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Extracorporeal shockwave treatment for chronic diabetic ulcers and wounds: a clinical perspective

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Presenter: Kenneth Craig

KOMPASS Health Associates

Conflict of Interest Declaration: ESWT

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MTS-TRT Inc. USA, MediSpec Ltd. & CellSonic UK Ltd.

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Primary AIM

To discuss and invite more research collaboration in the area of diabetic foot ulcer utilising extracorporeal shockwave treatment




Introduction

Diabetic foot ulcers (DFU's)

- Complex & complicated to manage
- Attributed to diabetic progression and changes despite glycemic control
  - Neuropathy
  - Circulatory
    - Diminished tissue synthesis / disruption to epithelialization & TGF-ß transcription
    - Altered immuno-regulation & function (ie neutrophil function)
    - Infection
- Most common complication seen in DM & impacts approx. 15-25% of sufferers

1. International Best Practice Guidelines: *Wound Management in Diabetic Foot Ulcers.* Wounds International 2013.
2. Brownrigg JR, Davey J, Holt et al. The association of ulceration of the foot with cardiovascular and all-cause mortality in patients with diabetes: a meta-analysis. Diabetologia 2012; 55(11): 2906-12.
3. Yazdanpanah L, Nasiri M, & Adavishi S. Literature review on the management of diabetic foot ulcers. World J Diabetes 2015; 6(1):37 – 53.
4. Lavery LA, Armstrong DA, Wunderlich RP, et al. Risk factors for foot nfections in individuals with diabetes. *Diabetes Care 2006; 29(6):*1288-93.
5. The EURODIALE Study. Diabetologica. 2008; 51(5):747 - 55.

46 Pastar I, Stojadinovic O, Yin NC, Ramirez H et al. Epithelialization in Wound Healing : A Comprehensive Review. Advances in Wound Care. 2014; 3(7); 445 – 464.

47 Ramirez H, Patel SB & Pastar I. The Role of TGFß Signaling in Wound Epithelialization. Advances in Wound Care. 2014; 3(7): 482 – 491.

48 Wang LD, Lui X, Meisgen F, Grunler L, Botusan IR, et al. MicroRNA-132 enhances transition from inflammation to proliferation during wound healing. J Clin Invest. 2015; 125(8):3008 – 3026.

Introduction

Diabetic foot ulcers (DFU's): Underlying causes a key factor for management

- Ischaemic
- Neuropathic
- Neuroischaemic

- Increase in incidence
- Most commonly seen DFU's

1. International Best Practice Guidelines: *Wound Management in Diabetic Foot Ulcers.* Wounds International 2013.
3. Yazdanpanah L, Nasiri M, & Adavishi S. Literature review on the management of diabetic foot ulcers. World J Diabetes 2015; 6(1):37 – 53.
5. The EURODIALE Study. Diabetologica. 2008; 51(5):747 - 55.
6. Prompers L, Huijberts M, Apelqvist J, Jude E, Paiggesi A, et al. High prevalence of risk ischaemia, infection and comorbidity in patients with diabetic foot disease in Europe. Diabetologica. 2007; 50(1): 18 – 25.

Introduction

Diabetic foot ulcers (DFU's): Typical etiological features

Feature	Ischaemic	Neuropathic	Neuroischaemic
Sensation	Insensate	Painful	Some deg. of sensory deficit
Necrosis / Callus	Thick callus	Necrotic	Highly prone to necrosis with some callus present.
Wound bed	Granulated, pinkish, with callus present	Sloughy, pale, poor granulation	Generally poor granulation
Temp. & pulse	Warm with bounding pulse	Cold with absence of pulse	Cold with absence of pulse
Typical location	Weight bearing / pressure regions	Tips & in-between digits, lateral bor	Foot and toe margins
Other features	Dry skin	Non-healing	Non-healing + high risk of infection.
Incidence	10 – 20%	10 – 15%	>50%

1. International Best Practice Guidelines: *Wound Management in Diabetic Foot Ulcers.* Wounds International 2013.
3. Yazdanpanah L, Nasiri M, & Adavishi S. Literature review on the management of diabetic foot ulcers. World J Diabetes 2015; 6(1):37 – 53.
7. Malgrange D. Pathophysiology of the diabetic foot. Rev. Med Interne. 2008; 29 Suppl.2 S231 – S237.
8. Apelqvist J. Diagnostics and treatment of the diabetic foot. Endocrine 2012; 41(3): 384 – 397.

Introduction

Diabetic foot ulcers (DFU's): Current Management Guidelines:

- Treatment of primary and secondary disease & issues
  - Blood sugar; CVD; CAD; Habits etc.
- Improve micro & macro circulation where possible
- Wound management & infection control
  - Debridement (hydro / autolytic etc.); NPWT; biofilm detection and disruption; inflammatory control; moisture balance; antimicrobials; epithelial edge advancement
- Off load pressure regions

Aimed at amputation prevention!

1. International Best Practice Guidelines: *Wound Management in Diabetic Foot Ulcers.* Wounds International 2013.
3. Yazdanpanah L, Nasiri M, & Adavishi S. Literature review on the management of diabetic foot ulcers. World J Diabetes 2015; 6(1):37 – 53.
7. Malgrange D. Pathophysiology of the diabetic foot. Rev. Med Interne. 2008; 29 Suppl.2 S231 – S237.
8. Apelqvist J. Diagnostics and treatment of the diabetic foot. Endocrine 2012; 41(3): 384 – 397.
9. Bakker K, Apelqvist J, Schaper NC on behalf of the International Working Group on the Diabetic Foot Editorial Board 2012.
10. European Wound Management Association (EWMA), 2004.
11. Chadwick P. International case series: using Askina® Calgitrol® Paste in the treatment of diabetic foot infection. 2013
12. Lipsky BA, Holroyd KJ, Zasloff M. Topical antimicrobial therapy for treating chronic wounds. *Clin Infect Dis 2009*
13. Phillips PL, Wolcott RD, Fletcher J, et al. Biofilms Made Easy. *Wounds International 2010*
14. Davis SC, Martinez L, Kirsner R. The diabetic foot: the importance of biofilms and wound bed preparation. *Curr Diab Rep 2006*
15. Haycock S, Chadwick P. Debridement of diabetic foot wounds. *Nursing Standard 2012*

Introduction

Diabetes

- **Type 1**
- **Type 2**

Comorbidity

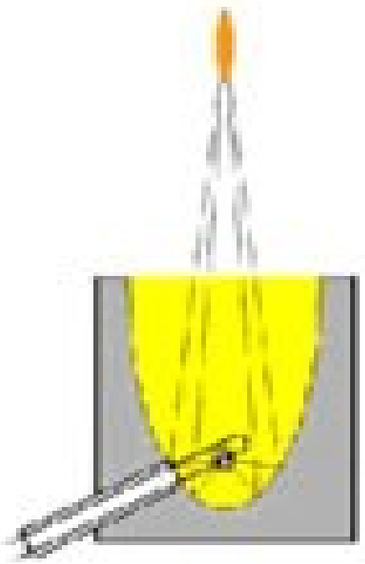
- Neuropathy
- Ischaemia
- Impaired tissue synthesis
- Immune alteration
- Infection
- Habitual tendencies

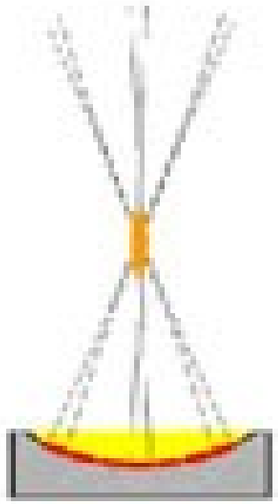
Management Aimed at Amputation Prevention

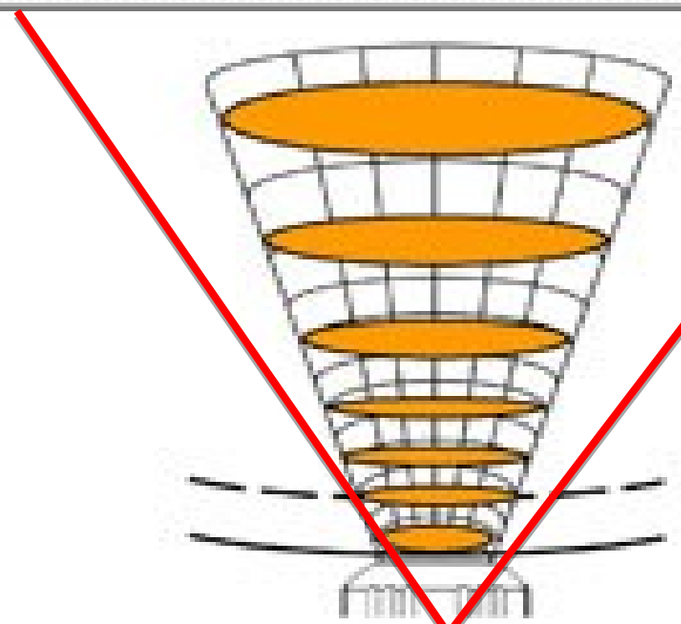
- How effective are current strategies?
- Economic viability and sustainability?
- Are there other methods?

Extracorporeal Shockwave Treatment (ESWT) An adjunct treatment options for the management of diabetic ulcers

ESWT







generation

spark discharge

Piezo-elektric

electro-magnetic

pneumatic

propagation

focused

➔ hard shockwave

radial

➔ soft shockwave

ESWT in Diabetic Ulcers

Extracorporeal shock wave therapy (ESWT) for wound healing: Technology, mechanisms, and clinical efficacy

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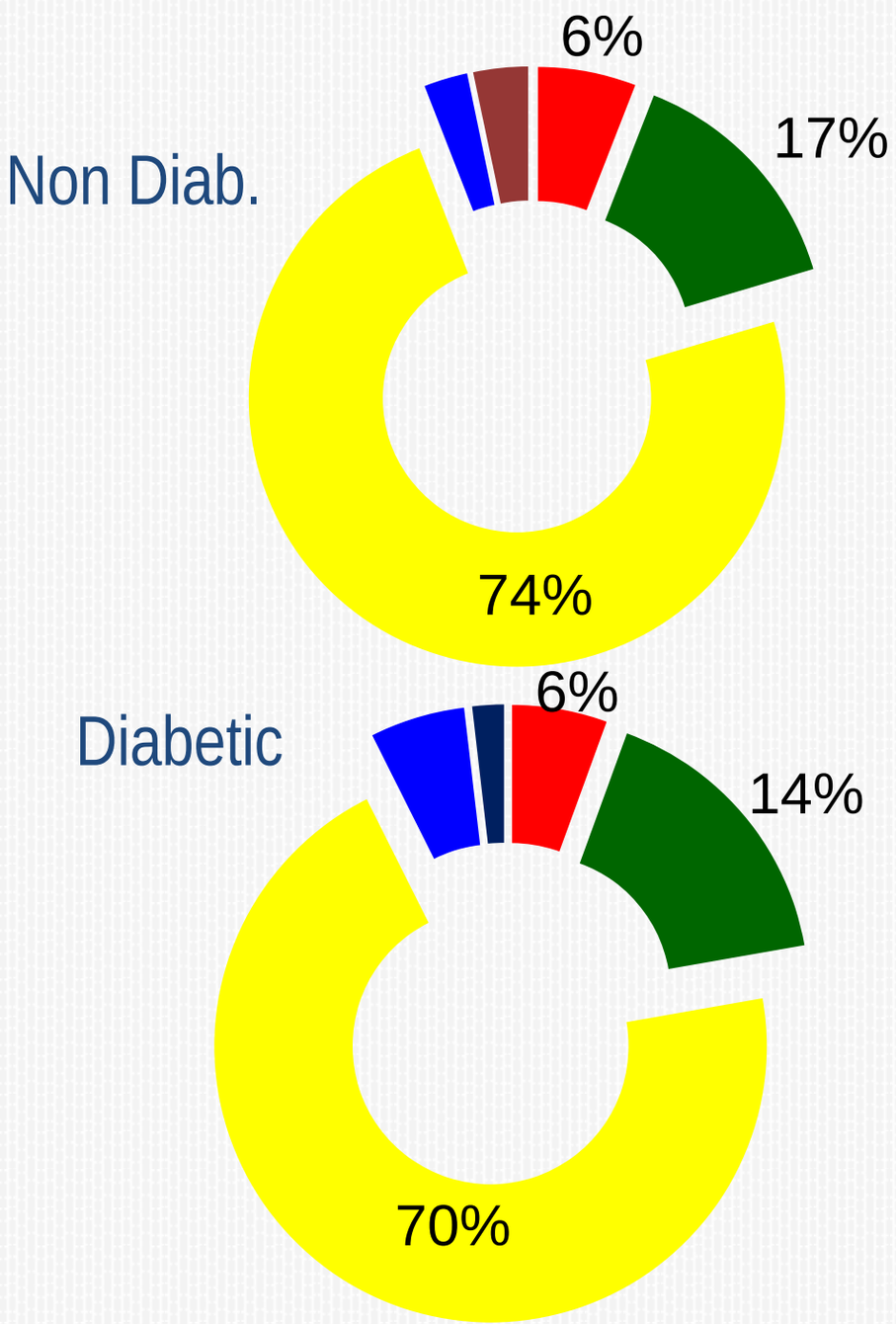
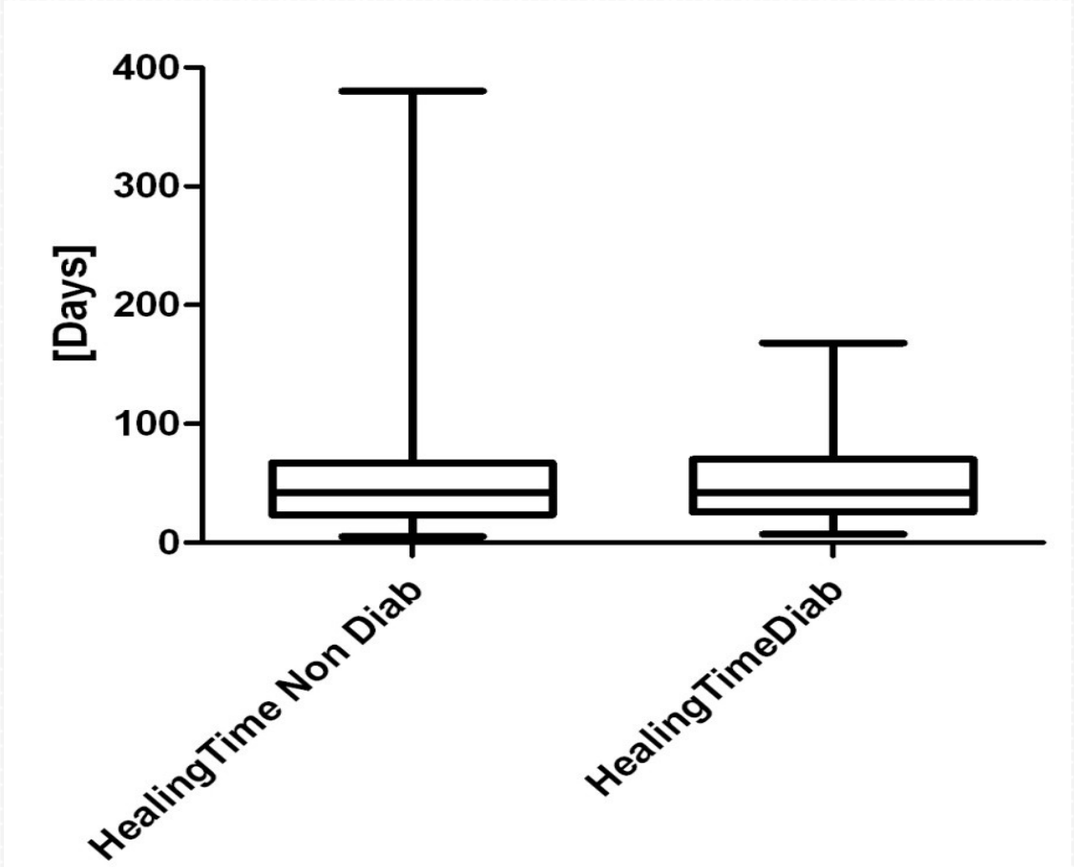
4. Burns Unit, Wound Healing Unit, Lapeyronie Hospital, Montpellier University Hospital, Montpellier, France,
5. Combat Wound Initiative Program, Washington, DC, and
6. Henry M Jackson Foundation for the Advancement of Military Medicine, Bethesda, Maryland

Wounds Repair and Regeneration. 2012; 20(4): 256 – 265.

Outcome





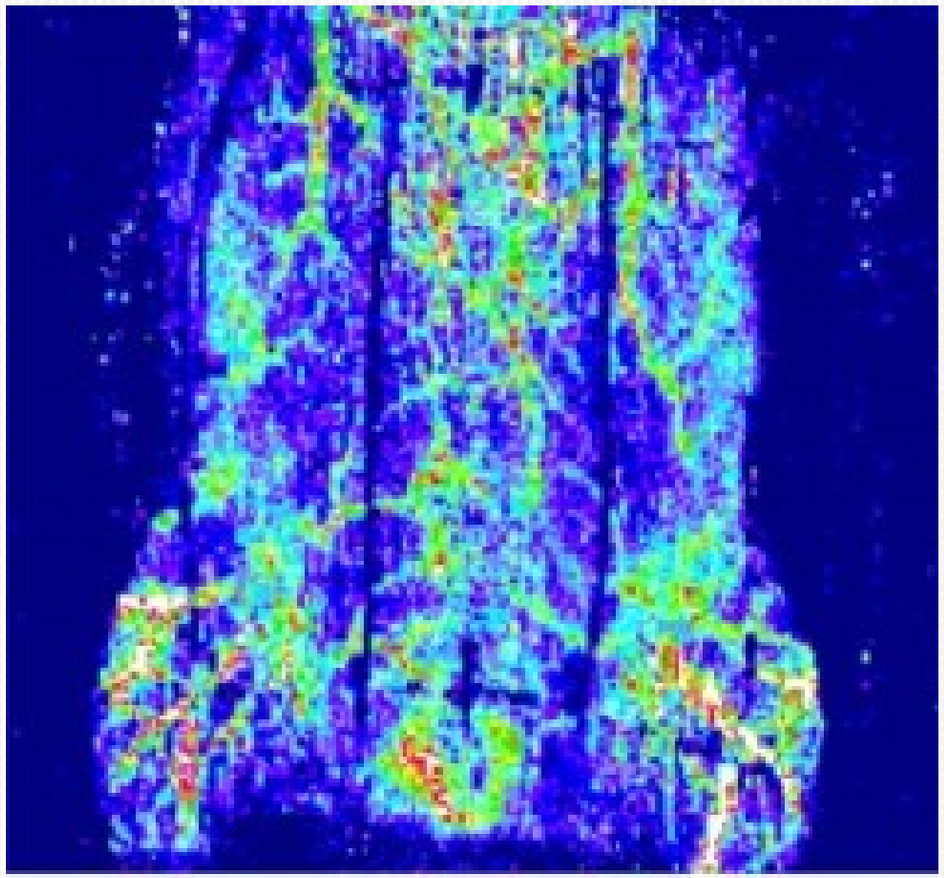
Healing time: 48 day from 1st ESW Tx

No of treatments: 3 – 5 sessions

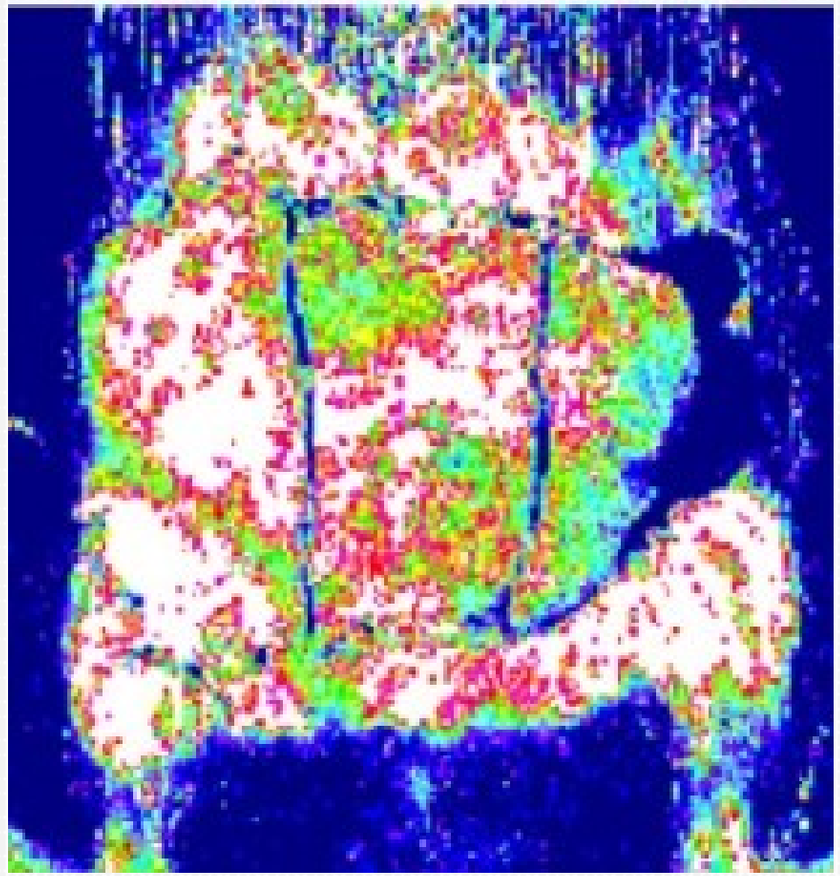
Similar response in both groups

Mittermyar et al Wound Rep Reg 2012; 20(4):256 – 265.

Outcome: Superficial Tissue Perfusion



Baseline



7 days post ESWT

Mittermyar et al Wound Rep Reg 2012; 20(4):256 – 265.

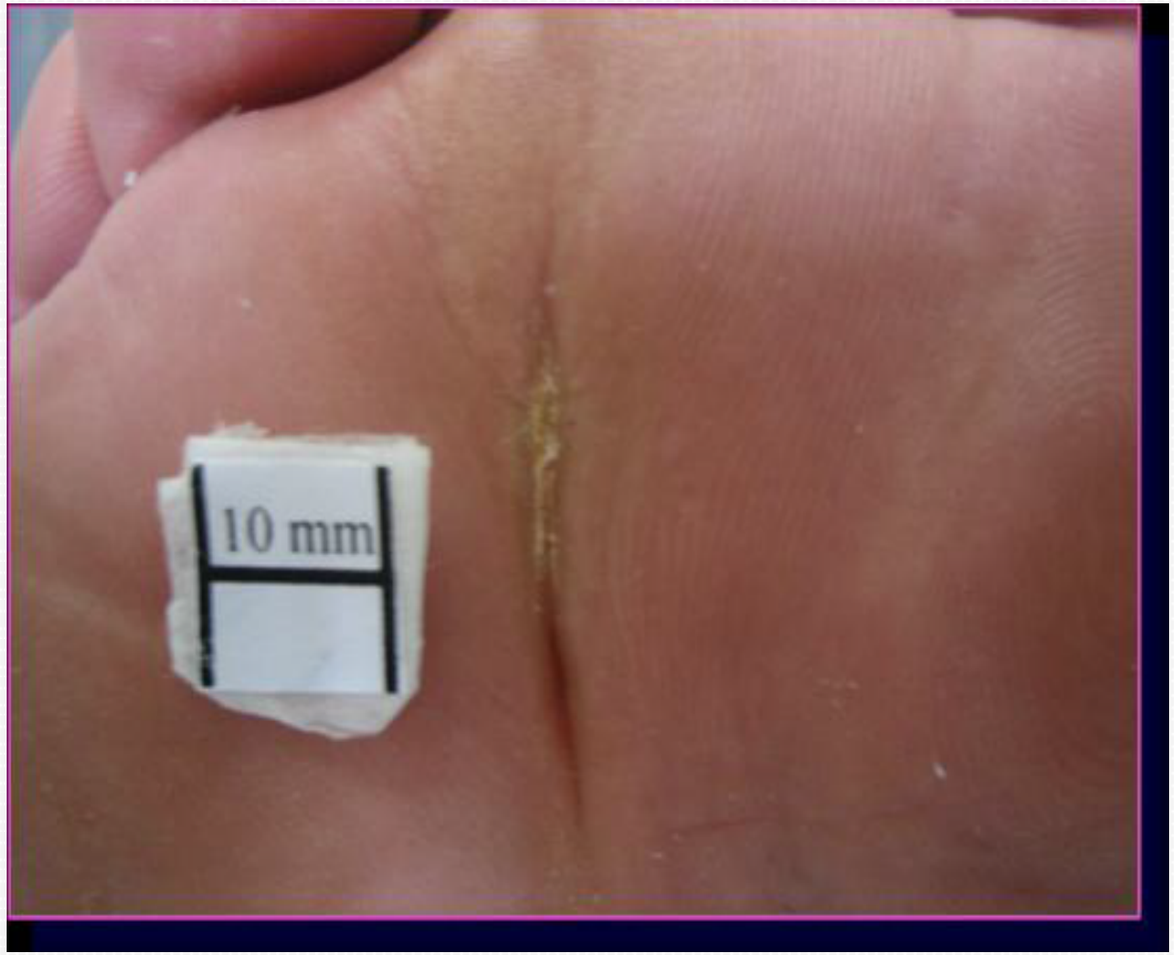
Outcome: Case file

Baseline
0.7cm x 1cm

2nd month post ESWT

Outcome: Case file

Baseline



52 days post ESWT (4 sessions)

Moretti, Notarnicola, Baggio et al. 2008 – Ref 36

ESWT in Diabetic Ulcers

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International Diabetes Federation

Treatment of diabetic foot ulcers: A comparative study of extracorporeal shockwave therapy and hyperbaric oxygen therapy

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Department of Orthopedic Surgery, Chang Gung University College of Medicine, Kaohsiung Chang Gung Memorial Hospital, 123 Ta-Pei Road, Niao-Sung Hsiang, Kaohsiung 833, Taiwan

2011; 92(2):187 – 193.

Outcome

Table 3 – The overall clinical results.

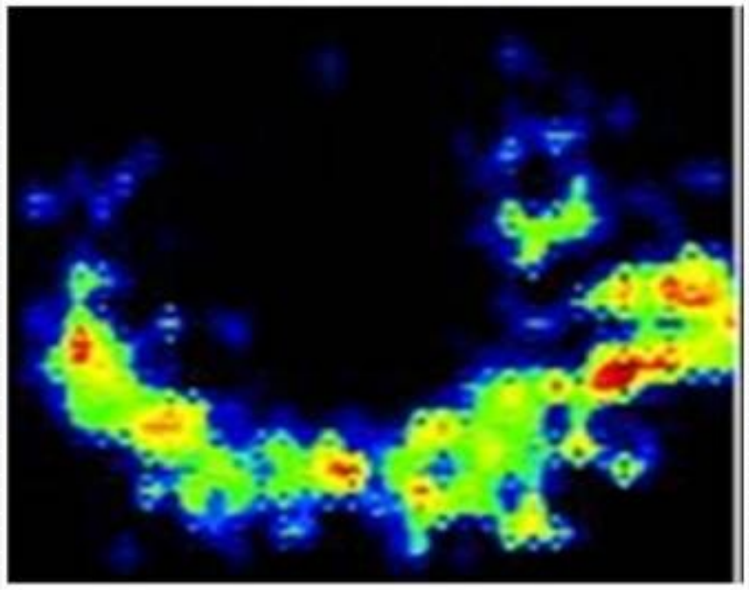
Ulcer status	ESWT	HBOT	P-Value
After one course of treatment	(N = 44)	(N = 40)	
Completely healed ulcers	57% (24 of 44)	25% (10 of 40)	0.003
≥50% improved ulcers	32% (14 of 44)	15% (6 of 40)	0.071
Unchanged ulcers	11% (5 of 44)	60% (24 of 40)	<0.001
Worsened ulcers	0	0	
After second course of treatment	(N = 14)	(N = 17)	
Completely healed ulcers	50% (7 of 14)	6% (1 of 17)	0.005
≥50% improved ulcers	43% (6 of 14)	47% (8 of 17)	0.815
Unchanged ulcers	7% (1 of 14)	47% (8 of 17)	0.015
Worsened ulcers	0	0	

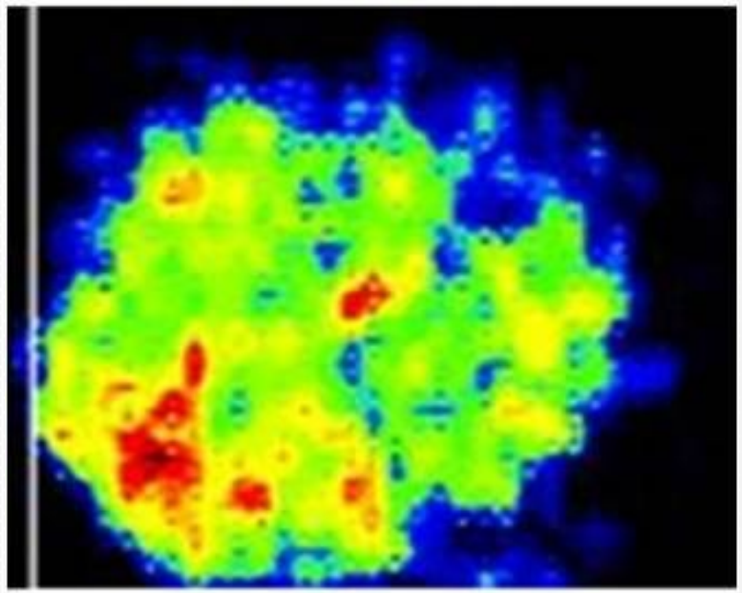
N: Numbers of foot.

P-Values: comparison between the ESWT group and the HBOT group.

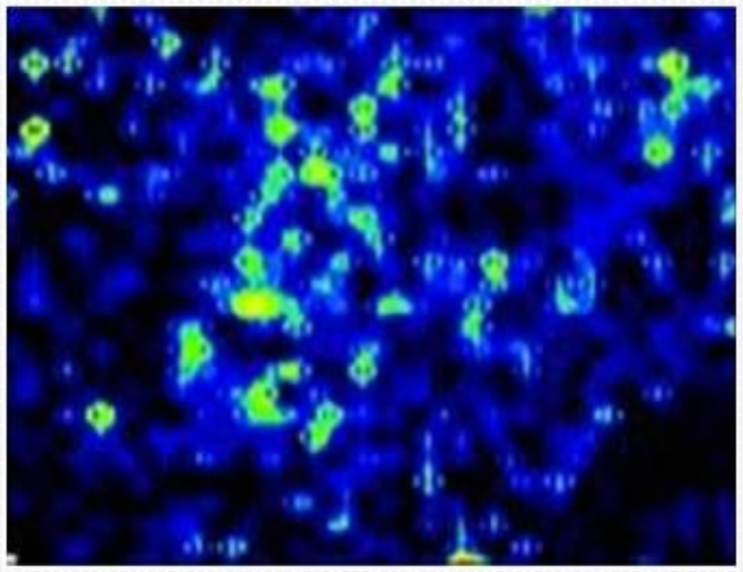
Wang et al Diab Res Clin Prac.2011; .92(2): 187 – 193.

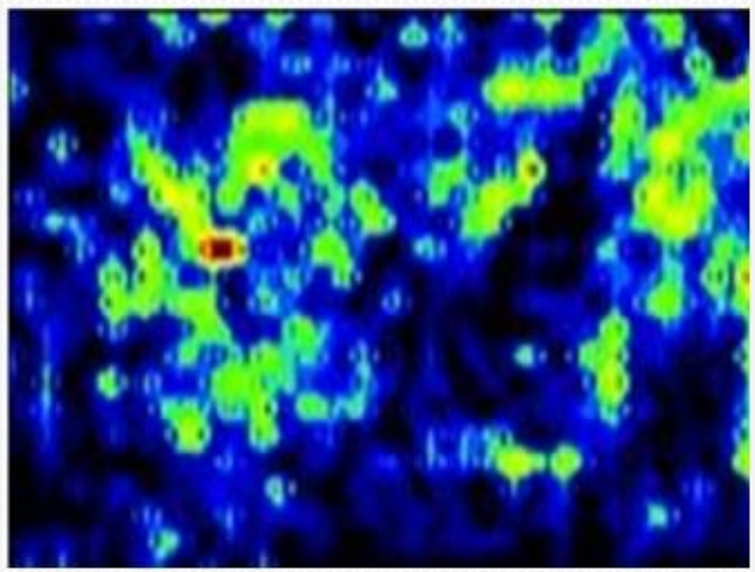
Outcome: Perfusion Status





Baseline Post ESWT



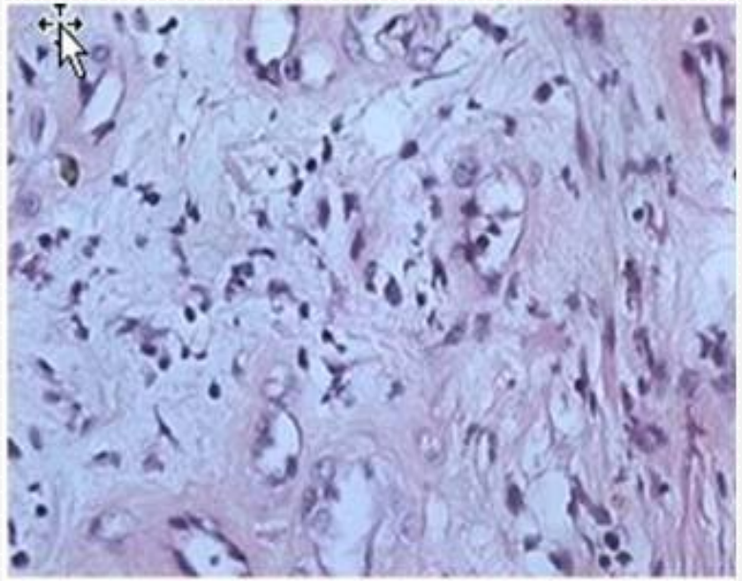


Baseline Post HBOT

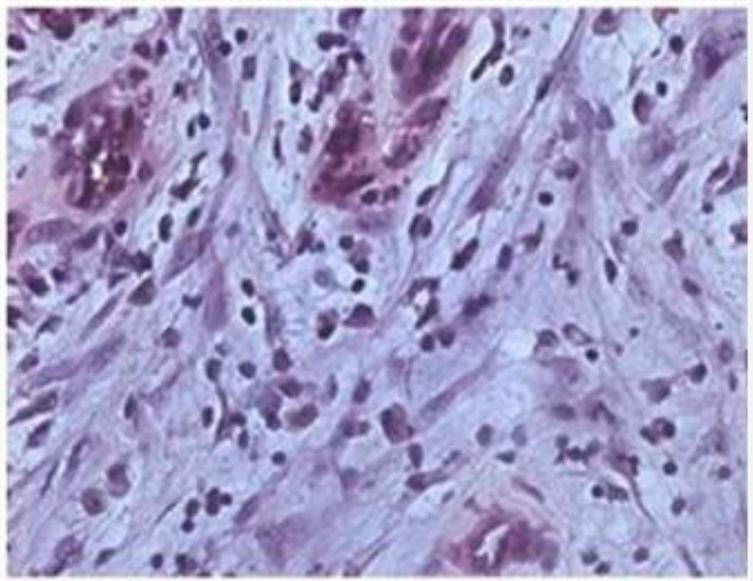
Significant increase in perfusion status in ESWT vs HBOT

Wang et al Diab Res Clin Prac.2011; .92(2): 187 – 193.

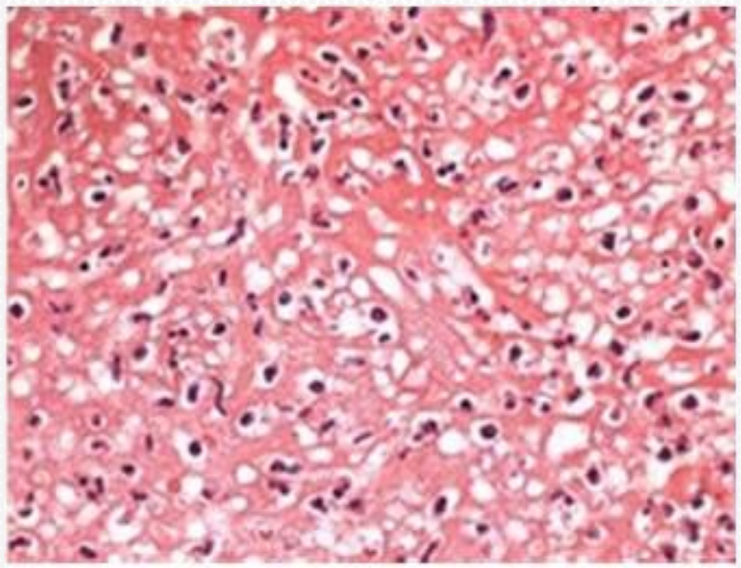
Outcome: Histological Features



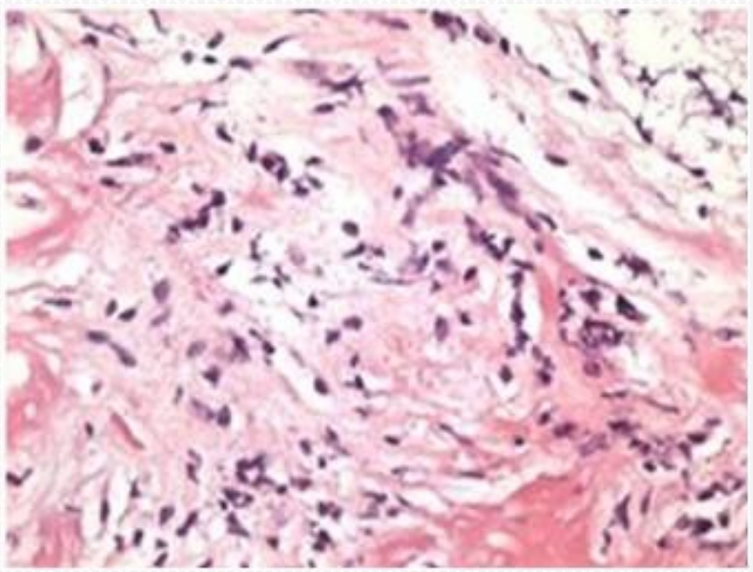
Baseline



Post ESWT



Baseline



Post HBOT

Significant increase in cell proliferation, concentration and activity in ESWT vs HBOT

Wang et al Diab Res Clin Prac.2011; 92(2): 187 – 193.

ESWT in Related Research

DIAB-5045; No. of Pages 7

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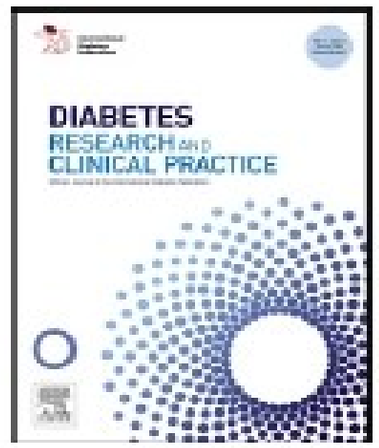

Utility of extracorporeal shock wave therapy to restore sensory perception in an insensate type-1 diabetic: an original exploratory case study

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Results: Baseline vs Post Tx – at 24wk

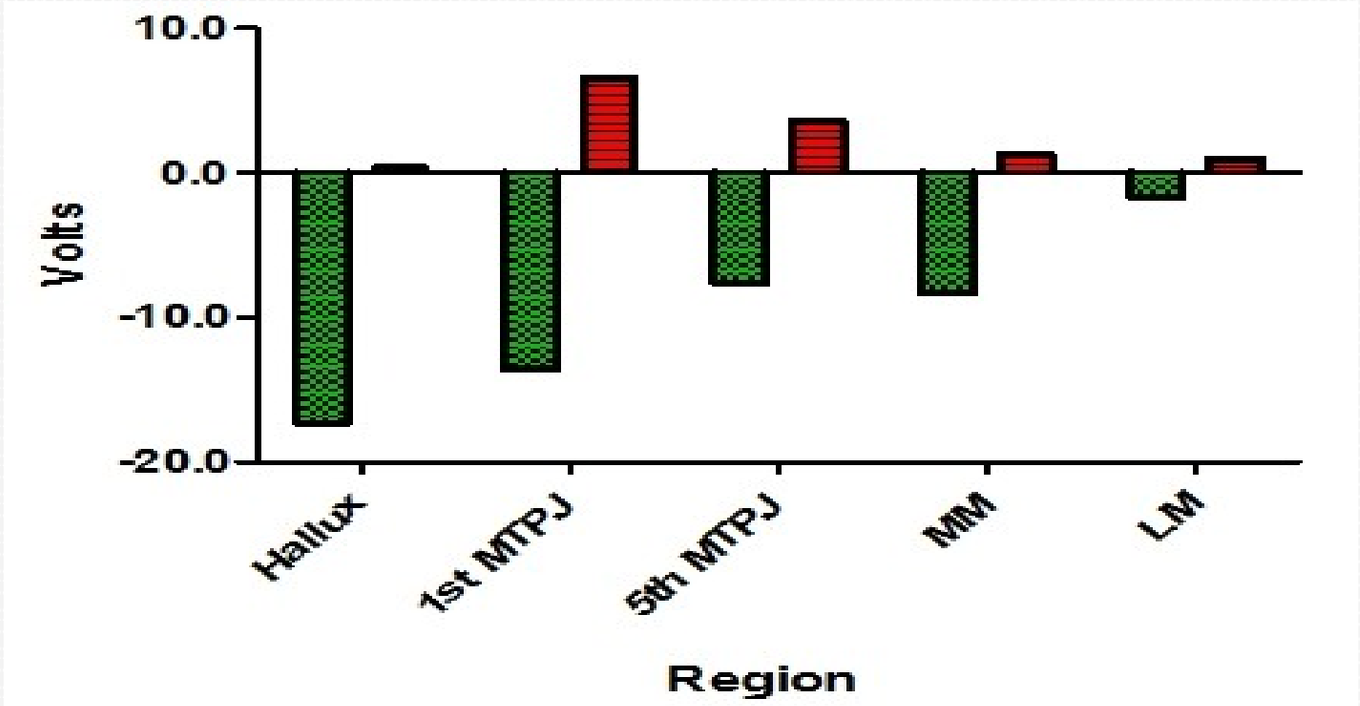


Figure 1 Comparison of post Tx. outcomes in vibration perception (Biothesiometer) scores:

Txl. (green) less volts required to detect stimulus from baseline.

Ctrl. (Red) continued disease progression from baseline

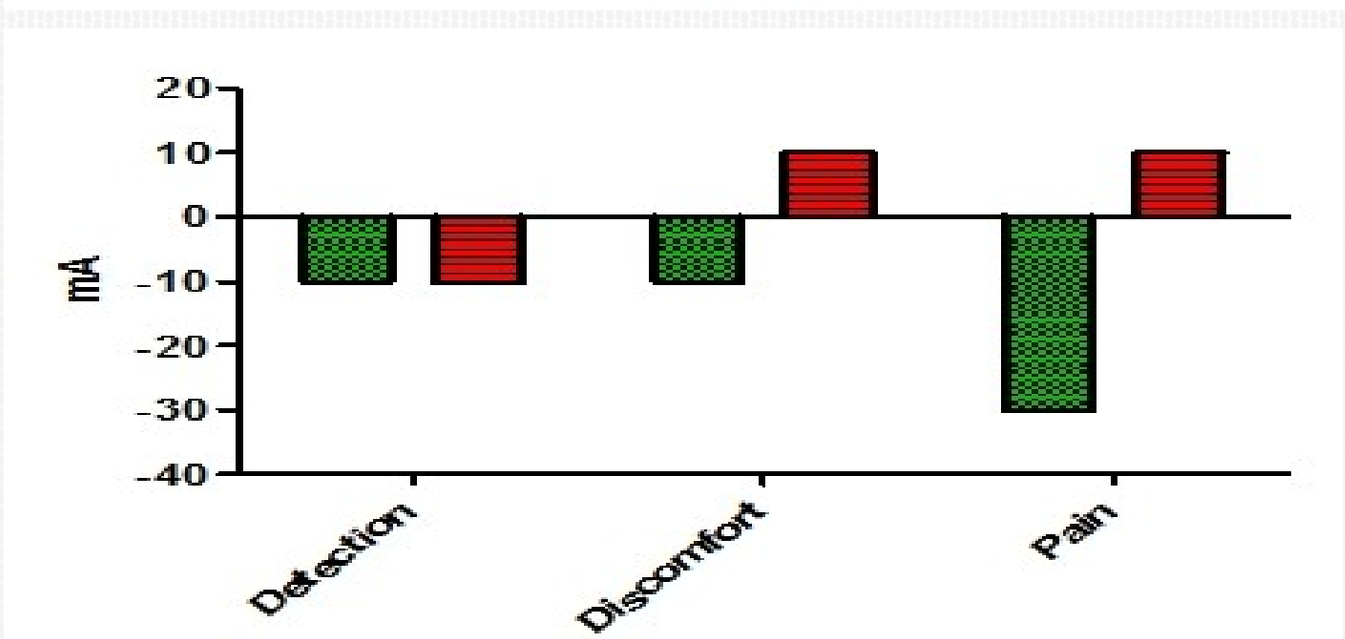


Figure 2 Comparison of post Tx. outcomes in electro-stimulation scores:

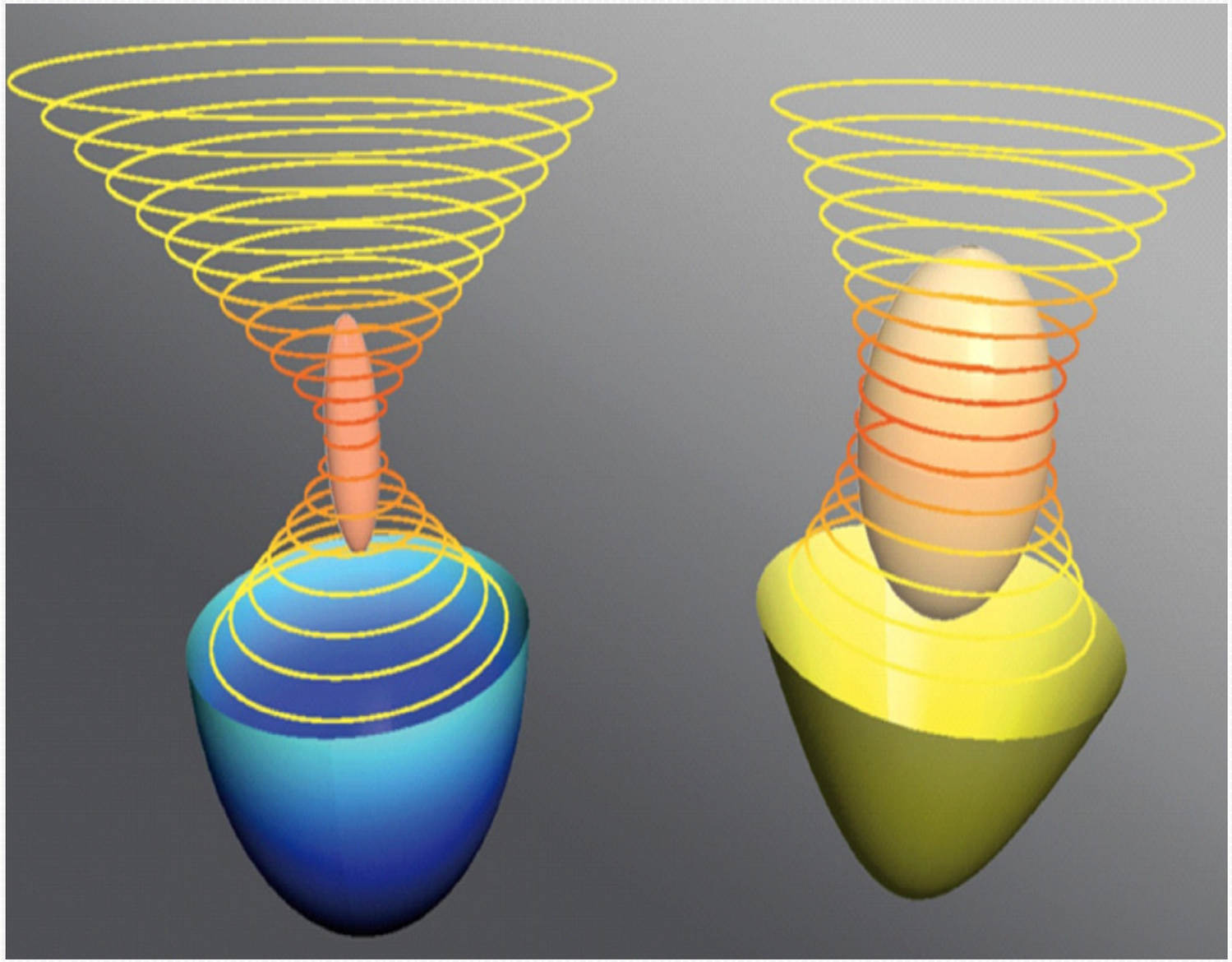
Txl. (Green) less volts required to detect stimulus in all 3 domains from baseline.

Ctrl (Red) continue disease progression except in detection domain – *which is a confounding factor*.

Results: Baseline vs Post Tx – at 24wk

Investigations	Pre-ESWT	Post ESWT	Comments
10g Monofilament	4/10 regions detected	9/10 regions detected	Improvement to pressure & touch perception
128Hz Tuning Fork	Undetected in 5 regions	Detected in all 5 regions	Improvement to vibration perception
Neurotip	Not distinguished	Distinguished in 4/5 regions	Improvement to noxious / innocuous detection
Thermal	Intact	Intact	Unchanged
Electrostimulation	DE: 25mA DC: 45mA PN: 135mA	DE:15mA DC: 35mA PN; 105mA	Overall improvement observed in all 3 domains of stimulus; Detection, Discomfort and Pain. Highest change noted in Pain Domain .
Biothesiometer	37.74volts (Average)	28.04volts (Average)	Overall improvement observed over all 5 regions.
Subjective report			Patient noted sensory changes in Txl in being able to feel fine sand particles and water droplets from a hand held shower.

ESWT: Physics



Electrohydraulic shockwave field:

Ellisoidal (Blue)
Parbolic (Yellow)
Focused / diffused
High / Soft-intensity
Narrow / wide therapeutic zone

ESWT: Impact on Human Tissue

References: 16 - 45

ESWT: Safety & Efficacy

Rationale for further investigation & implementation for DFU's

ology 1970's

- Systemically neutral
- Safe
- Hypoxic & Ischaemic correction
- Neuro modulation
- Inflammation modulation
- Tissue synthesis promotion
- High rate of resolution
- Low number of Tx
- Economically viable

thopaedics &
orts Medicine
90's
ardiology 2000
ED 2010

References: 16 - 45

Welcome

19th International Congress of the **ISMST 2016**

International Society for Medical Shockwave Treatment

KUCHING, SARAWAK
MALAYISA

14 - 16 July 2016

Reference

1. National Institute for Health and Clinical Excellence. Diabetic foot problems: inpatient management of diabetic foot problems. Clinical guideline 119. London: NICE, 2011. Available at: http://publications.nice.org. uk/diabetic-foot-problems-cg119. Accessed March 2013.
2. Brownrigg JR, Davey J, Holt et al. The association of ulceration of the foot with cardiovascular and all-cause mortality in patients with diabetes: a meta-analysis. Diabetologia 2012; 55(11): 2906-12.
3. Yazdanpanah L, Nasiri M, & Adavishi S. Literature review on the management of diabetic foot ulcers. World J Diabetes 2015; 6(1):37 – 53.
4. Lavery LA, Armstrong DA, Wunderlich RP, et al. Risk factors for foot infections in individuals with diabetes. *Diabetes Care 2006; 29(6):* 1288-93.
5. The EURODIALE Study. Diabetologica. 2008; 51(5): 747 – 755.
6. Prompers L, Huijberts M, Apelqvist J, Jude E, Paiggesi A, et al. High prevalence of risk ischaemia, infection and comorbidity in patients with diabetic foot disease in Europe. Diabetologica. 2007; 50(1): 18 – 25.
7. Malgrange D. Pathophysiology of the diabetic foot. Rev. Med Interne. 2008; 29 Suppl.2 S231 – S237.
8. Apelqvist J. Diagnostics and treatment of the diabetic foot. Endocrine 2012; 41(3): 384 – 397.
9. Bakker K, Apelqvist J, Schaper NC on behalf of the International Working Group on the Diabetic Foot Editorial Board. *Practical guidelines on the management and prevention of the diabetic foot 2011. Diabetes Metab ResRev 2012; 28(Suppl 1): 225-31.*
10. European Wound Management Association (EWMA). Position document: *Wound bed preparation in practice. London: MEP Ltd, 2004.*
11. Chadwick P. International case series: using Askina® Calgitrol® Paste in the treatment of diabetic foot infection: case studies. London: *Wounds International, 2013.*
12. Lipsky BA, Holroyd KJ, Zasloff M. Topical antimicrobial therapy for treating chronic wounds. *Clin Infect Dis 2009; 49(10): 1541-49.*
13. Phillips PL, Wolcott RD, Fletcher J, et al. Biofilms Made Easy. *Wounds International 2010; 1(3):*
14. Davis SC, Martinez L, Kirsner R. The diabetic foot: the importance of biofilms and wound bed preparation. *Curr Diab*

Reference

17 Wang CJ, Wu RW & YangYJ. Treatment of diabetic foot ulcers: A comparative study of extracorporeal shockwave therapy and hyperbaric oxygen therapy . DiabRes Clin Prac. 2011; 92(2): 187 – 193.

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

19 Gotte G, Amelio E, Russo S, Marlinghaus E, Musci G, Suzuki H. Short-time non-enzymatic nitric oxide synthesis from L-arginine and hydrogen peroxide induced by shock waves treatment. *FEBS Lett 2002; 520: 153–5.*

20 Kuo YR, Wang CT, Wang FS, Yang KD, Chiang YC, Wang CJ. Extracorporeal shock wave treatment modulates skin fibroblast recruitment and leukocyte infiltration for enhancing extended skin-flap survival. *Wound Repair Regen 2009; 17: 80–7.*

21 Mariotto S, Cavalieri E, Amelio E, Ciampa AR, de Prati AC, Marlinghaus E, Russo S, Suzuki H. Extracorporeal shock waves: from lithotripsy to anti-inflammatory action by NO production. *Nitric Oxide 2005; 12: 89–96.*

22 Mittermayr R, Hartinger J, Antonic V, Meinl A, Pfeifer S, Stojadinovic A, Schaden W, Redl H. Extracorporeal shock wave therapy (ESWT) minimizes ischemic tissue necrosis irrespective of application time and promotes tissue revascularization by stimulating angiogenesis. *Ann Surg 2011; 253:* 1024–32.

23 Nishida T, Shimokawa H, Oi K, Tatewaki H, Uwatoku T, Abe K, Matsumoto Y, Kajihara N, Eto M, Matsuda T, Yasui H, Takeshita A, Sunagawa K. Extracorporeal cardiac shock wave therapy markedly ameliorates ischemia-induced myocardial dysfunction in pigs in vivo. *Circulation 2004; 110: 3055–61.*

24 Brañes C, Contreras H, Cabello P, Antonic V, Guiloff L, Brañes M. Rotator cuff responses to extracorporeal shockwave therapy (ESWT): morphological and immunohistochemical analysis. *J Shoulder Elbow Surg (In press).*

25 Aicher A, Heeschen C, Sasaki K, Urbich C, Zeiher AM, Dimmeler S. Low-energy shock wave for enhancing recruitment of endothelial progenitor cells: a new modality to increase efficacy of cell therapy in chronic hind limb ischemia. *Circulation 2006;* 114: 2823–30.

26 Ciampa AR, de Prati AC, Amelio E, Cavalieri E, Persichini T, Colasanti M, Musci G, Marlinghaus E, Suzuki H, Mariotto S. Nitric oxide mediates anti-inflammatory action of extracorporeal shock waves. *FEBS Lett 2005; 579: 6839–45.*

Reference

27 Moretti, B., Notarnicola, A., Maggio, G., Moretti, L., Pascone, M., Tafuri, S & Patella, V. (2009). A volleyball player with bilateral knee osteochondritis dissecans treated with extracorporeal shock wave therapy. Musculoskeletal Surgery 93(1) 37 – 41.

28 Craig K, d'Agostino M, Poratt D & Walker M. Original hypothesis: Extracorporeal shockwaves as a homeostatic autoimmune restorative treatment (HART) for Type 1 diabetes mellitus. Med Hypotheses. 2014;83(1); 250 – 253.

29 Angehrn F, Kuhn C, Sonnabend O, Voss A. Impact of extracorporeal shock waves on the human skin with cellulite: a case study of an unique instance. Clin Interv Ageing 2008;3(1):175–82.

30 Craig K, D'Agostino C, Poratt D, Lewis G, Hing W. Original Exploratory Case Study: Utilization of ESWT to Restore Peripheral Vibrosensory Perception in a non-Sensitive Type I Diabetic Foot. Paper Presented at the 15th International Society for Medical Shockwave Treatment Congress, Cartagena, Columbia, 2012.

31 Cacchio, A., Giordano, L., Colafarina, O., Rompe, J. D., Tavernese, E., Ioppolo, F., Flamini, S., Spacca, G. & Santilli, V. (2009). Extracorporeal Shock-Wave Therapy Compared with Surgery for Hypertonic Long-Bone Nonunions. The Journal of Bone and Joint Surgery, 91 2589 – 2597.

32 Craig, K. & Miller, A. (2011). Extracorporeal shockwave therapy (ESWT) an option for chronic tendinopathy management: a clinical perspective. New Zealand Pain Society Publication, Summer Issue, 8 – 16.

33 Craig, K. & Walker, M. (2012). Medical Shockwaves for the treatment of peripheral neuropathic pain in a Type II diabetic: a case report. New Zealand Pain Society Publication, Winter Issue, 7 – 16.

34 D'Agostino, C. Romeo, P., Amelio, E. & Sansone, V. (2011). Effectiveness Of ESWT In The Treatment Of Kienbock's Disease. Ultrasound in Medicine and Biology, 37(9), 1452 – 1456.

35 Furia, J. P. (2008). Jigh Energy Extracorporeal Shock Wave Therapy as a Treatment for Chronic Non-insertional Achilles Tendinopathy. The American Journal of Sports Medicine 36(3) 502 – 508.

36 Moretti, B., Notarnicola, A., Maggio, G., Moretti, L., Pascone, M., Tafuri, S & Patella, V. (2009). The management of neuropathic ulcers of the foot in diabetes by shock wave therapy. BMC Musculoskeletal Disorders 10 (54). Retrieved May 20, 2009 from www.biomedcentral.com/1471-2474/10/54/

Reference

37 Notarnicola, A., Moretti, L., Tafuri, S., Panella, A., Filipponi, M., Casalino, A., Panella, M. & Moretti, B. (2010). Shockwave therapy in the management of complex regional pain syndrome in medial femoral condyle of the knee. Ultrasound in Medicine & Biology, 36 (6) 874 – 879

38 Romeo, P. D'Agostino, C. M., Lazzerini, A., Sasone, V. C. (2011). Extracorporeal Shockwave Therapy inPillar Pain after Carpal Tunnel Release: A Preliminary Study. Ultrasound in Medicine and Biology, 37(10), 1603 – 1608..

39 Schaden, W., Thiele, R., Kölpl, C., Pusch, M., Nissan, A., Attinger, C. E., Maniscalo-The berge, M. E., Peoples, G. E., Elster, E. A. & Stojadinovic , A. (2007). Shock Wave Therapy for Acute and Chronic Soft Tissue Wounds: A Feasibility Study, 143 (1) 1 – 12.

40 Taki, M., Iwata, O., Shiono, M., Kimura, M. & Takagishi, K. (2007). Extracorporeal Shock Wave Therapy for Resistant Stress Fracture in Athletes. The American Journal of Sports Medicine, 35 (7) 1188 – 1192.

41 Tizanni, E., Amelio, E., Marangoni, E., Guerra, C., Puccetti, A., Codella, O. M., Simeoni, S., Cavalieri, E., Montagnana, M., Adani, R., Corrocher, R. & Lunardi, C. (2010). Effects of shock wave therapy in the skin of patients with progressive systemic sclerosis: a pilot study. Rheumatology International, 12. Retrieved January 28, 2010

42 Trompetto, C., Avanzino, L., Bove, M., Marinelli, L., Molfetta, L., Trentini, R. & Abbruzzese, G. (2009). External shock waves therapy in dystonia: preliminary results. European Journal of Neurology, 16 (4) 517 – 521.

43 Vasyuk, Y. A., Hadzegova, A. B., Shkolnik, E. L., Kopeleva, M. V., Krikunova, O. V., Iouchtchouk, E. N., Aronova, E. M. & Ivanova, S. V. (2010). Initial Clinical Experience With Extracorporeal Shock Wave Therapy in Treatment of Ischemic Heart Failure. Original Research.

44 Yardi, Y., Appel, B., Jacob, G., Massarwi, O. & Gruenwald, I. (2010). Can low-intensity Extracorporeal Shockwave Therapy Improve Erectile Function? A 6-Month Follow-up Pilot Study in Patients with Organic Erectile Dysfunction. European Urology, *58*: 243 –248.

45 Wang, C. J., Ko, J. Y., Chan, Y. S., Weng, L. H., Hsu, S. L. (2007). Extracorporeal Shockwave for Chronic Patellar Tendinopathy. The American Journal of Sports Medicine, 35(6) 972 – 978.

46 Pastar I, Stojadinovic O, Yin NC, Ramirez H et al. Epithelialization in Wound Healing : A Comprehensive Review. Advances in Wound Care. 2014; 3(7); 445 – 464.

47 Ramirez H, Patel SB & Pastar I. The Role of TGFß Signaling in Wound Epithelialization. Advances in Wound Care. 2014;

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