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Minimally invasive saphenous vein harvesting for coronary artery bypass grafting – comparison of three less invasive methods

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SUMMARY

Introduction: *Saphenous vein is routinely harvested using one or a few long continous skin incisions. This method is associated with typical healing complications such as oedemas, pain, necrosis, what often restricts proper rehabilitation. An alternative minimally invasive techniques may decrease these complications.*
Material and methods: *This prospective randomised trial compared outcomes associated with saphenous vein harvested using three minimally invasive techniques versus a traditional longitudinal incision.*
Results: *In the less invasive group we observed statistically significant improvement in all estimated parameters of wound healing, oedemas and pain. We present also costs analysis between the groups.*
Conclusions: *We conclude that less invasive techniques of saphenous vein harvesting may be alternatively introduced in coronary bypass surgery.*

INTRODUCTION

Apart from the internal mammary artery, the great saphenous vein (SV) is still the vessel of choice for coronary artery bypass graft [1,2].

The traditional method of harvesting the saphenous vein for coronary revascularization, by an extended lower extremity incision, is associated with several complications. Although severe wound complications are rare 1–3%, there are many minor complications, including oedema, cellulitis, ischemic skin flaps, dermatitis, and saphenous neuralgia, ranging between 24 and 44%. These complications lead to a prolonged hospital stay and cause patients dissatisfaction with the surgical experience [1–6].

The potential benefits from minimally invasive SV harvesting include decreased wound complication rate, lower extremity pain, earlier mobility and ambulation [1,2,7,8].

This prospective, randomised trial compared outcomes associated with SV harvested using three less invasive techniques versus a standard excision method.

In addition, the following clinical parameters were also assessed: quality of harvested conduit (evaluated macroscopically), improvement of early rehabilitation (wound healing, existence of haematomas, oedemas and pain) and additional treatment costs.

MATERIAL AND METHODS

Sixty consecutive patients undergoing coronary artery bypass surgery were randomised prospectively into four groups.

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Patients in groups I - III ('less invasive' groups) had their greater SV harvested using a minimally invasive methods. In group I Mini Harvest System (Auto Suture, USSC, Norwalk, CT) was used. Patients from group II were operated with the aid of Endopath System (Ethicon Endo - Surgery), and in the group III vein was harvested using Vaso View™ System (Origin). Patients from group IV were treated with standard open method.

Exclusion criteria included: emergent operation, presence of leg decubitus ulcerations, and extensive crural varices.

Operative procedures

Mini Harvest System – Auto Suture, USSC, Norwalk, CT is a disposable set, composed of a retractor coupled to a cold light source. Retractor can be fixed to a support.

The SV was harvested by a few 3–4 cm skin incisions along the course of the vein. Incision in the ankle and the knee areas were avoided. With this kind of approach the SV was prepared under the skin bridges.

Endopath System – Ethicon Endo Surgery consists of subcutaneous dissector (Endopath Subcu–Dissector), subcutaneous retractor equipped with endoscope (Endopath Subcu–Retractor), and the vein dissector (Endopath Vein Dissector). Endopath System requires: 5 x 300 mm endoscope; 3 chip camera; light source, and 19 inch monitor (Storz).

In these cases harvesting was based on 3–4 cm long incision in the course of the vein just above the knee.

After the vein exposure an endoscope was inserted in the endopath subcu – dissector. Under endoscopic control a tunnel along the vein was created. Afterwards the subcutaneous retractor was inserted. The vein was prepared and harvested under video control with the use of endoscopic dissector and other endoscopic instruments.

Endoscopic harvesting of the SV by using Vaso View™ System – Origin requires 10 x 400 mm endoscope compatible of dissector (Vaso View Balloon Dissection Cannula) and working device with orbital dissector (Vaso View Orbital Dissection Cannula).

Harvesting technique was based on 1–1.5 cm incision in the course of the vein above the knee joint. Dissector with a balloon (Vaso View Balloon Dissection Cannula) was inserted through the incision and, under endoscopic control, subcutaneous tunnel was created. Then the air tight seal (10 mm Blunt Tip Trocar) was inserted and the tunnel was insuflated with CO_2 creating subcutaneous emphysema. Using the orbital dissector (Vaso View Orbital Dissection Cannula), under video control, the main stem of the vein was separated. Through an additional instrumental port bipolar coagulating scissors was inserted for separation, coagulation and dissection of side branches. Main stem was clipped and dissected at the groin near its ostium.

In the IV group of patients vein was harvested with the open, standard method using a long skin incision on the course of the harvested vessel.

In all cases side-branches were closed with the use of ligaclips, the subcutaneous tissue was sutured with absorbable suture 3–0. Skin was closed with continuous, absorbable, intracutaneous 4–0 suture.

Clinical parameters

– Demographic data
– Length of the harvested vein (cm)
– Length of the incision and cumulative length of the incisions (cm)
– Wound healing
– Presence of haematoma, oedema and pain
– Macroscopic quality of the harvested SV.

The following was used as a guideline: Grade 1: mechanical vein damage requiring additional suturing, Grade 2: presence of varicous widening, Grade 3: termal injury associated with the use of bipolar coagulation. Significant, major, mechanic or termal damages were criteria of disqualification of harvested material. Minor injures lowered the assesement.

Quality and length of the harvested vein was estimated by operating surgeon.

Evaluation of cumulative skin incisions lengths, wound healing process and the presence of haematomas was done on the 7th day after operation.

Presence of oedemas was assessed on the base of both lower legs circumference, on the 4 levels (foot, ankle joint and 10 cm above and below the knee). Difference of more than 1cm of the circumference length measured on 4 levels was significant.

On the 7th day after operation patients were also asked to fill the questionnaire concerning local pain classified as moderate (not requiring treatment) and severe (requiring farmacotherapy)

Statistical analysis

Statistic analysis was based on Student's t test for non parametrical variables and on Fisher test for parametrical variables. $p > 0.05$ was stated as statistically significant.

RESULTS

All groups were demographically similar (Table 1). Mean operation time was prolonged in investigated groups what was influenced by harvesting time. However all differences were not statistically significant (Table 2).

Revascularization with the use of left internal thoracic artery was performed in all cases. Average number of venous bypasses was 1.8 to 2.2. Differences were not statistically significant. Statistically significant differences were noted in the cumulative length of the leg's skin incisions after vein harvesting. Particularly high statistical significance was observed between group II and IV and between III and IV. Taking into account topography of vein harvesting, it was stated that in the II and III group where the endoscopic method was used, significantly more often vein was harvested only from the femoral part of the leg (Table 2).

Negative influence on macroscopic evaluation of the vein was not observed. In all groups of patients macroscopic assessment of harvested vein in order to qualify it to coronary revascularization was positive, and differences not statistically significant (Table 3).

Table 1. Preoperative Demographics.

	Group I (n = 15)	Group II (n = 15)	Group III (n = 15)	Group IV (n = 15)	PI, II, III vs IV
Mean age	56.8±12.3	59.2±10.4	60.1±6.3	61.4±7.1	NS
Sex (F/M)	5/10	3/12	4/11	4/11	NS
Obesity	4 (26.6%)	3 (20.0%)	4 (26.6%)	5 (33.3%)	NS
Diabetes	2 (13.3%)	2 (13.3%)	3 (20.0%)	1 (6.6%)	NS
Peripheral vascular disease	1 (6.6%)	1 (6.6%)	2 (13.3%)	1 (6.6%)	NS

Table 2. Operative Variables

	Group I (n = 15)	Group II (n = 15)	Group III (n = 15)	Group IV (n = 15)	P
CPB time(min)	67.3±9.4	62.2±8.2	64.2±5.7	63.2±8.1	NS
Operation time (min)	173,1±15.4	184,4±12.4	186,2±9.4	132,6±15.8	NS
No. of venous graft	2. 1±1. 2	1. 8±1. 9	2. 0±1. 6	2. 2±1. 2	NS
Harvesting time (min)	37.3±4.5	43.4±5.4	39.4±7.2	35.4±5.3	NS
Length of the veins (cm)	33.2±9.8	29.5±8.1	34.3±11.2	36.2±9.6	NS
Cumulative length	15.3±3.1	7.4±1.2	3.5±1.6	36.1±12.1	I:IV<0.05, II:IV<0.001, III:IV<0.001
Length of one incision	4.6±1.8	5.4±0.7	2.5±0.6	—	—

Table 3. Vein Quality

Vein quality	Group I (n = 15)	Group II (n = 15)	Group III (n = 15)	Group IV (n = 15)	PI, II, III vs IV
Good	14 (93.4%)	13 (86.2%)	14 (93.4%)	14 (93.4%)	NS
Fairly good	1 (6.6%)	2 (13.2%)	1 (6.6%)	1 (6.6%)	NS
Bad	0	0	0	0	NS

On the 7th day postoperatively, all patients were analysed for wound healing assessment and the presence of hematoma, oedema and pain.

A correct wound healing was observed in all cases from III group and in 93.4% and 86.8% patients from group I and II, respectively. Correct wound healing was noted only in 67% from the control group (IV). Differences were statistically significant.

Inflammatory process of minor degree was noted in 6.6% patient from the I group, in 13.2% patients from the II group and 26.4% patients from the IV group. Differences were not statistically significant. Marginal skin necrosis requiring surgery intervention was stated in 6.6% patients from IV group (Table 4).

Presence of haematomas was observed in all groups of patients, the majority of them, however, were slight haematomas located in the area of incisions not requiring additional surgery intervention. Statistically significant lower frequency concerning haematomas occurrence was noted in studied groups. A massive haematoma of subcutaneous tissue of medial thigh was observed in one case from the control group (Table 5).

Leg oedemas were observed in 11 cases from control group and in 1 case from I group. The difference was statistically significant (Table 5).

DISCUSSION

Minimally invasive surgical techniques have now entered the area of saphenous vein harvesting. Multiple open techniques have been used for SV harvesting, ranging from a one long continuos incision, to leaving a skin bridge at the knee region, to multiple small incisions.

Minimally invasive vein harvesting techniques offer the promise of fewer and smaller leg incisions, which translates into less pain, decreased wound complication rate, earlier ambulation and shorter hospital stays [8].

Conventional SV harvesting is also associated with lymphatic channel injury and can lead to oedemas of the operated leg. The reduced postoperative oedema is likely to be a result of the tissues' sparing [2].

Female sex, obesity, diabetes mellitus, and peripheral vascular disease have been reported as preoperative risk factors for potential leg wound complications [2]. In the present study, these factors are not different between the groups.

In all less invasive techniques groups better wound healing process were observed. It's supposed that introducing a new technique shortening the length of skin incisions (group I), significantly improved the wound healing process. Further minimalisation of skin incisions by introducing endoscopic meth-

Table 4. Wound healing

Wound healing	Group I (n = 15)	Group II (n = 15)	Group III (n = 15)	Group IV (n = 15)	PI, II, III vs IV
Correct	14 (93.4%)	13 (86.8%)	15 (100%)	10 (66.6%)	I:IV- NS, II:IV- NS III:IV<0.05
Inflammation	1 (6.6%)	2 (13.2%)	0	4 (26.4%)	-
Necrosis	0	0	0	1 (6.6%)	-
Dehiscence	0	0	0	0	-

Table 5. Presence of haematoma, oedema and pain

Wound healing	Group I (n = 15)	Group II (n = 15)	Group III (n = 15)	Group IV (n = 15)	PI, II, III vs IV
HaematomaNo	13 (86.8%)	12 (80.0%)	14 (93.4%)	4 (33.4%)	p<0.05
Small	2 (13.2%)	3 (20.0%)	1 (6.6%)	10 (66.6%)	III:IV<0.05
Diffuse	0	0	0	1 (6. 6%)	-
Oedema	1 (6.6%)	0	0	11 (73. 3%)	p<0.05
Pain	0	0	0	6 (40.0%)	-

ods additionally improved cosmetic effect. Average incisions length reduction was 50% in the 1st group comparing to the control group, in the 2nd and 3rd group reached almost 90% (Table 2).

These methods (especially endoscopic Vaso View technique) contributed to a particularly precise operating procedure by a perfect visualisation of operation field and a possibility to use endoscopic instruments.

Because aorto-coronary bypass grafting (and SV harvesting) is the most common cardiac surgical intervention, any technique that could reduce the complication rate would have a dramatic impact on the health care delivery system [9]. The traditional method of saphenous vein harvesting is associated with morbidity rate as great as 24% which is not as marginal as it could be thought [3].

Costs of novel less invasive instruments are also high. In Poland, the cost of one disposable set 'Mini Harvest System' (Auto Suture, USSC, Norwalk, CT) is approximately 120$, 'Endopath System' (Ethicon Endo Surgery) and 'Vaso View™ System' (Origin) about 500$ each. It is supposed, however, that with widespread use of sets (especially endoscopic ones), their costs should drop.

In our opinion elevated costs of using less invasive methods are balanced by benefits for patient: improvement in the first period of rehabilitation (elimination of pain, oedema and proper wound healing) achieving the best cosmetic result and finally better acceptation and overall improved patient satisfaction with the surgical experience.

Only long-term longitudinal follow-up will adequately address whether graft patency is influenced by harvest method.

CONCLUSIONS

This prospective, randomised trial demonstrated that each of the introduced less invasive method improves the operation's results what can be seen in significant reduction or elimination of wound healing complications. We conclude that less invasive techniques of saphenous vein harvesting may be alternatively introduced in coronary bypass surgery.

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