〈Case Report〉

# A Case of Full-Body Thermotherapy for Healing a Stump Ulcer in an Elderly Patient with Lower Limb Amputation

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**ABSTRACT** **Introduction/Background:** More than 50% of lower limb amputations in elderly patients are attributed to peripheral circulatory disorders. Conditions such as collagen diseases and autoimmune disorders are significant risk factors for lower limb amputation. Furthermore, post-amputation, there is a heightened risk of developing intractable ulcers in the remaining limb, which can hinder proper prosthetic fitting and the restoration of gait function. Full-body thermotherapy, known as "Waon therapy" improves peripheral circulation. Here, we present a single case in which full-body thermotherapy was applied to a patient with systemic sclerosis and rheumatoid arthritis who underwent a lower limb amputation due to recurrent venous ulcers, ultimately achieving successful gait restoration with a transtibial prosthesis.

**Case Report:** A 70-year-old female patient with a medical history of systemic sclerosis, rheumatoid arthritis, and bilateral lower leg varicose veins experienced worsening cold sensations and pain in the right lower limb starting in early December. She was admitted to our hospital in January of the following year for treatment of a venous ulcer on her right foot. Although bypass surgery was performed on the affected limb, the ulcer progressively worsened, leading to a right lower limb amputation in April of the same year. Following the procedure, the patient was transferred to a convalescent rehabilitation ward for prosthetic training.

At the time of transfer to the convalescent rehabilitation ward, an ulcer was already present on the stump end. To improve peripheral circulation, we initiated simple whole-body heat therapy using hot packs and thermal sheets 4 weeks after the transfer. Cold sensation and pain at the stump improved within 1 week of starting this therapy. Over the course of treatment, improved skin perfusion pressure in both legs and epithelialization of the ulcer were observed, ultimately enabling optimal prosthetic fitting of the right lower limb and successful gait

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acquisition with bilateral Lofstrand crutches.

**Discussion:** In this case, we implemented a simplified full-body thermotherapy for an elderly amputee patient with multiple underlying conditions contributing to peripheral circulatory disorders and achieved favorable outcomes. This therapy is cost-effective, does not require specific facilities, and appears to be applicable in diverse settings.

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## INTRODUCTION / BACKGROUND

More than half of all elderly cases of lower limb amputation are caused by peripheral circulatory failure[1]. Arteriosclerosis resulting from diabetes and hypertension leads to peripheral circulatory failure. Collagen disorders and autoimmune disorders such as scleroderma and rheumatoid arthritis may also cause peripheral circulatory failure[2]. Elderly patients with such underlying conditions are at a higher risk of lower limb amputation. Furthermore, post-amputation complications affecting limbs other than the amputated one, such as intractable ulcers and pain, can significantly hinder prosthetic leg adaptation and the ability to walk.

In 1989, Waon therapy, a full-body thermotherapy invented by Tei *et al.*[3] for chronic cardiac failure, was reported to improve peripheral endothelial function, thereby contributing to the improvement of peripheral circulatory failure[3-6]. Waon therapy involves thermal treatment in a far-infrared-ray dry sauna at 60℃ for 15 minutes, followed by bed rest with a blanket for 30 minutes to raise core temperature by 1.0-1.2℃. Patients are encouraged to drink water to replenish fluids lost through perspiration.

The effects of Waon therapy are believed to include increased cardiac output via its peripheral vasodilatory action, angiogenesis induced by shear stress, and prevention and improvement of arteriosclerosis through enhanced vascular endothelial function[3-6]. Previously, Arai *et al.*[7] performed a simplified full-body thermotherapy, modeled after Waon therapy, on a patient with recurrent intractable ulcers caused by peripheral circulatory failure, resulting in reported improvement in skin condition.

We herein report a case of an elderly patient who underwent lower limb amputation after repeatedly experiencing stump venous ulcers and limb deformities due to scleroderma and rheumatoid arthritis. The patient received a combination of simplified full-body thermotherapy and prosthetic training, successfully achieving a prosthetic gait.

## CASE REPORT

The patient was a 70-year-old female who lived independently. Her activities of daily living (ADL) were not restricted. Her medical history included scleroderma, rheumatoid arthritis, bilateral lower leg varicosity, and arteriosclerosis obliterans of the lower limbs. During winter, ulcers would develop on both lower limbs, necessitating repeated dermatological treatments. In December X, the patient began experiencing worsening cold sensations and pain in the right lower limb. By January X+1, an ulcer had developed on the right foot, prompting her admission to our hospital. She was diagnosed with acute arterial obstruction and underwent a Femoral-Above knee Popliteal Arterial Bypass with Autologous vein. However, the ulcer worsened, ultimately leading to the amputation of her right lower leg in April. Post-amputation wound healing was insufficient. In May X+1, 46 days after the amputation, the patient was transferred to our department and admitted to the convalescent

rehabilitation ward.

The right lower leg was amputated distally, 13 cm from the lower border of the patella, with a circumference of 32 cm at 1 cm proximal to the stump and 29.1 cm at 5 cm proximal to the stump. The wound at the stump suture was mostly epithelialized, but an ulcer approximately 10 mm in size with a small amount of exudate was present at the end of the leg. The condition of scleroderma was stable, with no dermal sclerosis observed. The patient exhibited swelling and deformity of the fingers on both hands due to rheumatoid arthritis (Class Ⅲ of the Steinbrocker Staging System), resulting in limited joint mobility (flexion of the interphalangeal joint of the thumb: right: 10°/left: 10°; the second metacarpophalangeal joint extension: right: -40°/left: -20°; the third metacarpophalangeal joint extension: right: -30°/left: -20°; the fourth metacarpophalangeal joint extension: right: -20°/left: -20°; the fifth metacarpophalangeal joint extension: right: -20°/left: -10°) and reduced finger dexterity. Limited joint mobility was also noted in both knee joints due to deformity (flexion: right: 90°/left: 120°; extension: right: -15°/left: -10°). A manual muscle test revealed the following results: shoulder flexion: right: 5-/left: 5-; elbow flexion: right: 5/left: 5; elbow extension: right: 4/left: 4; wrist flexion: right: 4/left: 4; wrist extension: right: 4/left: 4; hip flexion: right: 3/left: 4; hip extension: right: 3/left: 4; knee flexion: right: 3/left: 4; and knee extension: right: 3/left: 4. The patient reported pain in her fingers due to rheumatoid arthritis, phantom limb pain of the embedded type in the amputated limb, and wound pain on the stump. Her activities of daily living (ADL) were independent for rolling over and getting up. However, she required moderate assistance for transfers, toileting, lower body dressing, and bathing. She was able to move around by herself in a wheelchair. The Functional Independence Measure (FIM) score was 45 for the motor subscale and 31 for the cognition subscale.

Rehabilitation was initiated to address transferring, toileting, and walking with a prosthetic limb. The mobility goal was to use a wheelchair for outdoor and long-distance travel and a prosthetic limb with a cane for indoor and short-distance mobility. The condition of rheumatoid arthritis had been stable with self-injection of abatacept, a selective modulator of T-cell co-stimulation, but this treatment was suspended upon admission, leading to swelling and pain in the fingers during the course. After the patient was transferred to our department, oral administration of prednisolone 10 mg was initiated, resulting in improvement in swelling and pain of the fingers. Phantom limb pain gradually improved with the oral administration of pregabalin 75 mg.

Two weeks after the transfer, a training prosthetic leg was created using a plaster cast socket, and the patient began standing training. The stump ulcer was monitored and sterilized daily, with wound care continued using hydrophilic polyurethane to prevent aggravation associated with the training load. Standing training was conducted while the cast socket was adjusted according to changes in the lower leg circumference. However, the ulcer repeatedly improved and worsened, impeding rehabilitation progress. Although stump skin perfusion pressure was low (36 mmHg on the medial side and 12 mmHg on the lateral side), contrast-enhanced CT angiography confirmed patency of the bypass graft, indicating that additional surgical revascularization was not indicated. Consequently, simplified full-body thermotherapy was initiated 4 weeks after the transfer to promote ulcer healing by improving peripheral circulation and to prevent new wounds associated with prosthetic limb use, referring to the report by Arai *et al.*[7] Heat packs were placed on both armpits and both groins, and the whole body was wrapped in an insulation sheet from the neck to the toes to maintain warmth. The therapy lasted for 45-60 minutes and was performed five times

a week. After each thermal therapy session, skin findings were examined, and skin perfusion pressure was measured regularly. Skin perfusion pressure measurements were performed at two sites—5 cm proximal to the distal end of the stump on both the medial and lateral aspects—at least 12 hours (i.e., the following day) after completion of the five-day treatment regimen.

One week after starting full-body thermotherapy, the cold sensation of the stump and wound pain improved. The color of the skin also improved gradually, and epithelialization of the stump ulcer was observed (Fig. 1) alongside an increase in the skin perfusion pressure of the lower leg (Table 1). Subsequently, the patient continued standing and walking training while wearing a training prosthesis, without developing any new wounds. A temporary prosthesis was created 13 weeks after the transfer, as the circumference of the lower leg had stabilized, and the patient was able to stand and walk between parallel bars. Although a total surface-bearing (TSB) prosthesis was initially considered, we opted for a skeletal prosthesis with a patellar-tendon-bearing (PTB) socket, a Solid Ankle Cushion Heel (SACH) foot, and a PTB cuff suspension strap for several reasons: (1) rolling up a silicone liner was

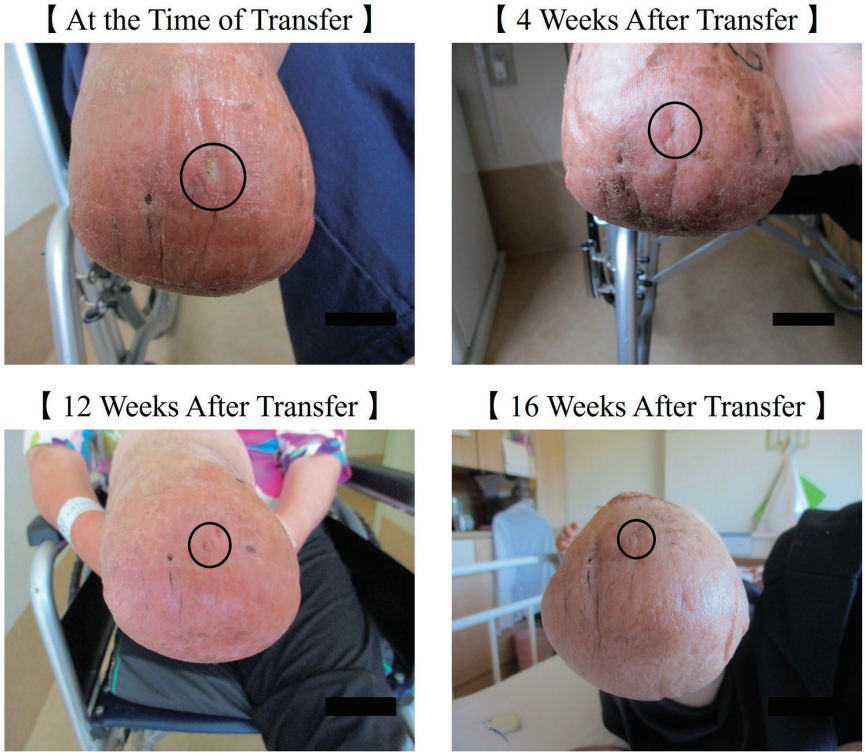


Fig. 1. Epithelialization of the stump ulcer (indicated by a circle) observed during full-body thermotherapy, with the stump showing signs of maturation.

Table 1. Changes in Skin Perfusion Pressure After Transfer

| Measurement site | 4 weeks | 8 weeks | 12 weeks | 16 weeks |
|---|---|---|---|---|
| Medial Side of the Stump End (mmHg) | 36 | 20 | 43 | 60 |
| Lateral Side of the Stump End (mmHg) | 12 | 16 | 20 | 30 |

challenging due to the patient's deformed fingers, (2) the patient was able to wear the PTB cuff, and (3) changes in the lower leg circumference can be easily managed on an outpatient basis. The patient then progressed to standing training with the temporary prosthesis and gait training using a forearm support walker, eventually achieving the ability to walk approximately 300 meters with Lofstrand crutches on both arms. She mastered the prosthetic fitting process independently, and her ADL became independent within the ward. She was discharged 27 weeks after the transfer. At the time of discharge, the FIM score was 81 for the motor subscale and 32 for the cognition subscale.

## DISCUSSION

Peripheral circulation disorder is not only a risk factor for lower limb amputation but also a significant post-amputation inhibitory factor in training, such as prosthesis incompatibility and the appearance of wounds in the non-amputated lower limb. In this case, we achieved a good outcome for a patient with various underlying diseases who suffered from peripheral circulation disorder by implementing simplified full-body thermotherapy. Tei *et al.*[3] reported that the acute effects of Waon therapy include increased cardiac output, while the chronic effects include improvement in cardiac function and vascular endothelial function. Waon therapy is believed to dilate peripheral vessels through increased body temperature, leading to enhanced peripheral blood flow and reduced vascular resistance. The increased shear stress on the vascular endothelium caused by these factors promotes the expression and activation of endothelial nitric oxide synthase (eNOS), which is involved in the production of nitric oxide (NO), an endothelium-derived vasodilator; this mechanism is believed to improve peripheral circulatory disorders by enhancing endothelial function and promoting angiogenesis[3-6]. However, this treatment is contraindicated for patients at risk of burns, such as those with sensory disturbances, active infections, or proliferative diabetic retinopathy. Additionally, it is not recommended for patients with severe stenosis in the left ventricular outflow tract due to the possibility of an increased left ventricular-aortic pressure gradient with augmented cardiac output[3-5]. Moreover, although clear indication or contraindication criteria based on wound size or depth have not been established, Waon therapy alone may be insufficient to achieve adequate healing in more extensive wounds or deep-seated ulcers. Apart from these conditions, Waon therapy has minimal adverse effects and is also expected to be effective in treating heart failure and arteriosclerosis. Hence, it is considered broadly effective for elderly patients, including those with amputated lower legs.

In our case study, we created a simple imitation of the Waon therapy environment using heat packs and insulation sheets. Although there was a limitation in the reproducibility of the temperature setting, there was a body temperature increase of approximately 1.0℃ after the treatment, indicating that we were able to recreate an environment and effects similar to Waon therapy. The method used in this case is low-cost, requiring only heat packs and insulation sheets, and the space needed is sufficient for a patient to lie down, meaning it can be performed anywhere regardless of the environment. Therefore, simplified thermal therapy is entirely feasible not only in acute care and convalescent hospitals but also in other facilities and at home once patients return to their daily lives.

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