A Dual-Needle Pumping Technique for Unblocking an Obstructed Central Venous Access Port

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Abstract

PURPOSE: To evaluate the usefulness and safety of the "dual-needle pumping technique” for central venous access port (CV port) obstruction due to thrombus or fibrin sheath formation.

PATIENTS AND METHODS: For 25 patients who had a CV port obstruction due to thrombus or fibrin sheath formation between 2001 and 2016, we performed the "dual-needle pumping technique.” The operator inserted two coreless needles in the port and alternately pumped the plungers of two syringes filled with distilled water or urokinase (UK) solution.

RESULTS: Overall, we achieved recanalization in 22 patients (88%). In 6 patients, success in recanalization was achieved by using distilled water only, while in 2 patients, failure occurred by using distilled water only before changing to the UK solution to achieve recanalization. Success in recanalization was attained in 14 patients by using the UK solution from the beginning. In 3 patients, the CV port system was withdrawn because the obstruction could not be removed. No complications occurred in relation to this procedure.

CONCLUSION: For removing an obstruction in the CV port system, the "dual-needle pumping technique” is a reasonable option to avoid system replacement. Thus, this procedure is considered useful and safe.

Key words: complications, obstructed central venous access port, recanalization

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INTRODUCTION

Obstruction of a central venous access port (CV port) system is well known as one of the most frequent complications after its implantation. Thus, management of such an obstruction has been investigated [1-6]. According to previous reports [2, 7, 8], injection of heparin or urokinase (UK) solution to relieve the obstruction has been conducted in most situations, but the recanalization rate has been insufficient at 50% to 88.9%. This wide range could be due to the great variability in the management of CV port obstructions among operators and institutions [2, 7, 8]. In our institution, for CV port obstructions due to thrombus or a fibrin sheath formation, we used a dual-needle pumping technique to recanalize the CV port. This study evaluated the usefulness and safety of this technique.

PATIENTS AND METHODS

For 25 patients in whom a CV port obstruction occurred between October 2001 and July 2016, the dual-needle pumping technique was performed. In all the patients, pressure infusion with saline or heparin was performed initially but failed to relieve the obstruction. Cases of CV port-catheter system obstruction due to mechanical trouble such as catheter kinking or fracture, or catheter-related infection with symptoms such as a spiking fever were excluded from this study. Ports were placed in the forearm in 23 cases and in a subclavian site in 2 cases. Five different brands of CV

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port-catheter systems were used, including the 5-Fr Anthron P-U catheter kit (Toray Industries, Inc., Tokyo, Japan; n = 21), 8-Fr polyurethane catheter and PowerPort isp M.R.I. (Bard, Inc., Salt Lake City, UT, USA; n = 1), 6-Fr Orphis CV kit (Sumitomo Bakelite Company Limited, Tokyo, Japan; n = 1), 5- to 3.3-Fr tapered catheter and P-U Celsite Port Baby (Toray; n = 1), and 5-Fr Vital-Port Titanium Vascular Access System, Mini (Cook Medical Inc., Bloomington, IN, USA; n = 1). The insertion periods from implantation of the CV port-catheter system until its obstruction ranged from 1 day to 738 days (median, 102 days).

Observations at the time of obstruction of the CV port-catheter system were as follows: Blood reflux was observed during drip infusion in 10 patients, drip infusion gradually became difficult in 7, and the CV port was not used for &gt;2 years in 1. Details of the observations were unknown in the remaining 7 patients. In 5 of the 7 patients in which drip infusion gradually became difficult, the cause of the CV port-catheter obstruction was fibrin sheath formation, which was confirmed by using contrast-enhanced computed tomography (CT) or venography obtained during infusion of contrast material from the port. In the other 2 cases, fibrin sheath formation was also suspected to be the cause of obstruction based on the clinical situation regarding the use of the CV port.

With the dual-needle pumping technique, the operator inserted two coreless needles (22 G, 25 mm in length, coreless needle; Nipro Corporation, Osaka, Japan) through the septum of the port and alternately pumped the two syringes filled with either distilled water (Otsuka Distilled Water, Otsuka Pharmaceutical Co., Ltd., Tokyo, Japan) or UK solution (Urokinase Fuji 60,000, Wakamoto Pharmaceutical Co., Ltd., Tokyo, Japan) to clean the inside of the chamber or lyse a thrombus. All the materials used in this procedure are readily available; that is, the two coreless needles and two lock-tip syringes with 2-3 ml and 20 ml of distilled water or 60,000 units of UK and 20 ml of saline. The steps in the procedure are as follows:

1. Fluoroscopy or venography is used to examine for a system break from the CV port. Cases with catheter kinking or catheter disconnection with the port are excluded.

2. Both 3-ml syringes are filled with 2.5 ml of distilled water or UK solution, and a coreless needle is attached to each of the syringes.

3. After sterilizing the patient’s skin, the two coreless needles are inserted close to each other through the septum margin as close to the orifice as possible (i.e., connection of the port with the catheter; Fig. 1a).

4. While the plunger in one syringe is pulled out with negative pressure, the plunger in the other syringe is pushed with positive pressure. The operator repeats the pumping alternately (Fig. 1b). If one plunger cannot be pushed, the operator reinserts the needle and proceeds. Meticulous care is taken not to raise the internal pressure in the port. If a coagulated blood clot in the port is well lysed and/or broken up, the solution within the syringe would gradually become bloody (Fig. 1c). When a small white or red thrombus is aspirated, it is disposed of and the pumping resumes. Decreased solution in the syringes suggests that the blood clot in the port has dissolved, resulting in resumption of flow from the port into the catheter. If the distilled water in the syringes does not decrease after persistent pumping, the solution is switched to the UK solution.

5. When a clot or thrombus is not aspirated at all even after continuing this procedure for some time, the operator stops applying negative pressure in one syringe. Alternatively, the operator resumes pumping with positive pressure in both syringes so that pressure inside the port would increase. If the solution in the syringes still does not decrease, the operator keeps pumping. When a resolution is still not obtained, a small amount of UK solution is infused into the port and left in place from 5 to 60 min. This period depends
Fig. 2. Cases for whom the dual-needle pumping technique for CV port obstruction was performed.

Table 1. Characteristics of cases with failed recanalization

| Case No. | CV port catheter system | Implanted period until obstruction | Situation at the time of obstruction | Possibility of pumping | Time required for this procedure | Solution                  |
|---------|-------------------------|-----------------------------------|--------------------------------------|------------------------|---------------------------------|---------------------------|
| 1       | 5-3.3Fr. tapered catheter and P-U Celsite Port Baby | 1 day | blood reflux | possible | 15 min | distilled water and urokinase |
| 2       | 5 Fr. ANTHRON® P-U catheter kit | 738 days | not used more than 2 years | possible | 20 min | urokinase            |
| 3       | 5 Fr. ANTHRON® P-U catheter kit | 395 days | unknown | possible | 20 min | urokinase            |

on circumstances. However, in most of the cases, this period was within 10 min. Thereafter, the operator repeats the same pumping procedure. The procedure is terminated if the solution within the syringe does not become bloody >15 min after changing to UK solution.

RESULTS

As shown in Fig. 2, recanalization of the CV port-catheter system was achieved in 22 (88%) of the 25 patients after performance of the dual-needle pumping technique. The mean time required to recanalize the port-catheter system was 5 min 30 s (range, 1-42 min; median, 3 min 45 s). Details of the 3 cases in which recanalization was impossible are shown in Table 1.

In 8 patients, distilled water was initially used in this procedure, resulting in success in recanalization in 6 patients (75%). In the remaining 2 patients, the solution was changed to the UK solution and the procedure was successfully continued. In 17 patients, the UK solution was used from the beginning. Overall, the procedure was performed by using the UK solution in 19 patients, with success in recanalization of the CV port-catheter obtained in 16 patients (84.2%). In all the 25 study cases, pumping action inside the port was finally possible. In 11 cases, pumping was easily performed without resistance from the beginning; in 10 cases, pumping gradually became possible without resistance; and in 4 cases, this information was not available. Although pumping could be performed easily from the beginning, recanalization was impossible in 3 cases, and the CV port system was removed. Inside the removed catheters, the lumen was filled with thrombus.

No complications occurred in relation to this procedure, such as a break in the CV port system, bleeding, or pulmonary embolism. Reobstruction did not occur in any patient during the 28- to 763-day follow-up (median, 185 days).

DISCUSSION

In CV port obstruction, the clinical situation necessitating
the use of a CV port up to the time of the obstruction is evaluated and the etiology of the obstruction is assessed. Fluoroscopy is used to evaluate for mechanical trouble with the catheter, and peripheral venography or contrast-enhanced CT from the CV port is additionally performed as appropriate [2, 9, 10]. Then, the appropriate procedure is performed to relieve the obstruction [9, 10].

Deborah et al. [9] and Jacquelyn et al. [10] reported that intraluminal thrombus or blood clot accounts for 5% to 25% of all catheter occlusions. In other reports, rates have ranged from 3.7% to 28% [1, 3, 11]. The most prevalent cause of CV port thrombotic obstruction is insufficient flushing after drip infusion or aspiration of blood through the CV port, and blood reflux during drip infusion due to insufficient device fixation [12]. Fibrin sheath formation is a normal biological reaction caused by foreign body insertion and occurs around the catheter approximately 2 weeks after placement [10]. When the fibrin sheath encases the distal end of the catheter tip, difficulty in aspiration of blood or drip failure occurs gradually, resulting in complete port obstruction.

Management of thrombotic obstruction of a CV port system, such as pumping in saline to push out the thrombus in the catheter or injecting as much UK solution as possible with a 1-ml syringe into the port to lyse blood clots, has been reported [2, 8]. A regular port catheter can resist pressure of up to 0.9 to 1.2 MPa (130.5-174.0 psi); however, with a 1-ml syringe, pressure of up to 3 MPa (435.1 psi) can be achieved [1]. As inadequate flushing may lead to fracture of a port system, manufacturers have recommended the use of a syringe of >10 ml. In our procedure, we used a 3-ml syringe to avoid exerting too much pressure. When we removed a blood clot from the syringe, we took care to dispose of only the thrombus, with minimal amounts of solution being discarded.

In the CV port system, the bottleneck in the lumen of the system is the connection between the port and the catheter, as the orifice of the chamber has a small cross-sectional area (approximately 1 mm in diameter). Even a small blood clot in the port may wedge easily at that site. Hence, we considered that conventional injection methods with positive pressure might result in a low rate of recanalization. Thus, with our technique, if a small white or red thrombus was grossly visible in the syringe during the pumping procedure, we removed it each time. These steady efforts could prevent wedging of the clot in the orifice.

In one of the 3 cases in which recanalization was not obtained with this method, a tapered catheter was used, and a red thrombus had filled the lumen of the removed catheter. We speculate that in tapered catheter port systems, even though the inside of the port could be washed, a thrombus in the catheter lumen cannot be pushed out because of the additional bottleneck in the tapered segment of the system. In the remaining 2 cases, a non-tapered catheter was used. In both cases, a solid organized thrombus had filled the removed catheter lumen.

Previous reports described methods of recanalization after thrombotic obstruction of a CV port system in which a micro guidewire was introduced into the orifice. Donald et al. [3] showed that a combination of guidewire manipulation and UK solution infusion would often salvage the catheter. Sobolevsky et al. [13] reported normal salvage by using a non-coring straight Huber needle and a 0.018-in tapered hydrophilic wire, and Andrews et al. [14] described catheter recanalization by using a 0.018-in Cope mandril guidewire with a 20-gauge spinal needle [3, 13, 14]. Andris et al. [9] described a procedure whereby a three-way stopcock was attached to a syringe and connected to a coreless needle; negative pressure was then created within the system and UK solution was pulled into the catheter lumen. However, these methods are considered to be expensive and inconvenient.

We speculate that the principle supporting the use of this dual-needle pumping technique is as follows: In an obstruction caused by a thrombus formed in the port by blood reflux during drip infusion, internal pressure in the port is only increased by injection of a solution with a syringe and pressure to the catheter lumen is not transmitted. Inserting two coreless needles in the port causes an eddying of the flow into the chamber without excessive pressure and crushes or lyses blood clots adjacent to the orifice in the port. Essential to this technique is pushing out the thrombus in the catheter by transmitting intra-chamber pressure to the catheter lumen without blocking the passage of the portion of the orifice. Therefore, it is extremely important to dispose of each intra-chamber clot, as it is aspirated during the procedure.

When the CV port system is obstructed by thrombus, the obstructed period is estimated to be relatively short and the thrombus is not organizing, making recanalization of the system possible by using the dual-needle pumping technique with distilled water. We used distilled water alone in some cases because we expected physical cleaning and destruction of erythrocytes [15, 16]. On the other hand, in the case of CV port system obstruction caused by a fibrin sheath formation on the catheter tip, we cannot expect recanalization without contact of the UK solution with the fibrin sheath. Therefore, from the beginning, we should use a UK solution.

The present study had some limitations in that it was not a prospective study and the number of participants was small. In addition, we did not compare the use of solutions with a single needle. Thus, further study with a larger number of participants might be necessary for results to be conclusive. However, in the present study, the success rate of recanalization was high at 88%. Recanalization was obtained in a short time without any severe complications. From the present results, we can suggest that the dual-needle pumping technique is a useful and safe procedure for obstruction of a CV port system.

Conflict of interest: The authors declare that they have no conflicts of interest to report.
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