

Side Graft Axillary Artery Cannulation in Proximal Thoracic Aortic Surgery

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Proksimal Torakal Aort Cerrahisinde Yan Greft Axiller Arter Kanülasyonu

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ABSTRACT

Objective: The most preferred arterial cannulation region during cardiopulmonary bypass is ascending aorta. However, alternative arterial cannulation regions may be needed in the surgical treatment of pathologies involving proximal thoracic aortic segments. For this purpose, femoral artery is frequently used in the past years, but nowadays axillary artery cannulation is very prevalently used. Axillary artery cannulation can be performed either directly or /indirectly using side graft technique. In this study, we aimed to evaluate the outcomes of our patients who were operated due to proximal thoracic aortic pathology with side graft axillary artery cannulation.

Method: Forty-six patients who were operated due to proximal thoracic aortic pathologies with side graft axillary cannulation technique between January 2008 - December 2018 in our hospital were evaluated retrospectively.

Results: Side graft axillary cannulation technique was successfully applied in all of these 46 patients. Axillary artery injury did not occur in any patient. No permanent neurological deficit developed at the right upper extremity and there was no infection at cannulation region in any patient. Inpatient mortality. There were 10 (21.7%) patients with hospital mortality.

Conclusion: Nowadays, axillary artery cannulation is increasingly preferred peripheral cannulation method for proximal thoracic aortic operations. The most important advantages of this method are achievement of antegrade cerebral/systemic perfusion and absence of retrograde embolization risk. Local complications (e.g. brachial plexus/axillary artery injury) due to axillary artery cannulation may occur. Using side graft axillary cannulation technique can reduce risk of developing these complications. In our study, we did not encounter any local/ systemic complications related to preferred cannulation region in our patients who were operated by side graft axillary artery cannulation technique.

Keywords: Side graft, axillary artery cannulation, proximal thoracic aortic surgery

ÖZ

Amaç: Kardiyopulmoner baypas sırasında en sık yeğlenen arteriyel kanülasyon bölgesi asendan aortadır. Ancak proksimal torakal aort segmentlerini içeren patolojilerin cerrahi tedavisinde alternatif arteriyel kanülasyon bölgelerine gereksinim duyulabilmektedir. Bu amaçla da geçmiş yıllarda femoral arter sık kullanılmakta iken günümüzde aksiller arter kanülasyonu çok yaygın olarak kullanılmaktadır. Aksiller arter direkt kanüle edilebileceği gibi yan greft tekniği ile indirekt kanülasyon da yapılabilir. Biz bu çalışmada, yan greft aksiller arter kanülasyonu tekniği ile opere ettiğimiz proksimal torakal aort patolojisi olan hastaların sonuçlarını değerlendirmeyi amaçladık.

Yöntem: Hastanemizde Ocak 2008 - Aralık 2018 tarihleri arasında yan greft aksiller arter kanülasyonu tekniği ile proksimal torasik aort patolojileri nedeniyle opere edilen 46 hasta retrospektif olarak değerlendirildi.

Bulgular: Bu 46 hastanın tamamında yan greft aksiller arter kanülasyon tekniği başarılı olarak uygulandı. Hiçbir hastada aksiller arter hasarı gözlenmedi. Hiçbir hastada sağ üst ekstremitede kalıcı nörolojik defisit gelişmedi. Hiçbir hastada aksiller kanülasyon bölgesinde enfeksiyon yoktu. On hastada (% 21.7) hastane mortalitesi saptandı.

Sonuç: Günümüzde proksimal torasik aort ameliyatları için giderek daha fazla tercih edilen periferik kanülasyon yöntemi aksiller arter kanülasyonudur. Bu yöntemin en önemli avantajı antegrad serebral ve sistemik perfüzyon sağlaması ve retrograd embolizasyon riskinin olmamasıdır. Aksiller arter kanülasyonuna bağlı olarak lokal komplikasyonlar (Örn. brakiyal pleksus ve aksiller arter hasarı) ortaya çıkabilir. Yan greft aksiller kanülasyonu tekniğinin kullanılması bu komplikasyonların gelişme riskini azaltabilir. Biz de çalışmamızda, yan greft aksiller arter kanülasyonu tekniği ile opere edilen hastalarımızda yeğlenen kanülasyon bölgesi nedeniyle herhangi bir lokal veya sistemik komplikasyonla karşılaşmadık.

Anahtar kelimeler: Yan greft, aksiller arter kanülasyonu, proksimal torakal aort cerrahisi

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INTRODUCTION

Cardiopulmonary bypass provides a bloodless and comfortable operating environment for surgeons. It is based on the principle of withdrawing blood through the venous cannula and passing it through the oxygenator and returning to the patient through the arterial cannula. In this process, the potassium-rich cardioplegia solution is administered to the coronary arteries to provide diastolic arrest. Thus, surgical intervention is performed in a still heart and bloodless environment. The most preferred artery for arterial cannulation is ascending aorta. Because it is easily applied with median sternotomy which is the most commonly used incision for open heart surgery. Many operations such as coronary artery bypass graft surgery and valve operations can be performed with this method. However, it may be necessary to select another arterial cannulation region in the operation for ascending aorta or aortic arch pathologies. The most commonly used vessels for peripheral arterial cannulation are the femoral and axillary arteries [1]. Axillary artery cannulation is increasingly preferred because retrograde athero-embolisation risk is not seen and also it allows antegrade cerebral perfusion. Axillary artery cannulation can be performed directly or using side graft technique. The complications related to the cannulation are being tried to be reduced by the side graft technique. [2] We wanted to present outcomes of 46 patients who were operated with using side graft axillary artery cannulation technique in our clinic in the last decade.

MATERIAL AND METHOD

Forty-six patients who were operated in our clinic due to proximal thoracic aortic pathologies by axillary artery cannulation between the years 2008 and 2018 are included in this study. The average age of the patients was 63 (29-90) years. Thirty-one patients were male and 15 patients were female. Patients who underwent preoperative cardiopulmonary resuscitation were not included in this study.

Table 1. Preoperative demographic data of all patients.

Age	63 (29-90)
Gender (M/F)	31/15
Hypertension	34 (74%)
Diabetes mellitus	3 (6.5%)
Ejection fraction (%)	52 (35-65)
Coronary artery disease	9 (20%)
Chronic obstructive pulmonary disease	10 (22%)
Chronic renal failure (Creatinine \geq 2.5 mg/dl)	3 (6.5%)
Cerebrovascular event	2 (4.5%)
Hemodynamic instability	6 (13%)
Redosternotomy	2 (4.5%)

Demographic data of all patients are shown in (Table 1). The most common concomitant disease was hypertension (34, %74). Two patients had hemodialysis-dependent chronic renal failure. Six patients (13%) were taken to the operation table in an unstable hemodynamic state. Patients with the following clinical findings were accepted as hemodynamically unstable: Pericardial tamponade, hypotension (< 80 mmHg), severe dyspnea-orthopnea, unconsciousness, acute coronary ischemic changes or evidence of newly developed conduction defected on electrocardiography. Thirty-nine (85%) of these 46 patients were operated on due to aortic dissection. The indications for surgery of all patients are given in (Table 2).

Table 2. Indications for surgery.

Aortic dissection	39 (85 %)
Ascending aorta and aortic arch aneurysm	4 (8.5%)
Intramural hematoma	3 (6.5%)

The axillary artery was exposed through right infra-clavicular transverse incision in all patients (Figure 1). The pectoralis major muscle fibers were retracted. The pectoralis minor muscle was retracted laterally. The axillary artery was palpated just superiorly and deep to the axillary vein. Attention was paid during the dissection to prevent brachial plexus injury. The artery was encircled by a nylon tape. Patients were heparinized at full dose. Vascular clamps were placed to the proximal and distal part of cannulation region. Vertical arteriotomy (10-15 mm) was performed. None of our patients had any dissection in



Figure 1. Right infraclavicular transverse incision. Red arrow shows clavicle.

the right axillary artery lumen. A 8 mm x 5 cm Dacron graft was anastomosed to the right axillary artery using end- to -side technique (Figure 2). A 18-21F cannula was inserted into the side graft and ligated by silk sutures. It was observed that there was sufficient backflow from the arterial cannula and then the cannula was connected to the arterial line. The cannula was fixed on the skin by a suture. All vascular clamps were removed from the axillary artery. Median sternotomy incision was performed in all patients. Cardiopulmonary bypass was instituted and then right atrial two-stage venous cannulation was performed in all patients except 2 patients who had previously undergone sternotomy. In these 2 patients, cardiopulmonary bypass was instituted following right femoral venous cannulation and resternotomy was performed after cardiac decompression was achieved. Isothermal blood cardioplegia solution was administered via antegrade, ostial or retrograde route to achieve diastolic arrest. A vent catheter was placed through the right upper pulmonary vein for left ventricular decompression. Twenty-six patients (56.5 %) underwent ascending aortic



Figure 2. Side graft axillary artery cannulation technique.

replacement. Systemic circulation was stopped in 5 patients and total circulatory arrest + antegrade cerebral perfusion was performed in these patients. These 5 patients underwent arcus aorta replacement. Total circulatory arrest was not applied as a sole procedure in any patient. After cardiopulmonary bypass procedure was terminated, the side graft was cut and sutured. The intraoperative data of all patients are shown in (Table 3).

Table 3. Intraoperative data of all patients.

Cross clamp time	84 minute (59-145)
Cardiopulmonary bypass time	146 minute (95-298)
Total operation time	242 minute (196-413)
Hypothermia (°C)	24°C (21-28)
The number of patients undergoing total circulatory arrest+Antegrad cerebral perfusion	5 (11%)
Total circulatory arrest and antegrade cerebral perfusion time	27 minute (19-34)
Ascending aorta replacement	26 (56.5%)
Bentall operation	15 (32.5%)
Ascending aorta and arch replacement	2 (4.5%)
Bentall operation and arch replacement	3 (6.5%)
Coronary artery bypass graft operation	5 (11%)
Aortic valve repair	4 (9%)

RESULTS

There were 10 (21.7%) patients with in-hospital mortality. The patients died due to low cardiac output syndrome (n=3), uncontrolled intraoperative bleeding (n=3), major stroke (n=1), development of mediastinitis (n=1) and endocarditis (n=1). Axillary artery injury did not occur in any patient. Only 1 patient had transient ischemia at his right hand postoperatively which was cured with medical treatment. In 3 (6.5%) patients, paresthesia developed at the upper right limb and all of them were completely healed within 4 weeks. No permanent neurologic deficit developed at the right upper extremity in any patient. Despite the use of synthetic grafts, there was no infection at the axillary cannulation region in any patient. Patients' mean intensive care unit stay time was 8 days. Patients mean total hospitalisation time was 19 days. One patient who had postoperative mediastinitis died at the end of 117 days in intensive care unit. Postoperative results of all patients are shown in (Table 4).

Table 4. Outcome of the surgical procedures.

Mortality	10 (21.7%)
Stroke	4 (8.7%)
Mediastinitis	2 (4.3%)
Pedocardial tamponade	7 (15.2%)
Hemorrhage related reoperation	9(19.5 %)
Temporary ischemia in right upper extremity	1 (2.2%)
Axillary artery injury	0
Temporary neurological deficit in right upper extremity	3 (6.5%)
Permanent neurological deficit in right upper extremity	0
Infection in the axillary cannulation region	0
Renal failure	4 (9.3%)
Respiratory failure	11 (24%)
Low cardiac output	5 (11%)
Endocarditis	1 (2.2%)
Time of mechanical ventilation (hours)	18 (3-1608)
Length of stay in the intensive care unit (days)	8 (3-117)
The time of hospitalization (days)	19 (9-117)

DISCUSSION

Several arterial cannulation methods can be used in the surgical treatment of proximal thoracic aortic pathologies such as aortic dissection and aneurysm.

These are femoral artery cannulation, axillary artery cannulation, central aortic cannulation and transapical cannulation [3]. All these arterial cannulation techniques have some advantages and disadvantages. The effects of cannulation methods on some factors such as the time until to start of cardiopulmonary bypass, maintaining of CPB, effective hypothermia and cerebral protection, malperfusion and further deterioration of the aortic pathology are very important. Femoral cannulation was the most commonly used cannulation method until recently in these patients. The most important advantage of the femoral cannulation method is that the cannulation time is very short (3-5 minutes). This time interval may be prolonged in patients with morbid obesity or with incision scar at the cannulation area. The most important disadvantage of this method is that it increases the risk of cerebral embolism due to migration of atheromatous plaques in the lumen of aorta by retrograde flow [4]. Transapical cannulation is not routinely used despite some advantages such as to supply antegrade perfusion, to be performed in a short time and lack of additional incision. Central aortic cannulation also have similar advantages but its most important disadvantages are false lumen perfusion and risk of aortic rupture [3]. Axillary artery cannulation is increasingly performed all over the world in the surgical treatment of aortic pathologies such as aortic dissection and arcus aneurysm. The advantages of this method are providing antegrade systemic and cerebral perfusion, lack of risk of retrograde embolism, and reduction of the risk of malperfusion [5]. The most important advantage of axillary cannulation is that it allows antegrade cerebral perfusion during total circulatory arrest. The disadvantages of axillary cannulation are the time required for cannulation is longer than other cannulation methods (15-20 minutes), requirement of an additional incision and the risk of brachial plexus injury [6]. Axillary artery injury may also occur in patients with direct cannulation. Axillary cannulation with side graft technique may be preferred to reduce these risks. In this method, the time spent for cannulation is several minutes longer, but, decannulation can be

done very easily with this technique and there is no risk for stenosis in the artery [7]. Benedetto et al. published a meta-analysis that included the results of 793 patients [8]. In this meta-analysis, the outcomes of axillary artery cannulation and femoral artery cannulation were compared. In this meta-analysis that evaluated the results of 8 studies, rates of hospital mortality and development of persistent neurological sequelae were found to be significantly lower in the axillary artery cannulation group than the femoral artery cannulation group. Sabik et al. published the results of 392 patients who underwent axillary artery cannulation by direct or lateral graft technique [9]. In this study, the complication rates (arm ischemia, brachial plexus injury, aortic dissection, axillary artery injury) related to axillary cannulation were 7.5% in the direct cannulation group and 2% in the side graft group. We used only side graft axillary artery cannulation technique in all patients in our study. Although we did not have a patient group to make a comparison as in the studies mentioned above, we did not encounter any systemic or local complications arising from cannulation method in any of these patients. We did not experience any complications due to the choice of cannulation site, so we believe that our study results are more successful than the above-mentioned studies. However, our total mortality rates are slightly higher than those reported in these studies. This may be due to the fact that these centers are more experienced in this cannulation technique.

CONCLUSION

Currently, the number of operations performed due to proximal thoracic aortic pathologies and / or cardiac reoperation are increasing. Various peripheral arterial cannulation methods are used in these operations. Nowadays, increasingly preferred peripheral cannulation method is axillary artery cannulation. The most important advantages of this method are the presence of antegrade cerebral and systemic perfusion and the absence of retrograde embolization risk. Local

complications (e.g. brachial plexus and axillary artery injury) due to cannulation of the axillary artery may occur. Using the side graft axillary cannulation technique can reduce the risk of developing these complications. In our study, we did not encounter any local or systemic complications due to preferred cannulation region in our patients who were operated by side graft axillary artery cannulation technique.

REFERENCES

1. Stamou SC, Gartner D, Kouchoukos NT, Lobdell KW, Khabbaz K, Murphy E, Hagberg RC. Axillary versus femoral arterial cannulation during repair of type A aortic dissection?: An old problem seeking new solutions. *Aorta (Stamford)* 2016 Aug; 4(4):115-23. <https://doi.org/10.12945/j.aorta.2016.16.007>
2. Hosono M, Shibata T, Murakami T, Sakaguchi M, Suehiro Y, Suehiro S. Right axillary artery cannulation in aortic valve replacement. *Ann Thorac Cardiovasc Surg.* 2016;22(2):84-9. <https://doi.org/10.5761/atcs.oa.15-00296>
3. Abe T, Usui A. The cannulation strategy in surgery for acute type A dissection. *Gen Thorac Cardio Vasc Surg.* 2017 Jan;65(1):1-9. <https://doi.org/10.1007/s11748-016-0711-7>
4. Gulins H, Pritisanac A, Ennker J. Axillary versus femoral cannulation for aortic surgery: enough evidence for a general recommendation? *Ann Thorac Surg.* 2007 Mar; 83(3):1219-24. <https://doi.org/10.1016/j.athoracsur.2006.10.068>
5. Talwar A, Wiadji E, Mathur MN. Experience with the axillary artery as an arterial cannulation site in patients with acute Type a aortic dissection. *Heart Lung Circ.* 2019 Feb;28(2):342-7. <https://doi.org/10.1016/j.hlc.2018.03.019>
6. Ogino H, Sasaki H, Minatoya K, Matsuda H, Tanaka H, Watanuki H, Ando M, Kitamura S. Evolving arch surgery using integrated antegrade selective cerebral perfusion: impact of axillary artery perfusion. *J Thorac Cardiovasc Surg.* 2008 Sep;136(3):641-8; discussion 948-9. <https://doi.org/10.1016/j.jtcvs.2008.02.089>
7. Önem G, Baltalarlı A, Gürses E, Özcan AV, Saçar M, Adalı F, Sungurtekin H. Cannulation of the right axillary artery is a safe method in proximal aortic surgery. *Turkish J Thorac Cardio Vasc Surg.* 2007;15(2):104-7.
8. Benedetto U, Mohamed H, Vitulli P, Petrou M. Axillary

versus femoral arterial cannulation in type A acute aortic dissection: evidence from a meta-analysis of comparative studies and adjusted risk estimates. *Eur J Cardiothorac Surg.* 2015 Dec;48(6):953-9. <https://doi.org/10.1093/ejcts/ezv035>

9. Sabik JF, Neme H, Lytle BW, Blackstone EH, Gillinov AM, Rajeswaran J, Cosgrove DM. Cannulation of the axillary artery with a side graft reduces morbidity. *Ann Thorac Surg.* 2004 Apr;77(4):1315-20. <https://doi.org/10.1016/j.athoracsur.2003.08.056>