International Surgery Journal
Trivedi MR et al. Int Surg J. 2023 Jan;10(1):28-34
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20223265

Original Research Article

A prospective study of peripheral inserted venous catheter related local complications

Mitesh R. Trivedi, Girish P. Bochiya*, Jenish V. Modi

Department of General Surgery, SMIMER, Surat, Gujarat, India

Received: 17 November 2022
Revised: 29 November 2022
Accepted: 30 November 2022

***Correspondence:**
Dr. Girish P. Bochiya,
E-mail: girishbochiya@gmail.com

ABSTRACT

Background: Different types of vascular access devices are commonly used for delivery of intravenous fluids, most common is peripheral intravenous catheter. It is inserted into peripheral vein of extremity and used for short-term delivery of intravenous fluids, medications, blood products. It is prone to complications and failure prior to completion of treatment. Aim was to study peripheral inserted venous catheter related local complications.
Methods: The observational study was conducted among 900 indoor patients admitted between April 2020 to September 2021 of surgery department who requires IV therapy and willing to give consent for study.
Results: Local complications significantly increased as the gauze of the vein flow increases in compare to caliber of veins Complications like thrombophlebitis, redness and pain are 0.8 times less in peripheral cather places over forearm than compared to places at hand. Peripheral cather have 0.8 times less risk of swelling and infiltration when served on forearm than hand. 40.92% of cases develop thrombophlebitis or redness or pain after 72 hours of peripheral catheter in situ. Swelling or infiltration observed in 27.02% cases after 72 hours of peripheral catheter in situ. 3 times cannulation on same vein has higher risk of developing complications.
Conclusions: Study supports choosing insertion site as forearm than hand, using chlorhexidine 2.5% as antiseptic solutions and Gauze of peripheral vein flow catheter as adequately enters the vein with a single prick on the same vein and changing of cannula within 72 hours of insertion.

Keywords: Extravasation, Infiltration, Peripheral intravenous catheter, Thrombophlebitis, Vein flow

INTRODUCTION

Vascular accesses devices (VADs) are essential to modern health care allowing the direct administration of supportive and interventional therapy into the bloodstream. Many different types of VADs are in use, the most common is the peripheral intravenous catheter (PVC). This flexible hollow tube is typically inserted into a peripheral vein of the forearm or hand or extremity and used for short-term delivery of intravenous (IV) fluids, medications, blood products and contrast media.[1] Peripheral intravenous catheters are a quick, simple and cost-effective method to gain vascular access.[1] Up to 70% of hospitalized patients will receive at least one PVC during their admission.[2]

However, these vital devices are prone to complications and failure prior to the completion of treatment; this has been reported to be as high as 67%, making it a common and expensive problem in healthcare.[3-5]

The most frequently reported peripheral intravenous catheter complications are phlebitis (irritation or inflammation of the vein wall), occlusion (blockage), infiltration (intravenous fluids moving into surrounding tissue), dislodgement, and infection (local and systemic).[6-10] Treating the sequelae of peripheral intravenous catheter

complications can be time-consuming for health professionals (frequently nurses), and often necessitates peripheral intravenous catheter replacement to continue treatment which results in increased fear and procedural anxiety related to hospitalisation.[11,12]

This study has sought to assess the different local complications related to peripheral venous cannula and effect of different variables like gauze of cannula, indwell duration, location of cannula placement, type of intravenous fluid infused as contributing factors for PVC failure and it's local complications.

Aim

Aim of the research was to study peripheral inserted venous catheter related local complications.

Objectives

Objectives of the study were to assess what gauze of cannula has less chances of complications and which site of cannula insertion has less chance of complications and duration in situ which leads to complications and which disinfectant solution is better to prevent complications and assess which type of IV fluids infusion has more chances of complications.

METHODS

The observational study will be conducted among indoor patients of general surgery department of SMIMER, Surat admitted between April 2020 to September 2021 (1.5 year) who willing to give consent for the study.

Sample size calculated considering the proportion of admitted patients in surgical department requiring intravenous fluid therapy having peripheral intravenous cannula.

Statistical day analysed by statistical package for the social sciences (SPSS) version 20 software.

Inclusion criteria

Patients of age 5 years and above admitted in surgery department who will require intravenous fluid therapy were included.

Exclusion criteria

Patients with local skin infection, central venous catheter, and children below 5 years of age were excluded.

After the admission into general surgery wards, peripheral intravenous cannula inserted peripherally whichever site better accessible under all aseptic precautions as follows: hand hygiene should be maintained with an alcoholic based hand rub before inserting an IV device; personal protective equipment (PPE) like gloves and mask with face shield was put on; better accessible or optimal insertion site was prepared, skin was prepared at insertion site by using an spirit/alcohol/chlorhexidine 2.5% solution based on availability in the wards by performing 30 seconds back and forth scrub and drying with air; intravenous cannula of varying gauzes were inserted, if the insertion fails on particular site 2-3 attempts were made and it was documented on the evaluation performa before choosing the next preferred site; sterile dressing was kept to ensure the fixity to the skin and to prevent retrograde infection by using adhesive bandage; the PIV lines were assessed on a daily basis – PIV was replaced if the site was no longer working or the sings of pain, redness, phlebitis, swelling, extravasating and other local complications; and ports, hub, needle-less connectors and stopcocks were disinfected before connecting or injecting.

Cannula site was examined daily for local complications and if any signs of local complications (pain, redness, swelling, thrombophlebitis, and extravasation) was observed, the cannula site was either changed or patient was shifted to oral drugs if not contraindicated and recorded on the evaluation sheet.

The study was approved by institutional ethics committee.

RESULTS

The observational study was conducted among indoor patients admitted between April 2020 to September 2021 (1.5 year) to surgical department of SMIMER who requires IV therapy and willing to give consent for the study.

The clinical and observational data were compiled and analysed and following observations were obtained.

Demographic data

Total 900 study cases, out of which 536 male and 374 female candidates were observed complications observed in 31% of male patient i.e. 171 number of male patient, and 64% of female patient i.e. 243 number of female.

In our study complications like swelling and infiltration were observed in 11.93% cases with 18 gauze cannulas, while 11.83% cases with 20 gauze cannulas whereas 13.67% cases observed with 22 gauze cannulas. Complications like swelling, infiltration/extravasation increases as the gauze of cannula increase, 22 no. of gauze cannula has more 1.16 times high rate of complication in compare to 18 gauzes (Table 1).

In our study complications like thrombophlebitis, pain, redness was observed in 27.84% cases with 18 gauze cannulas while 32.85% cases with 20 gauze cannulas whereas 39.74% cases observed with 22 gauze cannulas. Local complications like thrombophlebitis, redness and pain significantly increased as the gauze of the vein flow increases, 20 gauze ha 1.2 times high rate of complications

and 22 gauze has 1.71 times high rates of complication in compare to 18 gauze (Table 2).

In our study 36.36% of complication like thrombophlebitis, redness and pain were observed in intravenous catheter placed at hand whereas 31.84% of complications were observed in intravenous catheter placed at forearm. Complications like thrombophlebitis, redness and pain are 0.8 times less in peripheral cather places over forearm than compared to places at hand (Table 3).

From study 13.22% of complication were observed in intravenous catheter placed at hand and 11.73% of complications were observed in intravenous catheter placed at forearm. Peripheral cather have 0.8 times less risk of swelling and infiltration when served on forearm than hand (Table 4).

Table 1: Comparison of gauze of cannula versus complication like swelling and infiltration.

Gauze	No of patients	Complication (swelling/infiltration)	%	Odds ratio	95% CI	P value
18	176	21	11.93	Reference		
20	490	58	11.83	0.99	0.5822, 1.687	0.9609
22	234	32	13.67	1.16	0.6489, 2.107	0.6094

Table 2: Comparison of gauze of cannula vs complication like thrombophlebitis, pain, and redness.

Gauze	No. of patients	Complication (thrombophlebitis/pain/redness)	%	Odds ratio	95% CI	P value
18	176	49	27.84	Reference		
20	490	161	32.85	1.26	0.8676, 1.854	0.08189
22	234	93	39.74	1.71	1.122, 2.604	0.003192

Table 3: Comparison between site of PVC and complication like thrombophlebitis, pain, and redness.

Site of PVC	No. of patients	Complication (thrombophlebitis/pain/redness)	%	Odds ratio	95% CI	P value
Hand	363	132	36.36	Reference		
Forearm	537	171	31.84	0.81	0.6176, 1.082	0.1607

Table 4: Comparison between site of PVC and complication like swelling and infiltration.

Site of PVC	No. of patients	Complication (swelling/infiltration)	%	Odds ratio	95% CI	P value
Hand	363	48	13.22	Reference		
Forearm	537	63	11.73	0.87	0.5837, 1.303	0.5051

In our study 8.58% of cases were recorded who developed thrombophlebitis, pain or redness as the peripheral catheter duration in situ (PVC dwell time) increase the rate of complications like thrombophlebitis, pain and redness. 40.92% of cases develop thrombophlebitis or redness or pain after 72 hours of peripheral catheter in situ (Table 5).

Table 5: Comparison between duration of PVC in situ and complication like thrombophlebitis, pain, and redness.

Duration of PVC in situ (hours)	Complication (thrombophlebitis/ pain/redness)	%
<24	26	8.58
24-48	61	20.13
48-72	92	30.36
>72	124	40.92

In our study swelling or infiltration observed in 29.72% of patient in first 24 hours of peripheral catheter in situ. Swelling or infiltration observed in 27.02% cases after 72 hours of peripheral catheter in situ (Table 6).

Table 6: Comparison between duration of PVC in situ and complication like swelling and infiltration.

Duration of PVC in situ (hours)	Complication (swelling/infiltration)	%
<24	33	29.72
24-48	23	20.72
48-72	25	22.52
>72	30	27.02

In our study, 41.07% of cases undergone 3 times cannulation on same vein and it has 1.43 times higher risk of thrombophlebitis, pain or redness than cases on whom

vein flow attempted only one time whereas 34.66% of cases with 2-time cannulation attempt with 1.09 times higher risk of getting complications like thrombophlebitis pain or redness (Table 7).

In our study, 25% of cases undergone 3 times cannulation on same vein and it has 2.83 times higher risk of swelling or infiltration than cases on whom vein flow attempted only one time whereas 13.33% of cases with 2-time cannulation attempt with 1.2 times higher risk of getting complications like swelling or infiltration (Table 8).

In our study, 37.16% cases observed with complications like thrombophlebitis, redness and pain where spirit as a disinfectant solution used whereas 35.29% cases observed with povidone iodine as disinfectant solution and 30.59% cases with chlorhexidine 2.5% as disinfectant solution.

Chlorhexidine 2.5% has 0.82 times less chance of getting local complications like thrombophlebitis, pain or redness than spirit as a disinfectant, and povidone iodine has 0.92 times less chance of getting local complications like thrombophlebitis redness or pain (Table 9).

In our study, 13.71% cases observed with complications like swelling or infiltration where spirit as a disinfectant solution used whereas 13.6% cases observed with povidone iodine as disinfectant solution and 11.19% cases with chlorhexidine 2.5% as disinfectant solution.

Chlorhexidine 2.5% has 0.79 times less chance of getting local complications like thrombophlebitis, pain or redness than spirit as a disinfectant, and povidone iodine has 0.99 times less chance of getting local complications like swelling or infiltration (Table 10).

In our study 16.42% of cases presented with complications like thrombophlebitis swelling and infiltration in which blood components were infused in peripheral vein flow whereas in 83.57% cases had same complications where blood products were not infused.

Table 7: Comparison between no. of cannulation attempt on same vein and complication like thrombophlebitis, pain, and redness.

No of cannulation attempt on same vein (times)	No. of patients	Complication (thrombophlebitis/ pain/redness)	%	Odds ratio	95% CI	P value
1	619	202	32.63	Reference		
2	225	78	34.66	1.09	0.7939, 1.511	0.5784
3	56	23	41.07	1.43	0.8233, 2.514	0.2068

Table 8: Comparison between no. of cannulation attempt on same vein and complication like swelling and infiltration.

No of cannulation attempt on same vein (times)	No. of patients	Complication (swelling/ infiltration)	%	Odds ratio	95% CI	P value
1	619	67	10.82	Reference		
2	225	30	13.33	1.2	0.7998, 2.009	0.3156
3	56	14	25	2.83	1.467, 5.461	0.003894

Table 9: Comparison between types of disinfectant solution used and complication like thrombophlebitis, pain, and redness.

Types of disinfectant solution used	No. of patients	Complication (thrombophlebitis/ pain/redness)	%	Odds ratio	95% CI	P value
Spirit	226	84	37.16	Reference		
Providone iodine	272	96	35.29	0.92	0.6389, 1.2331	0.6657
Chlorhexidine 2.5%	402	123	30.59	0.82	0.5878, 1.162	0.2747

Table 10: Comparison between types of disinfectant solution used and complication like swelling and infiltration.

Types of disinfectant solution used	No. of patients	Complication (swelling/ infiltration)	%	Odds ratio	95% CI	P value
Spirit	226	31	13.71	Reference		
Providone iodine	272	37	13.6	0.99	0.5926, 1.655	0.9686
Chlorhexidine 2.5%	402	45	11.19	0.79	0.4859, 1.294	0.7065

DISCUSSION

Peripheral intravenous catheters necessary invasive clinical device, however they carry risk of getting dislodged, occluded before the completion of treatment. Ideally it should remain complication free during the duration of therapy but the findings of this study are that more than two third (46%) failed before the completion of treatment. The most frequently reported peripheral intravenous catheter complication is thrombophlebitis, pain or redness which is consistent with the results of studies from Ray-Barruel et al.[15]

In our study 64% of female developed one or more local complications. This study identifies female as a consistent variable associated with failure, infiltration/occlusion and phlebitis. This association has been reported in other studies like Abolfotouh et al, Dillon et al, Hirschmann et al and it has been suggested it may be related to the smaller calibre of female vessels compared to males Marsh et al and Dillon et al.[13,14,16,17]

In our study 13.22% of cases reported with complications like swelling and infiltration when catheters were placed at hand in compare to forearm complications developed in 11.73% cases.

Also, complications like thrombophlebitis are more observed in 36.36% of patients with catheter in hand compare to 31.84% of patients with forearm as catheter placement site. Insertion site, specifically at the point of flexion of joint (wrist joint and antecubital fossa) compared to insertion in the forearm was significantly associated with all causes of failure infiltration/occlusion, thrombophlebitis and catheter dislodgement. This is likely due to joint motion loosening the catheter dressing or causing catheter movement in the vein, peripheral vein flow kinking or mechanical occlusion. Peripheral intravenous catheter movement can cause the catheter tip to pierce the vessel wall leading to infiltration, inflammation, thrombus formation, occlusion, and/or complete dislodgement Helm et al and Hadaway.[18,19] These results are similar to studies reporting higher peripheral intravenous catheter failure rates when catheters were placed over joints Cicolini et al and doRego Furtado.[20,21] Peripheral intravenous catheter insertion in the forearm reduces failure and complications as there are no joint to cross over and better securement of dressing than at joints.

In our study 22 gauze needle has 1.71 times higher chances of getting local complications like thrombophlebitis, pain or redness and 20 gauze needle has 1.2 times higher chances of getting local complications like thrombophlebitis, pain or redness than 18 gauze. 22 gauze needle has 1.16 times higher chances of complications like swelling or infiltration compared to 18 gauze needles. Infiltration/occlusion and other complications were also significantly associated with catheter sizes 22 g and 20 g compared to 18 g catheters. This may be due to the size of catheter bore too big or smaller than the vein it is inserted into. Although studies included in this analysis did not report the length of the catheter, it is likely that 22 g and 24 g catheters were shorter (2.5 cm and 1.9 cm respectively) than catheters >20 g (3 cm). This may be due to greater catheter length in the vein decreasing catheter movement known to irritate the vessel wall and lead to complications such as phlebitis Marsh et al, or the complete dislodgement of the catheter out of the vein.[8] Over the last few years long peripheral intravenous catheters (>4.0 cm) have increased in popularity, particularly for patients with difficult vascular access Baht et al and Alexandrou et al.[11,22] The potential benefit of longer catheters needs to be explored in high quality RCTs to help guide clinicians and regarding recommended gauze of catheter.

In our study 40.92% of cases developed complications like thrombophlebitis, pain and redness when catheter is kept in situ for more than 72 hours, and complications like swelling and infiltration were observed in 29.72% of cases in first 24 hours which is consistent finding with another research.

Study by Tiger also suggested catheter removal between 48-72 hours.

In our study, 25% of cases undergone 3 times cannulation on same vein and it has 2.83 times higher risk of swelling or infiltration than cases on whom vein flow attempted only once.

Vein flow site where 3 or more times needle prick for catheter is taken is more prone for swelling or infiltration than one with single prick.

In our study disinfectant solutions where chlorhexidine 2.5% is used shows less risk (30.59%) of thrombophlebitis, redness or pain in compare to spirit (37.16%) or povidone iodine (35.29%). Study by Chaiyakunapruk also suggested similar findings.[23] To prove better antiseptic solution producing significant less complication need study with large group of subjects.

Limitations

Limitations of this study include the fact that it is based on patients recruited from a single setting. our sample size may not be adequate to determine potential confounders. Moreover, signs of thrombophlebitis were measured when the peripheral venous catheter were in situ. Consequently, its occurrence after removal of the peripheral venous catheter was not recorded, as we planned to discharge the patients after removal of peripheral vein flow catheter. Because phlebitis can arise after removal of peripheral venous catheter, thrombophlebitis frequency might have been higher than reported. As the peripheral vein flow catheter was inserted by different individuals having different expertise of the procedure so complications may vary according to the expertise of performing individual.

CONCLUSION

The result of the study supports choosing insertion site as forearm than hand, using chlorhexidine 2.5% as antiseptic solutions and gauze of peripheral vein flow catheter as adequately enters the vein with a single prick on the same vein and changing of cannula within 72 hours of insertion, in addition intravenous fluid with extreme PH and osmolarity has increased association with swelling, infiltration, thrombophlebitis.

ACKNOWLEDGEMENTS

Authors would like to acknowledge Dr. Jitendra Darshan (HOD general surgery, SMIMER) for guidance and general support.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Dougherty L. Peripheral cannulation. Nursing standard (Royal College of Nursing (Great Britain) 1987. 2008;22:49-56.
2. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. Int J Antimicrob Agents. 2009;34(4):S38-42.
3. Chico-Padrón RM, Carrión-García L, Delle-Vedove-Rosales L, González-Vargas CS, Marrero-Perera M, Medina-Chico S, Rodríguez-Díaz MP, Alonso-Díaz M, Jiménez-Sosa A. Comparative safety and costs of transparent versus gauze wound dressings in intravenous catheterization. J Nurs Care Qual. 2011;26(4):371-6.
4. Marsh N, Webster J, Flynn J, Mihala G, Hewer B, Fraser J, Rickard CM. Securement methods for peripheral venous catheters to prevent failure: a randomised controlled pilot trial. J Vasc Access. 2015;16(3):237-44.
5. Enes SM, Opitz SP, Faro AR, Pedreira Mde L. Phlebitis associated with peripheral intravenous catheters in adults admitted to hospital in the Western Brazilian Amazon. Rev Esc Enferm USP. 2016;50(2):263-71.
6. Bolton D. Improving peripheral cannulation practice at an NHS Trust. Br J Nurs. 2010;19(21):1346.
7. Rickard CM, Webster J, Wallis MC, Marsh N, McGrail MR, French V, Foster L, Gallagher P, Gowardman JR, Zhang L, McClymont A, Whitby M. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. Lancet. 2012;380(9847):1066-74.
8. Marsh N, Webster J, Ullman AJ, Mihala G, Cooke M, Chopra V, Rickard CM. Peripheral intravenous catheter non-infectious complications in adults: A systematic review and meta-analysis. J Adv Nurs. 2020;76(12):3346-62.
9. Indarwati F, Mathew S, Munday J, Keogh S. Incidence of peripheral intravenous catheter failure and complications in paediatric patients: Systematic review and meta analysis. Int J Nurs Stud. 2020;102:103488.
10. Webster J, Clarke S, Paterson D, Hutton A, van Dyk S, Gale C, Hopkins T. Routine care of peripheral intravenous catheters versus clinically indicated replacement: randomised controlled trial. BMJ. 2008;337(7662):a339.
11. Alexandrou E, Ray-Barruel G, Carr PJ, Frost SA, Inwood S, Higgins N, Lin F, Alberto L, Mermel L, Rickard CM; OMG Study Group. Use of Short Peripheral Intravenous Catheters: Characteristics, Management, and Outcomes Worldwide. J Hosp Med. 2018;13(5).
12. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: A quality improvement initiative. J Paediatr Child Health. 2019;55(10):1214-23.
13. Dillon MF, Curran J, Martos R, Walsh C, Walsh J, Al-Azawi D, Lee CS, O'Shea D. Factors that affect longevity of intravenous cannulas: a prospective study. QJM. 2008;101(9):731-5.
14. Marsh N, Webster J, Larson E, Cooke M, Mihala G, Rickard CM. Observational Study of Peripheral Intravenous Catheter Outcomes in Adult Hospitalized Patients: A Multivariable Analysis of Peripheral Intravenous Catheter Failure. J Hosp Med. 2018;13(2):83-9.
15. Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. J Eval Clin Pract. 2014;20(2):191-202.
16. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy HH. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. Ther Clin Risk Manag. 2014;10:993-1001.
17. Hirschmann H, Fux L, Podusel J, Schindler K, Kundi M, Rotter M, Wewalka G; EURIDIKI. European Interdisciplinary Committee for Infection Prophylaxis. The influence of hand hygiene prior to insertion of peripheral venous catheters on the frequency of complications. J Hosp Infect. 2001;49(3):199-203.
18. Helm RE, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. J Infus Nurs. 2015;38(3):189-203.
19. Hadaway L. Infiltration and extravasation. Am J Nurs. 2007;107(8):64-72.
20. Cicolini G, Bonghi AP, Di Labio L, Di Mascio R. Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study. J Adv Nurs. 2009;65(6):1268-73.
21. Carr PJ, Rippey JC, Cooke ML, Bharat C, Murray K, Higgins NS, Foale A, Rickard CM. Development of a clinical prediction rule to improve peripheral

intravenous cannulae first attempt success in the emergency department and reduce post insertion failure rates: the Vascular Access Decisions in the Emergency Room (VADER) study protocol. BMJ Open. 2016;6(2):e009196.
22. Bahl A, Hijazi M, Chen NW, Lachapelle-Clavette L, Price J. Ultralong Versus Standard Long Peripheral Intravenous Catheters: A Randomized Controlled Trial of Ultrasonographically Guided Catheter Survival. Ann Emerg Med. 2020;76(2):134-42.
23. Chaiyakunapruk N, Veenstra DL, Lipsky BA, Sullivan SD, Saint S. Vascular catheter site care: the clinical and economic benefits of chlorhexidine gluconate compared with povidone iodine. Clin Infect Dis. 2003;37(6):764-71.

Cite this article as: Trivedi MR, Bochiya GP, Modi JV. A prospective study of peripheral inserted venous catheter related local complications. Int Surg J 2023;10:28-34.