

Original Article

Tissue adhesives to secure peripheral intravenous catheters: A randomized controlled trial in patients over 65 years

Uğur Özkula^{a,*}, Ayhan Özhasenekler^c, Gülhan Kurtoğlu Çelik^c, Fatih Tanrıverdi^c,
Gül Pamukçu Günaydın^b, Mehmet Ergin^c, Çağdaş Yıldırım^c, Şervan Gökhan^c

^a University of Kyrenia, Faculty of Medicine, Department of Emergency Medicine, Girne, KKTC, Cyprus

^b Ankara Atatürk Training and Research Hospital, Department of Emergency Medicine, Ankara, Turkey

^c Yıldırım Beyazıt University, Faculty of Medicine, Department of Emergency Medicine, Ankara, Turkey

ARTICLE INFO

This article's abstract has been presented in 5th Eurasian Congress of Emergency Medicine 2016 as an Oral Presentation.

Keywords:

Peripheral catheterization tissue adhesive
Emergency department

ORCID:

UÖ: 0000-0002-1448-0784

AÖ: 0000-0002-2707-4099

GKÇ: 0000-0003-1259-3694

FT: 0000-0001-9959-5769

GPG: 0000-0001-8531-4591

ME: 0000-0002-9420-6514

ÇY: 0000-0001-7456-5395

ŞG: 0000-0002-1758-3383

ABSTRACT

Introduction: Peripheral venous catheterization is one of the most used medical procedures in hospitals worldwide. Recent researches state that using intravascular devices is a risk factor for both local and systemic complications. In this study, we aimed to test that addition of tissue adhesive to the insertion site of peripheral intravenous catheters (PIVC) in the emergency department (ED) would reduce the device failure rate at 6 h and 24 h following insertion.

Material and methods: We designed a single-site, two-arm, randomized, controlled trial. We inserted 115 PIVCs into 115 adult patients.

Results: PIVC device failure for the 6th hour follow up was 15.4% in the tissue adhesive group (95% CI: 4.1–26.7) vs. 25.6% with standard care group (95% CI: 11.9–39.3). There was no statistically significant difference between two groups ($p = 0.33$).

The number of patients for 24 h follow-up was not enough and the obtained data could not be included in the study.

Discussion: In this study, the routine use of tissue adhesives in addition to standard care to reduce PIVC failure for patients 65 years or older in ED was not supported due to not clear benefits and cost effectivity.

Conclusion: Even though the routine use of tissue adhesives is not recommended according to the study results, it may be reasonable to use tissue adhesives for long term hospitalization expected patients to protect from related complications due to current literature.

1. Introduction

Peripheral venous catheterization is one of the most used medical procedures in hospitals worldwide. In United States about 200 million peripheral venous catheters are inserted annually.¹ Recent scientific literature states that using intravascular devices is a risk factor for both local and systemic complications.² Securing the intravenous catheters is the major contributing factor to prevent the complications and also important for patient satisfaction.³ Many different researches and a recent Cochrane review concluded that there is uncertainty and lack of high quality evidence about the most suitable method to dress and secure peripheral catheters.⁴ The use of tissue adhesive at the insertion site has been reported to be effective for securing central venous, epidural, peripheral arterial catheters and lastly peripheral venous

catheters with improved fixation compared with standard polyurethane dressings.^{4–6} In addition, research suggests that tissue adhesives have potential benefits in preventing infection. Cyanoacrylate has antimicrobial properties; and in vitro testing shows direct inhibition of Gram-positive organisms.^{7,8} The venous peripheral catheter failure rate at 48 h with tissue adhesives was decreased by 10% in a large randomized trial compared with the standard securement methods in ED.⁴

Failure of peripheral intravenous catheters (PIVC) is associated with discontinuation of the therapy such as hydration, analgesia, antibiotics. Also, reinsertion of catheters increases patients' anxiety, discomfort and cost of the procedure during process. Costs to the healthcare system include increased staff time, hospital length of stay and adverse event management. According to Centers for Disease Control (CDC) 2011 report incidence of catheter related infections in the United States alone

Peer review under responsibility of The Emergency Medicine Association of Turkey.

* Corresponding author. University of Kyrenia, Faculty of Medicine, Şehit Yahya Bakır Sokak, Karakum, Girne, KKTC, Cyprus.

E-mail address: ugur.ozkula@kyrenia.edu.tr (U. Özkula).

<https://doi.org/10.1016/j.tjem.2018.08.003>

Received 6 February 2018; Received in revised form 14 August 2018; Accepted 14 August 2018

Available online 23 August 2018

2452-2473/ 2019 Emergency Medicine Association of Turkey. Production and hosting by Elsevier B. V. on behalf of the Owner. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

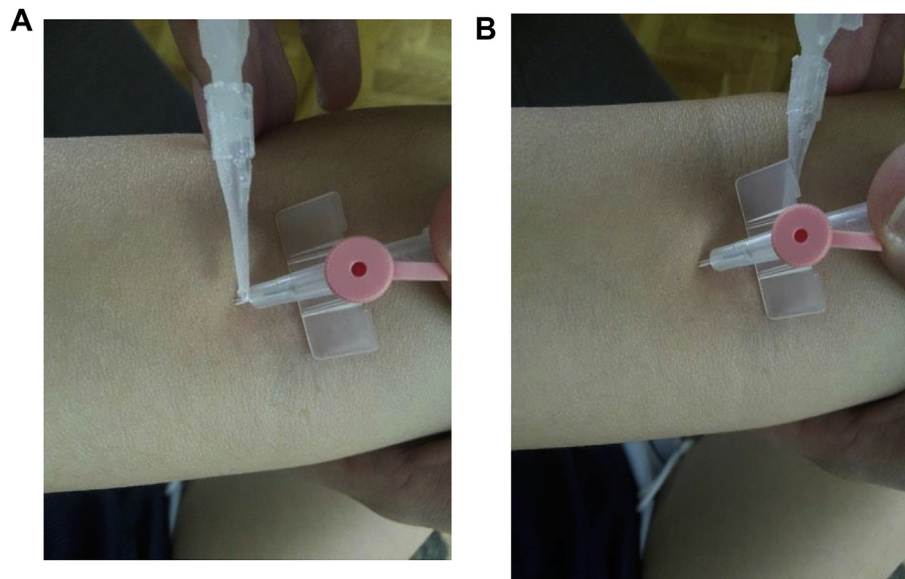


Fig. 1. Patients in the skin glue group received tissue adhesive one drop at the PIVC skin insertion site and one drop under the PIVC hub.

was 250.000 in a year.⁹ Emergency departments are the sections where one of the most peripheral venous catheter procedures done in hospitals and the disruption of therapy for patients in ED has critical consequences most of the time.

In this study, we aimed to test if addition of tissue adhesive to the insertion site of PIVCs in the emergency department would reduce the device failure rate at 6th and 24th hours following insertion. Our goal was to compare addition of tissue adhesive to standard therapy with standard approaches to secure the peripheral venous catheters.

2. Material and methods

2.1. Study design and setting

We designed a prospective, single-site, 2-arm, randomized, controlled trial in a training and research hospital that has 400-beds, with 125.000 ED presentations annually. The study period was between May 2016 to June 2016 for 8 weeks period.

Approval was obtained from the hospital human research ethics committee before commencement. Participants gave written informed consent.

The center that the study was performed, Ankara Atatürk Research and Training Hospital Emergency Service has two areas. One of them is for fast track patients, the other area is an observation unit. Patients were enrolled from the observation unit area of the emergency service. This area was preferred because the patients were mostly geriatric population with expected longer length of stay. Annual presentations for this section are about 15.000.

The study was carried out by two emergency nurses and the researcher who is an emergency medicine physician. And the nurses were retrained for the study before it started about IV catheter placement methods by a senior nurse. The nurses, both had more than five years of experience in ED. Patients were screened for eligibility by these ED nurses on their own shifts that was distributed to 24 h a day, 7 days a week.

2.2. Selection of participants

Patients eligible for enrollment were aged 65 years or older, without chronic renal insufficiency diagnosis or history of chemotherapeutic treatment and known peripheral vascular disease. The enrollment criteria were chosen to rule out patient related factors as much as possible.

Patients were excluded from the study if their body mass index was > 40 or if they had known allergy or irritation to tissue adhesive or standard PIVC securement material; history of phlebitis or venous thrombosis, if there was a high likelihood of intentional PIVC removal (e.g., agitated patients, patients in delirium); if the patient had infection or burn in both upper extremities and if the patient could not speak Turkish. The patient was excluded from the study after allocation if PIVC was placed in more than one attempt or the PIVC was placed to a site other than upper limbs.

2.3. Interventions

To randomize patients a box was prepared which includes marked and unmarked cards in opaque envelopes. The cards were grouped in blocks of 10 that had 5 marked and 5 unmarked envelopes. If the research nurses picked an unmarked card, PIVC was secured with standard care. If the research nurse picked an envelope that includes a marked card, tissue adhesive was used by the nurse to secure the PIVC in addition of the standard securement procedures. Patients in the standard care group received PIVC fixation with cloth-bordered transparent polyurethane dressing material (Tegaderm[®] IV Transparent Film Dressing 1633; 3M, St Paul, MN.) The dressing was labeled with time, date, and study name. We did not apply any 2 drops of liquid mimicking tissue adhesive before dressing material in the standard care group. Patients in the tissue adhesive group received 1 drop of *n*-butyl-cyanoacrylate glue (single-use LiquiBand[®] Standard, Advanced Medical Solutions, Devon, UK) at the PIVC skin insertion site (Fig. 1a) and a drop under the PIVC hub (Fig. 1b). The glue was allowed to dry for 30 s, and then standard PIVC securement dressing material was applied in a manner identical to that for the standard care group. LiquiBand[®] Standard tissue adhesive preferred for its colorless content. All PIVCs were inserted after cleaning the area with Ecolab Skinman Soft Protect (Lotherton Way, Garforth Leeds LS25 2JY, UK). And after treatment tissue adhesive was easily removed before PIVC removal by use of Ecolab Skinman Soft Protect (Lotherton Way, Garforth Leeds LS25 2JY, UK).

2.4. Methods and measurements

Baseline demographic details were collected by the study nurse at enrollment in the study form. The primary outcome was PIVC failure at 6th and 24th hours, defined as one or more of following: infection,

phlebitis, occlusion or dislodgement, need for replacement. We chose 6th and 24th hours for evaluation because patients predicted mean length of stay in ED is about 6 h and mostly limited to 24 h in Turkey.^{10,11}

Consistent with related studies, the following definitions for PIVC failure were applied and accepted as subgroups of primary outcome:

1. Infection: clinical impression of cellulitis or pus at the PIVC site;
2. Phlebitis: 2 or more symptoms of pain, redness, swelling, or palpable venous cord;
3. Occlusion: inability to flush 10 mL of 0.9% saline solution or history of PIVC removal because “it was not working”;
4. Dislodgement: subcutaneous extravasation of fluids
5. Need for replacement: replacement of PIVC for any reason other than intentional removal by the patient.^{6,11}

Outcomes were assessed by the research physician during patients' length of stay in ED at 6th and 24th hours (if the patient was still in the ED) after enrollment. PIVC failure was identified by a combination of direct visualization, chart review, and standard patient questionnaire.

2.5. Analysis

All data were entered directly to the research form, then exported into SPSS and all the statistical analyses were performed using SPSS for Windows (version 11.0; IBM). The categorical data were analyzed for significance by using the Pearson chi square test and fisher exact tests where $p < 0.05$ was considered to be statistically significant. Absolute differences of outcome rates were calculated with 95% confidence intervals. Furthermore, in the study, IV treatment methods; IV infusion vs. IV bolus allocated to determine in the case of effects on results.

3. Results

3.1. Characteristics of study subjects

A total of 218 patients were enrolled for the study first. There were 103 patients who met exclusion criteria in the first enrollment (Fig. 2). 115 adult patients were included and allocated of 115 PIVCs were inserted. 8 patients were excluded from the study after allocation because

Table 1
Patient and PIVC characteristics.

Number of Patients (n = 78)	Standard Care (n = 39)	Tissue adhesive (39)
Age, mean, y	73	72
Women	17	20
Number of PIVCs (78)	39	39
Insertion site		
Antecubital	22	21
Dorsum of hand	5	7
Forearm	12	11
PIVC gauge		
18	9	11
20	23	23
22	8	6
Treatment		
Antibiotic (Ab)	8	9
Blood products (BP)	3	2
BP + Ab	5	0
Other	23	28
Method of Treatment		
Infusion	20	20
Bolus	19	19

PIVC was placed in more than one attempt or the PIVC was placed to a site other than upper limbs. There were 29 patients lost to follow-up on 6th hour (these patients were discharged or transferred to other departments in 6 h). Data for 78 patients were analyzed for 6th hour group. Also 23 of 78 patients were present for the 24th hour follow up. Patients demographic data, peripheral catheter insertions sites, PIVC sizes, treatments and treatment methods summarized in Table 1.

3.2. Main results

PIVC device failure for the 6th hour follow up was 15.4% in the tissue adhesive group (95% CI: 4.1–26.7) vs. 25.6% with standard care group (95% CI: 11.9–39.3). There was no statistically significant difference between the two groups ($p = 0.33$).

The PIVC failure by occlusion was 5.1% in the tissue adhesive group

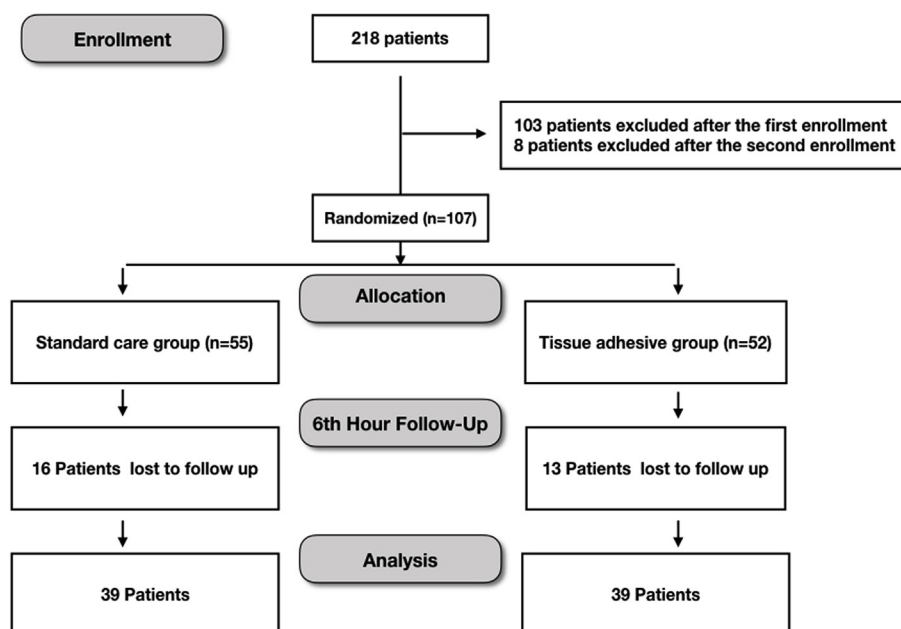


Fig. 2. Tracking of the study.

Table 2
Complication Ratios, Standart Group vs. Tissue Adhesive Group.

	Standart Group	Tissue Adhesive Group	Total
Infection	0	0	0
Phlebitis	0	0	0
Occlusion	4	2	6
Dislodgement	6	4	10
Total	10	6	16

(95% CI: -1.8- 12) and 10.2% in the standard care group (95% CI: 0.7–19.7). PIVC failure by extravasation was 10.2% in the tissue adhesive group (95% CI: 0.7–19.7) and 15.5% in the standard care group (95% CI: 4.1–26.9). There was no statistically significant difference between the two groups ($p = 0.33$) Table 2.

In addition, no peripheral catheter failures caused by phlebitis or infection was observed in either group.

PIVC failure rate was %23.6 (95% CI: 10.1–37.1) for catheters ($n = 38$) used for IV bolus followed by infusions, and %17.5 (95% CI: 5.7–29.3) for catheters ($n = 40$) used for IV infusions only. No statistically significant difference for complications was found between methods of treatment ($p = 0.36$).

PIVC device failure for the 24th hour follow up was 10% in the tissue adhesive group (95% CI: 4.1–26.7) vs. 25.6% with standard care group (95% CI: 11.9–39.3). Due to insufficient sample size statistical evaluation was not considered for this group.

Adverse skin reactions to the glue or its removal were assessed during patients' length of stay by the research nurses. No adverse events were reported on 6th or 24th hour.

4. Discussion

To our knowledge, this study is one of the earliest and the first randomized controlled trial using tissue adhesive to secure peripheral intravenous catheters in the ED setting. Failure rates in our control group (25.6%) was consistent with those in recent literature (33%–37%).² In the tissue adhesive group, catheter failure rate was 15.4%. The difference between two groups for the first 6th hour review was not statistically significant. And also, the number of 22 G PIVC inserted female patients is insufficient to make an inference. Peripheral intravenous catheter failure frequently occurs after 48 h post insertion and this may be the reason we did not find statistically significant difference in 6th hour or 24th hour review.⁴

The exclusion of patients who were younger than 65 years old, had chronic renal insufficiency diagnosis, with a history of chemotherapeutic drug use or known peripheral vascular disease or whose body mass index was > 40 was done to homogenize the patients. This may have affected our results since these are the groups with a higher potential failure rate. Future studies may focus on these groups to evaluate possible benefits of tissue adhesives for PIVC.

The short follow up time, with many PIVCs removed before 6 h, is also likely to have underestimated the benefit of tissue adhesive. As shown in literature, longer follow-up time is more likely to be related to catheter failures, and the tissue adhesive is expected to benefit more over time.¹²

Neither the tissue adhesive group nor standard care groups experienced phlebitis and occlusion because these complications are mostly seen after 72 h in literature.⁶

Considering also the added cost of tissue adhesive when added to standard treatment, our results do not support the use of tissue adhesive in addition to standard dressing for PIVC securement in patients > 65 years old with no defined risk factors for difficult catheter placement. (chronic renal insufficiency diagnosis, a history of chemotherapeutic drug use or known peripheral vascular disease or whose body mass index was > 40).

5. Limitations

The randomized controlled trial design was unblinded. The data was collected at a single site, (except fast track area of the ED) to include patients whom expected length of stay longer in ED admission. Since only 65 years and over age patients were included to homogenize the sample, sample size became small, thus limiting the power of the study. The analysis did not include patients lost in follow up.

Average ED length of stay is 6 h at our ED facility, so some patients were discharged or transferred to other departments before personnel review by the research physician. Patients who were discharged or transferred before 6th hour follow up were excluded thus leading to data loss. The patients included for the 24 h review has a smaller sample size.

Although, complications may be related to the insertion site (patients' dominant or non-dominant extremities, the site of peripheral venous catheter-hand, antecubital area), in this study we did not explore that issue. Patients' comorbidities (diabetes, hypertension, scleroderma, etc.) were not recorded, thus the treatment was not evaluated for these subgroups.

6. Conclusions

In summary, although the technique of tissue adhesive insertion is rapid, simple and harmless to use in an ED setting; according to this study, contrary to the literature studied on the hospitalized patients; the routine use of tissue adhesive in addition to standard care to reduce PIVC failure for adult ED patients admitted to hospital are not supported. To evaluate the issue further, there is need for future large sample-sized and double-blinded controlled clinical trials.

Funding

None.

Conflicts of interest

None declared.

Acknowledgments

Authors would like to thank the research nurses for their efforts and supports in this study.

References

- Maki DG. Improving the safety of PIVCs. *BMJ*. 2008;337:630.
- Tiwari M, Hermesen ED, Charlton ME, et al. Inappropriate intravascular device use: a prospective study. *J Hosp Infect*. 2011;78:128–132.
- Bausone-Gazda D, Lefaiver CA, Walters S-A. A randomized controlled trial to compare the complications of 2 PIVC-stabilization systems. *J Infusion Nurs*. 2010;33:371–384.
- Bugden S, Shean K, Scott M, et al. Skin glue reduces the failure rate of emergency department-inserted peripheral intravenous catheters: a randomized controlled trial. *Ann Emerg Med*. 2016;68(2):196–201.
- Wilkinson J, Chikhani M. The use of Histoacryl® skin adhesive to secure thoracic epidural catheters: a volunteer study. *48. Reg Anesth Pain Med*. 2007;32:148.
- Reynolds H, Taraporewalla K, Tower M, et al. Novel technologies can provide effective dressing and securement for peripheral arterial catheters: a pilot randomized controlled trial in the operating theatre and the intensive care unit. *Aust Crit Care*. 2015;28:140–148.
- Eiferman RA, Snyder JW. Antibacterial effect of cyanoacrylate glue. *Arch Ophthalmol*. 1983;101:958–960.
- Simonova G, Rickard CM, Dunster KR, et al. Cyanoacrylate tissue adhesives-effective securement technique for intravascular catheters: in vitro testing of safety and feasibility. *Anesth. Intensive Care*. 2012;40:460.
- O'Grady NP, Alexander M, Burns LA, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis*. 2011;52:62–193.
- Kocher KE, Meurer WJ, Desmond JS, et al. Effect of testing and treatment on emergency department length of stay using a national database. *Acad Emerg Med*. 2012;19:525–534.
- Mullins PM, Goyal M, Pines JM. National growth in intensive care unit admissions from emergency departments in the United States from 2002 to 2009. *Acad Emerg Med*. 2013;20:479–486.
- Miliani K, Taravella R, Thillard D, et al. CATHEVAL Study Group. Peripheral venous catheter-related adverse events: evaluation from a multicenter epidemiological study in France (the CATHEVAL project). *PLoS One*. 2017;12:e0168637.