

# Acute and chronic wound care

## A dermaPACE™ publication summary

### Pre Clinical Studies

- Haupt G, and Chvapil M. Effect of shock waves on the healing of partial-thickness wounds in piglets. *J Surg Res* 1990;49:45-48.

Re-epithelialization of wounds inflicted in normal or previously irradiated skin of piglets was significantly enhanced by low energy shock-wave treatment (Experimental Lithotripter XL1, Dornier, 1000 pulses at 14 or 18 kV energy level). Shock waves of intermediate (or high) energy were without effect.

- Kamelger FS, Djedovic G, Meirer R, and Piza-Katzer H. Deep partial thickness burn injury and the effect of eswt. An experimental investigation in rats. *Presentation no. 65; 8th Int Congress of the ISMST, May 29th to June 1st 2005, Vienna, Austria.*

Standardized deep partial thickness burns were applied to the backs of 30 rats. Immediately after burns the eswt treatment (0.11 mJ/mm<sup>2</sup>, 500 pulses) was applied on selected areas, whereas the remainder of the burns served as untreated controls. Re-epithelization was improved significantly at days 5 and 15, wound closure over time was enhanced as well (both,  $p < 0.05$ ).

- Meirer R, Kamelger FS, Huemer GM, Wanner S, and Piza-Katzer H. Extracorporeal shock wave may enhance skin flap survival in an animal model. *Presentation no. 59; 8th Int Congress of the ISMST, May 29th to June 1st 2005, Vienna, Austria.*

- Meirer R, Kamelger FS, Huemer GM, Wanner S, and Piza-Katzer H. Extracorporeal shock wave may enhance skin flap survival in an animal model. *Br J Plast Surg.* 2005;58(1):53-57.

Shock waves were directed onto surgically compromised epigastric skin flaps in rats (Epos Fluoro, Dornier, 2500 pulses at 0.15 mJ/mm<sup>2</sup>). Flap viability of the eswt-treated rats were compared to those of also operated, but untreated animals. Necrotic zones in the eswt-treated flaps were significantly smaller (2.2% of the skin surface, versus 17.4%,  $p < 0.01$ ) than in the untreated animals. Eswt seems to improve blood supply in ischemic tissue.

- Huemer GM, Meirer R, Gurunluoglu R, Kamelger FS, Dunst KM, Wanner S, and Piza-Katzer H. Comparison of the effectiveness of gene therapy with transforming growth factor-beta or extracorporeal shock wave therapy to reduce ischemic necrosis in an epigastric skin flap model in rats. *Wound Rep Reg.* 2005;13(3):262-8.

- Meirer R, Huemer GM, Oehlbauer M, Wanner S, Piza-Katzer H, and Kamelger FS. Comparison of the effectiveness of gene therapy with vascular endothelial growth factor or shock wave therapy to reduce ischaemic necrosis in an epigastric skin flap model in rats. *J Plastic Recon and Aesthetic Surg.* 2007;60:266-271.

The effect of gene therapy with adenovirus-mediated TGF-beta or adenovirus mediated VEGF was compared to that of shock wave therapy on the rat, using the epigastric skin flap model (Epos Fluoro, Dornier, 2500 pulses at 0.15 mJ/mm<sup>2</sup>). Eswt enhances skin flap survival more than either Ad-TGF-beta treatment (eswt: 2.3% necrotic area, Ad-TGF-beta: 9.7 and control 17.4%,  $p < 0.05$ ) or Ad-VEGF treatment (eswt: 2.23% necrotic area, Ad-VEGF: 9.25 and control: 17.4%,  $p < 0.05$ ).

- Hofmann M, Mittermayr R, Morton T, Pfeifer S, Redl H, Schaden W, and van Griensven M. Shockwave induces up-regulation of endogenous VEGF-R2 during early hindlimb ischemia-reperfusion injury. *Presentation no. 43; 10th Int Congress of the ISMST, June 6th to 9th, 2007, Toronto, Canada.*

Ischemia was induced in transgenic mice by a tension-controlled hindlimb tourniquet. Ischemia was maintained for two hours, with subsequent reperfusion for 24 hours. Control animals received no treatment, whereas the animals of the shockwave group (Orthowave 180, MTS) received 50 percutaneous pulses on the ischaemic hindlimb 15 min prior to reperfusion. Increased perfusion levels (108%) were observed in the shockwave group. VEGF-R2 expression was significantly increased versus the control group after 4 hours.

- McClure S, and Morgan D. Extracorporeal shockwave therapy in the treatment of distal limb lacerations. *Presentation no. 14; 10th Int Congress of the ISMST, June 6th to 9th, 2007, Toronto, Canada.*

In six horses a 4 cm diameter defect including skin, subcutis and periosteum was created on the metacarpus bilaterally. Esw was initiated on day 7 on one randomly selected metacarpus and repeated weekly until the wound was healed (EquiTron, SANUWAVE, 500 pulses at 0.11 mJ/mm<sup>2</sup>). The wound treated with esw healed in a mean of 76 days, as compared to 90 days for the untreated control (p=0.051).

- Mittermayr R, Hartinger J, Hogmann M, Morton T, van Griensven M, Schaden W, and Redl H. Shockwave therapy is protective against ischemia-induced tissue necrosis irrespective of application time. *Presentation no. 46; 10th Int Congress of the ISMST, June 6th to 9th, 2007, Toronto, Canada.*

A standardized epigastric skin flap model (left inferior epigastric vessel cut) was utilized to test whether the time point of esw application would influence the prevention of tissue necrosis. In the ischemic area 300 pulses at 0.1 mJ/mm<sup>2</sup> (DermaGold, MTS) were applied at different time points: 24 h pre-OP, post-OP, 24 h post OP. In comparison to the control groups, all shockwave treated animals showed substantially reduced necrosis, regardless when they were esw treated. There was no difference within the shockwave groups.

- Vasconez H, Edelmann S, Fink BF, Kirakodu S, Ferguson REH, Novak KF, Novak MJ, Schaden W, and Balke W. A study of the biological factors and wound healing of a skin flap model. *Presentation no. 45; 10th Int Congress of the ISMST, June 6th to 9th, 2007, Toronto, Canada.*

- Schaden W, Köppl C, Valentin A, Pusch M, Thiele R, Vasconez H, Novak MJ, Balke W, Fink B, and Ferguson REH. Extracorporeal shockwave therapy for chronic skin lesions. Preliminary report. *Presentation no. 72; 9th Int Congress of the ISMST, April 20th to 23<sup>rd</sup>, 2006, Rio de Janeiro, Brazil.*

A standardized epigastric skin flap model (left inferior epigastric vessel cut) was utilized in 16 rats to prove the effect of esw on the survival rate of the flap. Animals in the treatment group were exposed to 500 pulses at 0.15 mJ/mm<sup>2</sup> on the entire right half of the flap (DermaGold, MTS, defocussed). Seven days after esw the necrotic area of the esw-treated animals was reduced by approx. 68%, compared to the control animals (11.7cm<sup>2</sup> versus 3.8 cm<sup>2</sup>, p=0.0006).

In a second experimental series, animals were euthanized after 12,24,48 and 72 hours in order to test for growth factors and stem cell marker analysis.

- Kuo YR, Wu WS, Hsieh YL, Wang FS, Wang CT, Chiang YC, and Wang CJ. Extracorporeal shock wave enhanced extended skin flap tissue survival via increase of topical blood perfusion and associated with suppression of tissue pro-inflammation. *J Surg Res 2007;143:385-392*

Thirty-six rats in a caudally based, random dorsal skin flap model were randomized into three groups: control group I without esw treatment, group II esw treated immediately post-op and group III immediately post-op plus one day following surgery (Ossatron, SANUWAVE, 500 pulses at 14 kV, equivalent to 0.15 mJ/mm<sup>2</sup>).

Flap tissue blood perfusion was significantly increased three days post-operatively in group II (p < 0.005), and flap necrotic area in group II was significantly reduced seven days post-operatively compared with that of the control group (13±2.6% versus 42±5.7%, p < 0.01). There was only small and insignificant change in blood flow and necrotic area in group II compared with controls. Optimal dosage of esw treatment has a positive effect in rescuing ischemic skin flaps and is associated with suppressed topical tissue inflammation.