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Comparison of electrocautery and LigaSure™ vessel sealing system in radial artery harvesting as coronary artery bypass surgery conduit: A prospective, randomized study

Murat Ökten, Beril Okur, Mehtap Akbaba, Şahin Şenay, Hasan Karabulut

Department of Cardiovascular Surgery, Acıbadem Mehmet Ali Aydınlar University, Istanbul, Turkey

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ABSTRACT

Objectives: In this study, we aimed to compare the efficiency of electrocautery with the LigaSure™ vessel sealing system.

Patients and methods: This randomized study included a total of 53 patients (44 males, 9 females; mean age: 63.7±8.4 years; range, 39 to 83 years) who underwent coronary artery bypass grafting (CABG) for radial artery (RA) harvesting with electrocautery or LigaSure™ vessel sealing system between January 2019 and September 2019. The patients were randomly assigned into two groups. Group 1 consisted of 27 patients operated with the LigaSure™ small jaw sealer/divider and Group 2 consisted of 26 patients operated with electrocautery. The length of the conduit, the amount of intraoperative blood loss, the number of hemostatic clips before and after the anastomosis, the amount of postoperative blood loss, the number of ecchymoses, hematoma and infection are compared.

Results: The amount of blood loss from the beginning of harvesting to the end of the closure of the skin of left arm was significantly lower in Group 1 ($p=0.004$). The difference in the number of hemostatic clips before and after the anastomosis of RA to coronary artery was statistically significantly lower in Group 1 ($p<0.001$ and $p<0.001$, respectively). There was no statistically significant difference in the amount of blood loss postoperatively ($p>0.6$), number of ecchymoses ($p>0.1$), and postoperative hematoma ($p>0.1$) and infection ($p>0.03$) between the groups.

Conclusion: Our study results suggest that the LigaSure™ vessel sealing system is a better option of RA harvesting, particularly in patients who are prone to bleed.

Keywords: Cardiovascular pathology, coronary arteries, coronary circulation.

The radial artery (RA) is an excellent and a widely used conduit in coronary artery bypass grafting (CABG) owing to its own anatomical advantages for coronary revascularization. It is the most commonly used conduit after left internal mammary artery.[1] The major advantages are its muscular wall adapting to the arterial blood pressures, the luminal diameter that is 1.8 to 2.7 mm in local populations which is similar to that of the coronary arteries,[2] and the length that is >20 cm.[3] Also, as an arterial conduit lacks valves on the contrary of venous conduits, the luminal diameter usually remains unchanged throughout the length of the vessel.

The increasing usage of RA as a coronary artery conduit demands clinicians to improve the techniques of harvesting for greater clinical outcomes. The RA can be harvested endoscopically or by open techniques. In the open setting, harvesting can be done by sharp dissection, electrocautery, harmonic scalpel or vessels sealing device.

In the literature, there is no study comparing different open surgery techniques in RA harvesting. In the present study, we aimed to investigate the intra- and postoperative variables between RA harvesting with electrocautery and LigaSure™ small jaw device in open CABG.

PATIENTS AND METHODS

This prospective, randomized study was carried out in the Department of Cardiovascular Surgery, Acibadem Altunizade Hospital between January

Corresponding author: Beril Okur, MD. Acıbadem Mehmet Ali Aydınlar Üniversitesi Kalp ve Damar Cerrahisi Anabilim Dalı, 34684 Ataşehir, İstanbul, Türkiye. Tel: +90 539 - 761 80 82 e-mail: berilokur@hotmail.com

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2019 and September 2019. Patients with more than 90% stenosis of the coronary artery and those who were scheduled for CABG were screened. A total of 53 patients (44 males, 9 females; mean age: 63.7±8.4 years; range, 39 to 83 years) who underwent CABG for RA harvesting with electrocautery or LigaSure™ vessel sealing system were included. Both techniques were described in detail to all participants before the operation. A written informed consent was obtained from each patient. The study protocol was approved by the Acibadem Mehmet Ali Aydınlar University, Ethics Committee (Date: 21/03/2019; No: 2019/6-30). The study was conducted in accordance with the principles of the Declaration of Helsinki. The Allen test was performed to all patients. The patient's left arm was supinated and pulse oximeter was placed on the index finger of the left hand. Radial and ulnar arteries were palpated, and both were compressed until the pulse oximeter trace was present. Afterwards, the ulnar artery was released, and seconds were counted until the trace was fully returned. A positive result was considered between 3 and 5 sec, indicating a patent ulnar artery. The patients with a positive Allen test result were enrolled. By using a computer-generated random list, all patients were randomized into two groups. Group 1 consisted of 26 patients operated with the LigaSure™ (Medtronic, Minneapolis, MN, USA) small jaw sealer/divider (LF1212A) for RA harvesting during open CABG surgery and Group 2 consisted of 27 patients operated with low-energy electrocautery (Erbe Elektromedizin GmbH, Tübingen, Germany). Electrocautery is a device used for hemostasis and tissue dissection using direct or alternative current to generate heat. The LigaSure™ small jaw is a vessel-sealing device that uses both electrothermal energy and pressure.[4]

The lengths of the harvested RAs, duration of the harvest, amount of blood loss from the beginning of harvesting to the end of the closure of the skin of the left arm, number of hemostatic clips before and after the anastomosis of RA to coronary artery, amount of blood loss postoperatively, presence of ecchymoses, hematoma and infection were compared. The length of the RA was measured in cm. The amount of blood loss per operatively was measured by the number of gauzes used for left arm, and one gauze was estimated to absorb 10 mL. The amount of blood loss postoperatively was evaluated by the mL of blood collected in the drainage bag. Ecchymoses, hematoma, and paresthesia were documented as the absence or presence, 1 and 0, respectively. The length of the conduits was measured in cm. The duration of the harvest of the left RA was considered to be from the first incision of the left forearm to the freeing of the conduit. Data including age, sex, and body surface area (BSA) were recorded.

Subcutaneous tissue and fascia were dissected with the LigaSure™ curved, small jaw, open sealer /divider after the cutaneous incision in Group 1. Although the dissections were done mainly with the LigaSure™, some of the thin branches were dissected with scissors. The branches were freed from the RA at the distance of 2 mm with the LigaSure™. After the dissection was done, RA was ligated distally. Branches were clamped with bulldog clamps and the bleeding was checked. Branches larger than 5 mm were clipped. After the proximal and distal anastomosis were done, the branches were controlled and bleeding branches were clipped.

Once the incision was done along the length of the RA, subcutaneous tissue and fascia were dissected with electrocautery in Group 2. The branches of RA were dissected with scissors along the length. All branches were clipped with small titanium hemoclips (Horizon™ ligating clips; Weck-Teleflex, North Carolina, USA), and tissue side was tied with 4.0 silk. After the dissection was done, the RA was cut distally and clamped with bulldog clamps. The branches were checked by the antegrade flow. Leaking branches were clipped. After the proximal and distal anastomosis were done, the branches of the artery were controlled and clipped.

Statistical analysis

Statistical analysis was performed using the SPSS version 9 software (SPSS Inc., Chicago, IL, USA).

Table 1
Demographic characteristics of patients

	Group 1		Group 2	
Parameters	%	Mean	%	Mean
Age (year)		64.2±6.7		63.3±9.8
Sex				
Male	81.4		84.6	
Female	18.6		15.4	
BSA (m^2)		1.4±0.2		1.31±0.2

BSA: Body surface area.

Table 2
Intra- and postoperative data

Parameters	Group 1 Mean	Group 2 Mean	*p*
Amount of bleeding (mL)	47.0±24.3	102.3±65.4	0.004
Number of hemostatic clips used before harvest	0.1±0.3	0.8±1.1	0
Number of hemostatic clips used after harvest	0.3±0.6	1.7±1.8	0

Table 3
Postoperative data

Parameters	Group 1 n	Group 1 Mean	Group 2 n	Group 2 Mean	*p*
Amount of blood loss postoperatively (mL)		19.2±15.1		19.8±16.8	0.682
Number of patients with ecchymoses	8		6		0.104
Number of patients with hematoma	2		4		0.171
Number of patients with surgical site infection	1		0		0.039

Continuous variables were expressed in mean ± standard deviation (SD) or median (interquartile range [IQR]), while categorical variables were expressed in number and frequency. Continuous variables were compared using the Student's unpaired t-test. Categorical variables were compared using the chi-square test. A *p* value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic characteristics of the patients are shown in Table 1. During the study, 53 patients were operated. There were no significant differences in age and BSA between the groups.

The mean length of the RAs was 12.4±1.2 cm in Group 1 and 13.0±1.9 cm in Group 2. The difference in duration of the harvest between the groups was statistically non-significant (p=0.804). The amount of blood loss from the beginning of harvesting to the end of the closure of the skin of the left arm was significantly less in Group 1 (p=0.004). The difference in the number of hemostatic clips before and after the anastomosis of RA to coronary artery was also statistically significantly less in Group 1 (p<0.001 and p<0.001, respectively) (Table 2).

The amount of postoperative blood loss (p>0.6), number of ecchymoses (p>0.1), and postoperative hematoma (p>0.1) and infection (p>0.03) were comparable, indicating no statistically significant difference (Table 3).

The duration of the harvest and the length of the conduits are given in Table 4. The one-year survival rate of the patients was 100%. The patency rates of the conduits was planned to be determined after the control coronary angiography of the patients at the end of the 5th and 10th years. No control coronary angiography at the end of the first year was planned, due to the cost of angiographic procedures at the hospital setting.

Table 4
Duration of harvest and length of the conduit

Parameters	Group 1 Mean	Group 2 Mean
Duration of harvest (min)	41.8±8.3	38.6±8.3
Length of the conduit (cm)	12.4±1.2	13.0±1.9

DISCUSSION

The LigaSure™ sealing systems use bipolar radiofrequency and pressure to merge the collagen and elastin within the walls of vessels.[5] The effects of the LigaSure™ sealing systems have been a subject of studies, particularly in colorectal, urological, and gynecological surgeries. Nevertheless, the number of

studies using this device in CABG surgeries is still limited. In our study, the use of this device in RA harvesting was described.

Although electrocautery is a widely used instrument in various surgeries for tissue dissection, there are several undesired effects in graft harvesting for CABG surgeries. In a study, electrocautery was found to induce more spasms and intimal injuries, compared to harmonic scalpel.[6] It was also reported in another study that preparation for harvesting the RA using electrocautery took more time than using ultrasonic cautery during CABG and the amount of postoperative drainage was significantly lower in the later technique.[7]

The LigaSure™ is a relatively new device in CABG surgeries. Although more studies are needed in this context, a study showed lower mean operative time in patients who underwent thyroidectomy using the LigaSure™ rather than conventional clamp tie and electrocautery technique.[8] In a retrospective, observational study, the LigaSure™ usage resulted in lower blood loss and fewer blood transfusions and perioperative complications than suturing in the peripartum hysterectomy.[9] In another study, the LigaSure™ system reduced the volume of blood transfusions and intraoperative blood loss.[10] In CABG, blood flow through the internal thoracic artery was found to be sufficient in a study to be used as a conduit.[11]

Harmonic scalpel is a device that dissects and cauterizes the tissue simultaneously.[12] In a retrospective study, the use of a harmonic scalpel was associated with shorter dissection time with similar risks to conventional internal mammary artery harvesting.[13] Compared to blunt and sharp dissection, harmonic scalpel resulted in less spasm of the RA during CABG.[14] Nevertheless, harmonic scalpel resulted in more graft edema and longer operation duration than electrocautery in RA harvesting.[15] In our study, the amount of intraoperative blood loss was less during the use of LigaSure™ compared to electrocautery.

In conclusion, the significant difference in the amount of blood loss from the beginning of harvesting to the end of the closure of the skin shows a promising use of the LigaSure™ in patients who are prone to bleed. Although further large-scale studies are needed to show the differences in variables studied in this study and others, the outcomes of this study are encouraging for the LigaSure™ to be used in the CABG.

Declaration of conflicting interests

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REFERENCES

1. Baikoussis NG, Papakonstantinou NA, Apostolakis E. Radial artery as graft for coronary artery bypass surgery: Advantages and disadvantages for its usage focused on structural and biological characteristics. J Cardiol 2014;63:321-8.
2. Ashraf T, Panhwar Z, Habib S, Memon MA, Shamsi F, Arif J. Size of radial and ulnar artery in local population. J Pak Med Assoc 2010;60:817-9.
3. Verma S, Szmitko PE, Weisel RD, Bonneau D, Latter D, Errett L, et al. Should radial arteries be used routinely for coronary artery bypass grafting? Circulation 2004;110:e40-6.
4. Ignjatović M, Kostić Z. Thyroidectomy with LigaSure. Surg Today 2011;41:767-73.
5. Colella G, Giudice A, Vicidomini A, Sperlongano P. Usefulness of the LigaSure vessel sealing system during superficial lobectomy of the parotid gland. Arch Otolaryngol Head Neck Surg 2005;131:413-6.
6. Brazio PS, Laird PC, Xu C, Gu J, Burris NS, Brown EN, et al. Harmonic scalpel versus electrocautery for harvest of radial artery conduits: Reduced risk of spasm and intimal injury on optical coherence tomography. J Thorac Cardiovasc Surg 2008;136:1302-8.
7. Uysal D, Gülmen Ş, Özkan H, Sağlam U, Etli M, Bircan S, et al. Comparison of sharp dissection, electrocautery, and ultrasonic activated scalpel with regard to endothelial damage, preparation time, and postoperative bleeding during radial artery harvesting. Braz J Cardiovasc Surg 2019;34:667-73.
8. Bhettani MK, Rehman M, Khan MS, Altaf HN, Hakeem Khan K, Farooqui F, et al. Safety and cost-effectiveness of LigaSure® in total thyroidectomy in comparison with conventional suture tie technique. Cureus 2019;11:e6368.
9. Lauroy A, Verhaeghe C, Vidal F, Parant O, Legendre G, Guerby P. Perioperative outcomes using LigaSure compared with conventional technique in peripartum hysterectomy. Arch Gynecol Obstet 2020;301:229-34.
10. Levine NL, Zhang Y, Hoang BH, Yang R, Jurkowski ZH, Roth ME, et al. LigaSure use decreases intraoperative blood loss volume and blood transfusion volume in sarcoma surgery. J Am Acad Orthop Surg 2019;27:841-7.
11. Shimizu Y, Watanabe G, Tomita S, Matsumoto I, Iino K. A novel technique for harvesting the internal thoracic artery: Linear harvesting technique using an ultrasonic surgical aspirator. Interact Cardiovasc Thorac Surg 2011;12:998-1001.

12. Dutta DK, Dutta I. The harmonic scalpel. J Obstet Gynaecol India 2016;66:209-10.
13. Kieser TM, Rose MS, Aluthman U, Narine K. Quicker yet safe: Skeletonization of 1640 internal mammary arteries with harmonic technology in 965 patients. Eur J Cardiothorac Surg 2014;45:e142-50.
14. Fawzy HF. Harvesting of the radial artery for coronary artery bypass grafting: Comparison of ultrasonic harmonic scalpel dissector with the conventional technique. J Card Surg 2009;24:285-9.
15. Dumantepe M, Kehlibar T, Güllü AU, Arslan Y, Yılmaz M, Berköz K, et al. Comparison of ultrasonically activated scalpel and traditional technique in radial artery harvesting; an electron microscopic evaluation. Anadolu Kardiyol Derg 2011;11:250-6.