vein harvestingand 50 patients underwent open-vein harvesting. The study reported that the endothelium integrity of the grafts specimens before distension was similar in both methods of harvesting (EVH: 81.1% ± 6.11% *vs.* OVH: 80.8% ± 6.58%, P = 0.83). Similarly, the endothelium integrity after distention was not significantly different between the two groups (EVH: 70.7 ± 9.73% *vs.* OVH: 68.3 ± 9.60%, P = 0.217). Concluding that intraoperative distension of the graft could alter the continuity of the endothelium leadingto an early SVG failure [23].

The noticeable dissimilarity in the literature reports may have an important implication, that the overall patency rate does not entirely depend on the harvesting method. As vascular trauma during harvesting by endoscopic vein harvesting or the open technique is inevitable as with every procedure. The latter point was successfully established as described by Sajjad, et al., the key is to harvest the vein trauma-free, whether the procedure was performed via open vein harvesting or endoscopically harvesting, and that requires a skilled operator [24].

EVH and Covid-19: The outbreak of Corona virus disease (COVID-19) necessitated that surgical procedures must be modified to further minimize the risk of exposure of the aerosolized particles to the operators and patients and ensure their safety. Minimally invasive procedures carries lower risks of viral disease transmission, it has been established before that when compared to open procedure, minimally invasive procedures resulted in an improved survival, faster recovery and decreased length of stay [25,26]. Supported by the American College of Surgeons, which have stated that the surgeons should choose the approach that minimizes the operation time and maximizes safety [27]. However, in the current era minimally invasive procedures are questioned due to the fear of COVID-19 transmission from the potential generation of contaminated aerosols from the CO_2 leakage [28]. Sayed, et al. proposed that the non-sealed technique for endoscopic vein harvesting carries no risk of aerosolization due to CO_2 insufflation, in a study of 28 patients underwent coronary artery bypass grafting using the non-sealed endoscopic technique [29].

Reviewing the literature offered no solid evidence that minimally invasive procedure reduces viral transmission of COVID-19 compared to the open technique, However, in the light of the current publications during COVID-19 era it is conceivable, that all measures must be taken to decrease wound related complications, shortening the hospital stay, preventing viral contamination during the postoperative period and that can be achieved with endoscopic harvesting. Therefore, future investigations are necessary to validate the kinds of conclusions that can be drawn from this point.

Conclusion

The debate regarding the effectiveness of endoscopic vein harvesting over the open technique has been resolved, as endoscopic vein harvesting resulted in less wound healing complications, less donor site infections, less postoperative pain and noninferior outcomes for all-cause mortality, in-hospital death, andmajor adverse cardiac events compared to open vein harvesting. All the currently available publications within this review suspected clinical entanglements of inferior graft quality associated with endoscopic vein harvesting. However, there were several notable persistent discrepancies in the outcomes addressing the patency rates. Therefore, venous graft failure could be explained by multiple other factors, and inexperienced harvesters are susceptible to generate more conduit trauma. Taking into consideration the devices and equipment used for endoscopic harvesting. Based on these findings presented in this paper, further standardization of the endoscopic harvesting technique will be required to ensure durability and longevity of vein grafts. Followed by continued researching before obtaining a definitive answer to the safety of endoscopic vein harvesting.

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Conflict of Interest

The authors declare that there is no conflict of interest.

IRB Approval

Not required no patients have been investigated in the present paper.

Informed Consent

No consent was required.

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