

# The Effects of Wireless Micro Current Stimulation for Partial Thickness Burn Injury Treatment

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**Backgrounds:** The body has its own bioelectric system that influences wound healing. Wireless Micro Current Stimulation (WMCS) or Electrical Stimulation (ES) is defined as the use of an electrical current to transfer energy to a wound. The type of electricity transferred is controlled by the electrical source. Although scarce, there have been studies proposing that this type of electricity increased healing rate of various wounds. However the effect of this electrical stimulation on burn wounds has not yet been studied.

**Patient and Methods:** We present case series of superficial and deep partial thickness burns treated with ES and examine its effect on healing process. Six cases of second degree burn admitted to Cipto Mangunkusumo General Hospital (RSCM) from March–May 2011. They were chosen randomly to be treated with WMCS/ES. We applied the stimulation on the wound one hour daily. The wound was cleansed conventionally with moist gauze before and after the stimulation.

**Results:** All the patients reported that they feel comfort during and after the application. We found epithelialization within 6 to 9 days. However we cannot determined if the WCMS/ES induce faster wound healing, because we do not compare it with other treatment.

**Summary:** From six cases that we studied, we concluded that, the use of this WCMS/ES could have an effect of the epithelialization within 6-9 days. All the patients reported that they feel comfort during and after the application of WMCS/ES.

**Keywords:** *Wireless Micro Current Stimulation (WMCS), Electrical stimulation (ES), Burn Injury*

**Latar Belakang:** Tubuh memiliki sistem bioelektrik tersendiri yang mempengaruhi penyembuhan luka. Wireless Micro Current Stimulation (WMCS)/Electrical Stimulation (ES) didefinisikan sebagai arus listrik yang digunakan untuk mentransfer energi untuk mengobati luka. Jenis listrik yang ditransfer dikendalikan oleh sumber listrik. Meskipun langka, ada beberapa studi mengusulkan bahwa arus listrik dapat mempengaruhi penyembuhan berbagai jenis luka. Namun dampak dari stimulasi listrik pada luka bakar belum dipelajari.

**Pasien dan Metode:** Kami menyajikan serangkaian laporan kasus kasus luka bakar derajat dua dangkal dan dalam yang diterapi dengan WMCS/ES dan mengamati efeknya pada proses epitelisasi. Enam kasus derajat dua luka bakar yang dirawat di RSCM dari bulan Maret-Mei 2011 dipilih secara acak untuk diterapi dengan WMCS/ES. Kami memberikan stimulasi pada luka selama satu jam setiap hari, luka bakar dibersihkan secara konvensional dengan kassa lembab NaCl sebelum dan sesudah stimulasi.

**Hasil:** Semua pasien melaporkan bahwa mereka merasa nyaman selama dan setelah aplikasi. Tingkat penyembuhan atau epitelisasi tercapai dalam waktu 6 sampai 9 hari. Namun demikian kami tidak dapat menyimpulkan apakah WCMS/ES mempengaruhi penyembuhan luka bakar lebih cepat, karena penelitian ini tidak membandingkannya dengan jenis terapi lainnya.

**Ringkasan:** Dari enam kasus yang kami pelajari, kami menyimpulkan bahwa, penggunaan WCMS/ES dapat menginduksi epitelisasi dalam jangka waktu 6-9 hari. Semua pasien merasakan nyaman pada saat dan sesudah aplikasi terapi WMCS/ES.

**E**lectrical Stimulation (ES) in wound healing is defined as the use of an electrical current to transfer energy to a wound. ES transfers the current through surface electrode pads that is in wet, electrolytic contact

with the external skin surface and the wound bed. Two electrodes are required to complete the electric circuit.<sup>1</sup>

When wounding occurs there is a weak but measurable current between the skin and inner tissues called the “current of injury”. It is

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thought that the current continues until the skin defect is repaired and that the healing process is interrupted if the current ceases.<sup>2</sup>

ES may mimic the current of injury restarting or accelerating the wound healing process. So far the current has been introduced into the body by the use of electrodes, but despite the very positive effect on the healing rate of chronic wounds the method is not popular because of the disadvantages from using electrodes to transfer the current. The type of electricity transferred in ES is controlled by the electrical source. Capacitive coupling ES involves the transfer of electric current through an applied wet surface electrode pad, and contacts with the external skin surface and/or wound bed.<sup>1,2</sup>

When ES is in used, two electrodes are required to complete the electric circuit. Although there are many waveforms available on electrotherapy equipment, the one that has the most thorough and consistent evaluation in vitro, in animal studies and in controlled clinical trials is monophasic twin peaked high voltage pulsed current (HVPC). The pulse width varies with a range from 20-200 microseconds. The HVPC devices also allow for selection of polarity and variation in pulse rates both of which seem to be important in wound healing. It is a very safe current because it is very short pulse duration prevents significant changes in both tissue pH and temperature. Therefore, the most tested and safe type of stimulation is the one recommended.<sup>2,3</sup>

Electrical Stimulation and its effect on healing of chronic wounds are well documented. But the study about the effect on acute burn injury never has been done. The body has its own bioelectric system. This system influences wound healing by attracting the cells of repair, changing cell membrane permeability, enhancing cellular secretion through cell membranes and orientating cell structures.<sup>3</sup>

A current termed the "current of injury" is generated between the skin and inner tissues when there is a break in the skin. The current will continue until the skin defect is repaired. Healing of the injured tissue will be incomplete

if these currents no longer flow while the wound is open. A moist wound environment is required for the bioelectric system to function. A rationale for applying electrical stimulation is that it mimics the natural current of injury and will jump start or accelerate the wound healing process.<sup>4,6</sup>

Keeping a wound moist with normal 0.9% sodium chloride maintains the optimal bioelectric charge because it is like the electrolytic concentration of wound fluid. Dressings such as amorphous hydrogels and occlusive dressings help promote the body's "current of injury" by keeping the wound moist.<sup>4,6</sup>

Early studies using direct current stimulation reported long treatment times of 20-40 hours per weeks. Four controlled clinical studies and three uncontrolled studies with HVPC report a mean healing time of 9.5 weeks with 45-60 minute treatment 5-7x/week.<sup>2</sup>

Electrical stimulation affects the biological phases of wound healing in the following phases: (1) Inflammation phase, in this phase ES initiates the wound repair process by its effect on the current of injury, increases blood flow, promotes phagocytosis, enhances tissue oxygenation, reduces oedema, attracts and stimulates fibroblasts and epithelial cells, and also stimulates DNA synthesis. ES also provides infection control and solubilizes blood products including necrotic tissue. (2) Proliferation phase: stimulates fibroblasts and epithelial cells, stimulates DNA and protein synthesis, increases ATP generation, improves membrane transport, produces better collagen matrix organization, and stimulates wound contraction. (3) Epithelialization phase: stimulates epidermal cell reproduction and migration, and produces a smoother and thinner scar.<sup>5-8</sup>

Depending on the application, different biological effects of ES are: chemotaxis of macrophages and neutrophilic granulocytes to initiate wound cleaning, increased blood flow, increased oxygen concentration around the wound, stimulates granulation tissue formation, increased synthesis of collagen and other components of the extracellular matrix, reorga-

nizations of the extracellular matrix, facilitation of neoangiogenesis, activation of the growth factors (demonstrated for VEGF) and activation of re-epithelialization using targeted migration of keratinocytes. ES also has the antimicrobial effects, e.g., on Gram-positive (*S. aureus*, *S. epidermidis*, *Enterococcus faecium*) and Gram-negative (*P. aeruginosa*, *E. coli*, *Klebsiella-pneumoniae*) bacteria, however, not with the strength of typical antiseptics. Another advantages of ES are: reduction of oedema and reduction of pain around wounds.<sup>6-9</sup>

**PATIENT AND METHODS**

This study was conducted from March-May 2011, all the subjects was diagnosed as deep and superficial burn injury. Patients were admitted to the emergency unit Cipto Mangunkusumo General Hospital (RSCM) were given proper trauma respond according to ATLS (advanced trauma life support), and fluid resuscitation using the Parkland formula guidelines. The wounds were cleaned using normal saline and dressed with moist gauze.

The patients were treated with WMCS/ES in Burn Unit, Cipto Mangunkusumo Hospital. We applied stimulation on wounds one hour per day. Wounds were cleaned with moist gauze before and after the stimulation. Patients with second degree burns suffered from inhalation trauma and already had been given other topical agent except normal saline alone were being excluded from the study.

**RESULTS**

From March to May 2011, twelve patients were diagnosed with deep and superficial second degree burns. One of them suffered from inhalation trauma, 4 patients were referred from other hospitals, and they already received other topical agent for the wound. One patient refused hospitalization and discharged without permission. Six patients were included into the study as they met the inclusion criteria in this study, characteristics of the patients are shown on Table 1, and figures of patients are shown respectively (Fig. 1-4)

**DISCUSSION**

All the patients reported that they feel comfort during and after the application. Mean of epithelialization time was achieved in 6.6 days. This acceleration showed the positive biological effects of WMCS/ES which are stimulation of granulation tissue, synthesis of collagen and other components of the extracellular matrix. Also the facilitation of neoangiogenesis and activation of the growth factors, increased the re-epithelialization using targeted migration of keratinocytes.

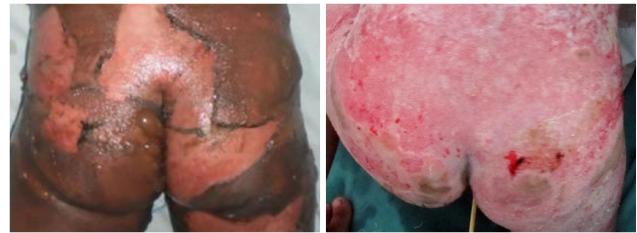
WMCS/ES also reduced the swelling around the burns wound, thus made all the patients more comfort. Another advantage in this method is we use less logistics for wound dressing. By using this treatment patient felt less pain when changing the dressing. In this study, we cannot determined if the WCMS/ES could accelerate faster healing in burns, because we do not compare it with other treatment.

**Table 1.** Characteristic of the patients, diagnosis and number of days to epithelialization

No	Patients	Diagnosis	Number of days to epithelialization
1	Male, 48 yo	Burns grade IIa-b 23% on the anterior trunks and lower extremity	7
2	Girl, 3 yo	Scald burns grade IIa-b 11% on the gluteal and lower extremity	3
3	Girl, 2 yo	Scald burns grade IIa-b 7% on the face and neck	8
4	Male, 37 yo	Burns grade IIa-b 5% on the face and anterior trunk	8
5	Girl, 3 yo	Scald burns grade IIa-b 10% on the anterior trunk and upper extremity	8
6	Female, 43 yo	Scald burns grade IIa 6% both lower extremity	6



**Fig.1.** Male, 48 years old, flame burn grade IIa-b TBSA 23%, 7 days after treatment (right).



**Fig.2.** Girl, 3 years old, scald burn grade IIa-b TBSA 11%, three days after treatment (right).



**Fig.3.** Male 37 years old, flame burn grade 2a-b TBSA 5% on the face and anterior trunk, 8 days after treatment (right).



**Fig. 4.** Female 43 years old, with scald burn grade IIa TBSA 6%, 6 days after treatment (right).

### SUMMARY

The use of this WCMS/ES have a good result in partial thickness burns treatment and could accelerate the epithelialization within 6-9 days. Patients also felt more comfort because of less pain in dressing change, and the use of WCMS/ES could reduce the logistic for dressing.

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