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Earthing Method as a Lifestyle Medicine to Accelerate the Healing of Chronic Diabetic Wounds

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Grounding;
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Abstract

Diabetes mellitus (DM) type 2 is a non-communicable disease that causes death number 6 worldwide. Caused by resistance to insulin, accompanied by many complications, including neuropathy (peripheral nerve damage), diabetic ulcers, heart disease, kidney failure, hypertension, retinopathy (damage to the retina in the eyes), blindness, leg amputation, stroke, and death. Diabetic wounds do not heal because of microbial infections in the wounds, accompanied by high blood sugar levels. This study aims to analyze the effect of earthing/grounding on chronic diabetes wound healing. This research was conducted in June-December 2023 in Karanganyar Regency, Central Java. The population in this study were clients with type 2 diabetes mellitus. Earthing intervention was carried out for 1 hour every day for 30 days. The sample size was 21 respondents taken by the purposive sampling method. Statistical analysis shows a P value of 0.000<0.000 and a Z-score of -4.032. Shows the significant effect of earthing/grounding therapy on accelerating diabetes mellitus wound healing. It is highly recommended for clients with type 2 DM to apply earthing/grounding as part of Lifestyle Medicine, which is integrated into life habits to cure infections and speed up wound healing, thereby preventing amputations.

Introduction

Diabetes mellitus is a non-communicable disease (NCD) that affects 10% of adults and is the 6th highest cause of death in the world. It is the most significant risk factor for cardiovascular disease, nephropathy (chronic kidney disease), neuropathy (peripheral nerve damage), blood vessels, diabetic ulcers, lower limb amputation, stroke, retinopathy (blindness) (1–3), cancer, chronic respiratory disease, cerebrovascular disease, influenza, and pneumonia [4]. In Indonesia, DM is the third largest cause of death, with a percentage of 6.7%, affecting 1 in 10 adults. Earthing's research on non-DM respondents can help normalize nerve function, reduce hypertension, and prevent coagulation or blood clots. Specifically, it restores the work function of the vagal nerve, which regulates the heart and blood vessels, and is very fast in wound healing to prevent lower limb amputation.

According to the International Diabetes Federation (IDF) Atlas edition 10, the prevalence of DM in Indonesia during the pandemic increased from 10.7 million in 2019 to 19.5 million in 2021, an increase from seventh rank [5]. The prevalence of DM in Central Java is 2.1% (Riskesdas 2018), and in Karanganyar Regency is 2.59% of the population aged >15 years [6].

DM is an incurable disease, and the therapy is palliative to control symptoms and prevent complications. However, the percentage of type 2 DM patients experienced at least 1 complication (52%), macrovascular (33.4%), and microvascular (34.7%). The prevalence of cardiovascular (30.1%), cerebrovascular (6.8%), neuropathy (17.8%), nephropathy (10.7%), ocular lesions (14.8%), and diabetic wounds (0.8%) [7]. Complications of type 2 DM are long-term, cause disability (amputation), and cause death (coma, heart attack, stroke, heart failure, kidney failure) [8,9,10].

Complications of diabetic wounds are difficult to cure. Of the total 115 DM patients who had diabetic ulcers, they did not heal (15.65%), healed (18.26%), and had leg amputations (30.43%) [11]. Diabetic wounds do not heal due to microbial infection in the wound, accompanied by high blood sugar levels [12].

So far, many therapies have been given to DM patients for managing blood sugar levels, hypertension, kidney failure, and diabetic wounds. However, there is a significant problem where this therapy is mostly pharmacotherapy, which requires the consumption of drugs that must be consumed for life [13].

Factors that cause DM are multifactorial, including age, ethnicity, low economic status, metabolic syndrome (14), smoking, family history of DM, overweight or high BMI, alcoholism (15), chronic stress (16), and the quantity and quality of diabetes mellitus poor sleep (17). Studies on non-DM respondents found that Earthing affected 1) reducing blood viscosity/anticoagulation(18–20), 2) accelerating wound healing, 3) increasing body immunity, 4) curing infections, 5) normalizing nerve function (21), 6) reducing hypertension (22). Earthing can be easily done by anyone and at any time.

The application of the Earthing method is still very minimal. In Indonesia, there has been no publication of clinical research on type 2 DM, even though Earthing provides significant benefits in treating the symptoms and complications of DM. The research purpose was to analyze the effect of Earthing therapy on type 2 DM patients by comparing the control group with the Earthing therapy intervention on the diameter of the wounds.

Methods

This research was quasi-experimental. The location was in the Work Area of the Karanganyar District Health Agency. The population in this study was type 2 DM patients with diabetic wounds, with a minimum total sampling for the pilot study is 12 (23).

The total sample was 21 patients with type 2 diabetes mellitus. The estimation of DM type 2 patients in Karanganyar Regency, according to Health Profil 2021, was 12.960 patients, and the estimation of those with diabetic wounds was 0.8% (96 patients).

Restriction Criteria:

Inclusion Criteria

a. Patients suffering from type 2 DM for > 1 year
b. Having diabetic wounds
c. Not taking insulin regularly

Exclusion Criteria

a. Have kidney problems
b. Not willing to be a respondent

Respondents were recruited by visiting the Health Center/Diabetes Wound Clinic/Hospital to obtain data on type 2 DM patients with diabetic wounds. Patients were given informed consent and filled out a consent form.

Research Instruments:

a. The earthing device was constructed in collaboration with Ph.D. Engineering from the Faculty of Mechanical and Industrial Engineering, Gajah Mada University, Indonesia; it consists of a copper plate, acrylic plate, copper wires, and copper rod planted in the ground.
b. The data collection instrument was a questionnaire containing the patient's socio-demographic characteristics, including age, education level, occupation, socioeconomic factors, duration of DM, and the wound's characteristics and diameter.
c. The earthing practice intervention was given during the intervention phase for 30 days: (1) installation of a grounding device; (2) explaining the procedure for installing a grounding device: DM patients sleep or sit comfortably with their feet directly attached to the copper plate; (3) during control phase, there was no intervention for 30 days, while the intervention phase was the grounding time was 1 hour/day for 30 days.
d. Time of observation and data collection: (1) the initial meeting; (2) visit 30 days after the initial stage of the control phase where there was no earthing intervention; 3) after 30 days of using the earthing device.
e. During the process, no emergency occurred such as dizziness, vomiting, or any inconvenience. The respondent's responses were all positive.

Results

Table 1. Socio-demographic variables of the respondents

Socio-demographic variables	Frequency	Percentage
Sex		
Male	13	61.90
Female	8	38.10
Age		
50-59 (late adult)	8	38.09
60-69 (youngest old)	10	47.62
70-79 (middle old)	3	14.29
Occupation		
Housewife	6	28.57
Self-employed	1	4.76
Teacher	2	9.52
Driver	1	4.76
Factory worker	7	33.33
Farmer	4	19.05
Alternative Medicine		
Yes	0	0
No	21	100
History of DM type 2		
1-5	2	9.52
6-10	12	57.14
>10	7	33.33

Based on table 1, most respondents were male 13 (61.90%), while females were 8 (38.10%). Most of them were youngest aged from 60-69 years old 10 (47.62%), followed by late adults aged 50-59 8 (38.09%), and middle-aged 70-79 3 (14.29). The majority of them work as factory workers 7 (33.33%), housewives 6 (28.57%), followed by farmers 4 (19.05%), teachers 2 (9.52%), and lastly, self-employed and drivers 1 (4.76). None of them use alternative medicine. The history of DM type 2 was mostly from 6-10 years 12 (57.14%), and lastly was from 1-5 years 2 (9.54%).

Table 2. Characteristic of the chronic wound

Characteristic of the wound	Frequency	Percentage
Duration (months)		
4-12	15	71.43
>12	6	28.57
Etiology		
Surgical	14	66.67
Abrasion (second degree)	7	33.33
Location		
Lower leg	16	76.10
Lower arm	5	23.81
Wound depth		
Superficial (loss of epidermis)	2	09.52
Partial Thickness (loss of epidermis + dermis)	14	66.67
Full Thickness (loss of dermis, subcutaneous fat)	5	23.80

Table 2 shows the characteristics of the chronic wound, where the majority of them are 4-12 months old (15 (71.43%) and more than 12 months old 6 (28.57%). The etiology mostly were surgical wound 14 (66.67%), and second-degree abrasion 7 (33.33%). The majority of the respondents had wounds in the lower leg; 16 (76.10%) and 5 (23.81%) had wounds in the lower arm. Most of them also experienced partial Thickness (loss of epidermis and dermis) 14 (66.67%), the rest were full Thickness (loss of dermis and subcutaneous fat) 5 (23.80%), superficial (loss of epidermis) was 2 (09.52%).

Table 3. Diameter the diabetic wounds before and after earthing

	Mean		Sig. (2 tailed)	Wilcoxon test
	Before Earthing	After Earthing		
Diameter of the wound	3.02	0.78	0.000	- 4.032

Table 3 shows the healing speed of diabetic wounds before and after earthing practice. The Sig 2 tailed resulted in a P-value of 0.000<0,05 and a Z score of -4.032, indicating a significant difference in the diameter of the wounds.

Discussion

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia (high blood sugar levels). It can be caused by insufficient insulin secretion, resistance to insulin action, or both. Chronic hyperglycemia causes damage to various organs and systems, leading to significant complications to multiple systems such as microvascular complications (neuropathy, retinopathy, nephropathy) and 4 times increased risk of macrovascular complications like cardiovascular disease (24).

The risk factors for type 2 DM are alcoholism, smoking, high body mass index (BMI), and a family history of DM (15). In addition, there is chronic stress (16), poor sleep quality, and a night's sleep duration of fewer than 6 hours (17). There is a link between stress and poor sleep quality and quantity. High-stress levels increase anxiety, overthinking, the inability to relax, and often waking up or can't sleep a profound sleep.

The study found the benefits of earthing therapy for a DM patient who had diabetic wounds for 8 months and had received pharmacological treatment from a wound specialist clinic but showed no progress. Vascular radiographs show poor blood circulation in the legs (peripheral artery disease). After earthing therapy for 30 minutes, the pain intensity decreased. After routinely doing earthing for 2 weeks, the wound on the leg healed completely, and the vascularity of the portion increased (21). These changes show that earthing works for accelerating the healing of the wound, that previously showed impaired healing ability.

Earthing is a practice of connecting the soles of the feet directly to the soil, ground, grass, sand, or stones for the transport of abundant electrons from the earth into the body system through the skin. Studies from around the culture in a worldwide, minimum of 30 minutes to 1 hour of earthing can generate a sense of well-being, improve general health, and increase the immune system (25). Earthing can be done by sitting or walking with the sole feet touching the ground.

Earthing therapy is beneficial for the body's physiological processes. Regular earthing application lowers blood sugar levels and sodium, potassium, magnesium, iron, total protein, and albumin concentrations while transferrin, ferritin, 1, 2, and globulins increase. Earthing during a night's rest reduces free tri-iodothyronine and increases thyroid-stimulating hormone, which primarily produces thyroxine hormone (a hormone whose primary function is to regulate body metabolism) (26). Balanced production of thyroxine hormone means optimal metabolism. A balanced metabolism in the body can allow the balance of nutrients that enter the body to be processed into energy for optimum performance of cells, organs, and body organ systems. Balanced nutrients processed in the gastrointestinal and cardiovascular systems can be transported to repair the wounded skin.

Particularly in diabetic patients, higher glucose levels in the blood cause the increase of blood viscosity in the circulation, slow the blood flow in the blood vessels, and delay the delivery of oxygen and nutrients to repair the wound on time. The presence of microbial infection also adds to the healing impairment making injury heal slowly or become chronic, unable to heal.

Earthing has a unique process that interferes with the electrical state of the body, Applewhite, an electrical engineer in the electrical industry with a specialization in the design of electrostatic systems found changes in the electrical status in the human body when connected to the earth, the body has the same electrical potential with the earth because of the instant electrons supply from the ground to the body (27). This was supported by Richard Feynmann, the Nobel Prize winner that said, when the body is connected directly to the earth's potential, it will become part of the giant electrical system that can resist, and discharge the excess electrical potential from the body's metabolism of the electromagnetic field radiation from the environment to become neutral(28) .

Wound healing is a complex biological process that involves proliferation and migration; after skin injury, the movement of the electric charges is the key to the repair of the wound (29,30). Endogenous electric field (EF)-directed migration of keratinocytes (galvanotaxis) is an essential step for the beginning of re-epithelization. The endogenous Efs are produced right after an injury because of the collapse of the transepithelial potentials. In this study, the electric field is supplied by the earth's giant battery that works to discharge the excess electromagnetic field radiation from the environment and recharge through the transportation of abundant electrons that promote the electric potential changes for wound healing.

Earthing can significantly accelerate wound healing by normalizing blood circulation and decreasing blood viscosity, leading to better transportation of oxygen and nutrients to the wounded skin to rebuild the cells and tissues. In addition, earthing also improves keratinocyte repair for both healthy and damaged keratinocytes and protects the skin by deepening sleep, which will facilitate collagen integrity for more skin elasticity, volume, and firmness and preserve its strength (31). Furthermore, earthing also helps heal inflammation and microbial infection and improves the immune system, accelerating wound healing (21,32).

Deep sleep is needed for body cells to heal and regenerate damaged and dead cells. Research from Clinical Sleep Medicine found that sleep is essential for health. The deep-sleep sleep cycle provides the patient with restoration, protection, and energy restoration processes. The quality and quantity of sleep

affect the body's ability to repair and replace cells, tissues, bones, and muscles and strengthen the body's immune system.

A chronic wound is a wound that does not heal in an orderly stage or in a predictable amount of time, or if it takes longer than three months. Chronic wounds may also prolonged too long for years or never heal, accompanied by persistent pain (31). Some wounds may not heal and lead to amputation, which is common among diabetes mellitus patients. The amputation will decrease self-image and lower the patient's quality of life. The etiology is poor circulation, neuropathy, and less activity and mobility. Other factors are the severity of the wounds, the poor state of health of the individual, systemic illness, age, and repeated trauma. (31,33,34). Venous arterial insufficiency, diabetes, and local pressure are the most significant cause of wounds and ulcers that causes local and systemic factors to impair the wound from healing. In particular, in diabetes mellitus patients, high glucose levels could interfere with nutrient absorption, causing the depletion of several nutrients (magnesium, zinc, B12, B6, and folic acid (34).

Insufficient protein and energy in the body may affect the ability of the wound to heal. Protein is also essential for the immune response, which, if impaired, will delay the process from inflammation to proliferation. The most important nutrients needed for wound healing beyond proteins are carbohydrates and fats to support the body's response to inflammation, cellular activity, angiogenesis, and collagen production for the proliferation phase of the healing process (35). Earthing, which will stabilize the vagal nerve, will normalize the function of gastrointestinal function, improving digestive function and nutrient absorption. While earthing also helps to decrease blood viscosity, it facilitates smooth blood circulation to the targeted wounded skin. Decreased blood viscosity accelerates the distribution of nutrients and oxygen supply to repair the injured skin through abundant cell migration and re-epithelialization.

Another research, aside from earthing, also utilizes electrical power for wounded skin. Naturally, the injured skin creates an electrical field to facilitate and guide the migration of the mechanism of action of the earth's direct current (DC) electricity to skin repair to a small DC electrical field to guide cell movement and wound healing after the injury, called electrotaxis (31,36–39). Meanwhile, the earth is also a giant battery; when the skin connects to the earth, the body connects to the DC energy that is applied exogenously to boost keratinocyte recovery, especially in the damaged cells and tissue, to improve wound healing and support rejuvenation of the skin. Many of the skin cells migration required for the healing is called electrotaxis, including neutrophils, monocytes, lymphocytes, macrophages, endothelial cells, fibroblasts, and keratinocytes. Electrical stimulation also helps speed wound healing by increasing capillary density and perfusion, boosting oxygenation in the blood circulation in the wound, and encouraging granulation and fibroblast activity (40–42).

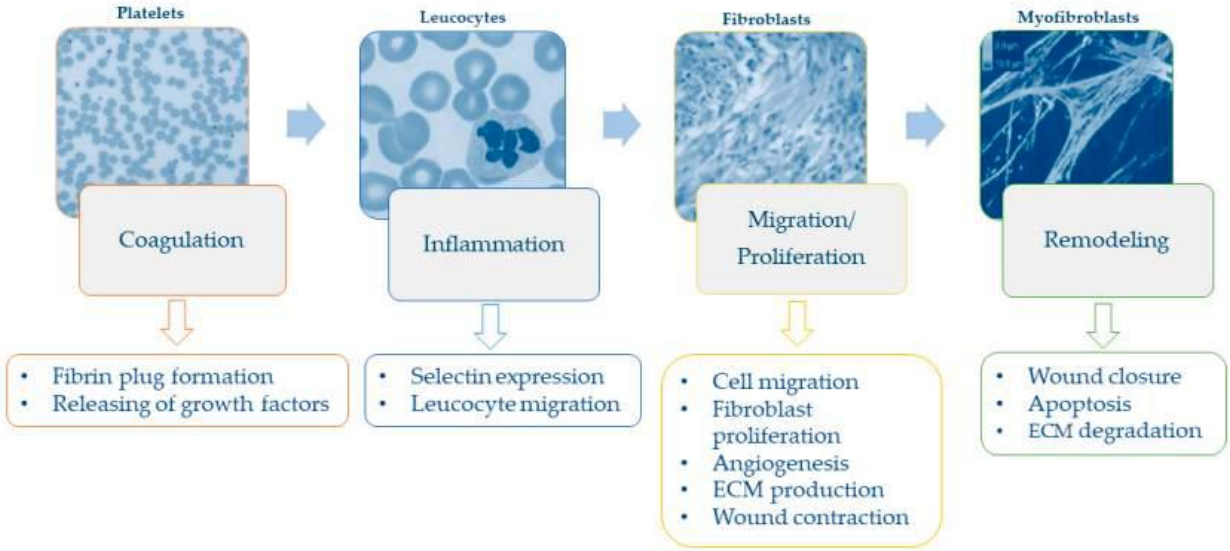

Figure 1. Phases and specific events of the wound healing process (Barchitta M, Maugeri A, Favara G, Magnano San Lio R, Evola G, Agodi A, Basile G, 2019)

The electricity stimulation of earthing promotes autolysis of the wounded skin and uses the positive polarity to attract negatively charged neutrophils and macrophages. The negative polarity encourages granulation tissue development and positively charges the fibroblast. Use positive polarity to attract negatively charged epidermal cells to promote muscle resurfacing. After the granulation tissue has filled the wound cavity, the epidermal cell migration is promoted to rebuild the epidermis. Electrical stimulation is also essential for healing chronic wounds, pressure ulcers, diabetic ulcers, and arterial ulcers (43).

As electrotaxis is essential for skin repair, the researcher has examined the application of external (exogenous) DC-current to help wound healing and boost the flow of DC guidance to the skin cells. To do this, they set up a portion of healthy skin, created a wound, and then applied DC-current. Another phase is to set up a model of diabetes mellitus wounds with impaired ability to heal. The exogenous application of the DC stimulation accelerates the wound closure of keratinocytes and keratinocyte repair, which can boost the healing of damaged and healthy skin. The DC-current tripled the healing of the skin three times faster, both the damaged and healthy skin, by boosting keratinocyte recovery. The skin with an impaired ability to heal can heal almost simultaneously with the healthy skin (44)

In this study, the chronic wound duration range from 4 months to 13 years was observed and significantly healed after 1 week of grounding and continuously improved with the continuous practice of earthing. The intense pain that was experienced for years disappeared. There is edema in the lower limb where the wound was found to be shrinking but sometimes will reappear in the afternoon after working or sitting for a long time. The color of the muscle was yellow pale and bluish skin around the wound. The yellow signifies the inflammatory exudate and damaged tissue, and black wounds are characterized by necrotic tissue; however, sometimes, this is brown. A bluish color surrounding the skin indicates bad circulation, and bright blue or green indicates a microbial infection.

Studies found that grounding healing inflammation simultaneously boosts the immune system, improving wound healing among multiple subjects(24). Grounding also helps to decrease blood glucose among diabetic patients, which explains why the skin heals as fast as the healthy skin or even faster. Due to the important benefits of earthing for chronic diabetic wounds, it is recommended to integrate earthing into the self-management diabetic wound treatment especially in the community settings. Further research is needed to investigate the effect of earthing on reducing high blood glucose, which also influences the healing mechanism of chronic diabetic wounds.

Conclusion

There is a significant difference in the healing speed of chronic diabetic wounds before and after the application of earthing/grounding with a P-value of 0.000 <0.05 and a Z score of -4.032. It is highly recommended for diabetes mellitus patients or other patients with chronic wounds to integrate earthing/grounding as a lifestyle medicine to heal microbial infection and inflammation, promote optimum cardiovascular and digestive function, repair skin injury, and prevent amputation. Earthing not only benefits the healing of the wound but also prevents peripheral artery disease by decreasing the blood viscosity and lowering the blood glucose, which will result in better blood circulation in the capillaries and prevent peripheral artery/venous disease.

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