

# **EFFECT OF PULSED GALVANIC ELECTRO STIMULATION AND ULTRASOUND ON BURN HEALING. A RANDOMIZED CLINICAL TRIALS**

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## **Abstract**

The goal of this study is to evaluate the effect of pulsed galvanic electro stimulation of high voltage and ultrasound on the healing of induced burn applied on rats.

48 rats (Sprague Dawley), mass between 300g and 400g, age between 3 months and 4 months. These rats are putted and the same experimental conditions of alimentation and hygiene. Rats are divided into 3 groups of 16 rats each. Each rat was induced to a uniform burn of second degree by a specific device fabricated specially to this study.

Group ES undergoes a treatment of electro stimulation by a pulsed galvanic current of high voltage for 10 min daily during 2 weeks.

Group US undergoes a treatment of pulsed ultrasound of 1w/cm<sup>2</sup> for 2 minutes daily during 2 weeks

Group control GC undergoes placebo treatment.

Measure are done by digital camera, results are analyzed by specific program (AutoCad) on computer.

Wound healing between the three groups are different and statistical tests ( T-tests and ANOVA) done between the two groups US and GC show no significant difference in the reduction of the surface of healing between them ( $\alpha > 0.05$ ), whereas the comparison between ES group and the two others group was significant ( $\alpha < 0.05$ ).

At the end of the second week of treatment, the best healing was presented in ES group where the wound was healed by 61.4 % whereas the groups GC and US were 11.9 % and 14.9 % respectively.

Therefore the ES group have the best results between than others groups (GC and US).

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**Keywords:** Skin healing, burn healing, galvanic electro stimulation, ultrasound,

**Introduction:**

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**Methodology:**

Our study aims to compare the effect of pulsed galvanic current of high voltage and pulsed ultrasound in the acceleration of wound healing on induced burn on rats.

**Hypothesis:**

There is no significant difference in the level of wound healing of induced burn between the 3 groups (ultrasound, electro stimulation and control group) during the first and the second week.

**Population:**

48 rats (16males and 32 females) are selected randomly to this experiment, they have been selected from the lab of AUB (American Lebanese University) of same specie (Sprague Dawley). Their mass vary between 300g and 400g, age between 3 months and 4 months. These rats are putted and the same experimental conditions of alimentation and hygiene. Also the sequence of 12 hours in light and 12 hours in darkness was respected during the experiment.

The 48 Rats are divided into 3 groups of 16 rats each, randomly selected:

- Group ES: 16 rats undergoes a treatment by electrostimulation.
- Group US: 16 rats undergoes a treatment by ultrasound.
- Group CT: 16 rats control group.

**Tools:**



**Dynatron 850 plus**



**Sonopuls 590**



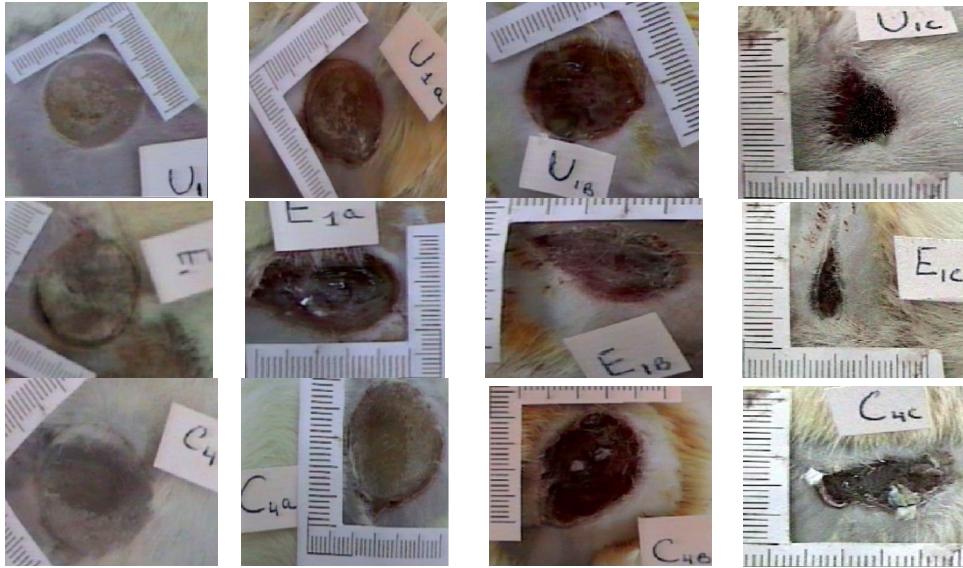
**Specific device constructed specially to induce burns**

**Procedure of burn:**

- The 48 rats are anesthetized by Kitamine intra muscular by a Veterinarian, each dose respect to the mass of each rat.
- The lateral part of the hip is well shaved.
- Burn is produced perpendicularly. Temperature 95 degree, time 20 seconds producing a burn of second degree.

**Procedure of measure:**

- Photos are taken directly after burn, in day 1, day 8, day 14 and day 21, with a scale to calculate the surface.
- Surfaces are calculated by AUTOCAD.



Figures showing the difference between burns healing in the 3 groups during the 2 weeks.

**Procedure of treatment:**



Treatment with electro stimulation



Treatment with ultra sound

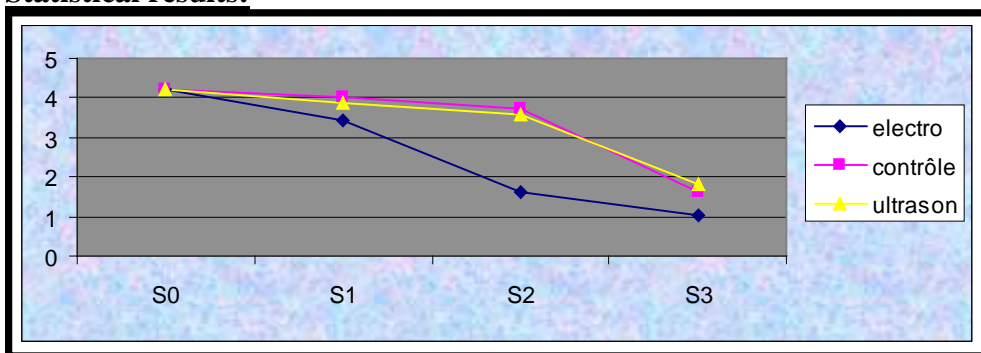
**Parameters:**

ES group: pulsed galvanic current, high voltage applied 10 min around the burn for 2 weeks.

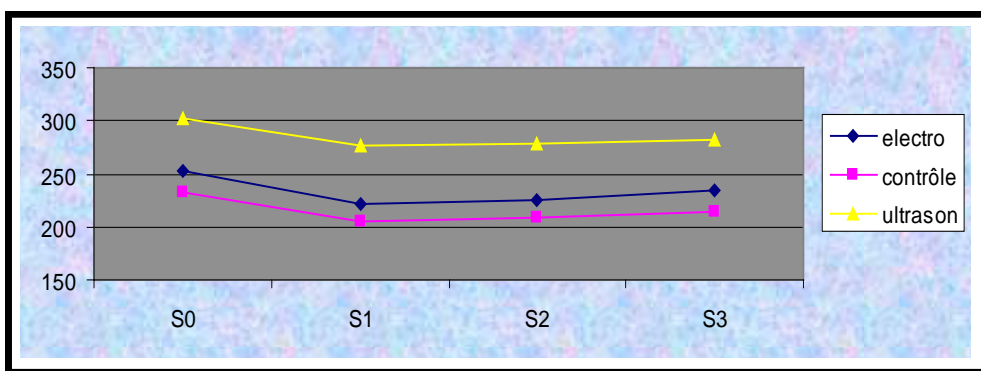
US group: 1 MHz, pulsed 20% , 2 ms , 100 Hz , 1 W/cm<sup>2</sup>, surface of the head 0.5 cm<sup>2</sup>.

There was no treatment applied during the third week.

**Statistical results:**



**Variation of the mean of the surfaces (in cm<sup>2</sup>) between the 3 groups during the 3 weeks.**



**Variation of the mean of the mass (in g) between the 3 groups during the 3 weeks**

		Sum of squares	Df	f	P
<b>ES</b>	Between groups	9.332	2	17.203	0.000
	Within groups.	10.566	39		
<b>US</b>	Between groups	21.972	2	70.044	0.000
	Within groups.	7.058	45		
<b>CT</b>	Between groups	33.586	2	75.577	0.000
	Within groups.	9.555	43		

**ANOVA between the surfaces of the 3 groups during the 3 weeks**

**Discussion of the results:**

Group US did not represented any significant difference in the reduction of the surface of lesion in compare with the control group. The results may be caused by:

- High intensity (1W/Cm<sup>2</sup>).
- Application of the head around the lesion.
- Frequency 1 MHz.
- Short duration for 2 weeks only.
- Histological effect of ultra sound.

Group electro stimulation present a significant difference in the reduction of the surface of lesion in compare with control group.

- Best result was between week 1 and week 2 .
- Polarity of the wound was negative.
- Direct effect.

### **Recommendation:**

- Trying to apply the treatment to patients suffering from burns by galvanic pulsed current at high voltage to reduce surface of lesion.
- Application of 10 minutes was sufficient.
- It is not recommended to use pulsed ultra sound with intensity 1 W/Cm<sup>2</sup> in the treatment of burn.

### **Conclusion:**

The application of pulsed galvanic current of high voltage in the treatment of burn increase the healing process.

The application of pulsed ultra sound in the treatment of burn has no significant effect in the reduction of the surface of lesion.

### **References:**

- Hugeux P. La cicatrisation de la peau brulée. Hôpital d'instruction des Armées PERCY 92141. 1995
- Zilliox Conférence organisée par le laboratoire KYRN (centre des grandes brûlés Edouard herriot-Lyon), 2001.
- Rochet JM, Wassermann D, Carsin H et al. Rééducation et Réadaptation de l'adulte brûlé. Encycl. med.chir (Elsevier, paris).kinésithérapie-médecine physique-réadaptation,26-280-C-10,1998, P 27.
- Revol M, Servant JM, Fleuridas G et al. Cicatrisation Cutané. Manuel de chirurgie plastique reconstructrice et réparatrice. Edition pradel 4, Paris, p 3-4.
- Charlotte F: Histopathologie et mécanisme de la cicatrisation. Travail du Service d'Anatomie Pathologique(Pr. Y. Le Charpentier) Groupe Hospitalier Pitié-Salpêtrière. Paris: 47-83, 1995.
- Wolf ML, Whuler PC and wolcott LE : Cold leaf treatment of Ischemic skin ulcers. JAMA 196: 693, 1996.
- Kanof NM: Cold leaf in treatment of coetaneous ulcers. J Invest Derm 43: 441, 1964.
- Robertson WG: Digby's receipts. Ann Med History 7:216-219, 1925.
- Pories WJ, Henzel JH, Strain WH: Acceleration of wound healing in Man with zinc sulfate Given by mouth. Lancet 1:121, 1967.
- Moyer GA, Brentanol L, Gravens DL et al: Treatment of large human burns with 0.5 per cent silver nitrate solution. Arch Surg (Chicago) 90: 812, 1965.

Lundgren C and Sandberg N: Influence of hyperbaric oxygen on the tensile strength of healing skin wounds in rats; in IMCA. Lrodingham, Ed. Hyperbaric oxygenation. Baltiore, the Willians and Wilkins company ,p 394, 1965.

Sumano HL; Ocampo CL, Caytone CG et al: Eficacia cicatrizante de varios. medicamentos de paciente, Zybila et prop-leo. Veterinaria Mexico 18: 33-37, 1987.

Sumano LH, Aur AA and Olampo CL: Evaluacing de mezcla propeleo-zybila (Aloe. Vera) como cicatrizante. Veterinaria Mexico 20: 407-413, 1989.

Gupta SK, Singh Hand Varshny AC: Maltodextron, NF powder: a new concept in equine wound healing. J Equine Vet Sci 15:296-298, 1995.

Zheng J, Wang S and Guo L: Promotion of wound healing with fibroblast growth factor in combined burn radiation injury. Chinese J Plastic Surg 10:146-149, 1994.

Byl NN, McKenzie AL, West JM et al: Low-dose ultrasound effects. On wound healing a controlled study with Yucatan pigs. Arch Phys Med Rehabil 73: 654-64, 1992.

Houghton PE and Campbell KE: choosing an adjunctive therapy for the treatment of chronic wounds. Ostomy Wound Management 45:43-52, 1999.

Atrick M K: Applications of therapeutic pulsed ultrasound. Physiotherapy 64: 103-4, 1978.

Byl NN, McKenzie AL, west JM et al: Low Dose Ultrasound Effects on Wound healing a controlled study with Yucatan pigs. Arch Phys Med Rehabil 73: 656-664, 1992.

Nussbaum E, Biemann I, Mustard B: Comparison of ultrasound/ultraviolet-C and laser for treatment of pressure ulcers in patients with spinal cord injury. Phys Ther 79: 812-823, 1994.

Ter Riet G Kessels AG, Knipschil LP: A randomized clinical trial of ultrasound in the treatment of pressure ulcers. Phys Ther 76: 1301-12, 1996.

Castillo E, sumano LH, fortoul TI et al: the influence of pulsed electrical stimulation on wound healing in burned rat skin. Arch Med Res 26: 185-189, 1995.

Sussman C and Byl N: Electrical stimulation for wound healing. In: Sussman C and Bates-Jensen BM: wound care collaborative practice manual for physical therapist and nurses. Aspen Publishers.1998.

Bach SI, Hyodo A, Negami S et al: Experimental wound healing with electrical stimulation. Artificial Organs 23: 460-462, 1999.

Stromberg BV: Effects of electrical currents on wound healing. J Plast Surg 21: 121-123, 1988.

Kloth LC, feeder JA: Acceleration of wound healing with high voltage monophasic pulsed current. Pyhs Ther 68:503-508, 1988.

Brown MB, MC Donnell MK, Menton DN: Polarity effects on wound healing using electric stimulation in Rabbits. Arch Phys Med Rehabil 70: 624-627, 1989.

Sussman C: Electrical stimulation, 234 PLACE TORRANCE, 1997.

John L, Ann R, Mary D: Therapeutic directs current. In: Electrotherapy Explained (principles and practice). Second edition. Oxford, p 18, 1994.

Smith J, Romansky N, Venero J et al: The effect of electrical stimulation on wound healing in diabetic mice .J Am Podiatry Assoc 74:71-75, 1984.

Alvarez OM, Metrz PM, Smerbeck RV and Eaglstein WH: Healing of superficial skin Wounds is stimulated by external electrical current. J Invest Dermatol 81:144-148, 1983.

Wolcott LE, Wheeler PC, Hardwicke HM et al: accelerated healing of skin ulcers by electrotherapy. South Med J 62:795-801, 1969.

Brown M, Gogia PP: Effects of high voltage stimulation on cutaneous wound healing in rabbits. Phys Ther 67:662-667, 1987.

Konikoff JJ: Electrical promotion of soft tissue repairs. Ann Biomed Eng 4: 1-5, 1976.

Alvarez OM, Mertz DM, Smerbeck BV et al: External electrical current stimulates the healing of superficial skin wounds. J Invest Dermatol 81:144 – 148, 1983.

Carley PJ, wainazel SF: Electrotherapy for acceleration of wound healing low intensity direct current. Arch phys Med Rehabil 66:443-446, 1985.

Gaults WR, Gatens PF: Use of low intensity directs current in management of ischemic skin ulcers. Phys Ther 5:265-269, 1976.

Patric JC, Stanley F. electrotherapy for acceleration of wound healing low intensity direct current. Arch Phys Med Rehabil 66:443-446, 1976.

Brawn M, Mc Donnell MK, Menton DN. Polarity effects on wound healing using electrical stimulation in rabbits. Arch Phys Med Rehabil 70:624-628, 1989.

Cruz N, Byron F, Suarez A. Accelerated healing of full-thickness burns by the use of high-voltage pulsed galvanic stimulation in the pigs. Ann.Plast Surg 28:49-55,1989.

Assimacopoulos D. Wound healing promotion by the use of negative electric current. Am Surg 34: 423-431, 1968.

Darryl S, Weiss MD, Robert K et al. Electrical stimulation and Wound Healing. Arch Dermatol 126: 222-225, 1990.

Kloth Lc, Mc Culloch JM, Feidar JA. Wound healing alternatives in management. Philadelphia: Davis, 1990.

Kramer JF. Ultrasound: Evaluation of its mechanical and thermal effects. Arch phys Med Rehabil 65: 223-227,1984.

Lehmann JF. Therapeutic heat and cold (ed 4). Baltimore Williams and Wilkins 1990.



- Dyson M, Suckling J. Stimulation of tissue repair by ultrasound: a survey of the mechanisms involved. *Physiotherapy* 64:105-108,1978.
- Tuner SM, Powell ES. The effect of ultrasound on the healing of repaired cockerel tendon: in collagen cross-linkage a factor 2 *J Hand Surg* 9Br) 14:428-433,1989.
- Peschen M, Weichenthal M, Schopf E et al. Low frequency ultrasound treatment of chronic venous leg ulcers in an out patient therapy *Acta . Derm Venerol* 77: 311-314,1997.
- Young SR, Dyson M. macrophage responsiveness to therapeutic ultrasound. *Ultrasound Med Biol* 16: 809-16,1990.
- Taskan I, Ozyazgan I, Tercan M et al. A comparative study of the effect of ultrasound and Electro-stimulation on wound healing in Rats. *Plast Reconstr Surg* 100: 966-972,1997.
- Byl NN, MC kenise A, wong T et al. Incision wound healing a controlled study of low and high dose ultrasound. *J orthop sports phys ther* 18: 619-628,1993.
- Mortimer AJ, Dyson M. The effects of therapeutic ultrasound on calcium uptake in fibroblasts. *Ultrasound Med Biol* 14: 499-506,1998.
- Young SR, Dyson M. Macrophage responsiveness to therapeutic ultrasound. *Ultrasound Med Biol* 16: 809-816,1990.
- Prentice WE. *Therapeutic modalities in sports medicine*, 3<sup>rd</sup> edition. ST Louis: Mosby, 1994.
- Téot L . Structure de la peau et cicatrisation cutanée. *Revue de l'infirmière* 80:20-23,2002.
- Encarta. *Encyclopedie Microsoft. Peau* . Microsoft corporation. 2001.
- Revol M, Servant JM. Fleuridas G et al : *Manuel de chirurgie plastique reconstructrice et reparatrice*. Edition pradel 4 . passager de la main d'or ,paris .p 11-13;26-27.
- Gerbault O: *Cicatrisation cutanée*. *Encycl Méd Chir (Elsevier, paris), technique chirurgicales. Chirurgie Plastique Reconstructrice et Esthétique* 45-010: p 19,1999.
- Faure E. *Les brûlures*. Brûlure, untitled document.2002