Nursing Cooperation of a Case of Leonardo's Robot-assisted Off-pump Whole Artery Small Incision Coronary Artery Bypass Grafting

Qing Liu

The First Affiliated Hospital of Anhui Medical University, Hefei 230022, Anhui, China

DOI: 10.32629/ajn.v3i1.980

Abstract: Objective — To summarize the nursing experience of a case of Leonardo's robot-assisted off-pump total artery small incision coronary artery bypass grafting. Methods — The key points of surgical cooperation included: Preoperative visit and communication with medical staff, detailed understanding of surgical methods, preoperative preparation of items, intraoperative position placement and placement of Leonardo's robot equipment, reasonable arrangement of operating room according to surgical methods and close intraoperative cooperation. Results — The patient was successfully conducted with cardiac surgery with less intraoperative bleeding and was admitted to ICU for further treatment. Tracheal intubation was removed on the 1st postoperative day, and the patient was transferred to cardiac surgery ICU on the 2nd postoperative day. Chest drainage tube was removed on the 6th postoperative day, and the patient was discharged successfully on the 9th postoperative day. Conclusion — Robot-assisted off-pump whole artery small incision coronary artery bypass grafting enjoys obvious advantages over thoracotomy. There is less bleeding in the postoperative with low complication rate, so the pain of patients is reduced with fast the postoperative recovery. Therefore, it won high satisfaction among patients. Good preoperative, intraoperative and postoperative nursing is an important guarantee to promote the rehabilitation of patients.

***Keywords*:** robot, internal mammary artery, radial artery, coronary artery bypass grafting, nursing cooperation

Coronary atherosclerotic heart disease is a common and frequently-occurring disease of cardiovascular system. Coronary artery bypass grafting (CABG) is an effective method for the treatment of CHD[1]. A large number of clinical studies have confirmed that CABG has higher long-term benefits and lower secondary revascularization rate compared with interventional therapy[2]. In its nearly 60 years of development, a variety of vascular materials have been used as bridges. The anastomosis of left internal mammary artery transplantation to left anterior descending branch is recognized as the "gold standard" because of its excellent long-term effect. At present, authoritative studies have proved that the radial artery is superior to the great saphenous vein bridge, which is close to the left internal mammary artery bridge in long-term patency[3-4]. Studies have shown that the patency rate of great saphenous vein was only 47% after operation (5.0±3.8 years), which is far lower than that of left internal mammary artery bridge (85%) and radial artery bridge (82%) in the same period[3].

The radial bridge has a suitable diameter (mean diameter 2.5mm, almost the same as that of coronary arteries), sufficient length (mean length 22cm), and is easy to obtain with few complications. Studies have shown that male, young and non-insulin-dependent diabetic patients are the main beneficiaries of radial artery bridge[5]. The Leonardo's robotic surgical system is safe and effective for cardiac surgery, which not only shorts the ICU time and postoperative hospital stay, but also reduces the use of blood products during hospitalization[6].

In the case of robotic cardiac surgery without thoracotomy, the 3D surgical field presented by this technology can fully reproduce the internal structure of human tissues in proportion, and the diameter of its minimally invasive instruments is 8mm.Through keyhole-sized incisions into human tissue, it can perform difficult movements impossible to do with human hands. The instrument arm has 7 degrees of freedom, which can greatly reduce the difficulty of obtaining internal mammary arteries, especially bilateral internal mammary arteries[7]. The perioperative clinical efficacy of Leonardo's Robot system was significantly higher than that of traditional median thoracotomy[8]. This paper summarized the nursing experience of a case of Leonardo's Robot -assisted off-pump total artery small incision coronary artery bypass grafting. The report is as follows.

1. Clinical data

1.1 General information

The patient is a male who is aged 33-year-old.The patient was admitted to hospital with "sudden chest pain for one

day". The patient had a sudden precardiac pain without obvious inducement on the previous day and no relief after rest. CAG showed 85% proximal stenosis of the left anterior descending artery (LAD) involving the D1 opening, and about 95% stenosis of the D1 opening. There was a definite coronary lesion that required surgical treatment. All the laboratory tests were normal, and there was no history of chest surgery or pleurisy.

1.2 Surgical methods

After successful anesthesia, the patient was placed in supine position with left pad height of about 20°and left upper limb abduction. Right radial artery catheterization was followed by invasive arterial pressure measurement, ECG and blood oxygen saturation were monitored, and anesthesia depth was monitored. The superior vena cava was placed through the right internal jugular vein and sealed with heparin for later use. Iodophor is used to disinfect the skin of the surgical area and apply towels. A 0.8cm right and left hand operation hole was inserted into the third intercostal space inside the left axillary front and the seventh intercostal space inside the left axillary front respectively, and a 1.2cm lens hole was inserted into the fifth intercostal space in the left axillary front.

The left and right instrument arms and the endoscopic imaging system were respectively inserted, and the bilateral internal mammary arteries were dissociated and obtained using minimally invasive tweezers and electric shovels. From the first rib to the fifth rib, all branches of the internal mammary arteries were clipped with titanium clips to stop bleeding. In the other group, the left radial artery was separated about 15cm. Heparinize blood and maintain ACT > 300s. The robot was evacuated and a small incision of about 5cm was made in the fourth intercostal area of the left midclavicular line to enter the chest. The pericardium was cut and suspended to expose the anterior descending branch and the first diagonal branch, and the anastomotic site was fixed with a cardiac surface fixator. The LiMa and the anterior descending branch were anastomosed end-to-end using 8-0 prolene line.

A small incision of about 2cm was made in the second intercostal space of the middle clavicular line in the right thoracic cavity, and the incision protective sleeve was inserted. The right internal mammary artery (RiMa) was removed and the left radial artery was anastomosed end-to-end. The right internal mammary artery and the first diagonal branch were anastomosed end-to-end using 8-0 prolene line. After the anastomosis was completed, the flow meter indicated that the flow rate was satisfactory and the anastomosis was unobstructed. Protamine neutralized heparin, thoroughly stopped bleeding, placed a thoracic drainage tube, and closed the chest layer by layer.

1.3 Results

The operation was successfully conducted with little intraoperative bleeding. After surgery, the patient was intubated under general anesthesia and sent to ICU for further treatment.The endotracheal intubation was removed on the 1st postoperative day. On the 2nd postoperative day, he was transferred to the cardiac surgery ICU. Thoracic drainage tube was removed on the 6th day after surgery. She was discharged successfully on the 9th day after surgery.

2. Nursing

2.1 Preoperative nursing

2.1.1 Preparation for patients

Robot based heart surgery is unfamiliar to patients and their families, and it is aimed at patients' preoperative nervous and anxious psychological state. This paper briefly introduces the surgical methods, procedures and operations based on the patient's participation and cooperation. Targeted psychological nursing can enhance the confidence of patients and their families for the operation, so that they can better cooperate with the treatment and nursing.

2.1.2 Preparation by nurses

Nurses should participate in the case discussion before surgery,and fully understand the surgical steps, surgical coordination and all kinds of conditions that may occur during surgery. 2 sets of plans can be set for surgical preparation. Option 1: Off-pump whole artery small incision coronary artery bypass grafting assisted by Leonardo's Robot. Advantages: (1)There is no need to saw the sternum,without the change of the sternum structure. ② Less intraoperative bleeding with faster postoperative recovery. Disadvantages: (1) Narrow chest space with limited operating range, and there is more possibility of collision between the manipulator and the lens. The surgical fluency decreased and the surgical time extended[7].② Obtaining the right internal mammary artery can be achieved based on operation across the mediastinum, which increases the risk of damage to the heart and surrounding organs[9]. Option 2: Insufficient length or injury of the internal mammary artery may lead to a transfer to extracorporeal bypass surgery.

2.1.3 Preparations in equipment and articles

Leonardo's robotic surgical system is composed of three parts: Console for doctors, surgical platform for patients and

image processing platform. The patient's operating platform needs to be charged within 24 hours, and the three parts can be started online during the operation, and the power cannot be cut off after the operation. In addition, there are many instruments and equipment needed in cardiac surgery, such as anesthesia machine, defibrillator, gas tank, headlamp and suction device. Therefore, the layout of the operating room should be reasonably planned in advance, and the optimal docking route should be designed according to the power socket and lifting tower of the operating room. The duration of moving instruments and equipment during surgery should be reduced,and accidental power failure of instruments and equipment during surgery should be prevented to ensure the normal operation of the robotic surgical system.

Because the difficulty in this kind of operation, delicate operations are required. Therefore, in addition to conventional cardiac surgery instruments, special and fine instruments and items related to cardiac surgery should be prepared, such as defibrillation electrode stick, fine coronary artery probe, coronary knife, perforator, blowing tube, sternal sutures, 7-0, 8-0 prolene line several roots, etc. All medicines and liquid preparations before operation should be prepared, such as heparin, papaverine, etc.

2.2 Intraoperative coordination

2.2.1 Cooperation of itinerant nurses

The nurses should adjust operating room temperature and humidity, prepare items to establish venous access, connect power to various instruments and connect patient to operating room. After anesthesia, the patient was placed in supine position with left hand abduction and left side pad height of about 20. The operating table was tilted 30°to the right and to fully exposing the left chest wall. The patient's right arm was provided with radial artery invasive manometry and venous access. Due to the particularity of intraoperative robot operation, the patient's surgical platform was docked with the patient on the right side of the operating table. Therefore, to avoid squeezing the patient's arm, the visiting nurse should place protective restraints on the right arm in advance.In addition, the abduction angle of the left arm should not exceed 90° to avoid collateral injury caused by excessive stretching of the brachial plexus. Properly fix the patient, prevent the patient's body displacement during the operation to bring risks to the operation, reduce the skin shear force so as to avoid pressure injury. Insert catheter and anal temperature wire, monitor intraoperative temperature, and closely observe the operation progress, and timely provide surgical needs. After the robot obtained bilateral internal mammary arteries, the patient was evacuated from the surgical platform in time and related instruments and equipment were connected to prepare for coronary artery bypass grafting through small incisions.

2.2.2 Cooperation with instrument nurse

2.2.2.1 Instrument table

Wash your hands 30min in advance and fully organize the sterile instrument table. Due to the large number and complexity of surgical items, 3 sterile instrument carts are required during the operation. The first sterile instrument truck prepared conventional instruments and related dressings for extracorporeal circulation surgery, and coronary artery bypass, shunt plug, titanium clip ligating nails and other related items should be prepared for the second sterile instrument truck. Besides, minimally invasive bipolar coagulation forceps for robotic cardiac surgery, single-stage shovel, titanium clamp and robotic endoscopic imaging system can be prepared for the third sterile instrument vehicle. A sterile protective sleeve was installed on the patient's surgical platform, an endoscope was installed on the camera head, and white balance was set and 3D calibration was performed. The instrument nurse should master the structure, function and using method of the robot arm instrument, and be able to handle the alarm prompt that may appear on the table.

2.2.2.2 Acquisition of bridge vessels

The surgery was performed in two groups: One group dissociated the bilateral internal mammary artery and the other group dissociated the left radial artery. Since the operation was concentrated on the left side of the patient, during the operation, in addition to ensuring that the ligating nails were intact during each replacement of the robotic instrument arm to clamp the internal mammary artery branch, the sterile operation of radial artery acquisition should be ensured during the operation. Compared with the internal mammary artery bridge, the radial artery bridge has a thicker middle layer and is completely composed of dense smooth muscle cells, so it is more prone to spasm, thrombosis and occlusion [5]. Therefore, the spasm of the radial artery bridge can be alleviated by spraying the surface of the radial artery with papaverine and placing the removed radial artery in warm saline containing papaverine and heparin for preservation.

2.2.2.3 Vascular anastomosis

After the small incision was made into the chest to explore the target vessels, the cardiac surface fixator and fog blowing tube were transferred in time, and the correct connection was made to maintain patency and ensure safe pressure, so as to ensure a clear anastomotic field. During the operation, when the vascular clamp was used to temporarily clamp the bridge vessels, the no. 0 line was tied to the end of the vascular clamp due to the small surgical incision. The end of the line was

left outside the incision to avoid the difficulty of removing the vascular clamp from the chest cavity. The stitches used for surgical anastomosis are small. During continuous anastomosis, water should be poured on the operator's hand to increase the operator's hand feel of the stitches and the smooth feeling of knotting. And timely recovery of stitches, ensure that the number of stitches is correct. After the anastomosis was completed, the flow rate was satisfactory and the anastomosis was unobstructed.

2.2.2.4 Close the incision

A chest drainage tube was placed, the materials were counted with the visiting nurse, and the chest and left arm incisions were closed layer by layer. The operation was completed.

2.2.3 Handling of special items after surgery

Leonardo aseptic protective sleeve is disposable consumable material, which will be destroyed as medical waste after use. All robotic instrument arms have a limit on the number of times of use, and the remaining times are marked on the instrument after operation for processing. Conventional instruments and precision instruments are pretreated and then sent to the disinfection supply center for centralized treatment and autoclave sterilization.

3. Conclusion

Coronary artery bypass grafting, which emerged in the 1960s, is a representative of minimally invasive technology applied in cardiovascular surgery[10]. It is also the main treatment method for left main coronary artery disease or multi-branch coronary artery disease. Radial artery bridge is suitable in diameter, sufficient in length, easy to obtain, with few complications, and the long-term patency rate has been proved to be higher than that of great saphenous vein [5]. The application of Leonardo's robot to obtain the internal mammary artery can provide more favorable technical support for accurate operation.

At present, various literature reports also indicate that Leonardo's surgical robot is superior to traditional coronary artery bypass surgery in perioperative complications and postoperative recovery[11]. Because there are many and complex objects used in the operation, the instrument nurses involved in the operation are required to be master specialized knowledge and be familiar with the performance and characteristics of the robot system.They should prepare the instruments in advance, be familiar with the operation steps, cooperate with the operation accurately and quickly to shorten the operation time, and ensure the smooth completion of the operation. The itinerant nurse should evaluate the patient comprehensively, pay close attention to the progress of surgery and the change of the condition, and do a good job in the emergency treatment of the emergency situation. Only in this way can such operations be carried out safely and smoothly.

References

[1] Manuel L, Fong LS, Wolfenden H, et al. Is totally endoscopic coronary artery bypass grafting compared with minimally invasive direct coronary artery bypass grafting associated with superior outcomes in patients with isolated left anterior descending disease?. *Ann Med Surg (Lond)*, 2020, 57: 264-267.

[2] Stone GW, Kappetein AP, Sabik JF, et al. Five-year outcomes after PCI or CABG for left main coronary disease. *N Engl J Med*, 2019, 381(19): 1820-1830.

[3] TRANBAUGH R F, DIMITROVA K R, FRIEDMANN P, et al. Coronary artery bypass grafting using the radial artery: clinical outcomes,patency,and need for reintervention[J]. *Circulation*, 2012, 126(11 Suppl 1): S170-S175.

[4] DEB S, COHEN E A, SINGH S K,et al.Radial artery and saphenous vein patency more than 5 years after coronary artery bypass surgery:results from PAPS (Radial Artery Patency Study)[J]. *J Am Coll Cardiol*, 2012 , 60(1): 28-35.

[5] Ye Cong, Zhao Qiang. Research progress of radial artery in coronary artery bypass grafting [J]. *Journal of Qingdao University School of Medicine*, 2015, 51(04): 497-499. DOI: 10.13361/j.qdyxy. 201504042.

[6] Wang Dongjin, Wang Qiang. Clinical application experience of da Vinci robotic surgery system in cardiac surgery [J]. *Chinese Journal of Circulation*, 2018, 33(S1): 40.

[7] Liu Bing, Cheng Nan, Shen Hua, Wang Rong. Robot-assisted bilateral internal mammary artery to obtain five coronary artery bypass grafts with minimally invasive small incision [J]. *Chinese Journal of Thoracic and Cardiovascular Surgery*, 2021, 28 (06): 650-655.

[8] Huang Weimin, Zhang Yuhai, Wang Liang. Meta-analysis of the clinical effect of traditional open heart surgery using the Da Vinci surgical system in China [J]. *Chinese Journal of Cardiovascular Circulation*, 2022, 20(01): 30-34. DOI: 10.13498/j.cnki.chin.j.ecc.2022.01.08

[9] Cheng Nan, Yang Ming, Wang Mingyan, Liu Bing, Shen Hua, Guo Pengfei, Zhao Yuancheng, He Tiantian, Xu Ke, Wang Rong. Cardiac multivessel disease[J]. *Journal of Robotic Surgery(Chinese and English)*, 2020, 1(01): 43-49+22.

[10] Kong Xiangyi, Xia Yujun, Wang Shoubiao. Clinical application and research progress of minimally invasive coronary artery bypass grafting [J]. *Qilu Medical Journal*, 2011, 26(05): 468-470.
[11] Hammal F, Nagase F, Menon D, et al. Robot-assisted coronary artery bypass surgery: a systematic review and meta-analysis of comparative studies[J]. *Can J Surg*, 2020, 63(6): E491- 508.