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Impact of Ultrasound Guidance During Placement of Tunnel Dialysis Catheter

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Author`s Contribution

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ABSTRACT

Objective: To determine incidence of neck hematoma between with and without ultrasound guided placement of internal jugular vein tunnel dialysis catheter

Methodology: A retrospective study was conducted at Heart and Vascular Institution, Kulsum International Hospital, Islamabad. Period: Six months from October 2021 to March 2022. Patients, who presented with End Stage renal failure requiring tunnel dialysis catheter for hemodialysis, were included into this retrospective study. Patient's statistic profile, indications, signs and symptoms were recorded. Tunnel dialysis catheters were placed through internal jugular vein with or without ultrasound guidance. The study's outcome was measured in terms of the incidence of neck hematoma compared between the two study groups.

Results: Overall, out of twenty patients, 13 (65.0%) were male and 7 (35.0%) were female. Age ranged from 16 to 70 with average of 51.0 ± 16.2 years. The incidence of neck hematoma was 3 (30.0%) in internal jugular vein tunnel dialysis catheter placement without ultrasound guidance (group B) compared to none 0 (0.0%) in patients undergoing internal jugular vein tunnel dialysis catheterization with ultrasound guidance (group A).

Conclusion: The incidence of neck hematoma was 30% which can be reduced to 0% if ultrasound is used as guidance in cannulation of internal jugular vein during the placement of tunnel dialysis catheter.

Keywords: Tunnel dialysis catheter, Neck hematoma, Ultrasound guided cannulation

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Introduction

Chronic kidney disease (CKD) is a prevalent condition associated with significant morbidity and mortality.[1] Renal replacement therapies (RRT) become necessary in cases of end-stage renal disease. In 1990, CKD was ranked as the 27th leading cause of death worldwide, but by 2010, it had risen to 17th place.[2] Globally, 2.618 million patients received renal replacement therapy (RRT) in 2010, and this number is projected to escalate to 5.439 million patients by 2030, with the most substantial increase anticipated in Asia. In 2010, an estimated 2.284 million deaths occurred due to the unavailability of RRT.[3] A study conducted in Pakistan revealed that 80% of patients commenced hemodialysis via central venous catheters (CVC), compared to 20% through arteriovenous access.[4] Similar trends have been observed in studies conducted in Europe and the United States.[5]

In the majority of cases, hemodialysis is initiated in acute settings using temporary dialysis catheters, such as tunnel dialysis catheters (perma cath), to bridge the gap until more definitive surgical treatments like AV fistulas or AV grafts are mature, or until a renal transplant is undertaken. The rising preference for tunneled cuffed catheters (TCC), necessitating fluoroscopic guidance, is becoming more common, yet not all facilities have access to this technology. This study aims to outline the safety, precision, and cost-effectiveness of ultrasound-guided catheter placement methods, with or without fluoroscopic assistance, especially in settings with limited resources.

Although the placement of a central venous catheter (CVC) is a routine procedure in intensive care units, CCUs, and anesthesiology, it is not uncommonly associated with acute severe complications such as arterial puncture, hematoma, hemothorax, thrombosis, pneumothorax, and infection at the site.[6,7] Due to CVC placement, if an artery is injured and the site cannot be effectively compressed, there can be a risk of hematoma, airway obstruction, stroke, and false aneurysm.[8] According to another study, mechanical complications[9] were higher with three punctures compared with one, thus ultrasound guidance, when available, can reduce the risk of mechanical complications. Successful CVC placement is largely dependent on the experience of the doctor doing the procedure; this also applies to TCC placement.[10]

Doppler vascular ultrasound (US) is increasingly utilized to mitigate complications associated with central venous catheter (CVC) insertion and enhance the safety and precision of the procedure. Conventionally, CVC placement relies on landmark techniques, which involve identifying anatomical structures and palpating arteries adjacent to the veins. However, these landmark techniques cannot account for anatomical variations at the CVC insertion site, which have been described in a relevant proportion of patients for the internal jugular vein (IJV), the subclavian vein (SV), and the femoral vein, which are common access sites for CVC and hemodialysis catheters.[7]

The introduction of Doppler vascular ultrasound guidance in tunnel dialysis catheter insertion has nearly eliminated access site complications like injury to surrounding structures and hematomas, and helps in the selection of good-sized veins for better flow. Additionally, in expert hands with ultrasound-assisted cannulation, the need for fluoroscopy can be eliminated, reducing time and cost of procedures.[8,9] This technique, after proper training, can be adopted in non-fluoroscopic centers, increasing its use with good safety profiles.

In this study, we demonstrated the use of ultrasound-guided venous puncture for tunnel hemodialysis catheter insertions from the internal jugular veins (IJV), mainly on the right side. The aim was to reduce bleeding complications/hematomas to control morbidity and mortality, as well as the cost of hospital stays. We compared the rate of neck hematomas in patients with and without ultrasound-guided placement of internal jugular vein tunnel dialysis catheters in dialysis cases.

Methodology

It was a retrospective analysis conducted on patients presented over a six-month period from October 2019 to March 2020. The study was approved by the Ethics Committee of the Hearts and Vascular Institution, Kulsum International Hospital, Islamabad. The study included 20 end-stage renal failure patients requiring a tunnel dialysis catheter for hemodialysis. Patients' statistical profiles, indications, signs, and symptoms were recorded. Tunnel dialysis catheters were placed through the internal jugular vein with or without the utilization of ultrasound guidance during cannulation. Verbal consent and written permission were obtained from the head of the department at Hearts and Vascular Institution, Kulsum International Hospital, Islamabad.

Patients were fully counseled regarding the procedure and potential complications. Proper aseptic measures were observed during the procedure, and local anesthesia was administered at the site of catheter insertion. The modified Seldinger technique was used for catheter passage. Patients were monitored immediately and within six hours post-procedure for the development of neck hematoma. The study's outcome was measured in terms of the incidence of neck hematoma compared between the two study groups.

Results

In the present study of the total 20 patients, 13 (65.0%) were male and 7 (35.0%) females. Age ranged from 16 to 70 years old with an overall mean age of 51.0 ± 16.2 years. There were 2 (10.0%) patients between 16 to 30 years of age, 7 (35.0%) patients were between 31 to 50 years while majority 11 (55.0%) were between 51 to 70 years of age. (Figure I) and (Figure II)

When further analysis was carried out according to two study groups i.e. group A and group B. There were 10 (50.0%) patients who underwent internal jugular vein tunnel dialysis catheter under ultrasound guided cannulation of internal jugular vein (group A) while an equal number i.e. 10 (50.0%) underwent internal jugular vein tunnel dialysis catheter without ultrasound guidance. There were 7 (70.0%) males and 3 (30.0%) females in group A while there were 6 (60.0%) male and 4 (40.0%) females in group B, and no statistical difference was observed among the two groups statistically (p-value, 0.63). The average age was 48.1 ± 16.2 years in group A and 52.1 ± 14.4 years in group B and no difference was

proven statistically (p-value, 0.51). In the ultrasound guided group, 7 (70.0%) patients have right internal jugular vein cannulated and 3 (30.0%) patients have left internal jugular vein cannulation while in the internal jugular vein tunnel dialysis catheter without ultrasound guidance group all 10 (100.0%) had right jugular vein cannulated. (Table I)

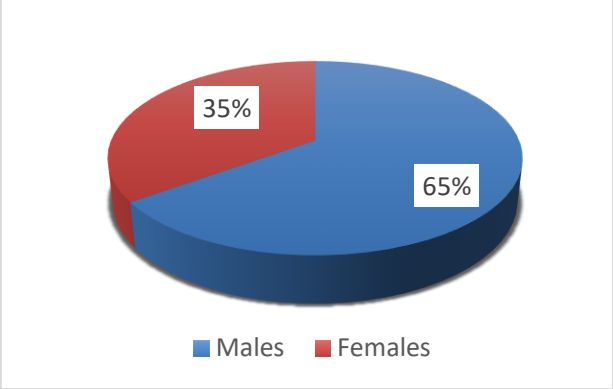

Figure I. Gender distribution in the study. (n=20)

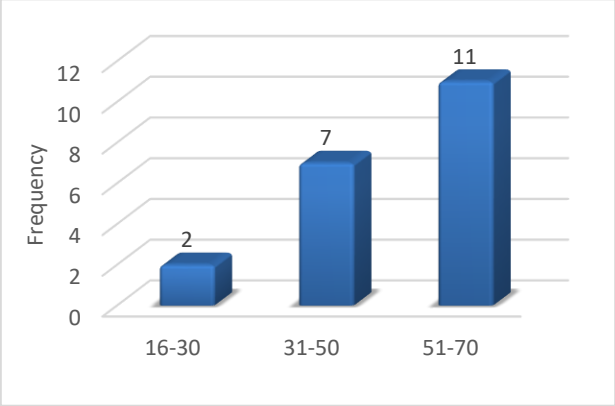

Figure II. Age distribution. (n=20)

Table I: Baseline characteristics in the two groups

	Group A (n=10)	Group B (n=10)	p-value
Gender			
Male	7 (70.0%)	6 (60.0%)	0.63
Female	3 (30.0%)	4 (40.0%)	
Age (years)			
Mean ± SD	48.1 ± 16.2	52.1 ± 14.4	0.51
Jugular vein side			
Right	7 (70.0%)	10 (100.0%)	0.05
Left	3 (30.0%)	0 (0.0%)	

The incidence of neck hematoma was compared among ultrasound guided group (group A) and internal jugular vein tunnel dialysis catheter placement without ultrasound guidance (group B). In the ultrasound guided cannulation of internal jugular vein no patient 0 (0.0%) suffered neck hematoma. While out of 10 (50.0%) patients who underwent internal jugular vein tunnel dialysis catheter placement without ultrasound guidance, 3 (30.0%) patients developed neck hematoma. The remaining 7 (70.0%) patients in group B were free of neck hematoma. Though borderline significance (p-value, 0.06) but there was a proportionate difference proven regarding the advantage of ultrasound guided cannulation of internal jugular vein. (Table II)

Table II: Comparison of neck hematoma between the two groups.

	Group A (n=10)	Group B (n=10)	p-value
Neck hematoma			
Yes	0 (0.0%)	3 (30.0%)	0.05
No	10 (100.0%)	7 (70.0%)	

Discussion

This study's findings underscore the critical importance of ultrasound-guided cannulation of the internal jugular vein in end-stage renal disease patients undergoing dialysis. The incidence of neck hematoma post-cannulation was significantly higher in patients undergoing internal jugular vein cannulation without ultrasound guidance compared to zero occurrences in the group receiving ultrasound-guided cannulation. Our study demonstrated a 100% safety and success rate in right internal jugular vein (IJV) cannulation with ultrasound guidance. While tunneled cuffed catheters (TCCs) can be successfully and safely placed in the right IJV under ultrasound guidance, difficult cases, particularly involving the left IJV approach, may necessitate fluoroscopic assistance to prevent failures. Previous research has also observed a higher failure rate with left IJV cannulation, which is probably related to the left IJV's angulated path towards the right atrium and the history of multiple catheterizations that resulted in thrombosed or stenosed vessels in cases of central venous obstruction because of altered venous anatomy.[13-15]

While ultrasound guidance has been shown to reduce complications such as neck hematoma, the overall complication rate remains noteworthy, ranging from 1% to 26% in various studies.[16] Operator experience, ultrasound guidance, and regular training courses have been identified as crucial factors in minimizing complication rates. [10,17,18] Our research did not document instances of arterial catheterization, cardiac tamponade, pneumothorax, hemothorax, air embolism, cardiac arrhythmias, guidewire embolism, catheter breakage, neurologic injury, or hemorrhage. However, due to loss to long-term follow-up, data on long-term complications such as infection rates, venous thrombosis, and central venous stenosis were unavailable, thus hindering their assessment.

Establishing a reliable vascular access is paramount for effective hemodialysis. Non-cuffed catheters (NCCs), while useful in emergencies, pose long-term risks such as infections, thrombosis, stenosis, low flow velocities, and high rates of recirculation. TCCs serve to bridge the gap between the initiation of hemodialysis and the maturation of native arteriovenous fistulas (AVFs) or synthetic arteriovenous grafts (AVGs). Ideally, NCCs should be replaced with TCCs if hemodialysis is expected to extend beyond one week. However, the lack of expertise and limited resources present significant obstacles to TCC placement.[10] Through this study, we have delineated an easy, safe, and cost-effective method for TCC placement under ultrasound guidance, eliminating the need for fluoroscopy.

The strengths of this study are manifold. Firstly, given the increasing prevalence of cardiac diseases and end-stage renal failure, generating such evidence is of paramount importance. Additionally, data on jugular vein cannulation in dialysis patients are scarce, making this study one of the few attempts to compare post-cannulation neck hematoma rates. Finally, our findings further validate the importance of ultrasound guidance during TCC placement.

Conclusion

Our study results re-enforces the use of ultrasound guidance for insertion of TCC, tunneled cuffed dialysis catheters in obtaining safe and accurate vascular access for sick end stage renal disease patients with and without fluoroscopic guidance.

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References

1. Ricardo AC, Athavale A, Chen J, Hampole H, Garside D, Marucha P, et al. Periodontal disease, chronic kidney disease and mortality: results from the third National Health and Nutrition Examination Survey. BMC nephrology. 2015;16(1):1-7. https://doi.org/10.1186/s12882-015-0101-x
2. Jha V, Garcia-Garcia G, Iseki K, Li Z, Naicker S, Plattner B, et al. Chronic kidney disease: global dimension and perspectives. Lancet 2013;382(9888):260-72. https://doi.org/10.1016/S0140-6736(13)60687-X
3. De Nicola L, Cozzolino M, Genovesi S et al. Can SGLT2 inhibitors answer unmet therapeutic needs in chronic kidney disease?. J Nephrol 2022; 35:1605-1618. https://doi.org/10.1007/s40620-022-01336-7
4. Nasir Mahmood S, Naveed Mukhtar K, Iqbal N, Umair SF. Pre Dialysis care and types of Vascular Access Employed in Incident Hemodialysis Patients: A study from Pakistan. Pak J Med Sci 2013;29(3):828-31. https://doi.org/10.12669/pjms.293.3385
5. Noordzij M, Jager JK, van der Ver SN, Kramar R, Collart F, Heaf JG, et al. Use of vascular access for haemodialysis in Europe: a report from the ERA-EDTA Registry.Nephrol Dial Transplant 2014;29(10):1956-64. https://doi.org/10.1093/ndt/gfu253
6. Bowdle A. Vascular complications of central venous catheter placement: evidence-based methods for prevention and treatment. Journal of cardiothoracic and vascular anesthesia. 2014 ;28(2):358-68. https://doi.org/10.1053/j.jvca.2013.02.027
7. Coutinho JM, Zuurbier SM, Aramideh M, Stam J. The incidence of cerebral venous thrombosis: a cross-sectional study. Stroke. 2012;43(12):3375-7 https://doi.org/10.1161/STROKEAHA.112.671453
8. Guilbert MC, Elkouri S, Bracco D, Corriveau MM, Beaudoin N, Dubois MJ, Bruneau L, Blair JF. Arterial trauma during central venous catheter insertion: case series, review and proposed algorithm. Journal of vascular surgery. 2008;48(4):918-25 https://doi.org/10.1016/j.jvs.2008.04.046
9. Calvache JA, Rodríguez MV, Trochez A, Klimek M, Stolker RJ, Lesaffre E. Incidence of mechanical complications of central venous catheterization using landmark technique: do not try more than 3 times. Journal of intensive care medicine. 2016 Jul;31(6):397-402 https://doi.org/10.1177/0885066614541407
10. Yoon HK, Hur M, Cho H, Jeong YH, Lee HJ, Yang SM, Kim WH. Effects of practitioner's experience on the clinical performance of ultrasound-guided central venous catheterization: a randomized trial. Sci Rep. 2021;11(1):6726. https://doi.org/10.1038/s41598-021-86322-y
11. Engstrom BI, Horvath JJ, Stewart JK, Sydnor RH, Miller MJ, Smith TP, et al. Tunneled internal jugular hemodialysis catheters: impact of laterality and tip position on catheter dysfunction and infection rates. J Vasc Interv Radiol 2013;24(9):1295-302 https://doi.org/10.1016/j.jvir.2013.05.035
12. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. Elsevier 2006; 81:1159-1171 https://doi.org/10.4065/81.9.1159

13. Napalkov P, Felici DM, Chu LK, Jacobs JR, Begelman SM. Incidence of catheter-related complications in patients with central venous or hemodialysis catheters: a health care claims database analysis. BMC cardiovascular disorders. 2013;13(1):1-0 https://doi.org/10.1186/1471-2261-13-86
14. Sherertz RJ, Ely EW, Westbrook DM, Gledhill KS, Streed SA, Kiger B, Flynn L, Hayes S, Strong S, Cruz J, Bowton DL. Education of physicians-in-training can decrease the risk for vascular catheter infection. Annals of internal medicine. 2000 Apr 18;132(8):641-8. https://doi.org/10.7326/0003-4819-132-8-200004180-00007
15. Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA. 1999;282(9):867- 74. https://doi.org/10.1001/jama.282.9.867
16. Smith RN, Nolan JP. Central venous catheters. BMJ 2013;347:f6570. https://doi.org/10.1136/bmj.f6570
17. Franco-Sadud R, Schnobrich D, Mathews BK, Candotti C, Abdel-Ghani S, Perez MG, Rodgers SC, Mader MJ, Haro EK, Dancel R, Cho J, Grikis L, Lucas BP; SHM Point-of-care Ultrasound Task Force; Soni NJ. Recommendations on the Use of Ultrasound Guidance for Central and Peripheral Vascular Access in Adults: A Position Statement of the Society of Hospital Medicine. J Hosp Med. 2019 Sep;14(9):E1-E22. https://doi.org/10.12788/jhm.3287
18. Boulet N, Muller L, Rickard CM. How to improve the efficiency and the safety of real-time ultrasound-guided central venous catheterization in 2023: a narrative review. Ann. Intensive Care 2023; 13: 46 https://doi.org/10.1186/s13613-023-01141-w