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2024

**Background**

Patients with end-stage renal disease are required to undergo haemodialysis treatments or a kidney transplant for survival. In patients undergoing haemodialysis renal replacement, the vascular access must be well-maintained for long-term treatment. Even though arteriovenous (AV) fistula is an excellent option for the successful long-term access, however the cumulative incidence of loss of AV fistula patency demonstrated an increasing trend. At present, treatment of loss of AV fistula patency mainly includes percutaneous, thrombectomy or surgical procedures. While there are positive effects of these treatments, the evidence does not focus on the immature fistula preservation and only assess on short-term duration of efficacy. Moreover, in terms of wound healing, slow rate of healing is associated with a reduction in blood flow due to total or partial obstruction, or known as vascular occlusion. A vascular blockage of blood vessel supplying the skin can cause tissue death and skin necrosis if treatment is not received. Several conventional methods to overcome the above medical issues have some limitations. Hence, attention has focused on far infrared therapy as an alternative. This therapy involves electromagnetic wave penetrates through skin into subcutaneous tissues at a specified energy setting for a predetermined number of sessions for a set treatment duration and number of treatments. While its mechanism of action is still not completely clarified, the far infrared energy is believed to resonate with cellular frequencies and interact with biological structure. This relieve pain and activate immune response.

**Objective**

The objective of this technology review was to assess the effectiveness, safety and economic implication.

**Methods**

A systematic review was conducted. Review protocol, search strategy and literature search was developed by the main author related to far infrared therapy for the treatment of AV fistula function and wound healing. The following electronic databases were searched through the Ovid interface: MEDLINE® All <1946 to 1st March 2024. Comparative searches were run in PubMed, USFDA and INAHTA database while further articles were retrieved from reviewing the bibliographies of retrieved articles. Only articles on humans were included in the review. There was no language restriction in the search. The most recent search was carried out on 5th March 2024.

**Results and conclusion:**

The initial searches yield a total of 580 citations. After assessing for eligibility criteria, five full text articles were subsequently retrieved and included in the review, which consists of one systematic review and meta-analysis, one randomised controlled trial, one non-randomised experimental trial, one cohort study and one experimental study. The studies were conducted in Sweden, Korea, China and Indonesia.

**Effectiveness:**

There was limited and fair level of retrievable evidence to suggest far infrared therapy improved AV fistulas function and wound healing regarding patient-subjective outcomes relative to those who received placebo/ rehab program/ iodine control treatment. Findings in general indicated that:



- i. Far infrared therapy improved vascular access flow levels ( $p < 0.001$ ), AV fistulas diameter ( $p < 0.001$ ) and primary patency rates ( $p < 0.001$ ).
- ii. Far infrared therapy reduced the incidence of AV fistula occlusion ( $p < 0.001$ ) and needling discomfort ( $p < 0.001$ ).
- iii. Far infrared therapy increased blood velocity over the fistula from mean  $2.1 \text{ ms}^{-1} (\pm 1.0)$  to  $2.3 \text{ ms}^{-1} (\pm 1.0)$ ;  $p = 0.02$  and venous diameter from  $0.7 \text{ cm} (\pm 0.2)$  to  $0.8 \text{ cm} (\pm 0.2)$ ,  $p = 0.006$ .
- iv. Fistula blood velocity and base line serum-urate correlated positively ( $r = 0.52$ ,  $p = 0.004$ ).
- v. Venous diameter and base line orosomucoid levels correlated significantly ( $r = 0.51$ ,  $p = 0.005$ ).
- vi. Far infrared therapy decreased visual analogue scale (VAS) at five weeks ( $1.7 \pm 1.0$  vs.  $2.8 \pm 1.4$ ,  $p = 0.002$ ) and three months ( $2.4 \pm 1.3$  vs.  $3.2 \pm 1.8$ ,  $p = 0.041$ ).
- vii. Far infrared therapy emissivity correlated significantly with skin blood perfusion ( $r = 0.81$ ).
- viii. HaCat and Huvec in far infrared therapy group proliferated better.
- ix. Far infrared therapy demonstrated larger healing area in the HaCat and Huvec.
- x. Far infrared therapy improved redness, oedema, ecchymosis, discharge and approximation (REEDA) scale on both groups from day 1 to day 2 ( $p = 0.00$ ), and on far infrared group from day 2 to day 3 ( $p = 0.04$ ).

**Safety:**

There was limited and fair level of retrievable evidence suggesting that far infrared therapy was generally safe with no incidence of adverse events and well-tolerated by patients during the treatment of AV fistulas and wound healing. Overall, studies reported that far infrared therapy was not associated with skin burn, infection, wound problem, hypersensitivity reaction and body temperature elevation during the sessions or the follow up. However, the United States of Food and Drug Administration (USFDA) only has approved far infrared therapy as a treatment for muscle and joint pain/ stiffness.

**Economic implication:**

There was no retrievable evidence on cost-effectiveness of far infrared therapy for treating AV fistulas and wound healing. The global market and Malaysian far infrared device prices differ, as do their levels of advancement.

**Organisational:**

There are several international organisations that have published statement/ guideline recommendations surrounding far infrared therapy including International Commission on Non-ionising Radiation Protection (ICNIRP; 2006) and European Renal Associations – European Dialysis and Transplant Associations and Nephrology

Dialysis Transplantation (ERA-EDTA; 2019). The statement updated on the guideline of far infrared utilisation, especially on several patients with chronic/ unstable condition. This therapy is also recommended for AV fistulas maturation and long-term maintenance of AV fistulas patency.

**Conclusion:**

There was limited evidence of far infrared therapy for patients with AV fistula and its usage for wound healing. The evidence showed fair improvement in AV fistulas functions, wound healing rate and pain, and the effect might last up to six to 12 months. Up to three months after surgery, adjuvant daily therapy and rehabilitation exercises reduced post-surgical wound pain. In terms of safety, the evidence demonstrated that the technology is a safe and well-tolerated treatment. In contrast, although it has been recommended for AV fistulas maturation and long-term maintenance of AV fistulas patency, it is still being investigated and has not yet received USFDA approval as a therapy option.