



Handgrip exercise reduces peripherally-inserted central catheter-related venous thrombosis in patients with solid cancers: A randomized controlled trial



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ABSTRACT

Background: Peripherally-inserted central catheter-related venous thrombosis has serious complications including the loss of vascular access, recurrent venous thrombosis, and post-thrombotic syndrome. Current guidelines recommend non-pharmacological strategies to prevent peripherally-inserted central catheter-related venous thrombosis. There is little evidence for the effectiveness of handgrip exercise on the prevention of peripherally-inserted central catheter-related venous thrombosis.

Objectives: To examine the effectiveness of handgrip exercise using an elastic ball to prevent peripherally-inserted central catheter-related venous thrombosis in patients with solid cancers.

Design: A randomized controlled trial.

Settings: One teaching hospital in Nanjing, China.

Participants: In total, 120 subjects with solid cancers were eligible; each had a new peripherally-inserted central catheter. They were recruited and randomly assigned into two exercise groups and one control group.

Methods: Subjects from exercise groups 1 and 2 performed a 3-week, 25-repetition handgrip exercise, 3 and 6 times daily, respectively. The control group subjects performed a gentle limb exercise with no frequency and intensity requirements. Ultrasound was used to detect venous thrombosis development and examine axillary vein blood flow over the three points.

Results: There were 32 cases of peripherally-inserted central catheter-related venous thrombosis detected. Two venous thrombosis cases in the control group were symptomatic, but all venous thrombosis cases in the exercise groups were asymptomatic. All venous thromboses were partial. There were significant differences in the incidence of venous thrombosis among the three groups ($\chi^2 = 12.813$, $p = 0.002$; $\chi^2 = 9.340$, $p = 0.009$; $\chi^2 = 11.480$, $p = 0.003$; and $\chi^2 = 10.534$, $p = 0.005$, respectively) at days 2, 3 and 21. The incidence of venous thrombosis in the two exercise groups was lower than that in the control group over the 3 time points (all, $p < 0.05$). The between-group effects and interaction effect in vein maximum velocity and time-mean flow velocity showed significant differences ($F = 4.180$, $p = 0.025$; $F = 4.010$, $p = 0.045$; and $F = 2.928$, $p = 0.025$) at days 2, 3, and 21, respectively. The axillary vein blood flow parameters in the control group were lower than those in the two exercise groups at day 21 (all, $p < 0.05$). However, no significant differences occurred in the incidence of venous thrombosis and axillary vein blood flow parameters between the two exercise groups.

Conclusion: Handgrip exercise using an elastic ball daily for three weeks could decrease the incidence of

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peripherally-inserted central catheter-related venous thrombosis. The method is simple, with no negative consequence reported. Further studies are required to confirm this conclusion and to explore the optimal frequency of handgrip exercise.

What is already known about the topic?

- Cancer patients with peripherally-inserted central catheter are at greater risk of venous thrombosis compared with the general population.
- Stasis is a critical factor in the formation of thrombi.
- Handgrip exercise using a soft ball in patients with new arteriovenous fistula has shown increased cephalic vein blood flow volume and could be examined further.

What this paper adds

- This paper presents the findings of the examination of the effectiveness of handgrip exercise using an elastic ball to prevent peripherally-inserted central catheter-related venous thrombosis in patients with solid cancers.
- Lower incidence of venous thrombosis occurred in the two exercise groups compared to the control group over the three time points; significant difference between-group effects and the interaction effect in vein maximum velocity and time-mean flow velocity were found.
- This study suggests that the 3-week handgrip exercise using an elastic ball could decrease the incidence of peripherally-inserted central catheter-related venous thrombosis and increase venous blood flow.

1. Introduction

Central venous access devices, which include tunneled or non-tunneled central venous catheter, subcutaneous venous port, and peripherally-inserted central catheter, have been widely used to administer chemotherapeutic agents (Patel et al., 2014). There is no consistent evidence as to which type of central venous access devices is preferable for patients with cancer (Bertoglio et al., 2016). The benefit of peripherally-inserted central catheter is to avoid mechanical complications associated with central venous catheter placement, such as pneumothorax, arterial puncture, and hemorrhage (Comerlato et al., 2017; Johansson et al., 2013). Peripherally-inserted central catheterization can be performed by a nurse-led team at the bedside. The method decreases costs and saves time compared to insertion by an interventional radiologist, which requires patients, including critically ill patients on the intensive care units, to be sent to the interventional radiology room (Oakley et al., 2000). Reports indicate that the use of peripherally-inserted central catheter has become increasingly popular among Chinese populations (Li et al., 2014; Liu et al., 2015).

However, complications associated with peripherally-inserted central catheters are well-recognized, including venous thrombosis (Liem et al., 2012) and other serious adverse events (Chopra et al., 2013; Leroyer et al., 2013). Patients with cancer with peripherally-inserted central catheters are at greater risk of venous thrombosis than the general population (Chopra et al., 2013). Furthermore, the average incidence of recurrent venous thrombosis in patients with cancer has been reported to be 5.1% (Bleker et al., 2016). Therefore, it is crucial to prevent thrombosis in patients with cancer. Virchow's well-known triad describes the three key components of clot formation: endothelial injury, circulatory stasis, and hypercoagulable states (Yacopetti, 2008). Until now, the existing guidelines have not recommended any routine use of pharmacological prophylaxis to prevent peripherally-inserted central catheter-related venous thrombosis in patients with cancer (Kahn et al., 2012; Siragusa et al., 2012). Therefore, non-

pharmacological strategies to prevent thrombosis should be used (Yacopetti, 2008).

Recent studies focused on the effectiveness of strategies that may reduce venous thrombosis, including the use of ultrasound to ensure the appropriate catheter to vein ratios, insertion techniques, tip positions, flushing techniques, and patient education (Mitchell et al., 2013; Sharp et al., 2016; Takashima et al., 2017). However, randomized controlled trials on post-insertion nursing care are necessary, which may reduce venous thrombosis (Fallouh et al., 2015; Takashima et al., 2017). Stasis is a critical factor in the formation of thrombi according to Virchow's triad (Yacopetti, 2008). The cephalic vein blood flow volume increases when the handgrip exercise, using a soft ball, in patients with new arteriovenous fistula, is performed (Kong et al., 2014). Yet there is little evidence for the effectiveness of handgrip exercises to prevent venous thrombosis in populations undergoing peripherally-inserted central catheter insertion.

The aim of the study was to examine the effectiveness of handgrip exercise using an elastic ball to prevent peripherally-inserted central catheter-related venous thrombosis in patients with solid cancers.

2. Methods

2.1. Study design

This study was a parallel, efficacy, randomized, controlled trial, conducted over a 21-day period. All eligible subjects were randomly assigned into a control group, exercise group 1, or exercise group 2. Data were collected at four time points, including the baseline (before exercise on day 1), days 2, 3, and 21, or whenever patients felt arm discomfort at the site of insertion. The retrospective registry website for the study was <http://www.chictr.org.cn/showproj.aspx?proj=10172>.

2.2. Study settings

The study was conducted between March 1 and July 30, 2014 on the respiratory, oncology, and radiotherapy wards of a teaching hospital in Nanjing, China. The teaching hospital is a 3000-bed urban tertiary facility, which is consistently ranked as a top hospital in East China and provides state-of-the-art diagnosis and treatment services.

2.3. Study participants

Inclusion criteria were as follows: 1) patients with solid cancers aged between 20 and 80 years; 2) patients with new peripherally-inserted central catheters inserted via the basilic vein; 3) location of the catheter tip in the superior vena cava; 4) over 60 points on the Karnofsky performance scale; 5) no dyskinesia; 6) no history of thrombosis; and 7) catheter maintenance occurring at the same hospital. Exclusion criteria were as follows: 1) history of central venous access device and new venous thrombosis; 2) conditions affecting venous return, including but not limited to, axillary lymph node enlargement and congestive heart failure; and 3) presence of a pacemaker or/and arteriovenous fistula. Subjects were excluded from the study for poor compliance (at least 80% follow-up at the end of the recommended treatment period was necessary, loss to follow-up, including early hospital discharge, or transfer to another hospital, withdrawal from the study or death).

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