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Clinical Experience with Peripherally Inserted Central Catheters in Patients Undergoing Lung Resections

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Abstract

Objective: In the general thoracic surgery department peripherally inserted central catheters (PICCs) may be an alternative option to standard central and peripheral venous catheters for patients undergoing surgical procedures and possible candidates to adjuvant chemotherapy. We report the results of our experience with PICCs in patients undergoing lung resections.

Materials and Methods: We retrospectively reviewed data of 54 PICCs inserted in adult patients who underwent lung resection. Rate of complications at insertion and during maintenance were recorded. Each patient was followed from the implant to the removal of the device (median 20 days, range 10-370 days). In 23 cases PICCs were also used for adjuvant chemotherapy.

Results: Insertion was successful in 98% of cases. There were no major complications and 15% minor complications (local hematoma, repeated punctures of the vein, difficulty in progression of the catheter and malposition) at insertion. During maintenance there were no episodes of catheter-related bloodstream infection; two (3,7%) episodes of symptomatic thrombosis occurred during the chemotherapy period, associated to deep vein thrombosis of the legs, treated with medical therapy. Accidental removal of the catheter was observed in one patient. Removal of the catheter was never required because of complications.

Conclusion: PICCs are a useful and safe device for patients undergoing lung resections. Their insertion is successful in 98% of cases and is not associated with significant risks, even in patients with coagulation disorders. Their maintenance is associated with an extremely low rate of infectious and non-infectious complications.

Keywords: Peripherally inserted central catheters; Lung resections; Adjuvant chemotherapy

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Introduction

The use of peripherally inserted central catheters (PICCs) has many theoretical advantages in the general thoracic surgery department (GTSD) setting, because these devices are associated with low-risk insertion, even in patients with altered coagulation and/or, in case of standard central venous catheters (CVCs), difficult neck anatomy [1,2]. PICC insertion can be carried out with no risk of pleuro-pulmonary damage and with no clinically significant risk of local hemorrhage or hematoma, if compared with standard CVCs [2,3]. Furthermore, PICC insertion in the upper mid-arm is characterized by an easy dressing of the exit site, this benefit being particularly evident in patients with tracheostomy [4]. Although the issue is somehow controversial, PICCs are also usually considered a device at low risk for catheter-related bloodstream infection (CRBSI), which may be an additional advantage in surgical patients [5,6]. PICCs can also be used for central venous pressure monitoring, specifically when using polyurethane, open-ended catheters >4 Fr, as long as they have no evidence of malfunction [7]. Although the potential benefit of PICCs in the thoracic surgical patient looks straightforward, some limitations have slowed their introduction into clinical practice such as the low flow rate, now days overcome with the advent of the power-injectable PICCs. We report the results of our recent experience with PICCs in patients undergoing lung resections.

Materials and Methods

We retrospectively reviewed data of 54 PICCs inserted the day before surgery in patients who underwent lung resection at our department. Indication for PICC insertion was: thoracotomy for major lung resection (lobectomy and pneumonectomy) and candidate to adjuvant chemotherapy. All PICCs were inserted as an elective procedure, contralaterally to the thoracotomy because of the

Table 1: Results of PICCs in patients undergoing lung resections at GTSD.

Number of patients	54
Inserted catheters	53 (98%)
Follow-up duration (dwell time)	73 days (20 days median value)
Major Complications	0 (0%)
Minor Complications	8 (15,09%)
Accidental Removal	1 (1,89%)
Regular Removal	52 (98,11%)
Patients undergoing adjuvant-chemotherapy	22 (41,5%)

arm compression on the surgical bed and post-surgical hypomobility of the arm. Standard contraindication to PICC insertion was: small deep veins of the arm (brachial/basilic vein <4 mm). Severe arm edema and/or obesity are not considered contraindications to PICC insertion [8], although in these situations the brachial and basilic vein might be too deep (>3 cm) so the cephalic vein is preferentially cannulated. We considered both multiple-lumen and single-lumen catheters, of different sizes (from 4 to 5 Fr) and different brands, as long as they were inserted the day before surgery. All PICCs were inserted according to the specific protocol defined by our GTSD. All of the catheters were inserted by ultrasound-guided puncture of the deep veins in the upper mid-arm, as recommended by current guidelines, using the micro-introducer technique. A standard 10 MHz linear ultrasound probe was used. Veins with diameter = or >4 mm were considered suitable for 4 Fr catheters and veins = or >5 mm suitable for 5 Fr catheters. Maximal barrier precautions were consistently used during the procedure (cap, mask, sterile gown, sterile gloves, and vast sterile field). The correct position of the tip of the catheter (that is, in proximity of the junction between the superior vena cava and the right atrium) was verified during the procedure using the intracavitary electrocardiography (EKG) method [9]; a post-procedural chest X-ray for checking the tip position was required only when the EKG method was not applicable (atrial fibrillation and/or no evident P-wave at the basal EKG) and during the first 12-months (learning curve associated with EKG method). All PICCs were secured to the skin using sutureless devices, as currently recommended [10]. All procedures were performed by physicians specifically trained for PICC insertion. Maintenance of the line and dressing policies were carried out according to the intervention bundle for preventing line infections adopted by our GTSD (preferential use of 2% chlorhexidine for antisepsis of the exit site, preferential use of transparent dressing, and so forth). Occlusion of the line was prevented by a specified policy of periodic flushing and locking with saline. We collected all relevant data and information, including indication for PICC insertion, duration of the dwell time for the device, incidence of complications at insertion or during maintenance, and cause of removal. All data were included in a software-operated database and analyzed by standard descriptive statistics. Values are reported as the mean±standard deviation.

Results and Discussion

During the study period, 54 open-ended PICCs (standard and power-injectable polyurethane) were inserted at our GTSD. Thirty-three catheters were standard PICCs (polyurethane single-lumen 4 Fr) and 20 power-injectable polyurethane catheters (polyurethane double-lumen 5 Fr). PICCs were successfully inserted in 98% of cases (Table 1). Only one (2%) insertion was unsuccessful because of subcutaneous emphysema of the arm that did not allow ultrasonographic visualization of the veins. Minor complications at insertion were local hematoma (two cases, 3.7%), repeated punctures of the vein (three cases, 5.6%), difficulty in progression of the catheter (two cases, 3,7%), and one malposition (1,8%, patient with no evident P-wave on basal EKG, where the intracavitary EKG method could not be used). This latter case required repositioning of the PICC by exchange over guide wire. A few patients had severe obesity (body mass index >35, two patients); in these patients PICCs were inserted without difficulty, via the cephalic vein since brachial and basilica veins were too deep. The average dwell time of the device was 73 days (median value 20 days): most catheters stayed in place for more than 2 weeks and were removed when the patient was discharged or completed adjuvant chemotherapy. No PICC was removed because of complications during the hospital stay and after discharge, and there were no dislodgements, but in one patient we observed accidental removal of the device for two times. Twenty-two patients underwent adjuvant chemotherapy after hospital discharge. There were no relevant episodes of occlusion or of persistent difficulty in blood withdrawal; six cases of partial obstruction were resolved by simple saline flushing under pressure. There was not a single case of CRBSI. Symptomatic catheter-related central venous thrombosis occurred only in two patients associated to deep vein thrombosis (DVT) of the lower limbs, successfully treated with therapeutical dose of low molecular weight heparin. Power-injectable PICCs were used easily for high-flow intravenous infusions (>1,000 ml/hour, by infusion pump), as well as for measurement of the central venous pressure [7] and were also used for injection of contrast medium during computed tomography (CT) scans. In the Literature, there is no clinical experience with PICCs in general thoracic surgery patients, from the surgical period to the eventual adjuvant chemotherapy. The potential advantages of PICCs in the hospital settings have been described by many authors in other fields; however, reports dealing specifically with the use of PICCs in surgical patients are scarce. To the best of our knowledge, the present paper is the first clinical study reporting a detailed analysis of the complications associated with the use of PICCs in adult patients in the GTSD. Our rate of complications at insertion has been extremely low. Complications at insertion are known to be minimal when using both ultrasound guidance and the micro-introducer technique [3].

With regards to the incidence of CRBSI, there is accumulating evidence that PICCs are associated with a lower rate of infection if compared with CVCs; probably because of an exit site that is less prone to contamination (upper mid-arm skin is characterized by a lower bacterial colonization if compared with skin at the neck or in the infra-clavicular area). As reported in similar papers on ICU patients, in our experience the rate of CRBSI was zero- although our investigation was an uncontrolled retrospective study and did not aim to compare CVCs with PICCs in terms of infection rate [5]. Mechanical complications were also uncommon in our series and reversible. Dislodgement has been described as a problem only in studies not using ultrasound-guided insertion in the upper mid-arm and/or not using sutureless devices for PICC securement. Also, mechanical damage such as ruptures usually occurs with silicone PICCs rather than with polyurethane PICCs. The ultra-resistant polyurethane of power-injectable PICCs appears to protect from mechanical damage, dislodgement and occlusion. The incidence of clinically symptomatic PICC-related thrombosis has been reported in two cases, associated with DVT of the lower limbs. The two cases of symptomatic PICC-related thrombosis in our study may be explained

by the hypercoagulability state of the oncological patients undergoing chemotherapy. Since standard PICCs are catheters with small caliber (typically, 4 to 5 Fr) and relevant length (30 to 40 cm on average), they are associated with a high resistance to flow. A single-lumen 4 Fr PICC may achieve a flow rate of 2 to 3 ml/minute (by gravity infusion) and 10 to 11 ml/minute (with pump); the flow rates of a single-lumen 5 Fr PICC are only slightly higher (3 to 4 ml/minute by gravity and 11 to 13 ml/minute with pump). Double-lumen PICCs have worse performance in terms of flow, because increasing the number of lumens reduces the lumen size and further decreases the flow rate. The situation changed following the recent development of PICCs made of ultra-resistant polyurethane, which were originally introduced for use with the high-pressure pumps (so-called power injectors) commonly utilized for high-velocity infusion of contrast media during CT scan and other radiological procedures. Power injectors may develop pressures as high as 300 pressure surface inch (psi); silicone catheters tolerate no more than 50 to 60 psi, and most polyurethane catheters approximately 100 psi. Such power-injectable PICCs-developed and marketed by several companies-have been shown to have the additional advantage of delivering infusions at a very high rate (3 to 5 ml/second=180 to 300 ml/minute), if coupled with an appropriate infusion pump. They all share several features that make them particularly attractive for the GTSD setting: low risk of mechanical and hemorrhagic complications at insertion, low risk of CRBSI, high flow (up to 300 ml/minute), easy monitoring of central venous pressure, low risk of lumen obstruction, and safe use for radio-diagnostic procedures. In the present paper, we have reported our preliminary experience with the use of both standard and power-injectable PICCs in GTSD patients.

Conclusion

In conclusion, this preliminary retrospective report shows that PICCs can be successfully utilized in most thoracic surgical patients, even in that requiring adjuvant chemotherapy. Contraindications to PICC insertion are few, such as the need for an emergency central line, need for a central line with more than three lumens, and lack of availability of a vein >4 mm in the upper mid-arm. CRBSI and catheter-related venous thrombosis appear to be uncommon. Most early and late complications can be successfully minimized by the adoption of an insertion protocol including key recommendations such as ultrasound guidance, by the choice of a vein with appropriate caliber, by careful positioning the tip by the EKG method, and by the consistent use of sutureless securement devices. Considering the results of this preliminary retrospective analysis, further prospective, controlled, randomized trials comparing the clinical outcome of CVCs with PICCs in GTSD patients are warranted.

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