Comparative Study between Conventional and No Touch Technique Vein Graft Harvesting in Coronary Artery Bypass Surgery

Original Article

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ABSTRACT

Background: Coronary artery bypass grafting (CABG) surgery is proved to treat ischemia of the myocardium. The left internal mammary artery (LIMA) is the gold standard conduit with patency rate reaching 90% at 10 years. Compared to 50% to 70% of saphenous vein (SV) grafts patency at 10 years.. A novel no touch (NT) technique in SV harvesting with its surrounding tissue as a cushion is proposed as an alternative option, This technique leads to better endothelial preservation and nitric oxide synthase (NOS). Recent studies proposed that the NT harvesting could improve patency rate post operatively.
Aim: To compare between conventional vein harvesting and no touch technique regarding patency at a period of 6 months.
Subject and Methods: A total of 52 patients underwent saphenous vein graft harvesting for on pump coronary artery bypass grafting at Kobri ELKobba, 26 patients were done using the conventional method and 26 with No touch technique. Patency was assessed using MSCT after 6 months as a primary study outcome, while ECG, tropinin and leg parasthesia were regarded as secondary outcome.
Results: 52 participants had multi-slice computed tomography on coronary vessels (MSCT) at 6 months after surgery. The NT group showed significant lower rates of vein graft occlusion compared to the conventional group at 6 months (11.5% of conventional method in contrast to 3.8% via no touch technique $p<0.043$). But had significant risk of post operative leg parathesia $p<0.05$.
Conclusion: In comparison with the conventional vein harvesting in coronary artery bypass grafting, the NT technique showed significant increase in the patency rate of great saphenous vein and decreased the recurrence of angina but had a significant risk of post operative leg paraesthesia.

Key Words: Conventional Vein-Grafting Harvesting, Coronary Artery Bypass Grafting, No Touch Technique Vein graft Harvesting.

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INTRODUCTION

Annually, millions of patients are diagnosed with Myocardial ischemia resulting from obstructed coronary arteries (coronary artery disease), and it accounts for the most common cause of mortality in several countries. [1].

Over than 1 million patients do coronary artery bypass grafting (CABGs) each year. CABG has been performed for more than 50 years. It has witnessed improvement in surgical technique, CABG currently have less adverse complications and the outcomes have improved over time[2].

Harvested grafts can be arterial or venous conduits to bypass atheromatous obstructions in the coronary vessels. The left internal mammary artery (LIMA) with 90–95% are patent at 10 years is currently the gold standard option used for coronary artery bypass surgery (CABG) while only 50% of saphenous vein grafts are patent at 10 years[3] In Addition, 15% of vein grafts are occluded, in the 1st month, and 15–30% are occluded in the first year surgery[3].

These high early occlusion rates in the conventional vein harvest can be caused by technical factors, endothelial damage during harvesting and distention by high pressure

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leading to significant intimal damage affecting the patency of the venous grafts [4].

A novel ―no touch (NT) technique for the saphenous vein harvesting has been introduced for the first time in 1996. No touch technique is a technique to harvest the SV with the tissue surrounding the vein as a cushion avoiding touching the vessel. This technique leads to better endothelial preservation and nitric oxide synthase (NOS). In recent trials, NT venous graft has shown favorable biochemical and in-vitro findings, as the fatty pedicle provide external support, and reduces the risk of kinking of the SVG after anastomsis [5].

Previous studies done observed better patency rate of NT saphenous vein grafts, from 5.5% at 3 years to 10% after 8 years from surgery. whereas the patency rate of the conventionally harvested vein grafts is nearly 50% [6].

In addition, the use of the no-touch saphenous venous graft is recommended by the 2024 European Revascularization Guidelines with Class of Recommendation IIa, Level of Evidence B. However, the effectiveness of the technique is unknown enough to generalized in countries with low- and middle-income, where the dominant harvesting technqiue is the conventional vein graft harvesting [7].

PATIENTS AND METHODS

Study Design:

- Prospective cohort study

Population of study:

Patients with multi vessels disease undergoing on-pump coronary artery bypass grafting were participated in this study. This was a done on patients of Kobry El Kobba military cardiac hospital over a period of 6 months from February 2023 to august 2023. The protocol was approved by Armed Forces College of Medicine committe and all participants provided written informed consent.

Inclusion criteria:

Patients scheduled to have isolated elective CABG and requiring at least one SVG were included.

Exclusion criteria:

- Patients with who had a previous coronary artery bypass surgery.
- Patients undergoing a combined coronary and valve surgery
- Patients with other systemic disease(s) (e.g. liver and kidney disease, endocrinal disorder).
- Patient with secondary varicose veins or previous deep venous thrombosis.
- Aim of the study:

The primary aim of this study is to compare the patency rates of saphenous vein grafts harvested using the conventional technique versus the no-touch technique in patients undergoing coronary artery bypass grafting (CABG) at 6 months postoperatively.

secondary aims:

1. To evaluate postoperative mediastinal bleeding requiring surgical exploration on the day of surgery.

2. To assess early cardiac ischemia using ECG and troponin levels on the first postoperative day.

3. To monitor postoperative leg paresthesia and wound complications one month after surgery.

4. To investigate the relationship between vein graft harvesting techniques and vein graft patency using multi-slice CT scans at 6 months postoperatively.

Comprehensive history taking and a detailed physical examination were conducted for patients, along with coronary angiography. Additionally, echocardiography was performed as well as radiological imaging, including chest X-rays or CT scans,

Surgical procedures

Open (conventional) vein harvest:

A - Exposing the great saphenous vein (SV)

An initial 5 cm incision was usually started anterior to the medial malleolus. And contniued along the medial edge of the tibia.

If preoperative markings were not done by venous duplex, fine scissors careful dissection was used to identify the saphenous vein course underneath the skin. This is very useful when the subcutaneous fat is encountered and using small stepwise incisions to follow the vein along its anatomical course. The division of the subcutaneous tissues is done using heavy scissors. Exposing the entire desired length.

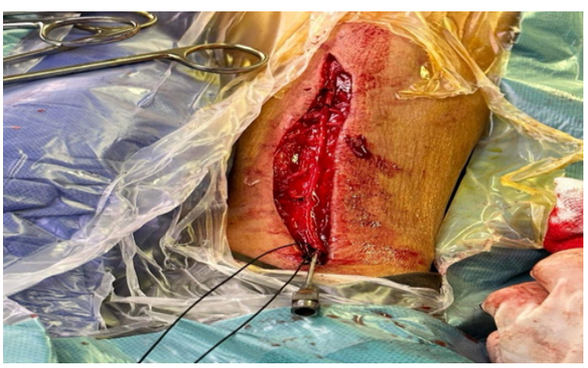

Fig.1: Exposing the great saphenous vein

B - Ligating side-branches and dissecting the SV

Careful dissection of the side-branches is needed then ligating the side braches with 3/0 silk suture.After ligation of the side-branches, the vein graft is freed from its bed with Careful plane formation beneath the SV and elevating it with a fine scissor or using the index finger from the surrounding tissues with sharp dissection.

C - Cannulating the vessel and removing the vein

The cannula was carefully inserted in the true lumen of the vein and tied with heavy silk suture. The saphenous vein was inflated with ringer lactate mixed with heparin. Any leaking branches were found was ligated with silk sutures and then the vein was removed to be ready as a conduit.

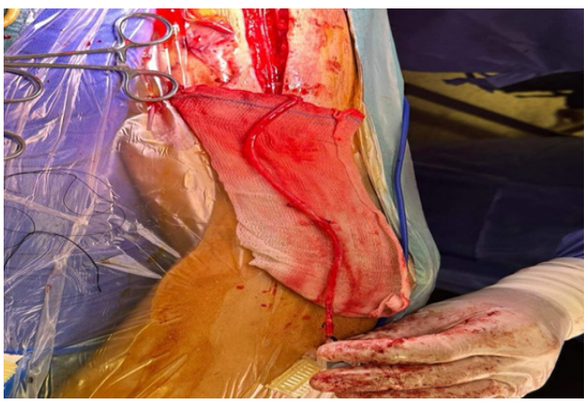

Fig.2 : Removing the vein after dissection from its surronding tissue

D - Closing the leg wound

After ensuring hemostasis, the wound was closed in layers. Use a running suture with absorbable polyfilament (3/0) for the subcutaneous tissues and a fine (4/0) absorbable monofilament as a running intracutaneous suture to close the skin.

No touch technique

A-Exposing the great saphenous vein.

Before skin incision, vein mapping is done to show the exact course and lumen of SV. Previously, the vein quality is assessed after open exposure Recent studies have shown that vein mapping is useful in determining the size and course of the greater saphenous vein.

The vein mapping was done using bedside with a ultrasonography machine with a 10-MHz probe. Ultrasonographic measurements of the vein were taken in at 3 locations. Then the course of the greater saphenous vein is mapped and marked.

Fig. 3: Vein mapping using lower limb venous duplex

An incision was made at the GSV in the marked site. Then the incision was continued reaching the desired length.

Fig. 4: Marking the vein site before harvesting

After skin incision using scalpel in the marked site, the subcutaneous layer is exposed layer by layer using uni polar diathermy till reaching the great saphenous vein.

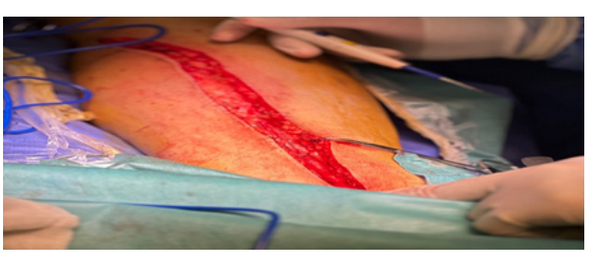

Fig. 5: Exposing the great saphenous vein after marking using diathermy

B- Ligating the side branches

Side branches of the great saphenous vein are usually visible and both proximal and distal end of the side branches are clipped then divided.

C-removing the vein

A plane around the vein was created. Perivascular fat on was included in the plane of maximum 1 cm on

both sides. The SV was harvested from its bed with the perivascular fat and all side branches were ligated. it is the perivascular tissue that was only touched during harvesting thus no venous spasm occurs.

As a result, manual dilation was not needed. Then the vein was preserved in ringer lactate solution mixed with heparin. At last, leg wound was closed in layers.

Parameters:

Parameters of the patients vitals and data collection starts immediately after the surgery using a data collection tool created by Google forms https://forms.gle/VhonhMgbKT6fLbUB9. Starting with the patient's name in Arabic, hospital number, gender and age,. The first section in data collection demonstrates the patient's pre-operative data including height in cm, weight in kilograms, if the patient is diabetic, smoker. Early post operative, the patient is closely monitored for post operative mediastinal bleeding. Then, day 1 after surgery data collection include detection of ECG changes and tropinin test. After1 months from surgery the wound conditon and parasthesia is assessed in the outpatient clinic. Finally, MSCT on coronary vessels is done after 6 months of surgery to assess the patency of the venous grafts.

Statistical analysis

We analyzed the data using statistical package for social sciences version 24 for windows. Categorical data was described in terms of frequencies and percentages. Numerical data was described in terms of means and standard deviations if normally distributed and median and interquartile ranges if non parametric. Chi square test was used to test the association between categorical variables. P value less than 0.05 was considered statistically significant

RESULTS

Fifty-two patients were invited to participate in the study. They all had severe IHD candidate for CABG.

Patients were divided into 2 groups according to the technique performed for lower limb vein harvesting.

- Group A included 26 patients underwent saphenous vein harvesting via the conventional method.
- Group B included 26 patients underwent vein harvesting via no touch technique.

We compared between both groups regarding sociodemographic characteristics and found that:

Patients underwent conventional method for saphenous vein harvesting were slightly younger when compared to the other group. However, this was statistically insignificant (p=0.574). Similarly, there was a male predominance among patients in both groups. this was also statistically insignificant (p=0.490) as shown in table 1.

We also found that BMI was slightly lower among patients subjected to conventional technique when compared to the other group (25.7 ± 3.24 vs 27.15 ± 4.1) kg/m2. However, this was statistically insignificant (p=0.149) as shown in table

Regarding associated comorbidities, we found that Dm was prevalent among 46.16% of patients underwent conventional method for saphenous vein harvesting. This was slightly more than what was reported among patients subjected to no touch technique, among whom 38.5% were diabetic, however, this was statistically insignificant (p=0.231) as shown in table 1. On the other hand, we found that hypertension prevalence was not significantly different among patients in both groups (53.8% vs. 46.15%) in both groups; p=0.638.

We also found that there was no significant difference between either group regarding their baseline EF (p=0.117) as shown in table 1.

Table 1 : Difference between both study groups concerning Sociodemographic characteristics.

	Conventional group (n=26)	No touch group (n=26)	*P value*
Age	64 ± 8.02	65.2 ± 6.62	0.574 T
Gender Male Females	 26 (100) 0	 24 (92.3) 2 (7.7)	 0.490 F
Diabetes mellitus	12 (46.16)	(38.5) 10	0.231 C
Hypertension	14 (53.8)	12 (46.15)	1.00 C
Active smoking	10 (38.5)	9 (34.6)	0.638 C
BMI	25.7 ± 3.24	27.15 ± 4.1	0.149 T
EF	53.2 ± 7.42	56.5 ± 7.5	0.117 T

T; independent sample t test. F; Fissure exact test. C; Chi square test.

Table 2: Difference between both study groups regarding mean time of harvesting

	Conventional group (n=26)	No touch group (n=26)	*P value*
Mean harvesting time	31.04 ±8.30	36.23±7.83	0.0245 T Statistically significant

T; t-test.

Postoperative follow up

All patients were followed up for a duration of 6 months. Multi-slice Coronary angiography was performed

for all patients to investigate the patency of venous grafts and delineate any form of either proximal, mid or distal anastomotic stenosis more than 70% of the lumen of the vein graft.

We found that only 11.54% of patients who underwent conventional method (3 patients) developed postoperative significant stenosis. In contrast to those who underwent vein harvesting via no touch technique; among whom 3.85% developed venous graft stenosis as shown in table 2.

Postoperative complications:

Immediately after surgery the patients were monitored for post operative bleeding which revealed that 7.69% of patients subjected to no touch venous graft harvesting underwent re-exploration of the mediastinum due to bleeding. This was slightly more than what was reported among patients who underwent conventional venous graft harvesting. however, this was statistically insignificant (p=0.513) as shown in table 2 and was not related to the harvesting technique.

Troponin was performed for all patients post operatively and revealed that 11.54% of patients subjected to conventional technique tested positive. On the other hand, 3.85% of patients subjected to no touch technique (1 patient) tested positive. This was also statistically significant (p=0.045) as shown in table 2.

ECG was performed for all patients at early follow up period. 11.54% of patients with vein graft harvested via conventional method had ECG ischemic changes in the form of either ST elevation or depression or newly discovered bundle branch block. This was significantly more than what was reported among patients subjected to no touch technique among whom only 3.85% of patients developed ECG ischemic changes (p=0.038) as shown in table 2.

Regarding postoperative wound leg wound infection, we found that 3.85% of patients subjected to conventional technique developed lower limb wound infection. in contrast to only 7.7% of patients subjected to no touch technique. However, this was statistically insignificant (p=0.668) as shown in table 2.

On the other hand, we found that paresthesia was significantly more reported among patients subjected to no touch technique when compared to the other group (46.15% of patient's vs 23.1% of patients) respectively, p=0.002 as shown in table 2.

Table 3: Difference between study groups concerning postoperative complications (n=52).

	Conventional group (n=26)	No touch group (n=26)	P value
ECG changes Present Absent	 3 (11.54) 23 (88.46)	 1 (3.85) 25 (96.15)	 0.038
Paresthesia	6 (23.1)	12 (46.15)	0.002 C
Wound infection	1 (3.85)	2 (7.7)	0.668 F
Exploration	1 (3.85)	2 (7.69)	0.513 C
Positive troponin	3 (11.54)	1 (3.85)	0.045 F

C; Chi square test. F; Fissure exact test.

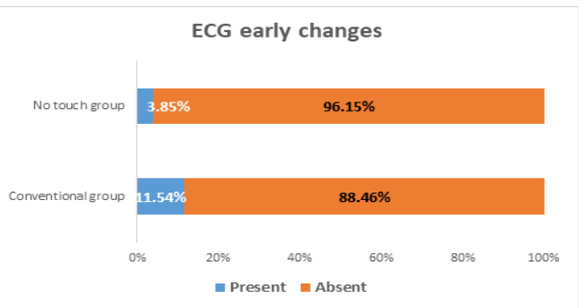

Fig. 6: Difference between study groups concerning follow up early ECG changes.

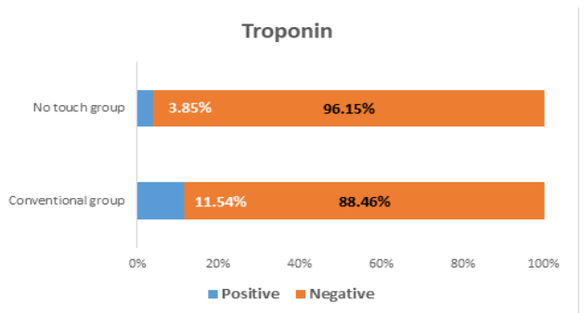

Fig.7: Difference between study groups concerning postoperative troponin serum levels.

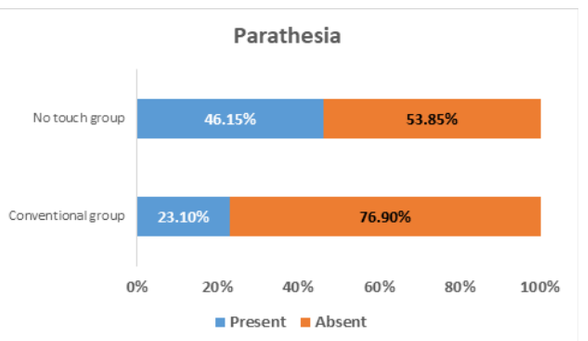

Fig.8: Difference between study groups concerning postoperative paresthesia.

Table 4: Difference between study groups concerning follow up MSCA (n=52).

Venous graft	Conventional group (n=26)	No touch group (n=26)	*P value*
No stenosis	23 (88.46)	25 (96.15)	0.043 C Significant
Significant stenosis	3 (11.54)	1 (3.85)	

C; Chi square test.

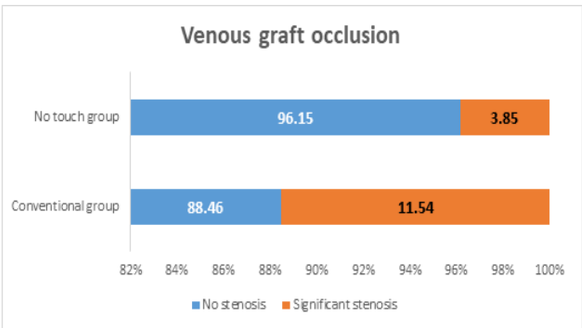

Fig.9: Difference between study groups concerning follow up MSCT results.

Postoperative follow up

All patients were followed up for a duration of 6 months. Multi-slice Coronary angiography was performed for all patients to investigate the patency of venous grafts and delineate any form of either proximal, mid or distal anastomotic stenosis more than 70% of the lumen of the vein graft.

We found that only 11.54% of patients who underwent conventional method (3 patients) developed postoperative significant stenosis. In contrast to those who underwent vein harvesting via no touch technique; among whom 3.85% developed venous graft stenosis as shown in table 3.

Subgroup analysis:

For those with conventional vein harvesting:

We found patients who developed postoperative vein graft occlusion had significantly more BMI when compared to those with no stenosis (p=0.043). on the other hand, no significant association was found between having hypertension and development of venous graft occlusion. Unlike diabetes mellitus, we found that 100% of patients who developed venous graft stenosis were diabetic (p=0.039) as shown in table 4.

We also found that lower EF was significantly associated with development of postoperative venous grafts occlusion when compared to others. This was statistically significant (p<0.001) as shown in table 4.

Table 5: Association between Vein graft occlusion and sociodemographic characteristics among patients subjected to conventional vein harvesting technique.

	Venous graft stenosis (n=3)	No vein graft stenosis (n=23)	*P Value*
Age	62.31 ± 9.91	65.69 ± 5.44	0.294 T
Diabetes mellitus	3 (100)	9(40.9)	0.049 F
Hypertension	2 (66.67)	12 (54.55)	0.238 C
Active smoking	3 (100)	7 (30.43)	1.00 C
BMI	26.92 ± 3.82	24.38 ± 1.94	0.043 T
EF	48.54 ± 6.55	57.92 ± 4.91	<0.001 T

T; independent sample t test. F; Fissure exact test. C; Chi square test.

For those with no-touch vein harvesting:

in the analysis of vein graft occlusion among patients undergoing no touch technique we concluded that sociodemographic variability did not cause any significant confounding as all the p values were found to exceed the accepted level of significance (p > 0.05)

Table 6: Association between Vein graft occlusion and sociodemographic characteristics among patients subjected to No touch technique vein harvesting technique.

	Venous graft stenosis (n=1)	No vein graft stenosis (n=25)	*P Value*
Age	58	65.2 ± 5.9	0.111 Z
Diabetes mellitus	1 (100)	9 (36)	0.385 F
Hypertension	1 (100)	11 (44)	0.937C
Active smoking	0 (0)	9 (36)	1 C
BMI	22	26 ± 3.7	0.1401 Z
EF	55	54 ± 3.2	0.378 Z

Z; z value. F; Fissure exact test. C; Chi square test.

DISCUSSION

It is known that CABG is one of the most complicated procedures as it requires meticulous attention to detail at every stage. Harvesting saphenous veins (SVs) is one of those steps, but it acts as a big concern for the fast atherosclerosis in SV grafts harvested by the conventional method due to rough handling and frequent overdistension (8). On the other hands, the no touch technique, the SV is harvested with its pedicle of perivascular adipose tissue Thus avoiding conduit distention and the subsequent endothelial damage and maintaining blood supply to the media of the SV [9].

There are likely other factors at play in the reduced probability of graft spasm seen with NT vein conduits. The maintenance of the vasa vasorum enable blood to perfuse

through the vein wall from the graft lumen, reducing transmural ischemia damage, intimal hyperplasia and the atherosclerotic progression [10].

That is why in our study, we conducted this study on patients admitted at Kobry El Kobba military cardiac hospital with a diagnosis of severe IHD for CABG (on pump CABG)

Fifty-two patients were invited to participate in the study.

They were randomized into two groups according to the method of SVG harvesting.

• Group A included 26 patients underwent saphenous vein harvesting via the conventional method.

• Group B included 26 patients underwent vein harvesting via no touch technique.

All included patients underwent multi-slice coronary angiography in order to determine the graft patency. We found that 7.6% of all included patients experienced venous graft stenosis. Comparing the two groups; we found that 11.5% of patients undergoing conventional vein graft occlusion. This was compared to 3.8% of patients undergoing no touch vein graft harvesting, which was statistically significant ($p<0.05$).

This was slightly fewer than what was reported by Tian et al. who performed a multi-center study including 2655 patients undergoing CABG in more than 7 hospitals in the duration between April 2017 and June 2019. They were followed up at two intervals at 3 months and one year postoperative. They reported that vein graft occlusion occurred among 2.8% of those undergoing no touch technique compared to 4.8% of those undergoing conventional vein graft harvesting by the end of the third month of the postoperative period, which was statistically significant. [11].

To add on a study was made by Peng et al. who retrospectively studied 767 cases undergoing off-pump CABG from (June 2017 to October 2021). Patients were divided into 2 groups according to the method of vein graft harvesting. Postoperative coronary angiography was performed for all included patients in both groups. They revealed that saphenous vein graft patency was 99.6% for patients underwent no touch technique compared to 96.2% of patients undergoing conventional method. This rate decreased over the first year to reach 97.3% among no touch group versus 93.1% among conventional technique group which was statistically significant. [12].

On the other hand, Deb et al. performed a multi-center study including 250 patients undergoing CABG. They reported that no touch technique was not superior to the conventional method over one year of follow up. Vein graft occlusion occurred among 5.5% of patients experienced the no touch technique compared to 10.6% of patients undergoing the conventional method ($p=0.15$). (10).

In our study, the ECG showed ischemic changes among 11.54% of patients subjected to conventional vein graft harvesting. This was also significantly more than what was found among the other group among whom 3.85% of patients had early ischemic changes.

Regarding lower limb wound infection, The excision of perivascular tissues and skin flaps by the no-touch technique can lead to more tissue damage. In our study, we found that the wound infection was in the form of minimal wound dehiscence and mild amount of serous discharge. It was found in 7.7% NT group compared to only 3.85%. in Conventional group. However, it was not statistically significant. This was much lower than what was reported by Deb et al. who reported a higher rate of wound infection in patients receiving the no-touch technique (23.3% versus 9.5%) of both groups respectively [10].

In our study we measured post operative parathesia and leg wound pain, it was found that paresthesia was significantly more reported among patients subjected to no touch technique when compared to the other group (46.15% of patient vs 23.1% of patients) respectively, $p=0.002$. This was higher compared with Tian et al. Who reported in his study 10.1% of patients underwent no touch technique developed persistent pain and paraesthesia even after 3 months of follow up. Also, was higher than the deb et al who reported 11.2% of no touch group had persistent pain. However, this ratio decreased over the next 9 months to reach 8.4% vs 7% of both groups respectively at the end of the first year of follow up [10].

Our study was the first to make an association between exploration and vein harvesting technique as compared to souza et al 2021 and zhao et al 2021 who only established relation mainly regarding patency rates. In the NT technique, the vein is usually harvested with perivascular tissue and fascia. In addition, the vein is carefully inflated to avoid intimal tear. This could lead to unligated branch which can cause significant bleeding. In our study we found that, 7.69% of patients subjected to no touch venous graft harvesting underwent re-exploration. This was slightly more than what was reported among patients who underwent conventional venous graft harvesting (3.85%). Also, the cause of exploration was not related the unligated branch of saphenous vein. However, this was statistically insignificant ($p=0.513$) [13] [14]

Limitations of the study

- the sample size was relatively small,
- period of follow up in this study was limited to short-term effectiveness due to the short study period (6 months).

- Surgeon bias: there was no blinding of main surgeon to harvesting technique which may introduce bias due to surgeon preferences and experience
- Low generalizability: study was conducted at a single center
- Study did not assess long term outcomes such as quality of life, long term survival or readmission due to cardiac events

CONCLUSION

No touch technique is superior to the conventional method for saphenous vein graft harvesting. They help maintain the patency of the grafts over short follow up period. However, they may be associated with more rates of lower limb wound infections and more numbness and paresthesia in the operated lower limb due to nerve affection.

LIST OF ABBREVIATIONS

CABG	Coronary artery bypass grafting
DM	Diabetes millets
ECG	Electrocardiogram
GSV	The greater saphenous vein
HTN	Hypertension
IHD	Ischemic heart disease
LAD	Left anterior descending artery
LIMA	The left internal mammary artery
MHz	Megahertz
MSCT	Multislice CT
NOS	Nitric oxide synthase
NS	Normal saline
NT	No touch technique
PCI	Percutaneous coronary intervention
SV	Saphenous vein
SVG	The saphenous vein grafts

DECLARATIONS

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Disclosure

The authors report that there was no funding source for the work and declare no conflicts of interest. The research was not supported by any commercial source; there were no financial relationships with any organizations that might have an interest in the submitted work

REFERENCES

1. Caliskan E, De Souza DR, Boening A, Liakopoulos OJ, Choi YH, Pepper J, Gibson CM, Perrault LP, Wolf RK, Kim KB, Emmert MY. Saphenous vein grafts in contemporary coronary artery bypass graft surgery. Nature Reviews Cardiology. 2020 Mar;17(3):155-69.
2. Davidson LJ, Cleveland JC, Welt FG, Anwaruddin S, Bonow RO, Firstenberg MS, Gaudino MF, Gersh BJ, Grubb KJ, Kirtane AJ, Tamis-Holland JE. A practical approach to left main coronary artery disease: JACC state-of-the-art review. Journal of the American College of Cardiology. 2022 Nov 29;80(22):2119-34.
3. 3 Farina P, Gaudino MF, Taggart DP. The eternal debate with a consistent answer: CABG vs PCI. InSeminars in thoracic and cardiovascular surgery 2020 Mar 1 (Vol. 32, No. 1, pp. 14-20). WB Saunders
4. Nolte A, Secker S, Walker T, Greiner TO, Neumann B, Simon P, Ziemer G, Wendel HP. Veins are no arteries: even moderate arterial pressure induces significant adhesion molecule expression of vein grafts in an ex vivo circulation model. The Journal of cardiovascular surgery. 2011 Apr 1;52(2):251-9.
5. Souza DS, Dashwood MR, Tsui JC, Filbey D, Bodin L, Johansson B, Borowiec J. Improved patency in vein grafts harvested with surrounding tissue: results of a randomized study using three harvesting techniques. The Annals of thoracic surgery. 2002 Apr 1;73(4):1189-95.
6. Papakonstantinou NA, Baikoussis NG, Goudevenos J, Papadopoulos G, Apostolakis E. Novel no touch technique of saphenous vein harvesting: Is great graft patency rate provided?. Annals of Cardiac Anaesthesia. 2016 Jul 1;19(3):481-8.
7. Thielmann M, Bonaros N, Barbato E, Barili F, Folliguet T, Friedrich G, Gottardi R, Legutko J, Parolari A, Punjabi P, Sandner S. Hybrid coronary revascularization. European Journal of Cardio-Thoracic Surgery. 2024 Aug;66(2):ezae271.
8. Hwang HY, Paeng JC, Kang J, Jang MJ, Kim KB. Relation between functional coronary artery stenosis and graft occlusion after coronary artery bypass grafting. The Journal of Thoracic and Cardiovascular Surgery. 2021 Mar 1;161(3):1010-8.
9. Kopjar T, Dashwood MR. Towards endoscopic no-touch saphenous vein graft harvesting in coronary bypass surgery. Brazilian journal of cardiovascular surgery. 2022 Sep 5;37(spe1):57-65.

10. Deb S, Singh SK, de Souza D, Chu MW, Whitlock R, Meyer SR, Verma S, Jeppsson A, Al-Saleh A, Brady K, Rao-Melacini P. SUPERIOR SVG: no touch saphenous harvesting to improve patency following coronary bypass grafting (a multi-centre randomized control trial, NCT01047449). Journal of cardiothoracic surgery. 2019 Dec;14:1-0.

11. Tian M, Wang X, Sun H, Feng W, Song Y, Lu F, Wang L, Wang Y, Xu B, Wang H, Liu S. No-touch versus conventional vein harvesting techniques at 12 months after coronary artery bypass grafting surgery: multicenter randomized, controlled trial. Circulation. 2021 Oct 5;144(14):1120-9.

12. Peng Z, Zhao R, Liu Z, Liu Y, Yang Y, Yang X, Hua K. The No-Touch saphenous vein harvesting improves graft patency after off-pump coronary artery bypass surgery: a propensity-matched analysis. Brazilian Journal of Cardiovascular Surgery. 2022 Sep 5;37:69-78.

13. Samano N, Souza D. No-touch saphenous vein grafts in coronary artery bypass surgery. State of the Art Surgical Coronary Revascularization. 2021 Feb 4:243.

14. Zhao TY, Bu JQ, Gu JJ, Liu Y, Zhang WL, Chen ZY. The Short-Term Patency Rate of a Saphenous Vein Bridge Using the No-Touch Technique in off-Pump Coronary Artery Bypass Grafting in Vein Harvesting. International Journal of General Medicine. 2021 Jun 3:2281-8.

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