Received: 28 February 2021 | Revised: 8 May 2021 | Accepted: 12 May 2021

DOI: 10.1111/iwj.13624

ORIGINAL ARTICLE

IWJ WILEY

Treatment for grade 4 peripheral intravenous infiltration with type 3 skin tears: A case report and literature review

Jie Wang BSN[1] | Man-Man Li BSN[2] | Le-Peng Zhou BSN[1] | Ri-Hua Xie PhD[1] | Smita Pakhale MD[3,4,5] | Daniel Krewski PhD[5,6,7] | Shi Wu Wen PhD[4,5,8]

[1]Department of Nursing, The Seventh Affiliated Hospital of Southern Medical University, Foshan, Guangdong, China

[2]Digestive Medical Center, The Seventh Affiliated Hospital of Southern Medical University, Foshan, Guangdong, China

[3]Division of Respirology, Department of Medicine, The Ottawa Hospital, Ottawa, Ontario, Canada

[4]Ottawa Hospital Research Institute Clinical Epidemiology Program, Ottawa, Ontario, Canada

[5]School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada

[6]McLaughlin Centre for Population Health Risk Assessment, Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada

[7]Risk Science International, Ottawa, Ontario, Canada

[8]Department of Obstetrics & Gynecology, University of Ottawa Faculty of Medicine, Ottawa, Ontario, Canada

Correspondence
Ri-Hua Xie, PhD, Department of Nursing, The Seventh Affiliated Hospital of Southern Medical University, 28 Liguan Road, Lishui, Foshan 528244, China.
Email: xierihua928@hotmail.com

Abstract

Grade 4 peripheral intravenous infiltration with skin tears has seldom been reported. On 4 August 2020, a 35-year-old female patient was admitted to the emergency department of our hospital because of postprandial abdominal pain for 2 hours. She was diagnosed with a severe acute pancreatitis with type II diabetes mellitus. On 7 August, a vein detained needle was inserted into the dorsal vein of her right foot to infuse drugs. On 9 August, a grade 4 infiltration, discoloured and bruised skin with a swollen area of 11 cm × 9 cm around the infusion part of her right foot, was discovered. The infusion was stopped immediately and the residual drug was aspirated at the infusion site. When removing the vein detained needle, the skin surrounding the infusion site on the right foot was torn by the adhesive dressing. The size of the skin tears was 6 cm × 3 cm (type 3). The patient was provided with appropriate dressing, manual lymphatic drainage, and surgical intervention. Two months later, she was fully recovered with no functional impairment of the affected foot. Timely local wound interventions could lead to a satisfactory outcome for severe peripheral intravenous infiltration with skin tears.

KEYWORDS

manual lymphatic drainage, peripheral intravenous infiltration, skin tear, wound treatment

Jie Wang and Man-man Li contributed equally to this study.

Key Messages

- a case of grade 4 peripheral intravenous infiltration with type 3 skin tear and its treatment were reported
- the origins and developments of a grade 4 peripheral intravenous infiltration with type 3 skin tear were described and an integrated intervention including manual lymphatic drainage to treat this type of wound was introduced
- several measures including choosing access site, joint stabilisation, and timely assessment of vascular access site for patients with severe underlying condition such as diabetes could prevent or mitigate the impact of this type of wound. Comprehensive intervention including appropriate dressing, manual lymphatic drainage, and surgery could lead to a satisfactory outcome without impairment of the affected tissues

1 | INTRODUCTION

Infiltration is the inadvertent administration of a non-vesicant solution or medication into surrounding tissues of the intravenous (IV) catheter. It is one of the most common complications in infusion therapy involving an IV catheter.[1] Previous prospective observational studies have shown that average incidence of infiltration was 14.2%, ranging from 5.9% to 36.3%.[2-4] The Infusion Nurse Society Standards of Practice recommends that peripheral IV infiltration is classified into five grades from 0 to 4.[5] Grade 2 is the most commonly observed (67.2%), followed by grade 3 and grade 1.[6] Grade 4 (0.4%), the most severe injury, is rarely reported.[6] Grade 4 cases may result in serious complications including full skin loss, muscle necrosis, and tendon necrosis requiring reconstructive surgery or even amputation, which further lead to longer hospital stay, as well as higher morbidity and higher costs of care.[1,7] Treatments for IV infiltration consist of removing the vascular access device, elevating the limb, and applying a warm or cold compress.[1]

According to the International Skin Tear Advisory Panel (ISTAP), a skin tear is a wound caused by shear, friction, and/or blunt force with the separation of skin layers.[8] The prevalence of skin tears typically varies between 3.3% and 19.5%.[9,10] The skin tears are classified into three types, with type 3 being the most serious one.[8] Skin tear is painful and distressful for patients and may prolong hospital stay (particularly if related to the lower extremities and involving underlying pathology), increase costs of care, and impact quality of life on the affected patients.[11,12] Peripheral IV infiltration with skin tear is a rare and complex wound. Here, we presented an IV infiltration with skin tears occurring during IV treatment. We applied an integrated intervention including manual lymphatic drainage (MLD) to treat the IV infiltration with a satisfactory outcome.

2 | CASE PRESENTATION

On 4 August 2020, 11:15 am, a 35-year-old female patient with a body mass index of 25 kg/m^2 (height, 158 cm; weight, 62.5 kg) was admitted to the emergency department of The Seventh Affiliated Hospital of Southern Medical University, after postprandial abdominal pain for 2 hours. The patient was diagnosed with severe acute pancreatitis with a history of type II diabetes mellitus (before treatment: fasting glucose, 9.1-18.3 mmol/L; after treatment: fasting glucose, 5.1-15.4 mmol/L) and hyperlipidaemia (fasting total cholesterol, 22.52 mmol/L; fasting triglycerides, 32.95 mmol/L).

On 6 August, the patient presented coma and dysphoria. Also she had oedema in low limbs (grade 1). To ensure safety, the patient's limbs were properly secured on the ward bed with restraints.

On 7 August, 12:30 am, a vein detained needle (24-gauge; BD™) was inserted into the dorsal vein of her right foot to infuse blood plasma and furosemide.

Given pharmaceutical incompatibility, the dorsal vein of her right foot was chosen because her left femoral vein with a catheter and right subclavian vein with a catheter had continually been infused gentamicin, remifentanil, and norepinephrine since 6 August.

On 8 August, when blood plasma was stopped (2:00 pm), furosemide was continually infused into the dorsal vein of the right foot (7:00 pm).

On 9 August, 3:55 pm, the skin on the dorsum of the right foot was found discoloured and bruising with a swollen area of 11 cm × 9 cm. The patient had moderate pain with a score of 4. Therefore, we defined the IV infiltration as grade 4.

The furosemide infusion was discontinued immediately and the residual drug was aspirated using a 5 mL syringe. When removing the transparent bio-occlusive dressing (10 cm × 11.5 cm; Tegaderm™; 3M) and vein detained needle, the patient made a sudden big kick of her right foot, causing a size of 6 cm × 3 cm skin tear

FIGURE 1 The skin tear area: 6 cm × 3 cm, the colour of the wound base was 100% red. The infiltration area: 11 cm × 9 cm, bruised skin, grade 1 oedema. Exudate: Scant amount, serous. Pain score (numeric rating scale): 2

(type 3) in the right foot by the adhesive dressing (Figure 1).

3 | LOCAL WOUND ASSESSMENT

The wound was located at the right anterior ankle, with a size of 6 cm × 3 cm, 100% black base and a scant amount of serous exudate. The skin from the dorsum of the right foot to the front of the tibia was bruised and swollen, measuring 15 cm × 10 cm. Pitting oedema is present in the right foot (grade 1). Palpation revealed a weaker pulse in the right foot than in the left. The pain score was 4 in her right lower limb using numeric rating scale.[13] IV infiltration was rated as grade 4 and skin tear was rated as type 3.

4 | WOUND HEALING PROCESS

4.1 | Wound cleaning

On 9 August, the wound was rinsed repeatedly with normal saline, and then it was covered with a Vaseline gauze dressing to maintain moisture balance. The right lower limb was elevated to reduce oedema.

4.2 | Moisture balance and oedema reduction

Since 10 August, liquid wound dressing (Baoshiman™, ZhongTengYiYao) with three times a day, 50% magnesium sulphate dressing with twice a day (Figure 2), and hydrogel dressing (HARTMANN, Hydrosorb®) with once every 3 days (Figure 3) had been applied to the wound area to absorb wound exudates, reduce oedema, and promote wound healing. On 19 August, the wound was suspected to be infected as its exudate became brown and sticky. An ionic silver hydrogel dressing (URGO®, Urgotul SSD) which has a broad spectrum of antimicrobial activity was applied (Figure) twice a day to prevent wound infection.

On 24 August, it was discovered that the wound oedema had been insufficiently reduced. After consultation with a wound specialist, we used MLD to relieve the wound oedema because it is able to significantly reduce swelling of the tissue surrounding the wound.[14] MLD consists of six steps: gently rub the inguinal lymph nodes; massage the flabby thigh muscles; rub the popliteal lymph nodes; relax the calf muscles and gently massage toward the centre, including the ankle; relax toes to help their movement; and massage the skin around the wound. MLD was performed on daily basis from 24 to 31 August, one session with about 60 minutes per day.

On 31 August, the wound oedema in the affected foot disappeared and the dorsal pedis arterial pulse returned to normal, with equal strength on both sides.

4.3 | Debridement and skin flap transplantation

The skin in the infiltration area gradually turned black and sunken as compared with the surrounding skin, with a sense of fluctuation when touched. Puncture and flaking were performed at the lower area of the wound. And an ionic silver hydrogel dressing drainage strip (URGO®, Urgotul SSD, once a day) was applied to drain out the cloudy and brown liquid. A 10% povidone iodine cream (Guangdongkelun) with cotton pad was used externally to accelerate debridement once a day (Figure 5).

On September 11, the wound area of the right foot was completely covered by black scab, with clear division from the surrounding healthy skin. The patient was sent to the operating room for surgical debridement, expansion, and vacuum sealing drainage (VSD) of the necrotic skin (Figure 6).

On September 23, the wound was covered with fresh granulation and free lower limb skin flap transplantation was performed (Figure 7).

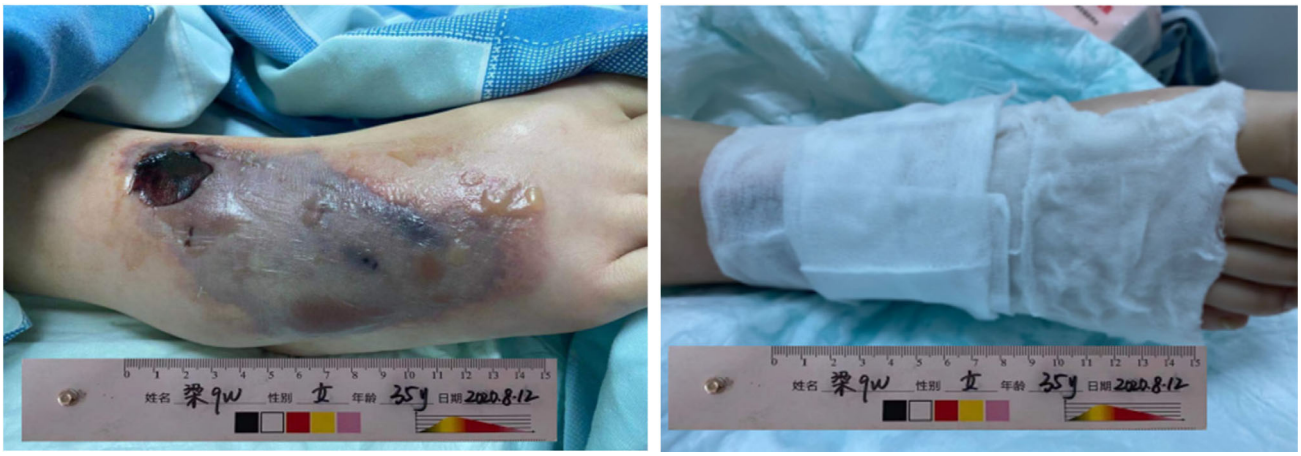

FIGURE 2 The skin tear area: 3 cm × 3 cm, the colour of the wound base was 100% black. The infiltration area: 15 cm × 8 cm, bruised skin with scattered blisters, grade 2 oedema. Exudate: Moderate amount, serous. Pain score (numeric rating scale): 4. Treatment: The wound area was covered with wet compress with 50% magnesium sulphate, and the wet compress was changed twice a day

FIGURE 3 The skin tear area: 4 cm × 3 cm, the colour of the wound base was 50% black and 50% yellow. The infiltration area: 15 cm × 10 cm, bruised skin, grade 3 oedema. Exudate: Moderate amount, serous. Pain score (numeric rating scale): 4. Treatment: The wound area was covered with hydrogel dressing (HARTMANN, Hydrosorb®) and the dressing was changed once every 3 days

5 | WOUND HEALING OUTCOME

Stitches were removed on October 7, and the wound was mostly healed (Figure 8). Three months later, the patient experienced a complete and satisfactory healing outcome with no functional impairment of the affected foot.

6 | DISCUSSION

As a result of erosion or penetration of the catheter into or through the venous wall, infiltration could lead to infusion of fluids and/or medications into the surrounding soft tissues. Studies have showed that factors for infiltration are various, such as inflammatory effects of traumatic movement of the catheter within the vessel, caustic or other chemical injuries by the infuscate, and previous needle injuries.[2,15] Peripheral IV catheters placed in joint regions have been shown to have higher rates of infiltration and loss, presumably because of movement of the vessel wall relative to the catheter tip.[15] In the present case, there were several reasons for the infiltration. First, drugs were infused into the dorsal vein of the right foot (near the ankle), which may increase the risk of movement. Second, blood plasma was administered through this IV catheter the day before furosemide infusion. The osmotic pressure of blood plasma is high, and continuous blood plasma infusion may cause injury to the dorsal foot vein. Third, the patient had suffered from type 2 diabetes mellitus, therefore, her immunity and local vascular condition may be compromised. Fourth, the patient had developed oedema in lower limbs before the infusion, and she was in a coma and unable to express pain or discomfort, making early infiltration

FIGURE 4 The skin tear area: 4 cm × 3 cm, the colour of the wound base was 25% black and 75% yellow. The infiltration area: 15 cm × 10 cm, maceration, grade 3 oedema. Exudate: Large amount, seropurulent. Pain score (numeric rating scale): 2. Treatment: The wound area was covered with ionic silver hydrogel dressing (URGO®, Urgotul SSD) and the dressing was changed once a day

FIGURE 5 The wound area: 15 cm × 13 cm, the colour base of the wound base was 50% black and 50% red, grade 1 oedema. Exudate: Large amount, seropurulent. Pain score (numeric rating scale): 2. Treatment: The wound area was covered with 10% povidone iodine cream (Guangdongkelun) and the cream was changed once a day

difficult to detect. Therefore, a combination of these factors has led to the development of grade 4 IV infiltration in this case.

The three main risk factors for skin tears are fragile skin conditions, impaired mobility and mechanical trauma, and poor general health status (eg, comorbidities, polypharmacy, and impaired cognition).[16,17] Skin tears could be uncomplicated (healing within 4 weeks) or complicated.[8] Lower leg oedema is well documented to contribute to delayed wound healing, regardless of the wound aetiology.[8] In our case, the patient's lower limbs were secured by restraints on the ankles. While removing the IV catheter, the patient suddenly made a big kick because of dysphoria.

Friction between the restraint straps and the skin increases the risk of skin tears. In addition, the comorbidities, such as type II diabetes mellitus and polypharmacy for her serious and complex health conditions

FIGURE 6 The wound area:12 cm × 6 cm, the colour of the wound base was 100% black, tendons were not injured. Exudate: Small amount, seropurulent. Pain score (numeric rating scale): 2. Treatment: Surgical debridement and expansion of the skin, as well as using vacuum sealing drainage (VSD) to cover the skin

FIGURE 7 The wound area: 12 cm × 6 cm, the colour of the wound base was 100% red. Exudate: Small amount, sanguineous. Pain score (numeric rating scale): 2. Treatment: Free lower limb flap transplantation

contributed greatly to the skin tear. Moreover, wound oedema also delayed or impeded healing of this patient's skin tear.

When the wound was discovered by an in-charge nurse, it had already developed into a grade 4 infiltration with typical pain at the site, swelling, blanching of the area, a decreased level of capillary refill, a decreased pulse, and skin blistering. According to the 2016 Infusion Therapy Standards of Practice, dry and cold compresses of non-irritant and hyperosmolar fluids and medications are recommended for management of infiltration sites. Magnesium sulphate can relax vascular smooth muscle, telangiectasia, improve local blood circulation, and reduce local inflammatory response,[18] thus, it has been widely applied in the treatment of IV filtration. Studies[19,20] have demonstrated that traditional Chinese medicine and hydrogel dressing may have effects on the treatment of IV filtration. Based on different indications, non-adherent mesh dressings, foam dressing, hydrogels, cyanoacrylate, solvent free cyanoacrylate-based skin protectants, calcium alginates, gelling fibres, and acrylic dressing could be used to treat type 3 skin tear.[16,21] If skin tears were infected, methylene blue and gentian violet dressings and ionic silver dressings could be performed. This patient's wound was grade 4 infiltration with type 3 skin tear. According to the moist wound healing theory,[22] we chose liquid wound dressing (Baoshiman™, ZhongTengYiYao), 50% magnesium sulphate dressing, and hydrogel dressing (HARTMANN, Hydrosorb®) to absorb wound exudates, reduce oedema, and promote wound healing. Considering potential wound infection because of the large skin tear wound area and patient's

FIGURE 8 Stitches were removed and the wound was mostly healed

poor immunity, ionic silver hydrogel dressing (URGO®, Urgotul SSD) which has broad spectrum antimicrobial activity was applied.

Two weeks after the injury, as the wound oedema was insufficiently reduced with dressing and elevating, MLD was recommended because it can drain congested areas by increasing activity of normal lymphatics and bypassing ineffective or obliterated lymph vessels.[14] A systematic review[23] demonstrated that MLD relieved muscular pain, lymphedema, chronic complex regional pain syndrome, and inflammatory mediators in patients with athletic injuries. Torres et al[24] revealed that MLD could decrease the risk of lymphedema after surgery in breast cancer patients. However, no study has been conducted with regard to the effects of MLD on relieving oedema at the site of IV infiltration. In our case, MLD had been applied to the injured lower limb at 11:00 am, lasting an hour each session, for 8 days and the oedema around the wound gradually reduced and disappeared after the 8-day treatment course. Our case suggested that MLD may be an effective way to reduce oedema caused by IV infiltration.

However, skin necrosis occurred and the patient continued to feel pain after conservative local treatment, which has been cited as an indication for surgical interventions. When surgery is indicated, early debridement of necrotic tissues and entrapped drugs could minimise the risk of subsequent damage to the deeper tissues: wide excision and skin grafting are the most used procedures.[2] VSD can help promote wound healing and formation of granulation tissues. In our case, the patient was sent to the operating room for surgical debridement, expansion of the necrotic skin, as well as using VSD to cover the skin. Once the wound being covered with fresh granulation, free lower limb skin flap transplantation was performed.

Because of timely comprehensive interventions for the wound with no subsequent harms to the tissues such as tendons, the patient completely healed with no functional impairment of the affected foot.

7 | LESSONS LEARNED

Several lessons could be learned from this case. First, when choosing the peripheral vascular access site, we should avoid the veins of the lower limb, especially infusing high osmotic pressure substances such as plasma. Second, when placing a short peripheral catheter near the ankle joint, we should stabilise the joint using devices such as splint, to facilitate infusion delivery, maintain patency, and minimise complications. Third, we should regularly and carefully monitor and assess the vascular access site and vascular pathway to make an early detection of injuries and may launch immediately remedy measures. Limitations for this case were that we did not use x-rays or a CT scan to examine the soft tissue girth around or for lower-leg/foot assessments, nor did we measure the ankle-brachial index to determine blood supply of lower limbs, to objectively assess the wound and its healing process.

8 | CONCLUSION

Choosing the right access site, joint stabilisation, and regular and careful assessments of vascular access site for patients with severe conditions such as diabetes could prevent the occurrence of complex grade 4 infiltration with type 3 skin tear or mitigate its impact. Comprehensive interventions including appropriate dressing, MLD, and surgery could lead to a satisfactory outcome without impairment of the affected tissues. Further documentation of similar cases with objective measurements of the wound healing process such as CT scans could help assess added value of MLD in serious and complicated wounds as described in this case.

ACKNOWLEDGEMENTS

We would like to credit the patient for her participation in this case study, as well as wound specialists Li-Juan Zhang and Mei-Chun Zheng from Sun Yat-Sen University Cancer Center for their valuable consultation with regards to the patient's MLD treatment.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Doellman D, Hadaway L, Bowe-Geddes LA, et al. Infiltration and extravasation: update on prevention and management. *J Infus Nurs*. 2009;32(4):203-211.
2. 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.
3. Mestre Roca G, Berbel Bertolo C, Tortajada Lopez P, et al. Assessing the influence of risk factors on rates and dynamics of peripheral vein phlebitis: an observational cohort study. *Med Clin*. 2012;139(5):185-191.
4. Dillon MF, Curran J, Martos R, et al. Factors that affect longevity of intravenous cannulas: a prospective study. *QJM*. 2008;101(9):731-735.
5. Gorski LA. Standard 54: infiltration. *J Infus Nurs*. 2007;30(6):330-331.
6. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. *J Clin Nurs*. 2019;28(9–10):1585-1599.
7. Diehl-Svrjcek BC, Dawson B, Duncan LL. Infusion nursing: aspects of practice liability. *J Infus Nurs*. 2007;30(5):274-279.
8. LeBlanc K, Campbell KE, Wood E, Beeckman D. Best practice recommendations for prevention and management of skin tears in aged skin: an overview. *J Wound Ostomy Continence Nurs*. 2018;45(6):540-542.
9. LeBlanc K, Christensen D, Cook J, Culhane B, Gutierrez O. Prevalence of skin tears in a long-term care facility. *J Wound Ostomy Continence Nurs*. 2013;40(6):580-584.
10. Chang YY, Carville K, Tay AC. The prevalence of skin tears in the acute care setting in Singapore. *Int Wound J*. 2016;13(5):977-983.
11. LeBlanc K, Baranoski S, Holloway S, Langemo D, Regan M. A descriptive cross-sectional international study to explore current practices in the assessment, prevention and treatment of skin tears. *Int Wound J*. 2014;11(4):424-430.
12. Rayner R, Carville K, Leslie G, Roberts P. A review of patient and skin characteristics associated with skin tears. *J Wound Care*. 2015;24(9):406-414.
13. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: which to use? *Am J Emerg Med*. 2018;36(4):707-714.
14. Lymphoedema Framework. *Best Practice for the Management of Lymphoedema. International Consensus*. London, UK: MEP Ltd; 2006.
15. Hadaway L. Infiltration and extravasation. *Am J Nurs*. 2007;107(8):64-72.
16. Maida V, Ennis M, Corban J. Wound outcomes in patients with advanced illness. *Int Wound J*. 2012;9(6):683-692.
17. LeBlanc K, Campbell K, Beeckman D, et al. *Best practice recommendations for the prevention and management of skin tears in aged skin*. London: 2018. pp. 4–15. https://www.woundsinternational.com/resources/details/istap-best-practice-recommendations-prevention-and-management-skin-tears-aged-ski.
18. Chen CX, Li JM, Wu WQ, Wang J, Zhao ZJ. Study on the effect of partly magnesium sulfate wet packing to venous indwelling needle. *Modern Prev Med*. 2008;35(2):360-363.
19. Geng XP, Yao JS, Jin Y, Dong J, Hao L. Evaluation of nursing effect of Chinese herbal medicines wet wrapping technology on 65 elderly stroke patients with infiltration of infusion drugs. *J Tradit Chin Med*. 2019;38(12):1230-1233.
20. Zhong MR, Yao LY, Xu JL, Liu FZ. Observation on the effect of two different methods on drug intravenous. *Contemp Nurse*. 2017;12:133-134.
21. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th edition. *J Infus Nurs*. 2021;44(1S Suppl 1):S1-S224.
22. Bryan J. Moist wound healing: a concept that changed our practice. *J Wound Care*. 2004;13(6):227-228.
23. Vairo GL, Miller SJ, McBrier NM, Buckley WE. Systematic review of efficacy for manual lymphatic drainage techniques in sports medicine and rehabilitation: an evidence-based practice approach. *J Man Manip Ther*. 2009;17(3):e80-e89.
24. Torres Lacomba M, Yuste Sánchez MJ, Zapico Goñi A, et al. Effectiveness of early physiotherapy to prevent lymphoedema after surgery for breast cancer: randomised, single blinded, clinical trial. *BMJ*. 2010;340:b5396.

How to cite this article: Wang J, Li M-M, Zhou L-P, et al. Treatment for grade 4 peripheral intravenous infiltration with type 3 skin tears: A case report and literature review. *Int Wound J*. 2022;19(1):222–229. https://doi.org/10.1111/iwj.13624