Original Article

Initial experience with use of infrared assistance for intravenous injection of radiopharmaceuticals

ABSTRACT

Radiopharmaceutical injection is challenging as it poses radiation exposure to staff as well as patient. Infrared light-assisted devices have been available since many years and have garnered mixed reviews in the pediatric age group. However, there are no data on outcome of infrared assistance for radiopharmaceutical injection. We compared results of first-attempt intravenous access (in cubital veins) with and without infrared assistance device for injection of radiopharmaceuticals. All adult patients who underwent nuclear scan in the initial weeks of infrared device installation were injected utilizing infrared device assistance. These were compared with those who underwent injection without infrared assistance. Three hundred consecutive patients were studied for success of intravenous injection with and without infrared assistance. Of these, 150 were injected with and 150 without infrared assistance. A success rate of 72%/51.3% was noted with and without infrared assistance, respectively, on the first attempt which was statistically significant. In our initial experience, assistance with infrared device was found to improve the outcome of first-attempt intravenous access for injection of radiopharmaceuticals. This method has potential of improving outcome for radiopharmaceutical injection.

Keywords: Infrared assistance, injection, intravenous, radiopharmaceutical

INTRODUCTION

Intravenous cannulation is the most common procedure used for sampling of blood, fluid infusion, medications, parenteral nutrition, and chemotherapy. It is also used in nuclear medicine for intravenous injection of radioisotopes or radiopharmaceuticals. Challenge areas include pediatric patients where size of veins and patient co-operation are factors, chemotherapy patients with thin or fragile veins, obese patients, and patients with dense hair or dark skin tone making visualization of veins difficult. These challenges can lead to multiple attempts, failed attempts leading to increase in morbidity, and associated bad impact of skilled nurses or doctors among patients. A vein viewer is a biomedical device which is used to indicate the exact location of the subcutaneous vasculature using infrared light. Earlier, an invasive technique was used to give direct injection or any fluids during emergency surgery when veins are not visualized properly, however, newer devices work noninvasively and are more advanced systems.

Aim

We studied the initial results of first-attempt intravenous access with and without infrared assistance device for injection of radiopharmaceuticals.

MATERIALS AND METHODS

Inclusion criteria

Adults who routinely presented for nuclear medicine scans and were to undergo intravenous access via cannulation or

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direct injection were included in the study. Patients were randomized into intravenous access with and without infrared assistance on alternate days for three consecutive months.

Exclusion criteria

Pediatric patients were not included in the study.

Methods

During intravenous access, first, we placed the tourniquet belt on the arm of the patient. Then, we kept the vein viewer over the arm. The source light falls on the patient's arm, and the reflected image is captured by the vein viewer. After processing, the image is projected back onto the patient's arm with a projector using infrared light. In this projected image, blood-containing veins appeared dark. When the vein was visualized, it was accessed and either cannulated or directly radiopharmaceutical was injected under vein viewer. On alternate days, intravenous access was performed directly without the device. Results of the first attempt were noted with both methods.

RESULTS

We included initial 300 patients in this study, of which 150 patients were injected without vein viewer and 150 patients were injected with vein viewer. Cubital veins were accessed in all patients [Figure 1]. The results are shown in Table 1.

The Chi-square statistic is 18.4607. The *P* value is 0.000098. The result is significant at $P < 0.05$.

Results were statistically significant for success on the first attempt of intravenous access with vein viewer (infrared assistance).

DISCUSSION

"As Low As Reasonably Achievable" is the concept which is used for dose optimization (not reduction) for the use of radiation. It aims to achieve desired results with the minimum radiation possible to the workers and patients.[1] In simple terms, this means that exposure to radiation must be optimized, without compromising on delivery of patient care and information desired from the procedure to be performed. This is relevant while using/injecting radiopharmaceuticals in nuclear medicine as it involves the use of unsealed radiation.

We used an infrared device commercially known as Vein Viewer Flex R which is a standalone table-mounted device that simply projects near-infrared light onto the field of its view. It has an inbuilt video camera which captures the light that is reflected from the area surrounding the veins; no light is reflected from the veins, so they stand out. A microprocessor makes the image better with contrast, and it is back projected on the patients' skin real time for assessment and venepuncture/injection.[2]

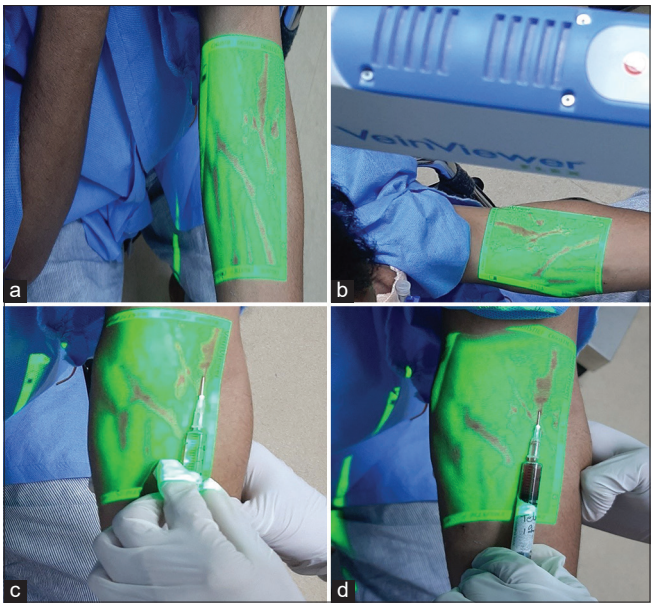

Figure 1: Images under vein viewer. (a) Appearance of veins, (b) Positioning of arm under vein viewer, (c) Needle inserting into the vein, (d) Drug administration into the vein

Table 1: First-attempt results

Extravasation status	Without infrared assistance ($n=150$), *n* (%)	With infrared assistance ($n=150$), *n* (%)
No extravasation	78 (51.3)	113 (72)
Partial extravasation	53 (35.3)	24 (13.3)
Total extravasation	19 (12.6)	13 (8.7)

Infrared assistance is one of the potential devices which can be of assistance to reduce failed attempts at intravenous injection/cannulations and can reduce the time taken for the procedure. This can be especially beneficial to delineate vessels difficult to be visualized by naked eye, especially where contrast may be lesser due to the presence of hair or darker skin tones.

Reduction of failed attempts also reduces the overall time taken for the procedure which indirectly affects the radiation exposure and extravasation frequency.

Extravasation of radiopharmaceuticals increases patient morbidity, radiation dose delivered, suboptimal scan in addition to increased radiation exposure of staff due to repeated failed procedures. This is especially true in patients receiving chemotherapy routinely presenting to nuclear medicine for positron emission tomography/computed tomography scan or bone scans.

Initial reports on these devices were published by Miyake *et al*. which showed promising results from the device in assisting venous access.[3] The study was performed on varicose veins and telangiectasis, and results were promising as the device could identify veins that were invisible to the naked eye and too shallow for ultrasound detection. The device showed potential for finding feeder veins for various vein treatments.

Chapman *et al*. studied a total of 323 children for peripheral intravenous catheter placement.[4] Their results did not show a significant difference in time, attempts, or pain scores in the pediatric age group. However, there were favorable results in time for placement as well as pain perception for the subgroup of age 0–2 years.

Further studies by Simhi *et al*. and Kim *et al*. found favorable results in facilitation of peripheral venous access and better first attempt for the pediatric population with infrared assistance.[5,6] Contrasting results were found by others where infrared assistance did not improve outcome or even worsened the first attempt of intravenous access, especially by skilled nurses in pediatric patients and in dark complexioned children.[7-10] Sun *et al*. found favorable results in a subgroup of critically ill 60 children.[11] Most studies have been performed on pediatric patients. Aulagnier *et al.* reported no improvement in results with infrared assistance in adults.[12] In the few reported randomized controlled trials, no significant difference was found with and without infrared assistance, though both studies do report better visualization of veins with the device.[13,14] It is thus postulated that nonvisualization of veins may not be the main cause for failed intravenous access.[14]

In our study, we observed a statistically significant reduction in number of extravasation on the first attempt with infrared assistance than without in adult patients. Probable reasons for the contradicting or even discouraging reports may be variations on account of the expertise or perception of the people performing the procedure. McNeely *et al*. reported that the nurses felt positively about the requirement of a biomedical device for assistance in intravenous access though their study did not demonstrate any significant difference in outcome.[15] It can be contemplated that experienced phlebotomists may not find much use for this device due to their experience as seen in Szmuk *et al*.[7] Whether newer workers and trainees may benefit more from this device is yet to be understood. In our study, the personnel involved were not experienced phlebotomists but a mixed group of younger staff comprising a nurse and technologist along with resident doctors with <5 years of experience.

We accessed only cubital veins in the first attempt for the patients included in our study. We have not compared other sites of access as this was a new technique for us, and larger veins were preferred to be accessed for initial results. This was also a personal choice for the personnel involved in the procedure.

In a meta-analysis on utility of infrared devices for the pediatric population, it was concluded that these devices may be potentially useful in situations with difficult cannulation.[16] Various commercially available devices have been compared with each other, and success at the first attempt was not significantly different across all devices.[17]

Thus, even though most direct comparisons do not favor results of assistance with infrared devices, it appears to have potential benefits in situations such as difficult cannulations, critical patients, inexperienced phlebotomists, and dark-skinned individuals. In the case of radiopharmaceutical injections, this is one of the first studies, and we have got favorable initial results. It would be interesting to study if these devices may be potentially beneficial to reduce the overall time of injection of radiopharmaceuticals.

CONCLUSION

There are still conflicting reports about results with the use of infrared assistance for intravenous access, and most literature is based on the pediatric population. In our knowledge, this is the first study where infrared assistance has been utilized for radiopharmaceutical injections and one of few on adult patients. Our initial experience with infrared-assisted device for intravenous access has shown better outcome with infrared assistance than without it. Further studies with different patient groups and effect on time taken for intravenous access/injection would be required to confirm these preliminary findings.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. National Council on Radiation Protection and Measurements. Report No. 107. Implementation of the Principle of as Low as Reasonably Achievable (ALARA) for Medical and Dental Personnel; NCRP Publications; 1990.
2. Conversano E, Cozzi G, Pavan M, Minute M, Gortan E, Montico M, *et al.* Impact of near infrared light in pediatric blood drawing Centre

on rate of first attempt success and time of procedure. Ital J Pediatr 2018;44:60.
3. Miyake RK, Zeman HD, Duarte FH, Kikuchi R, Ramacciotti E, Lovhoiden G, *et al*. Vein imaging: A new method of near infrared imaging, where a processed image is projected onto the skin for the enhancement of vein treatment. Dermatol Surg 2006;32:1031-8.
4. Chapman LL, Sullivan B, Pacheco AL, Draleau CP, Becker BM. VeinViewer-assisted intravenous catheter placement in a pediatric emergency department. Acad Emerg Med 2011;18:966-71.
5. Simhi E, Kachko L, Bruckheimer E, Katz J. A vein entry indicator device for facilitating peripheral intravenous cannulation in children: A prospective, randomized, controlled trial. Anesth Analg 2008;107:1531-5.
6. Kim MJ, Park JM, Rhee N, Je SM, Hong SH, Lee YM, *et al*. Efficacy of VeinViewer in pediatric peripheral intravenous access: A randomized controlled trial. Eur J Pediatr 2012;171:1121-5.
7. Szmuk P, Steiner J, Pop RB, Farrow-Gillespie A, Mascha EJ, Sessler DI. The VeinViewer vascular imaging system worsens first-attempt cannulation rate for experienced nurses in infants and children with anticipated difficult intravenous access. Anesth Analg 2013;116:1087-92.
8. de Graaff JC, Cuper NJ, van Dijk AT, Timmers-Raaijmaakers BC, van der Werff DB, Kalkman CJ. Evaluating NIR vascular imaging to support intravenous cannulation in awake children difficult to cannulate; a randomized clinical trial. Paediatr Anaesth 2014;24:1174-9.
9. Rothbart A, Yu P, Müller-Lobeck L, Spies CD, Wernecke KD, Nachtigall I. Peripheral intravenous cannulation with support of infrared laser vein viewing system in a pre-operation setting in pediatric patients. BMC Res Notes 2015;8:463.
10. van der Woude OC, Cuper NJ, Getrouw C, Kalkman CJ, de Graaff JC. The effectiveness of a near-infrared vascular imaging device to support intravenous cannulation in children with dark skin color: A cluster randomized clinical trial. Anesth Analg 2013;116:1266-71.
11. Sun CY, Lee KC, Lin IH, Wu CL, Huang HP, Lin YY, *et al*. Near-infrared light device can improve intravenous cannulation in critically ill children. Pediatr Neonatol 2013;54:194-7.
12. Aulagnier J, Hoc C, Mathieu E, Dreyfus JF, Fischler M, Le Guen M. Efficacy of AccuVein to facilitate peripheral intravenous placement in adults presenting to an emergency department: A randomized clinical trial. Acad Emerg Med 2014;21:858-63.
13. Kaddoum RN, Anghelescu DL, Parish ME, Wright BB, Trujillo L, Wu J, *et al*. A randomized controlled trial comparing the AccuVein AV300 device to standard insertion technique for intravenous cannulation of anesthetized children. Paediatr Anaesth 2012;22:884-9.
14. Cuper NJ, de Graaff JC, Verdaasdonk RM, Kalkman CJ. Near-infrared imaging in intravenous cannulation in children: A cluster randomized clinical trial. Pediatrics 2013;131:e191-7.
15. McNeely HL, Ream TL, Thrasher JM, Dziadkowiec O, Callahan TJ. Utilization of a biomedical device (VeinViewer®) to assist with peripheral intravenous catheter (PIV) insertion for pediatric nurses. J Spec Pediatr Nurs 2018;23:e12208.
16. Park JM, Kim MJ, Yim HW, Lee WC, Jeong H, Kim NJ. Utility of near-infrared light devices for pediatric peripheral intravenous cannulation: A systematic review and meta-analysis. Eur J Pediatr 2016;175:1975-88.
17. de Graaff JC, Cuper NJ, Mungra RA, Vlaardingerbroek K, Numan SC, Kalkman CJ. Near-infrared light to aid peripheral intravenous cannulation in children: A cluster randomised clinical trial of three devices. Anaesthesia 2013;68:835-45.