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Percutaneous internal jugular vein cannulation in minimally invasive cardiac surgery

Minimal invaziv kalp cerrahisinde perkütan internal jugüler ven kanülasyonu

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ABSTRACT

Objectives: In this study, we present our experiences of patients undergoing cardiopulmonary bypass grafting with percutaneous internal jugular venous cannulation during minimally invasive cardiac surgery.

Patients and methods: The data of a total of 191 patients (85 males, 106 females, mean age 38.7±14.8 years; range, 16 to 77 years) who underwent percutaneous internal jugular venous cannulation with minimally invasive cardiac surgery between January 2013 and October 2016 were retrospectively analyzed.

Results: Of the patients, 17 underwent port-access cardiac surgery. One-hundred seventy-four percutaneous internal jugular venous cannulations were performed during robotic cardiac surgery. After the operation, localized hematoma developed in two patients (1.04%), mediastinal hematoma in one patient (0.52%), carotid artery injury in one patient (0.52%) and two patients (1.04%) required vacuum support due to insufficient drainage. No neurological complications, upper extremity edema or permanent arrhythmia were observed in any patients after the procedure. There was no long-term morbidity due to cannulation in any patients.

Conclusion: In minimally invasive cardiac surgery, percutaneous internal jugular vein cannulation is one of the most important methods which facilitates the work of the surgeon. With increasing experience of the process, minimally invasive surgery will become a more practical and faster method.

Keywords: Complication; jugular vein cannulation; surgery procedures.

ÖZ

Amaç: Bu çalışmada, minimal invaziv kalp cerrahisinde perkütan internal jugüler ven kanülasyonu ile kardiyopulmoner baypas yapılan hastalara ilişkin deneyimlerimiz sunuldu.

Hastalar ve Yöntemler: Ocak 2013 - Ekim 2016 tarihleri arasında minimal invaziv kalp cerrahisi ile perkütan internal jugüler ven kanülasyonu yapılan toplam 191 hastanın (85 erkek, 106 kadın; ort. yaş 38.7±14.8 yıl; dağılım, 16-77 yıl) verileri retrospektif olarak incelendi.

Bulgular: Hastaların 17'sine port erişim kalp cerrahisi yapıldı. Yüz yetmiş dördüne robotik kalp cerrahisi sırasında perkütan jugüler ven kanülasyonu yapıldı. İşlem sonrasında iki hastada (%1.04) lokalize hematom, bir hastada (%0.52) mediastinal hematom, bir hastada (%0.52) karotis arter yaralanması ve iki hastada (%1.04) drenaj yetersiz olduğu için vakum desteği gerekti. İşlem sonrası hiçbir hastada nörolojik komplikasyon, üst ekstremite ödemi veya kalıcı aritmi gözlenmedi. Hiçbir hastada kanülasyon sonrasında uzun dönem morbidite izlenmedi.

Sonuç: Minimal invaziv kalp cerrahisinde, perkütan internal jugüler ven kanülasyonu, cerrahın işini kolaylaştıran en önemli yöntemlerden biridir. İşlem deneyiminin artması ile minimal invaziv cerrahi daha pratik ve daha hızlı bir şekilde uygulanabilir bir yöntem olacaktır.

Anahtar sözcükler: Komplikasyon; jugüler ven kanülasyonu; cerrahi işlem.

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Due to the increasing demand for minimally invasive cardiac surgery (MICS), most basic operations are currently performed with routine minimally invasive methods.[1] It is of utmost importance to perform cardiopulmonary bypass (CPB) without any complications for MICS to be successful. Vena cava superior (VCS) and vena cava inferior (VCI) drainage of the patients to be treated at right atrium should be separated. Therefore, VCS drainage can be performed percutaneously through internal jugular vein (PIJV) cannulation.[2] In this study, we present our percutaneously through IJV cannulation experiences and results of patients who were electively treated with MICS.

PATIENTS AND METHODS

A total of 191 patients (85 males, 106 females; mean age 38.7±14.8 years; range, 16 to 77 years) who underwent MICS by performing percutaneously through IJV in our hospital between January 2013 and October 2016 were retrospectively analyzed. A written informed consent was obtained from each patient. The study protocol was approved by the Institutional Review Board. The study was conducted in accordance with the principles of the Declaration of Helsinki. Patient data were obtained from perfusion and anesthesia records and archived files in our hospital data system. Complications that occurred during percutaneously through IJV cannulation procedures and the long-term follow-up were included in the study.

Surgical technique

An arterial branule was placed via the left radial artery to all patients who underwent MICS for arterial pressure follow-up. After general anesthesia and intubation, a 7-F three-way central venous catheterization procedure was performed. This procedure was performed primarily using the left internal jugular vein (IJV). If there were any difficulties in the procedure, the central catheter was positioned from the right IJV. Routinely, transesophageal echocardiography (TEE) probes were placed in each patient. Then, the percutaneously through IJV cannulation process was started. The percutaneously through IJV cannulation was performed with an anesthesiologist, a cardiac surgeon, and an assistant. Color Doppler ultrasonography (USG) was not used routinely. Some patients were assisted using Doppler USG, when there were difficulties in cannulation. The patients were covered with large sterile sheaths only on the right neck region and above before being covered for surgical treatment. After 1.5 mg/kg heparin administration, right IJV was achieved using the Seldinger method with a normal jugular venous catheter. The correct positioning of the wire tip in the right atrium was confirmed using TEE. The ground penetration point of the guidewire was, then, enlarged using a No. 11 scalpel. Subcutaneous and fascial tissues were expanded using a surgical clamp. Sufficient width for cannulation of the vein was provided using a dilator. A 17-F femoral cannula (DLP@ Femoral Arterial Cannula) was preferred

Table 1. Jugular vein cannulation steps and points to take into consideration

Steps	Points to take into consideration
Patient positioning	Use the trendelenburg position, turn the neck slightly to the right.
Transesophageal echocardiography probe is inserted	
Intravenous heparin is administered	1.5 mg/kg
Three-way jugular catheter is inserted	Can be placed on both sides, with priority on the right.
A guide wire is sent for jugular cannulation	Transesophageal echocardiography confirms that it is in the right atrium. Do not use routine Doppler ultrasonography
Skin and subcutaneous tissue is incised using no. 11 scalpel	
With the help of surgical clamps, the skin and subcutaneous is expanded	The most important step to make the cannula insert smoothly.
Muscle, fascia and vein are dilated with the help of a dilator	
Cannula is advanced 15 cm	17-F femoral arterial cannula below 70 kg, 20-F femoral arterial cannula above 70 kg is used.
Cannula is fixed to the skin	The cannula should be protected for not making any kinks.
At the end of the operation, after the administration of protamine, the cannula is removed and local pressure is applied for 15 minutes	Z-sutures are applied to the skin for bleeding control.

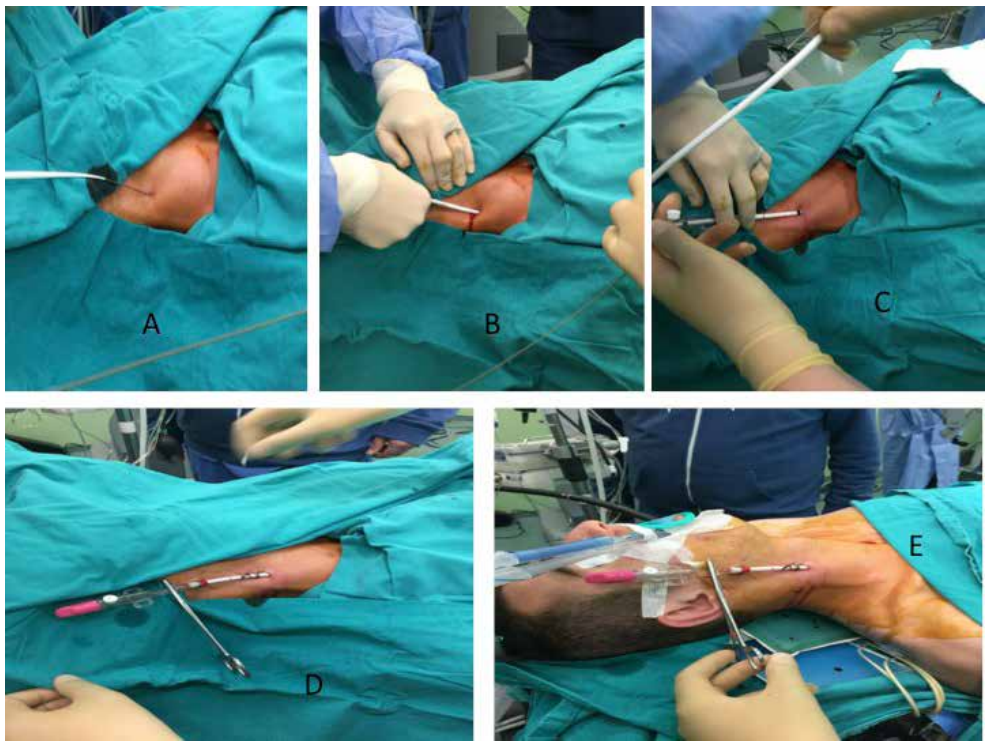

Figure 1. Jugular cannulation steps were shown.

in patients who weighed less than 70 kg, and 21-F cannulas were placed in those weighing over 70 kg. We advanced the cannula 15 cm.

The position was checked again with TEE. The cannula was washed with heparinized isotonic fluid and fixed on the skin. The perfusionist, then, checked the percutaneously through IJV cannula. Patients were sterilized and covered for MICS. After the cardiac procedures were completed CPB was ended, and systemic protamine was administered. After the protamine treatment, during the closure of the patient's skin and subcutaneous tissue, the cannula was pulled out and a suture was applied around the percutaneously through IJV cannula access hole and hemostasis was achieved through topical compression for 15 min. Jugular vein cannulation steps and points to take into consideration are presented in Table 1. Jugular cannulation steps are shown in Figure 1.

Statistical analysis

Statistical analysis was performed using the SPSS for Windows version 15.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables with normal distribution were expressed in mean ± standard deviation, and categorical variables were expressed in number and percentage.

RESULTS

The demographic data of the patients who underwent MICS procedures are shown in Table 2. Surgical interventions performed to the patients are shown in Table 3. Seventeen patients (8.8%) underwent port-access cardiac surgery, and 174 (91.2%) underwent robotic cardiac surgery. The mean duration of CPB in all patients was 67.4±23.4 min and the mean cross-clamp time was 37.4±23.4 min. The data of perioperative complications are shown in Table 4. The PIJN cannulation was not performed in two patients (1.04%). In one of these patients, the cannula was not advanced, the other patient had arterial injury; MICS was not performed in these two patients. Local hematoma developed in two patients (1.04%), mediastinal hematoma in one patients (0.54%), and carotid artery injury in one patient (0.52%), and there was inadequate drainage in the cannula of two patients (1.04%). Hemothorax and pneumothorax did not develop in any patients. The patients who had injuries in the carotid artery were treated with a

Table 2. Demographic data of all patients (n=191)

	n	%	Mean±SD	Min-Max
Age (year)			38.7±14.8	16-77
Gender				
Male	85	44.5		
Female	106	55.5		
Body Mass Index (kg/m^2)			25.0±4.8	15.62-38.36
Body surface area (m^2)			1.8±0.2	1.34-1.91
Additional disease				
Hypertension	20	10.47		
Chronic obstructive pulmonary disease	27	14.21		
Diabetes mellitus	16	8.37		
Cerebrovascular event	7	3.66		
Obesity	15	7.85		
Chronic renal disease	12	6.28		
Ejaculation fraction (%)			54.1±7.8	35-65

SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 3. Surgical procedures applied to patients and intraoperative data (n=191)

	n	%	Mean±SD	Min-Max
Port access (n=17)				
Mitral valve surgery	7	3.6		
Atrial septal defect repair	10	5.2		
Robotic surgery (n=174)				
Mitral valve surgery	56	29.3		
Mitral valve + tricuspid valve surgery	8	4.2		
Atrial septal defect repair	79	41.2		
Partial pulmonary venous return anomaly repair	9	4.7		
Atrial septal defect repair + tricuspid valve surgery	13	6.8		
Cardiac mass extraction	6	3.1		
Atrial septal defect repair + device removal + tricuspid valve surgery	1	0.5		
Partial atrioventricular canal defect	2	1		
Cardio-pulmonary bypass duration (minute)			67.4±3.4	23-428
Cross-clamp time (minute)			37.4±3.4	16-303

SD: Standard deviation; Min: Minimum; Max: Maximum.

carotid artery primary suture with a 2 cm skin incision. No further interventions were performed in patients who developed hematomas at the procedure site and mediastinum. Hematomas resorbed spontaneously.

Table 4. Perioperative complications

	n	%
Failed operation	2	1.04
Local hematoma	2	1.04
Mediastinal hematoma	1	0.52
Hemothorax	0	0
Pneumothorax	0	0
Surgical intervention required		
Arterial vessel injury	1	0.52
Venous vessel injury	0	0
Insufficient return	2	1.04
Upper extremity edema	0	0
Temporary-permanent arrhythmia	0	0

No postoperative venous thrombosis of the internal jugular vein occurred in any patients. No early or long-term morbidity was seen in any patients in whom complications developed.

DISCUSSION

The importance of peripheral cannulation techniques has increased with the development of minimally invasive cardiac surgeries.[3] In the course of performing surgical procedures on small incisions, CPB by performing peripheral cannulation provides a great advantage.[4] Peripheral cannulation is used in MICS, redo cases, and extracorporeal membrane oxygenator applications.[5] In particular, drainage of the VCS can be achieved with percutaneously through IJV in operations for opening the right ventricle of the heart.[6]

It is of utmost importance to avoid lethal complications in the process of percutaneously through IJV cannulation. There are approaches for which USG guidance is recommended during the initial insertion of the needle in the direction of the IJV.[7] Although several studies reported that USG required additional cost and carried the risk of infection,[4] Doppler USG may be a guide for variations that cause the IJV length to change and for localized hematomas. Denys and Uretsky[8] showed that the IJV was reported to be located 1 cm lateral of the carotid artery in 92% of cases and medial in 2% of patients. Although it is not routine in our procedures, some of our patients have had insertions with USG assistance.

The most important point to note is that for all peripheral cannulas, not just percutaneously through IJV cannulas, the position of the cannula should be determined using TEE.[9,10] We routinely checked that guidewire was in the right atrium using TEE in all patients, thus, we were confident of the location of the cannula. The use of TEE has vital importance to prevent any intraoperative complications. The percutaneously through IJV cannulation can often lead to high mortality complications.[11,12] In some centers that perform percutaneously through IJV cannulation for liver transplantation, the mortality rate was 0.32 to 0.7% and the morbidity rate was 1.28 to 4.1%.[13] In our patients, mortality was not observed due to percutaneously through IJV cannulation, also the morbidity rate was lower than these rates. In addition, the local hematomas that developed spontaneously resorbed and no additional surgery was needed. In the patient with carotid artery injury, surgery was required and the artery was repaired with a 2 cm incision made in the carotid artery. There were no long-term problems in any patients with morbidity. In recent studies, the incidence of venous IJV thrombosis was reported as high; however, in our series, IJV thrombosis occurred in no patients.[14]

Nonetheless, there are some limitations to this study. This study was conducted on a limited case group in a retrospective design. In addition, USG was not used routinely for IJV cannulation.

In conclusion, as minimally invasive cardiac surgeries develop, perfusion techniques will develop. The percutaneously through IJV cannulation, which improves the comfort of the surgeon and does not threaten patient safety, can be routinely administered in an effective, reliable manner with the support of an anesthesia team in necessary cases. As team experience and compliance increases, minimally invasive surgery will be able to be performed with low complication rates and efficiently.

Declaration of conflicting interests

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REFERENCES

1. Chan EY, Lumbao DM, Iribarne A, Easterwood R, Yang JY, Cheema FH, et al. Evolution of cannulation techniques for minimally invasive cardiac surgery: a 10-year journey. Innovations (Phila) 2012;7:9-14.
2. Ateş M, Sensöz Y. Toward the perfect heart-lung machine. [Article in Turkish] Anadolu Kardiyol Derg 2002;2:253-8.
3. Goldstone AB, Atluri P, Szeto WY, Trubelja A, Howard JL, MacArthur JW Jr, et al. Minimally invasive approach provides at least equivalent results for surgical correction of mitral regurgitation: a propensity-matched comparison. J Thorac Cardiovasc Surg 2013;145:748-56.
4. Maltepe F, Metin KS, Hepaguşlar H, Hancı V, Uğurlu B, Oto Ö. Percutaneous internal jugular vein cannulation for cardiac surgery. Turk Gogus Kalp Dama 2013;21:959-65.
5. Luciani N, Anselmi A, De Geest R, Martinelli L, Perisano M, Possati G. Extracorporeal circulation by peripheral cannulation before redo sternotomy: indications and results. J Thorac Cardiovasc Surg 2008;136:572-7.
6. Iribarne A, Easterwood R, Russo MJ, Chan EY, Smith CR, Argenziano M. Comparative effectiveness of minimally invasive versus traditional sternotomy mitral valve surgery in elderly patients. J Thorac Cardiovasc Surg 2012;143:86-90.
7. Troianos CA, Hartman GS, Glas KE, Skubas NJ, Eberhardt RT, Walker JD, et al. Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. J Am Soc Echocardiogr 2011;24:1291-318.
8. Denys BG, Uretsky BF. Anatomical variations of internal jugular vein location: impact on central venous access. Crit Care Med 1991;19:1516-9.
9. Kronzon I, Matros TG. Intraoperative echocardiography in minimally invasive cardiac surgery and novel cardiovascular surgical techniques. Am Heart Hosp J 2004;2:198-204.
10. Troianos CA, Hartman GS, Glas KE, Skubas NJ, Eberhardt RT, Walker JD, et al. Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. J Am Soc Echocardiogr

2011;24:1291-318.
11. Hirose H, Yamane K, Marhefka G, Cavarocchi N. Right ventricular rupture and tamponade caused by malposition of the Avalon cannula for venovenous extracorporeal membrane oxygenation. J Cardiothorac Surg 2012;7:36.
12. Jankovic Z, Boon A, Prasad R. Fatal haemothorax following large-bore percutaneous cannulation before liver transplantation. Br J Anaesth 2005;95:472-6.
13. Budd JM, Isaac JL, Bennett J, Freeman JW. Morbidity and mortality associated with large-bore percutaneous venovenous bypass cannulation for 312 orthotopic liver transplantations. Liver Transpl 2001;7:359-62.
14. Oh CS, Rhee KY, Yoon TG, Kim SH. Assessment of thrombosis in right internal jugular vein after percutaneous superior vena cava catheter insertion during cardiovascular surgery with cardiopulmonary bypass. J Thorac Cardiovasc Surg 2016;152:1592-9.