Original paper

The saphenous vein harvest procedure affects the arteriovenous system and postoperative wound healing in patients following coronary aortic bypass surgery

Wpływ techniki operacyjnej pobrania żyły odpiszczelowej na wydolność tętniczo-żylną oraz proces gojenia się rany pooperacyjnej u pacjentów z chorobą niedokrwienną serca poddanych rewaskularyzacji chirurgicznej

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Słowa kluczowe: zakażenie miejsca operowanego, wskaźnik kostka–ramię, żyła odpiszczelowa.

Abstract

Introduction: One of the parts of the coronary artery bypass grafting (CABG) or off-pump coronary artery bypass grafting (OPCAB) process is the collection of vascular material, which is then employed as a coronary aortic bypass due to the large number of coronary vessels necessitating an aorto-coronary bypass. An invasive surgical operation called saphenous vein harvest, also known as the great saphenous vein (GSV), has the potential to cause surgical site infection (SSI). There are currently 2 methods for harvesting GSV: the conventional method open vein harvest (OVH) and the endoscopic, minimally invasive method endoscopic vein harvest (EVH). The clinical issue is whether the GSV harvest approach can influence the patient's lower limb arteriovenous systems and help to lessen postoperative problems.
Aim of the research: To analyse the healing of a surgical incision on the lower limb and the effect of GSV harvest methods on the arteriovenous system.
Material and methods: In the study period May–September 2022, 60 patients with ischaemic heart disease, who were scheduled for surgical heart revascularization, were included. Clinical information was collected from 60 patients who met the inclusion criteria and were split into 2 groups at random.
Results and conclusions: The arteriovenous system of the lower extremities was unaffected by either the OVH or EVH methods utilized to harvest GSV. The OVH approach resulted in a higher rate of SSI in patients with an elevated risk of SSI based on the BHIS scale, particularly in individuals with atherosclerosis of the lower limbs.

Streszczenie

Wprowadzenie: Jednym z etapów pomostowania aortalno-wieńcowego (CABG) jest pobranie materiału żylnego, który następnie jest wykorzystywany jako pomost aortalno-wieńcowy, ze względu na dużą liczbę naczyń wieńcowych wymagających pomostowania. Pobranie żyły odpiszczelowej (GSV) jest inwazyjną procedurą chirurgiczną, która może prowadzić do zakażenia miejsca chirurgicznego (SSI). Istnieją dwie metody pobrania GSV: metoda klasyczna (OVH) oraz małoinwazyjna metoda endoskopowa (EVH). Problem kliniczny stanowi, jak techniki pobrania GSV mogą wpłynąć na układ tętniczo-żylny kończyny dolnej oraz pomóc w zmniejszeniu problemów pooperacyjnych.
Cel pracy: Analiza gojenia się miejsca operowanego na kończynie dolnej oraz wpływ techniki pobrania GSV na układ tętniczo-żylny.
Materiał i metody: Do badań, które trwały od maja do września 2022 r., włączono 60 pacjentów z niedokrwienną chorobą serca, u których zaplanowano chirurgiczną rewaskularyzację serca. Dane kliniczne zebrano od 60 pacjentów, którzy spełnili kryteria włączenia. Zostali oni losowo podzieleni na 2 grupy.

Wyniki i wnioski: Techniki OVH oraz EVH wykorzystywane do pobrania GSV nie wpłynęły na układ tętniczo-żylny operowanych kończyn dolnych. Technika OVH prowadziła do wyższego odsetka występowania SSI u pacjentów z podwyższonym ryzykiem SSI według skali Brompton and Harefield Infection Score, szczególnie u pacjentów z miażdżycą tętnic kończyn dolnych.

Introduction

Aorto-coronary bypass grafting with or without extracorporeal circulation is the mainstay of treatment for patients with multivessel coronary disease, comprising coronary artery bypass grafting (CABG) or off-pump coronary artery bypass grafting (OPCAB) [1, 2]. The CABG or OPCAB surgery requires collection of vascular material, which is then employed as a coronary aortic bypass [3, 4]. An invasive surgical operation called saphenous vein harvest is used (the saphenous vein is also known as the great saphenous vein (GSV)). There are currently 2 methods for harvesting GSV, the conventional method – open vein harvest (OVH) and the endoscopic, minimally invasive method – endoscopic vein harvest (EVH). Any surgical procedure has the potential to cause surgical site infection (SSI). In GSV harvest, SSI occurs between 1% and 24% of the time [5]. The aim of this study was to determine the likelihood of postoperative surgical site infection based on the GSV harvesting technique and its effects on the arteriovenous system of the lower extremities.

Aim of the research

The study's objectives are to analyse the healing of a surgical incision on the lower limb and the effect of GSV harvest methods on the arteriovenous system.

Material and methods

In the study period May–September 2022, 60 patients with ischaemic heart disease, who were scheduled for surgical heart revascularization, were included. Clinical information was collected from 60 patients who met the inclusion criteria and were split into 2 groups at random.

Inclusion criteria: under 80 years of age, planned coronary cardiac surgery using the saphenous vein as a coronary bypass, Brompton and Harefield infection score (> 2 points on the BHIS scale) indicating a medium or high risk of SSI [6] (Table 1).

Exclusion criteria: age over 80 years, pregnancy, low risk of SSI, patient did not consent to surgery.

Each group comprised 30 patients. GSV was extracted from each patient group using a unique surgical procedure. The traditional approach (OVH) was employed in group I, and the endoscopic method (EVH) was used in group II. Using the Scoring System for Saphenous Vein, a favourable intraoperative macroscopic evaluation of the harvested venous channel was carried out. The GSV was then put through a leak test. Additionally, a blood sample was taken to measure the level of D-dimers, and an ankle-brachial index (ABI) was done on the day of admission to the ward and after surgery to examine the impact of the GSV harvest on the arteriovenous system of the operated limb. Patients with elevated D-dimer levels after surgery underwent an ultrasound pressure test to rule out or confirm a suspected deep and superficial vein thrombosis.

On the 14th postoperative day, the wound of the operated site was confirmed using a customized questionnaire made up of critical elements in the evaluation of the wound healing process. The wound of the operated site after GSV harvest was evaluated each time during the dressing change. The guidelines for HAI-Net SSI (Healthcare-Associated Infections; Surgical Site Infections) were used to create the survey [7] (Tables 2, 3).

Table 1. Brompton and Harefield Infection Score scale

Parameter	Points
Diabetes or $HbA1_c$ > 7.5%	1 or 3
Obesity I or II degree	1
EF < 45%	1
Female	2
Emergency treatment	2

Techniques for conducting the D-dimer test

The patient's blood was taken from an arm vein as part of a regular blood sample for morphology to assess the patient's D-dimer level. The results are presented in μg/l.

Table 2. Preoperative patient data

Parameter	OVH (*n* = 30)	EVH (*n* = 30)
Gender [female/male]	9/21	8/22
Age [years]	39–75, average: 65	44–79, average: 65
Medium SSI risk according to BHIS	27	25
High SSI risk according to BHIS	3	5

OVH – open vein harvest, EVH – endoscopic vein harvest, BHIS – Brompton and Harefield Infection Score, SSI – surgical site infection.

Table 3. Operational patient data

Parameter	OVH (*n* = 30)	EVH (*n* = 30)
CABG/OPCAB	20/10	24/6
GSV is not tight	2	8
Coronary flow through SV [ml/min]	21–123, average: 62	19–165, average: 67
Counter-pulsation index [PI]	0.7–2.3, average: 1.0	0.6–2.5, average: 1.1

CABG – coronary artery bypass grafting, OPCAB – off-pump coronary artery bypass grafting, GSV – great saphenous vein.

Figure 1. Intraoperative open vein harvest

Figure 2. Intraoperative endoscopic vein harvest

The ABI test was conducted using the following methodology

After 5 min of adaptation, the patient underwent the ABI study while lying flat. Following measurements on both brachial arteries, the arterial pressure in the foot arteries was recorded after accounting for the greater number, which is thought to represent the systolic pressure in the aorta (posterior tibial and dorsal). Using a “blind Doppler” and ultrasound at a frequency of 5–10 MHz, the systolic pressure value was calculated.

Ultrasound pressure test

Patients were examined while lying flat on their back. On the operating limb, pressure was applied to the femoral and popliteal veins.

Saphenous vein harvest techniques

Classic

A skin incision was created over the medial ankle toward the knee joint. The length of the skin incision was roughly 25 cm. GSV was harvested with common surgical instruments (Figure 1).

Endoscopic

To reach the knee joint, a 2-cm incision was created over the medial ankle. Below the knee joint, the remaining 2 cm of the incision were made. GSV was obtained using endoscopic surgical tools (Figures 2, 3).

Figure 3. Surgical instruments for endoscopic vein harvest

Statistical analysis

Microsoft Excel and Statistica version 13.3 PL from StatSoft were used to perform statistical analyses and create graphics.

The verification of the statistical hypotheses concerning the study of the statistical significance of the percentage difference was carried out using the test for 2 fractions (proportions). The commonly used $\alpha = 0.05$ was adopted as the level of significance.

Table 4. Ankle-brachial index (ABI) among patients

ABI	OVH (*n* = 30)	EVH (*n* = 30)
Before the surgery	0.5–1.3, average: 1.1	0.4–1.2, average: 1.0
After the surgery	0.5–1.2, average: 1.1	0.4–1.3, average: 1.0

Table 5. D-dimers concentration among patients

D-dimers	OVH (*n* = 30)		EVH (*n* = 30)	
	< 500 μg/l	> 500 μg/l	< 500 μg/l	> 500 μg/l
Before the surgery	22	8	20	10
After the surgery	10	20	9	21

Table 6. Ultrasound pressure testing in patients with increased concentrations of D-dimers

Pressure test	OVH (*n* = 11)	EVH (*n* = 13)
Positive	0	0
Negative	20	21

Figure 5. Surgical procedure of endoscopic vein harvest

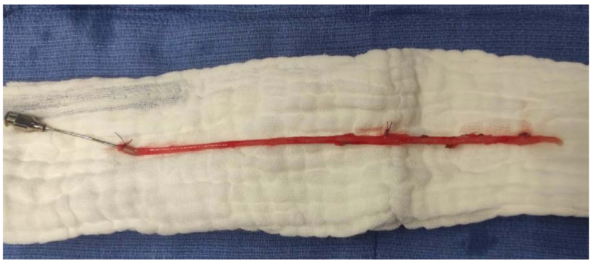

Figure 4. Great saphenous vein

Figure 6. Surgical site infection

Results

According to the BHIS scale, each participant in the study was categorized as having a low, moderate, or high risk of SSI. The patients in both groups were 65 years old on average, with a considerable, almost threefold predominance of men (Tables 4–6).

Both the OVH and EVH procedures were employed to harvest all the GSVs, which were then utilized during the treatment as a coronary aortic bypass. Based on the GSV rating system, the platform's quality was evaluated [8]. A macroscopic evaluation was performed on the vessel's thickness, diameter, number of varicose veins, and lining. GSV received a very good score of around 6 points and was approved in each group (Figure 4). In the OVH group, the intraoperative GSV leak test received higher ratings. To ensure that the GSV obtained via the EVH approach was completely tight, extra surgical preparation (metal staples, vascular sutures) was necessary. No impact was seen on the outcomes of the coronary flow or the pulsatility index (PI) despite the baseline difference in GSV tightness. The flow and PI were similar in both groups. In both the OVH and EVH groups, the postoperative values of the ABI index remained unchanged from the preoperative values. The D-dimer concentrations were elevated in half of the patients in both groups; however, the pressure test conducted on these patients disqualified the possibility of thrombosis. SSIs were more prevalent in the OVH group than in the EVH group. It was discovered that the percentages for the OVH method were much greater than for the EVH in the cases of discomfort and functional difficulties, purulent discharge at the site of the incision, and wound dehiscence (Figures 5, 6). The haematoma percentage of the EVH method was much higher than for the OVH method in this case. The percentage differences between the 2 approaches did not differ significantly for oedema, redness, fever, or necrotic tissues (Figure 7). Additionally, the OVH group's occurrence of SSI was highly influenced by the ABI index value of 0.9 (Tables 7–9, Figure 8).

Figure 7. Surgical site infection (necrosis)

Table 7. Presence of specific SSI complications on day 14 after surgery. Open vein harvest versus endoscopic vein harvest

Parameter	OVH (*n* = 30)	EVH (*n* = 30)	*P*-value
Pain and functional disorders	8 (26.67%)	2 (6.67%)	0.02
Redness or fever > 38°C	7 (23.33%)	3 (10.00%)	0.08
Haematoma	12 (40.00%)	19 (63.33%)	0.04
Oedema	15 (50.00%)	13 (43.33%)	0.3
Purulent discharge at the incision site	3 (10.00%)	0 (0.00%)	0.04
Separation of the edges of the wound	3 (10.00%)	0 (0.00%)	0.04
Necrotic tissues	1 (3.33%)	0 (0.00%)	0.16

Table 8. Comparison of the occurrence of SSIs among OVH patients with and without lower extremity artery disease (LEAD)

Parameter	ABI < 0.9 (*n* = 7)	ABI > 0.9 (*n* = 23)	*P*-value
Pain and functional disorders	4 (57.14%)	4 (17.39%)	0.02
Redness or fever > 38°C	2 (28.57%)	5 (21.74%)	0.4
Haematoma	2 (28.57%)	10 (48%)	0.2
Oedema	5 (71.43%)	10 (43.48%)	0.1
Purulent discharge at the incision site	1 (14.29%)	2 (8.70%)	0.3
Separation of the edges of the wound	2 (28.57%)	1 (4.35%)	0.03
Necrotic tissues	1 (14.29 %)	0 (0%)	0.03

Table 9. Comparison of the occurrence of SSIs among EVH patients with and without lower extremity artery disease (LEAD)

Parameter	ABI < 0.9 (*n* = 8)	ABI > 0.9 (*n* = 22)	*P*-value
Pain and disorders	2 (25.00%)	0 (0%)	0.01
Redness or fever > 38°C	0 (0%)	3 (13.64%)	0.1
Haematoma	4 (50%)	15 (68.18%)	0.2
Oedema	5 (62.50%)	8 (36.36%)	0.1
Purulent discharge at the incision site	0 (0%)	0 (0%)	–
Separation of the edges of the wound	0 (0%)	0 (0%)	–
Necrotic tissues	0 (0%)	0 (0%)	–

Figure 8. A "healthy" wound after surgery

Discussion

Both the ABI index and the ultrasonic pressure test are non-invasive, widely accessible, and essential for perioperative diagnosis. The venous system was not significantly impacted by either OVH or EVH. Venous thromboembolism, a common venous condition, can result in pulmonary embolism. Venous thromboembolism, which causes pulmonary embolism, has a high fatality rate of 15–25% [9]. Age over 40 years, heart disease, and leg surgery are among the major risk factors for thromboembolism. Candidates for aortic-coronary bypass surgery frequently exhibit the aforementioned characteristics. Almost 70% of thromboses are asymptomatic [10]. Therefore, the level of D-dimers was established for the initial diagnosis following surgery. Stable fibrin degrades into D-dimers as it breaks down. Although D-dimer is a sensitive parameter for fibrin, its specificity for venous thromboembolism is low (in the range 40–60%). Therefore, D-Dimers are used as a test of exclusion of venous thromboembolism because this parameter has very high negative predictive value. When a patient develops thromboembolism, its levels may go above 500 g/l. The study found that 20 patients in the OVH group and 21 patients in the EVH group had elevated D-dimer levels above 500 g/l. A thrombosis that develops after the saphenous vein is harvested may be linked to this clinical condition, which may also be the body's natural response to prior heart surgery [11]. To rule out deep vein thrombosis and broaden the diagnosis, an ultrasound pressure test was performed on the group of patients who had increased D-dimers following the procedure. A total of 41 patients from both groups underwent a negative pressure test, which eventually eliminated any possibility of venous thromboembolism. It should be emphasized that by the third day after surgery, the patients had recovered. No impact of GSV consumption on the vascular system of the lower extremities was seen in either patient group. The preoperative and postoperative ABI values were the same in the OVH and EVH groups. It is evident that the blood flow to the lower limb is unaffected by the GSV harvest. However, there are noticeable changes in the wound healing of the lower limb after surgery. In the OVH group, SSI-related complications are significantly more frequent. Patients with lower limb atherosclerosis (an ABI value of 0.9) were present in both groups. Lower limb atherosclerosis affects one in 4 patients with coronary artery disease (LEAD) [12]. The results show that the presence of LEAD increases the likelihood of SSI in OVH patients. As a result, preventive ABI testing should be advised for every patient who is a candidate for CABG or OPCAB, to ascertain whether the patient has LEAD, which increases the risk of SSI. Currently, intermittent claudication-related questions and pulse palpation are the only preoperative tests available in the cardiac surgery ward to identify LEAD. In their study, Spannbauer *et al.* found that only 10% of intermittent claudication is symptomatic and experienced by patients, and that 14% of those who do so correctly estimate the distance of the claudication [13]. This highlights how useless intermittent claudication diagnosis is, making it essential to employ the ABI test. In patients with EVH, the operated limb had greater haematomas. This might be the result of bleeding from the distal GSV siding. The side is tied off at the OVH with a 2.0 garter, making it obvious to the surgeon removing the vessel. Contrarily, in EVH, sidings were clipped using an endoscopic clipper when visibility was poorer and access was more challenging, which may have contributed to the vascular clip occasionally rolling off the siding and bleeding from the distal region. To avoid injuring the GSV tissue, the tightness of the GSV was tested intraoperatively by injecting a fluid (NaCl 0.9% + heparin) at a pressure of 50–100 mm Hg [14]. Similarly to EVH, the harvested GSV needed additional surgical care and a vascular suture. It is nevertheless important to keep in mind that the aforementioned issues could be brought on by the surgeon's steep learning curve and lack of prior expertise when collecting GSV using the EVH approach.

Conclusions

The arteriovenous system of the lower extremities was unaffected by either the OVH or EVH methods utilized to harvest GSV. The OVH approach resulted in a higher rate of SSI in patients with an elevated risk of SSI based on the BHIS scale, particularly in individuals with atherosclerosis of the lower limbs. The diagnosis of frequently asymptomatic LEAD, which increases the risk of SSI, and the use of the EVH technique – which is more expensive than the OVH technique but may significantly reduce the risk of SSI and shorten the hospitalization time of patients – will be made possible by the use of the ABI index in patients qualified for coronary artery bypass surgery.

Conflict of interest

The authors declare no conflict of interest.

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