

Safety and Feasibility of the Venous Access via Internal Jugular Vein Puncture Approach for Totally Implantable Venous Access Device Placements Compared with Subclavian Vein Puncture

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ABSTRACT

Background: The aim of this study was to evaluate the safety and feasibility of venous access via the internal jugular vein (IJV) for totally implantable venous access device (TIVAD) placements. In Japan, TIVADs are generally placed in position by the percutaneous subclavian vein puncture approach (SVPA). However, this approach causes infrequent intraoperative or postoperative complications. Using the internal jugular vein puncture approach (IJVPA), TIVADs could be placed more easily and safely. **Materials and Methods:** Fifty-six patients who received TIVADs for chemotherapy of colorectal carcinomas were enrolled in this study. The choice of approach (IJVPA or SVPA) was adopted at the discretion of each doctor in charge of the patient. The operation time, success rate and complications of the two approaches were compared and evaluated. **Results:** TIVAD placement was successful in all patients. Thirty patients received the device via IJV puncture, but 1 patient required conversion to SVPA. Twenty-six patients underwent SVPA for device placement, but 3 of these patients required conversion to IJVPA. Mean operation time was 34.3 min in IJVPA and 35.2 min in SVPA. The success rate was 96.6% in IJVPA and 88.5% in SVPA. No severe perioperative complications were observed. However, long-term complications were observed in five cases, 3 by IJVPA and 2 by SVPA, but no significant difference in the rate of complications was observed between these two approaches. A catheter-related thrombosis was found by CT scan in 3 patients, two of whom underwent IJVPA (6.7%) and one case underwent SVPA (3.8%). Two patients received simultaneous administration of bevacizumab. Catheter infections occurred in 1 patient who underwent IJVPA (3.3%) and 1 patient who underwent SVPA (3.8%). **Conclusions:** The IJVPA is a safe and feasible method for TIVAD placement.

Keywords: Totally Implantable Venous Access Device (TIVAD); Internal Jugular Vein; Chemotherapy; Colorectal Carcinoma

1. Introduction

Recently, significant improvements have been made in chemotherapy for colorectal carcinomas (CRCs). These improvements are mostly due to the development of combination chemotherapies including administration of fluorouracil, irinotecan, or oxaliplatin in conjunction with molecular targeting agents such as bevacizumab, cetuximab and panitumumab. Due to the efficacy of chemotherapy, its importance in the treatment of CRCs is on the rise. Notably, due to its ability to prolong overall survival, the duration of chemotherapy administration has

been lengthened. In order to administer chemotherapeutic agents such as FOLFOX or FOLFIRI in outpatients, it is necessary to insert a Groshong catheter, which enables the patients to pull out the TIVAD needle by themselves. Administration of TIVAD avoids vascular pain that is caused during peripheral injection. Moreover, the peripheral injections occasionally cause extravasation injury caused by chemotherapeutic agents. Thus, TIVAD is a useful device to administer chemotherapy safely and with less damage.

The puncture site for insertion of the Groshong catheter of the TIVAD is through the subclavian vein (SV),

internal jugular vein (IJV), femoral vein or axillary vein. In Japan, TIVADs are generally placed by the percutaneous subclavian vein puncture approach (SVPA). According to the Report from the Ministry of Health and Welfare in Japan (2009), about 82% of TIVADs were performed by SV puncture [1]. However, the perioperative complication rate of SVPA is reportedly higher than that of IJVPA.

The SV located just beneath the clavicle is punctured in SVPA. This approach has been shown to cause serious intraoperative or postoperative complications, such as pneumothorax, arterial puncture, hemothorax, injury of brachial plexus [2-6], and pinch-off syndrome [7]. When a misdirected puncture occurs to the subclavian artery, arterial hemostasis is very difficult to re-establish.

On the other hand, the IJV is located near the surface of skin, and it runs laterally to the carotid artery. IJV can be detected clearly by ultrasonography and is easily accessible. Thus, for TIVAD placement, the IJV approach is considered a low-stress procedure.

We examined the short-term outcomes of venous access via the IJV puncture approach for the placement of TIVADs compared with the SVPA.

2. Patients and Methods

Fifty-six consecutive patients who received chemotherapy for CRCs were enrolled in this study. They underwent TIVAD placement surgeries from June 2010 to August 2011 (**Table 1**). Written informed consent from each patient was obtained prior to the procedure. The choice of approach (IJVPA or SVPA) was adopted at the discretion of each doctor in charge of the patient.

Patients were brought to the X-ray fluoroscopy room and placed in a supine position. The operation was performed with local anesthesia (0.5% of Xylocaine, AstraZeneca, UK) and under maximal barrier precaution. The TIVAD placements were performed by two surgeons.

The operator punctured the IJV or SV under ultrasound guidance and inserted the guidewire using Seldinger's catheter technique. The catheter introducer was inserted into the vein along with the guidewire. The catheter was inserted through the introducer because the tip of the Groshong catheter (BardPort X-port isp, Bard Access Systems Inc., Salt Lake City, UT, USA) was closed to avoid blood reflux. The Groshong catheter was connected to the port, which was implanted into the subcutaneous space in the chest. The catheter tip position and shape of the catheter lumen were monitored by X-ray fluoroscopy. If the first IJV or SV puncture attempt was unsuccessful, the procedure was completed using the other approach. A chest radiography was performed after the operation to detect the position of the catheter tip and

the distortion of the catheter lumen. Operation times, as well as intraoperative and postoperative complications were examined. Long-term complications were examined using an electronic medical chart. Computed tomography (CT) scans were performed to check for intravenous thrombosis and distortion of the catheter every 3 - 4 months for 2 years and were evaluated by a radiologist and a surgeon. All patients were administered either FOLFOX or FOLFIRI and eighteen patients received simultaneous administration of bevacizumab.

3. Results

Fifty-six TIVAD placements were performed consecutively in total. IJVPA and SVPA were attempted in 30 and 26 cases, respectively. However, successful completion of IJVPA was obtained in 29 patients (**Table 2**) since it was necessary to convert to SVPA in 1 patient. SVPA was completed in only 23 patients since it was not successful in the remaining 3 patients and conversion to IJVPA was required. The completion rate was 96.5% in IJVPA and 88.5% in SVPA. Mean operation time was 34.3 min in IJVPA and 35.2 min in SVPA. No perioperative complications that required additional medical treatments were observed in both groups. In this study, no catheter distortion was detected by chest X-ray after the operation.

The total follow up period was 11,619 days in IJVPA and 11,563 days in SVPA. Late complications were observed in five cases, 3 by IJVPA and 2 by SVPA, which was not significantly different (**Table 3**). A catheter-related thrombosis was found by CT scan in 3 patients, two of whom underwent IJVPA (6.7%) and one case underwent SVPA (3.8%). Two patients received simul-

Table 1. Comparison of patients.

Patients	IJV	SV	p-value
Number of Cases	30	26	n.s.
Gender (male/female)	1.8	1.2	n.s.
Age	68.4	68.5	n.s.
BMI	20.7	21.6	n.s.

Table 2. Early term results.

Result	IJV	SV	p-value
Mean operation time (min)	34.3	35.2	n.s.
Success rate %	96.5	88.5	n.s.
Complication*	none	none	-

*No intraoperative or postoperative complications were observed.

Table 3. Late complications.

Complication	IJV	SV	p-value
Catheter-related thrombosis	2 (6.7%)	1 (3.8%)	n.s.
Infection	1 (3.3%)	1 (3.8%)	n.s.

taneous administration of bevacizumab. Catheter infections occurred in 1 patient who underwent IJVPA (3.3%) and 1 patient who underwent SVPA (3.8%).

4. Discussion

The best approach for placement of TIVADs still remains unclear. In Japan, TIVADs have been generally placed by SVPA. However, the SVPA has been shown to cause intraoperative or postoperative complications including pneumothorax, arterial puncture, hemothorax, and injury to the brachial plexus [2-6]. The intraoperative complication rate of SVPA was reportedly higher than that of IJVPA [8-10].

Although the technical aspect of TIVAD placement has become much safer than before due to the use of image-guided navigation, like venous ultrasonography or venography, however, the risk of complications by mispuncture still remains. In particular, arterial bleeding from the subclavian artery by misdirected punctures can develop into very serious problems since this artery is located beneath the clavicle and vessel hemostasis is very difficult to re-establish [11].

Further, pinch-off syndrome has been reported as a complication of TIVAD which was placed by SVPA [7, 12-15]. This syndrome is thought to be caused by the compression of the catheter by the clavicle and the first rib [7,12], which may lead to obstruction followed by fracture of the catheter. Pinch-off syndrome is also referred to as subclavian crush syndrome in the cardiovascular field [16]. Subclavian crush syndrome has been reported to occur in some patients when pacemaker leads were implanted via SVPA. In these cases, conductor fracture and insulation breaches develop by compression of a lead that passes between the first rib and the clavicle. Once the catheter is torn, the remaining tip of the catheter is brought to the right atrium or pulmonary artery, which may lead to fatal consequences. A benefit of IJVPA is that this approach does not cause catheter compression that may lead to the pinch-off syndrome.

It remains controversial which approach of the two has higher rates of catheter-related thrombosis. Some previous reports have suggested a higher rate in IJVPA [17], although more recent reports have suggested otherwise, that IJVPA may indeed result in a lower risk of thrombosis [8-10,18,19]. In our study, no significant difference was observed in the rate of catheter-related thrombosis

Table 4. Catheter-related thrombosis with bevacizumab.

Complication	Bmab +	Bmab -	p-value	
Thrombosis	+	2 (11.1%)	1 (2.6%)	
Thrombosis	-	16	37	n.s.

between IJVPA and SVPA. Bevacizumab has been reported to increase the risk of vein thrombosis in patients with TIVAD [20]. Although no statistically significant differences were found between the two groups in this study (Table 4), the incidence of thrombosis in the bevacizumab group (11.1%) was higher than in the bevacizumab group (2.6%). This finding suggests that catheter thrombosis could have been affected by administration of bevacizumab in our group of patients. Thus, clinicians should pay careful attention to the risk of catheter-related thrombosis in patients who receive administration of bevacizumab.

One further point to consider is the technical maneuver of IJVPA, which requires surgical technique to make a relatively long subcutaneous tunnel from the port to the puncture site. It is important to make a gradual curve of the subcutaneous tunnel to avoid creating a kink in the catheter.

5. Conclusion

In this study, we performed TIVAD placements by the IJVPA and evaluated the outcomes. We showed that IJVPA is a safe and feasible approach for TIVAD placement with outcomes that are comparable to the standard SVPA. Catheter thrombosis could have been affected by administration of bevacizumab.

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