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Research Paper:

The Impact of Taurolock Versus Heparin Lock for the Maintenance of Central Vein Catheters Patency in Pediatric Tertiary Care Hospitals

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ABSTRACT

Background and Aim: Central vein access is a common procedure in infants and neonates. In this regard, cutdown is a common central venous access technique. However, it is associated with complications, including catheter occlusion, infection, and spontaneous withdrawal. Catheter occlusion is a common complication of the cutdown procedure and causes catheter dysfunction and subsequent catheter removal. In this study, we compared the effect of heparin lock with Taurolock on the maintenance of central vein catheter potency placed in the greater saphenous vein at the saphenofemoral junction and their subsequent complications.

Materials and Methods: The children admitted to the pediatric hospital who required central vein access between December 2015 and July 2019 were recruited. There were two groups of patients. The first group received 0.5 mL Taurolock solution. The solution contains (cyclo)-taurolidine, heparin 500 IU/mL, and citrate (4%) before the catheter gets locked (Taurolock group). Another group received 0.5 mL heparin (contains 500 IU/mL heparin) before the catheter lock (heparin lock group). After the treatment period, the average duration of catheter usage and heparin-induced bleeding complications were evaluated.

Results: The average duration of catheter function was 13.4 days and 9.3 days in the Taurolock group, and the heparin lock group, respectively. The coagulation tests were performed on 179 patients (33.9%) during hospitalization, no heparin-induced coagulopathies were reported.

Conclusion: Using Taurolock after catheter use could significantly reduce catheter occlusion and increase the duration of catheter function. Taurolock reduces costs, prevents delays in treatment, and decreases pain sensation and discomfort in patients.

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1. Introduction

Central vein access is a common procedure in infants and neonates receiving Total Parenteral Nutrition (TPN) and or cytotoxic drugs. Also, when peripheral access cannot be achieved. Peripheral vascular access is challenging in children, especially in patients with small veins or when the patient is ill or dehydrated. Central vascular access is associated with more complications than peripheral access [1].

The cutdown technique is a more invasive central venous access in which a venotomy is made with venous ligation. Venous cutdown is associated with more complications than other central vein access techniques. Cutdown usually is performed to access the proximal greater saphenous vein into the femoral vein [2-4]. This technique provides vascular access only once through each vein. For this reason, the maintaining of the catheter function is essential. Conditions such as catheter infection, catheter occlusion, and spontaneous withdrawal of catheter affect catheter patency and may cause catheter removal and replacement [4-6]. Replacing a new catheter causes discomfort for the patient, delays the treatment, and increases the costs. Effective education of parents and health care staff, maintaining the sterility, and using anticoagulants can prevent the conditions and keeping the catheter potency [7]. Catheter occlusion is a common complication in central vein access procedures, including venous cutdown. The occlusion causes catheter dysfunction and removal. There are different strategies for maintaining catheter potency, including distributing fluid infusion and using anticoagulants [8, 9].

The administration of heparin is a common method for preventing catheter occlusion and maintaining its potency. Heparin lock is an efficient technique for the administration of heparin after catheter use. Heparin can cause some complications, including allergic reaction and Heparin-Induced Thrombocytopenia (HIT) [10-13]. Taurolock is a solution that contains (cyclo)-taurolidine, heparin 500 IU/mL, and citrate (4%). Taurolidine is an antimicrobial agent that has activity against Gram-positive and Gram-negative bacteria and fungi. Recent studies have shown that taurolidine lock decreases central venous catheter infection [14-16]. In this study, we compared the effect of heparin lock with Taurolock on the maintenance of central vein catheter potency placed in the greater saphenous vein at the saphenofemoral junction and their subsequent complications.

2. Materials and Methods

Patients and study design

This research is a prospective study conducted on 528 infants who needed central vascular access. They underwent venous cutdown in 3 pediatric health care (Hazrat Masoumeh Hospital, Shahid Beheshti Hospital, Golpayegani Hospital) centers in Qom City, Iran, between December 2015 and July 2019. The venous cutdowns were performed by Arrow® Seldinger Arterial Catheters (sizes range from 22 to 20 gauge, 8 cm length). We used this catheter because it is the most common type of catheter being used. The catheter was placed through the greater saphenous vein at the saphenofemoral junction. Due to the young age of the patients and the small size of the vessels and conditions in the health care centers, using the greater saphenous vein for venous cutdown was the best option. The study samples were two groups of A and B. Group A was the patients who did receive 0.5 mL Taurolock solution containing (cyclo)-taurolidine, heparin 500 IU/mL, and citrate (4%) before the catheter gets locked (Taurolock group) (Figure 1).

Group B received heparin. We diluted the heparin 5000 units/mL vials to 500 units/mL. Each patient received 0.5 mL heparin before the catheter gets locked (heparin lock group). Taurolock or heparin was given to the patients by the nurse in their rooms. In all five hospitals, Taurolock and heparin injections were done by a nurse under sterile condition. The lumen of the catheters was used for receiving Total Parenteral Nutrition (TPN), cytotoxic and nontoxic drugs, and fluids. The patients were educated about reducing the rate of infection and catheter occlusion and were followed for at least three months. After the treatment period, the average duration of catheter usage and heparin-induced bleeding complications were evaluated.

The inclusion criteria

- All patients weighing less than 5 kg and under 3 months of age.

- Willingness to participate in the study approved by the parents.

The exclusion criterion

- Patients with congenital coagulation disorders.

Ethical issues

The Ethics Committee of Qom University of Medical Sciences approved this study (IR.MUQ.REC.1396.70). Written informed consent was obtained from all patients' parents to access their file medical records.

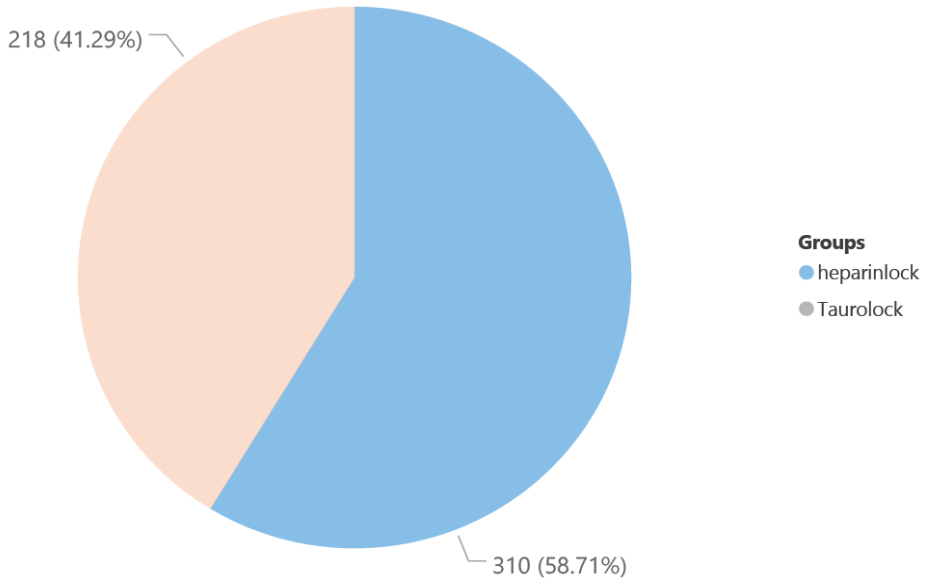

Figure 1. Taurolock and heparin group statistics

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Taurolock contains (cyclo)-taurolidine, heparin 500 IU/mL and citrate (4%) (n=218); heparin (500 IU/mL) (n=310).

Statistical analysis

Descriptive indices including mean, amplitude, and percentage were used to analyze data by SPSS version 22. Independent t test and logistic regression tests were used to analyze quantitative data. A Chi-square test was used to analyze qualitative data. The desired level of significance was less than 0.05 in this study.

3. Results

A total of 528 patients were enrolled in this study. Of them, 306 patients (57.95%) were male, and 222 patients (42.05%) were female. Also, 369 patients (69.88%) were under one month old at the time of hospitalization (Table 1). Their average age was 23 days (range: 3-80 days). Then, 218 patients received Taurolock solution (Taurolock group), and 310 patients have received heparin (heparin lock group). The average duration of catheter function was 13.4 days and 9.3 days in the Taurolock group and the heparin lock group, respectively. Therefore, there was a significant difference between the two groups ($P \leq 0.05$). The coagulation tests were performed on 179 (33.9%) patients during hospitalization; heparin-induced coagulopathies and heparin sensitivity were not reported (Table 2). There were no significant differences between the two groups regarding incidences of coagulopathy and heparin-induced thrombocytopenia and heparin sensitivity ($P \geq 0.05$).

Table 1 presents the patients' characteristics (Taurolock group vs. heparin group; 369 patients [69.88%] were under one month of age), catheter use, catheter location. Table 2 compares the outcomes between heparin lock and Taurolock groups. Catheters in the Taurolock group had, on average, longer performance compared to those in the heparin group. No coagulopathy, heparin-induced thrombocytopenia, or heparin sensitivity was seen in both groups.

4. Discussion

The central venous lines are a common way for obtaining vascular access in children. Obtaining peripheral venous access is challenging in the pediatric population because their veins are small and hard to detect, especially when they are ill or dehydrated. Venous cutdown is a common technique for obtaining central venous access. In this technique, vascular access is achieved through the jugular vein, facial vein, or the proximal greater saphenous vein into the femoral vein. Central vein catheters are associated with more complications, including catheter infections, catheter occlusion, and venous thrombosis, than peripheral vein access. Catheter occlusion is a common complication result in central vein catheter disfunction and removal. Using the heparin lock or Taurolock prevents catheter occlusion and maintains its function. In our study, using Taurolock had a significantly lower incidence of catheter occlusion and longer duration of catheter function compared to the heparin lock. These findings are similar to the results of previous

Table 1. Patients' characteristics, including taurolock and heparin group, 369 patients (69.88%) were under one month of age

Patients' Characteristics	No. (%)	
	Taurolock Group	Heparin Lock Group
Hemodialysis	4 (1.83)	30 (9.67)
Receiving Parenteral Nutrition (TPN)	27 (12.3)	34 (10.9)
Cytotoxic drugs	51 (23.3)	47 (15.1)
Peripheral access could not be obtained	202 (92.6)	297 (95.8)
Catheter cite	Greater saphenous vein (100%)	Greater saphenous vein (100%)
Age range	2-73 days	5-82 days
Age below one month	152 (69.7)	217 (70)
Age between 1 and 2 months	45 (20.6)	56 (18.06)
Age between 2 and 3 months	21 (9.6)	37 (11.9)
Male	114 (52.2)	181 (58.3)
Female	104 (47.7)	129 (41.6)
Presence of comorbidity	78 (35.7)	94 (30.3)

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studies [17-20]. Heparin lock and Taurolock were not associated with clinical coagulopathy. However, some patients had a mild prolonged Activated Partial Thromboplastin Time (APTT) in their coagulation test. The incidence of catheter occlusion and catheter exchange in the heparin lock group was higher in our study, similar to previous prospective studies [14, 18]. Heparin lock was associated with improved catheter function similar to the previous study [13, 21, 22]. However, the incidence of catheter exchange was lower in the Taurolock group. In previous studies, catheter insertion site, ultrasonography, the amount and type of catheter solutions (the total parenteral nutrition and lipid infusion) were proved to be correlated with the duration of catheter function [23-27]. However, there was no significant difference between the heparin group and the other groups in our study. In this study, we concluded that the use of Taurolock after catheter use could significantly reduce catheter occlusion and increase the duration of catheter function and decrease catheter exchange. Taurolock reduces costs, prevents delays in treatment, and decreases pain sensation and discomfort for patients.

5. Conclusion

We suggested that Taurolock is a safe and effective solution for preventing catheter occlusion and catheter exchange.

Table 2. Comparison of outcomes between heparin lock and taurolock groups

outcomes	Taurolock Group	Heparin Lock Group	P
Average duration of catheter usage function (day)	13.4±2.4	9.3±1.23	≤0.05
Coagulation test performed	97	82	≥0.05
Coagulopathy	0	0	≥0.05
Heparin induced thrombocytopenia	0	0	≥0.05
Heparin sensitivity	0	0	≥0.05

No coagulopathy or heparin sensitivity was seen in both groups.

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Ethical Considerations

Compliance with ethical guidelines

The Ethics Committee of Qom University of Medical Sciences approved this study (IR.MUQ. REC.1396.70). Written informed consent was obtained from all patients to access their medical file records.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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References

[1] Zeller K, Petty J. Vascular access procedures. In: Ziegler MM, Azizkhan RG, von Allmen D, Weber TR. Operative Pediatric Surgery. 2nd ed. New York: McGraw Hill Education; 2014. https://accesssurgery.mhmedical.com/content.aspx?bookid=959&Sectionid=53539574

[2] Lee MM, Loyd JW. Saphenous Vein Cutdown. Treasure Island (FL): Stat Pearls Publishing; 2019. https://europepmc.org/article/NBK/nbk532880

[3] Stas M, Mulier S, Pattyn P, Vijgen J, De Wever I. Peroperative intravasal electrographic control of catheter tip position in access ports placed by venous cut-down technique. Eur J Surg Oncol. 2001; 27(3):316-20. [DOI:10.1053/ejso.2000.1047] [PMID]

[4] Gauderer MWL. Vascular access techniques and devices in the pediatric patient. Surg Clin North Am. 1992; 72(6):1267-84. [DOI:10.1016/S0039-6109(16)45880-9]

[5] Melan NB, Wilson W, Soontharotoke CY, Koucky CJ. Saphenofemoral venous cutdowns in the premature infant. J Pediatr Surg. 1986; 21(4):341-3. [DOI:10.1016/S0022-3468(86)80199-3]

[6] Shockley LW, Butzier DJ. A modified wire-guided technique for venous cutdown access. Ann Emerg Med. 1990; 19(4):393-5. [DOI:10.1016/S0196-0644(05)82344-3]

[7] Church JT, Jarboe MD. Vascular access in the pediatric population. Surg Clin North Am. 2017; 97(1):113-28. [DOI:10.1016/j.suc.2016.08.007] [PMID]

[8] Dillon PW, Jones GR, Bagnall-Reeb HA, Buckley JD, Wiener ES, Haase GM, et al. Prophylactic urokinase in the management of long-term venous access devices in children: A Children's Oncology Group study. J Clin Oncol. 2004; 22(13):2718-23. [DOI:10.1200/JCO.2004.07.019] [PMID]

[9] Mitchell MD, Anderson BJ, Williams K, Umscheid CA. Heparin flushing and other interventions to maintain patency of central venous catheters: A systematic review. J Adv Nurs. 2009; 65(10):2007-21. [DOI:10.1111/j.1365-2648.2009.05103.x] [PMID]

[10] Beigi AA, Seyed HadiZadeh MH, Salimi F, Ghaheri H. Heparin compared with normal saline to maintain patency of permanent double lumen hemodialysis catheters: A randomized controlled trial. Adv Biomed Res. 2014; 3:121. [DOI:10.4103/2277-9175.133192] [PMID] [PMCID]

[11] Kulkarni M, Elsner C, Ouellet D, Zeldin R. Heparinized saline versus normal saline in maintaining patency of the radial artery catheter. Can J Surg. 1994; 37(1):37-42. [PMID]

[12] LeDuc K. Efficacy of normal saline solution versus heparin solution for maintaining patency of peripheral intravenous catheters in children. J Emerg Nurs. 1997; 23(4):306-9. [DOI:10.1016/S0099-1767(97)90216-6]

[13] Bertoglio S, Solari N, Meszaros P, Vassallo F, Bonvento M, Pastorino S, et al. Efficacy of normal saline versus heparinized saline solution for locking catheters of totally implantable long-term central vascular access devices in adult cancer patients. Cancer Nurs. 2012; 35(4):E35-42. [DOI:10.1097/NCC.0b013e31823312b1] [PMID]

[14] Touré A, Lauverjat M, Peraldi C, Boncompain-Gerard M, Gelas P, Barnoud D, et al. Taurolidine lock solution in the secondary prevention of central venous catheter-associated bloodstream infection in home parenteral nutrition patients. Clin Nutr. 2012; 31(4):567-70. [DOI:10.1016/j.clnu.2012.01.001] [PMID]

[15] Liu H, Liu H, Deng J, Chen L, Yuan L, Wu Y. Preventing catheter-related bacteremia with taurolidine-citrate catheter locks: A systematic review and meta-analysis. Blood Purif. 2014; 37(3):179-87. [DOI:10.1159/000360271] [PMID]

[16] Daoud DCh, Wanten G, Joly F. Antimicrobial locks in patients receiving home parenteral nutrition. Nutrients. 2020; 12(2):439. [DOI:10.3390/nu12020439] [PMID] [PMCID]

[17] Al Malki H, Othman M, Osman B, Rashid A, Fituri O, Asim M. Taurolock effectively reduces tunneled dialysis catheter-related infection and catheter exchange rates among hemodialysis patients. Open J Nephrol. 2016; 6(2):55-60. [DOI:10.4236/ojneph.2016.62007]

[18] Simon A, Ammann RA, Wiszniewsky G, Bode U, Fleischhack G, Besuden MM. Taurolidine-citrate lock solution (TauroLock) significantly reduces CVAD-associated gram-positive infections in pediatric cancer patients. BMC Infect Dis. 2008; 8:102. [DOI:10.1186/1471-2334-8-102] [PMID] [PMCID]

[19] Fontseré N, Cardozo C, Donate J, Soriano A, Muros M, Pons M, et al. Tunneled catheters with taurolidine-citrate-heparin lock solution significantly improve the inflammatory profile of hemodialysis patients. Antimicrob Agents Chemother. 2014; 58(7):4180-4. [DOI:10.1128/AAC.02421-14] [PMID] [PMCID]

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[20] Kavosi Z, Sarikhani Khorrami M, Keshavarz Kh, Jafari A, Hashemi Meshkini A, Safaei HR, et al. Is Taurolidine-citrate an effective and cost-effective hemodialysis catheter lock solution? A systematic review and cost-effectiveness analysis. Med J Islam Repub Iran. 2016; 30:347. [PMID] [PMCID]

[21] Weijmer MC, van den Dorpel MA, Van de Ven PJG, ter Wee PM, van Geelen JACA, Groeneveld JO, et al. Randomized, clinical trial comparison of trisodium citrate 30% and heparin as catheter-locking solution in hemodialysis patients. J Am Soc Nephrol. 2005; 16(9):2769-77. [DOI:10.1681/ASN.2004100870] [PMID]

[22] Zhao Y, Li Zh, Zhang L, Yang J, Yang Y, Tang Y, et al. Citrate versus heparin lock for hemodialysis catheters: A systematic review and meta-analysis of randomized controlled trials. Am J Kidney Dis. 2014; 63(3):479-90. [DOI:10.1053/j.ajkd.2013.08.016] [PMID]

[23] Froehlich CD, Rigby MR, Rosenberg ES, Li R, Roerig PLJ, Easley KA, et al. Ultrasound-guided central venous catheter placement decreases complications and decreases placement attempts compared with the landmark technique in patients in a pediatric intensive care unit. Crit Care Med. 2009; 37(3):1090-6. [DOI:10.1097/CCM.0b013e31819b570e] [PMID]

[24] Wolfe RR, O'Donnell TF, Stone MD, Richmand DA, Burke JF. Investigation of factors determining the optimal glucose infusion rate in total parenteral nutrition. Metab Clin Exp. 1980; 29(9):892-900. [DOI:10.1016/0026-0495(80)90130-4]

[25] Werlin SL, Lausten T, Jessen S, Toy L, Norton A, Dallman L, et al. Treatment of central venous catheter occlusions with ethanol and hydrochloric acid. JPEN J Parenter Enteral Nutr. 1995; 19(5):416-8. [DOI:10.1177/0148607195019005416] [PMID]

[26] Kerner Jr JA, Garcia-Careaga MG, Fisher AA, Poole RL. Treatment of catheter occlusion in pediatric patients. JPEN J Parenter Enteral Nutr. 2006; 30(1S):S73-81. [DOI:10.1177/01486071060300S1S73] [PMID]

[27] Murphy LM, Lipman TO. Central venous catheter care in parenteral nutrition: A review. JPEN J Parenter Enteral Nutr. 1987; 11(2):190-201. [DOI:10.1177/0148607187011002190] [PMID]