

Case Report**Utility of full-body thermotherapy for an elderly patient with multiple organ complications requiring lower-leg amputation**

Nobuyuki Arai, MD,¹ Hiromichi Metani, MD,¹ Rina Abe, MD,² Sayako Shimizu, MD,¹ Sosuke Seki, MD,¹ Takasi Hiraoka, MD,¹ Kozo Hanayama, MD,¹ Akio Tsubahara, MD¹

¹Department of Rehabilitation Medicine, Kawasaki Medical School, Kurashiki, Okayama, Japan

²Department of Rehabilitation Medicine, Saka General Hospital, Shiogama, Miyagi, Japan

ABSTRACT

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This report describes the case of an elderly amputee (lower leg) with obstructive arteriosclerosis, diabetes, angina (post CABG), and intractable ulcers on the non-amputated leg. The patient received full-body thermotherapy using heat packs and thermal sheeting and was subsequently able to walk. Despite drug therapy to improve peripheral circulation in addition to meticulous foot care, ulcers on the foot of the non-amputated side worsened. After full-body thermotherapy, however, skin perfusion pressure improved, and the ulcers gradually healed. The patient was discharged home, at which time the combined use of Lofstrand crutches, a prosthesis, and a footplate for pressure relief enabled outdoor walking for short distances. Patients with skin lesions who undergo amputation as a consequence of peripheral circulation disorders often have difficulty walking with a prosthetic limb. Moreover, the full-body thermotherapy provided similar effectiveness to the *Waon* dry sauna therapy, which is available only at a limited number of institutions. This thermotherapy is a promising supplemental therapy for elderly amputees with circulatory disorders, and could easily be provided by many institutions.

Key words: elderly, amputation, obstructive arteriosclerosis, diabetic foot lesions, thermotherapy

Introduction

The main cause of lower-leg amputation in geriatric cases is peripheral circulatory disorders [1]. The prevalence of peripheral circulatory disorders increases with advanced age, with the reported rate at 15% to 20% for those 70 years of age and older [2]. In Japan's super-aging population, the number of elderly patients requiring lower-leg amputation is expected to increase. Seniors who have undergone amputation because of peripheral circulatory disorders exhibit progressive arteriosclerosis throughout the body and frequently have concomitant chronic renal failure or ischemic heart disease. Many cases cannot proceed with active rehabilitation. Ulcers on the healthy lower leg tend to be a complication and consequent hindrance to gaining ambulatory capacity with a prosthesis after amputation. Recent reports have addressed the utility of the far-infrared-ray dry sauna as thermotherapy for chronic heart failure and obstructive arteriosclerosis by elevating deep body temperature by 1 to 1.2°C (*Waon* therapy) [3,4]. This therapy, however, requires special equipment and is not easy to administer. The procedure involves 15 min in a far-infrared-ray dry sauna with the temperature evenly controlled at 60°C, followed by 30 min of warming at rest while wrapped in blankets. In the present reported case, heat packs and thermal sheeting were used to elevate the entire body temperature as a variant to *Waon* therapy. The elderly patient in this case, who underwent lower-leg amputation and had multiple disorders, recovered the ability to walk outdoors and showed healing of intractable ulcers.

Case Description

Patient: Male, age 71 years

Diagnosis: Left lower leg amputation

History: Bilateral obstructive arteriosclerosis, diabetes, angina (post CABG), trichophytosis (finger- and toenails), chronic renal failure, cerebral infarction

Correspondence: Nobuyuki Arai, MD

Department of Rehabilitation Medicine, Kawasaki Medical School, 577 Matsushima, Kurashiki, Okayama 701-0192, Japan.

E-mail: dodobiyan@med.kawasaki-m.ac.jp

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(light residual paralysis on the left side)

Current illness:

After a procedure for ingrown toenails in January 201x, ulceration developed on the small toes of the left foot. Percutaneous angioplasty was performed at a local medical institution, but improvement was poor. The necessary circulatory reconstruction was not performed at the patient's request. In June of the same year, the wound became infected, and pain in the lower leg in August led to insomnia and restlessness. Left lower leg amputation was performed at the end of August. At the end of September, the patient was transferred to the sub-acute rehabilitation ward of the institution to be fitted with a prosthesis and to improve ADL.

The patient's status and stump at transfer are shown in Table 1 and Figure 1.

Before Thermotherapy

Alleviation of the load on the right lower leg was initiated because of bedsores and ulcers on the right foot (non-amputation side). Complications from

diabetes and obstructive arteriosclerosis suggested little likelihood of improvement for the bedsores and ulcers. A program that included range of motion (ROM) training, upper limb muscle strengthening, and transfer motion training was started with the aim of enabling self-management of daily activities in a wheelchair [5,6]. A right footplate to alleviate pressure on the non-amputated leg and a left lower-leg pylon were prepared at this time. ROM of the joints improved gradually, lower leg muscle strength attained "Fair" scores, and the FIM motor subscore reached 35. Insomnia and negative statements remained frequent, however, and rehabilitation training was not proceeding under favorable conditions. Stump pain prevented active soft dressings, while the ulcerated areas discolored to a dark red after rehabilitation, with increasing pain. Skin perfusion pressure at the right dorsum was 6 mmHg (17 mmHg under humidification).

Two weeks after the transfer, the variant *Waon* therapy with heat packs and thermal sheeting (described as thermotherapy herein) was started. Heat packs were placed at the underarm and groin areas

Table 1. Status at transfer.

ROM (assisted)	Extension of hip joint: R. -15° /L. -5° Extension of knee joint: R. -15° /L. -5°
MMT	Knee extension/flexion of amputated side: about 2 Lower leg muscle strength: 2 to 3
Sensation	Moderate disturbance of superficial and deep sensation of amputated lower leg
Stump	Stump length 19 cm, stump circumferences (32.5, 30.5, and 28.5 cm for every 5 cm from the inner fissure of the knee joint).
Non-amputated side	Third right toe (from dermal to subcutaneous tissue): Fontaine Class IV Dorsal skin perfusion pressure: 6 mmHg without humidification, 17 mmHg with humidification.
Movement, ADL	Full assistance FIM (motor subscore 17, cognitive subscore 19, total score 36).
Sleep	Awakens every 1 to 2 h because of pain. Insomnia causes unrest.



Figure 1. Stump and toes of the non-amputated right foot at transfer.

Intractable ulcers are recognized on the right foot. For the left stump, peripheral circulatory disorder, pain, and delayed healing of the wound prevented active dressing, and maturation was insufficient.

where the blood flow was maintained and no sensory obstruction was present. Body temperature elevation of 1–1.2°C was confirmed at the dorsum of the non-amputated foot, dermal surface of the stump, and underarm area. The entire body from below the neck was then wrapped in thermal sheeting for 30 to 60 min (Figure 2). Thermotherapy was scheduled for 4 to 5 days per week.

After Thermotherapy Initiation

Two weeks after starting therapy, skin perfusion pressure improved to 16 mmHg (66 mmHg under humidification) at the right dorsum. Pain had eased during rest and during motion, and insomnia was also alleviated. Statements from the patient turned positive, so the targets were made higher: independent indoor walking and independent outdoor walking for short distances using the prosthesis and a walker. Physical therapy was modified to focus on standing exercises, while occupational therapy was modified to focus on exercises for daily activities using a prosthetic leg.

After a further 2 weeks, standing balance within parallel bars using the prosthesis and footplate improved. Active soft dressings led to successful maturation of the stump. A temporary prosthesis was created, and practice wearing the prosthesis was started within the parallel bars. Four weeks after starting the thermotherapy, when walking practice with a walker had just started, signs of heart failure, such as edema of the lower leg, shortness of breath, BNP elevation, etc. were recognized. Walking practice with the prosthesis was continued while making adjustments to water intake, food, and drug therapy, as well as monitoring cardiac load with respect to the Borg scale, blood oxygen saturation, and heart rate during rehabilitation training. Indoor walking became

possible with dual Lofstrand crutches 12 weeks after the start of thermotherapy. The signs of heart failure subsided completely 18 weeks after thermotherapy began, and outdoor walking practice for short distances became possible with the use of dual Lofstrand crutches. At 19 weeks after the start of thermotherapy, no major concerns remained with the stump, and no signs of heart failure were evident. Discharged to his home, the patient could walk independently outdoors for short distances with dual Lofstrand crutches while wearing the PTB prosthesis and right footplate.

The patient's status and stump at discharge are shown in Table 2 and Figure 3.

Discussion

Known physical therapies for wound healing include *Waoon* therapy, hyperbaric oxygen, concentrated carbonated spring water, and microcurrent. Among these, *Waoon* therapy has proven effective for chronic heart failure patients, with improved NYHA cardiac function classification from an average 3.6 to 2.6 [3], and for obstructive arteriosclerosis patients, with alleviation of lower-leg pain, improved blood circulation [4], and restoration of autonomic nervous system balance [5]. As such, *Waoon* therapy is considered extraordinarily useful for elderly patients with chronic heart failure and obstructive arteriosclerosis requiring amputation [6,7]. *Waoon* therapy, a far-infrared dry sauna with evenly controlled temperature of 60°C, is characterized by no side effects, such as pain aggravation caused by water pressure or water temperature in hot bathing [8]. The therapy requires special equipment, however, which is difficult at general medical institutions. In the present case, our full-body thermotherapy was performed with heat packs in stock at most institutions

Items used:

Hot packs, thermal sheeting (sold in 100-yen "dollar" store)

Warmed areas:

Both underarms, and both sides of the groin (no sensory disorders)

Time: 30 to 60 minutes

Body temperature

measurement areas: right dorsum, dermal surface of stump, underarm

Body temperature: confirmed elevation of 1 to 1.2°C



Figure 2. Full-body thermotherapy.

Locking the far-infrared rays irradiated from hot packs in sealed airspace affords similar effectiveness to *Waoon* therapy.

Table 2. Status at discharge.

ROM (assisted)	Extension of hip joint: R. 0°/L. -5° Extension of knee joint: R. -10°/L. -5°
MMT	Knee extension/flexion of amputated side: about 4 Lower leg muscle strength: about 4
Sensation	Moderate disturbance of superficial and deep sensation of amputated lower leg
Stump	Stump length 19 cm, stump circumferences (33.5, 29.5, and 25.5 cm for every 5 cm from the inner fissure of the knee joint).
Non-amputated side	Third right toe (localized to dermis): Fontaine Class II to III Dorsal skin perfusion pressure: 16 mmHg without humidification, 66 mmHg with humidification.
Movement, ADL	Walking: dual Lofstrand crutches for indoor corrected independent walking, and for outdoor monitored walking (distance 120 m). FIM (motor subscore 81, cognitive subscore 35, total score 116).
Sleep	Interruptions once or twice.



Figure 3. Stump and toes of the non-amputated foot at discharge. After initiation of full-body thermotherapy, intractable ulcers have improved. Pain alleviation and improved peripheral circulation allow active dressing, and the left stump has matured.

and thermal sheeting available for purchase at 100-yen (“dollar”) stores in Japan. This thermal sheeting is produced through vapor deposition of aluminum, and has heat insulation properties (about 30% reflectance). According to Wien’s displacement law, heat is dispersed into the atmosphere from the body and heat packs in the form of far-infrared rays. The airspace between the body and thermal sheeting stores a portion of the heat. The heat volume, though smaller in comparison to the far-infrared dry sauna used under *Waon* therapy, is believed to create a similar condition with respect to full-body warming. Simple heat packs would allow heat to disperse into the atmosphere from parts of the body not directly in contact with the heat packs, and are unlikely to provide a hot-bath effect. Thermal sheeting alone would simply retain radiant heat emitted intrinsically by the body and could not warm the body to an elevated body temperature. An increase of 1°C in body temperature measured at the underarm suggested that radiant heat was stored from

the hot packs as well as from the body, and deep body temperature rose by about 1°C as a result. This full-body thermotherapy reproduced the even far-infrared sauna airspace by elevating deep body temperature by 1°C with thermal sheeting, and is considered to have provided effectiveness similar to *Waon* therapy. In fact, after starting this variant *Waon* therapy, pain alleviation, reduced sleep interruption, and improved skin perfusion pressure were observed. Moreover, despite the increase in load with motion, no signs of heart failure were present at discharge.

For the patient with lower-leg amputation, care after discharge for managing the stump and the non-amputated leg becomes important. Although ambulatory while in the hospital, stump nonconformity or stump wounds after discharge often make wearing the prosthesis difficult. Unlike *Waon* therapy, this thermotherapy does not require special equipment and can be performed under day care, day service, or outpatient clinic settings. Thus, the therapy can be

continued with relative ease in the community, and is considered extraordinarily useful.

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