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Novel pulsatile insulin therapy in foot crush syndrome by using BIONICA-MDI: A case study

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Abstract
This case study highlights the remarkable recovery of a 19-year-old male from a severe road traffic accident with right foot crush injury. The patient sustained extensive soft tissue trauma, comminuted fractures, joint dislocations, and was advised to undergo trans-metatarsal or below-knee amputation based on the viability of the skin flap and soft tissues. The patient refused amputation, and choose treatment at StemRx Bioscience Solutions Pvt. Ltd., Navi Mumbai. Over the next four months, the patient was treated with a treatment protocol that involved serial debridement, wound dressings, bone and skin grafting, antibiotics, growth factors, peptides, along with 52 sessions of BIONICA-MDI i.e., pulsatile insulin therapy. This interdisciplinary method focuses on restoring mitochondrial function, improving carbohydrate metabolism, lipid metabolism, enhancing cellular repair, that led to a successful limb salvage, restoring tissue integrity, and avoiding amputation. The case highlights the therapeutic potential of BIONICA-MDI in the management of complex crush foot injury and its role in improving mitochondrial function, reducing inflammation, and accelerating wound healing.

Keywords: Crush Foot injury, mitochondrial dysfunction, carbohydrate metabolism, lipid metabolism, pulsatile insulin therapy, BIONICA-MDI

1. Introduction
A crush injury occurs when an external force causes significant direct physical trauma to the soft tissues of a body part. This results in extensive muscle and nerve damage, bone damage, ischemia, tissue necrosis and systemic effects. Around, 20% of such patients require hospitalization due to crush injuries [1]. Crush Injuries occur in various settings, including motor vehicle accidents (both at home and elsewhere) and other types of accidents and disasters (including earthquakes, landslides, mine disasters, explosions, collapsing buildings, terrorist attacks, wars and plane crashes) [2].
Under normal physiological conditions, mitochondria are responsible for the production of the majority of adenosine triphosphate (ATP) in neurons [3, 4]. The injured tissue, including mitochondria experiences severe oxidative stress as a result of traumatic nerve injury [3]. This reduces ATP production, increases oxidative stress, and subsequent cell death, as well as a range of abnormal cellular processes [5]. Mitochondrial dysfunction will be improved by BIONICA-MDI (pulsatile insulin therapy) treatment.

2. Case presentation
19 years old rear passenger on a motorbike wearing helmet was hit by a motor vehicle with injury to the right foot. Patient sustained crush injury and fracture of right foot. Patient went to hospital, where wound debridement, suturing of lacerations and below knee back slab was applied to stabilize the foot.
The patient's X-ray showed fracture and loss of 1st metatarsal middle and distal part and loss of proximal part of proximal phalanx. Fracture and loss of proximal 2/3rd of 2nd metatarsal. Great toe- flexor and extensor tendons were damaged. There was gross soft tissue hematoma. The treatment plan rested on his damaged skin and soft tissue condition. If the skin and soft tissue condition (flap) is viable, patient would have surgery in the form of wound debridement / Trans-metatarsal amputation / Fixation. A below-knee amputation would be the next course of action if necrosis was found in order to improve the patient's functionality. Patient was not willing for surgery and expressed desire to travel abroad for further treatment. Patient was explained the risks attributable to not undergoing surgery for an open fracture *viz.*

Infection with the possibility of sepsis, osteomyelitis, necrotizing fasciitis, acute compartment syndrome, limb length discrepancy, fracture non-union/ Malunion, Deep venous thrombosis formation, embolization syndromes- Fat embolism, Marrow embolization, Septic embolization, Air embolism, Chronic pain syndrome, Reflex sympathetic dystrophy, loss of limb (Amputation), Neuropraxia / Nerve injury, Acute limb ischemia.

2.1 Treatment protocol

Patient came to StemRx Bioscience Solutions Pvt Ltd, Navi Mumbai, for further treatment. Over the next four months patient underwent serial debridement, dressings, spilt thickness, skin grafting, Bone grafting, antibiotics, growth factors, peptides and BIONICA-MDI treatment. 52 sessions of BIONICA-MDI therapy were administered over 4 months. While these interventions i.e., insulin injectable subcutaneous or intravenous have helped slow the decline in the health of foot crush injury, they have not been able to halt or reverse complications.

3. Results

The patient showed gradual and incremental improvement. The integrated use of BIONICA-MDI therapy, and standard wound care resulted in successful limb salvage with restoration of tissue integrity and function. BIONICA-MDI was an instrument in expediting the healing of the wound of the patient.

(a) **(b)**

Fig 1a: Day 1 - Pre - treatment (front view)

Fig 1b: Day 1 - Pre - treatment (side view)

(a) **(b)**

Fig 2a: At 15 days surgery

Fig 2b: At 15 days surgery

(a) **(b)**

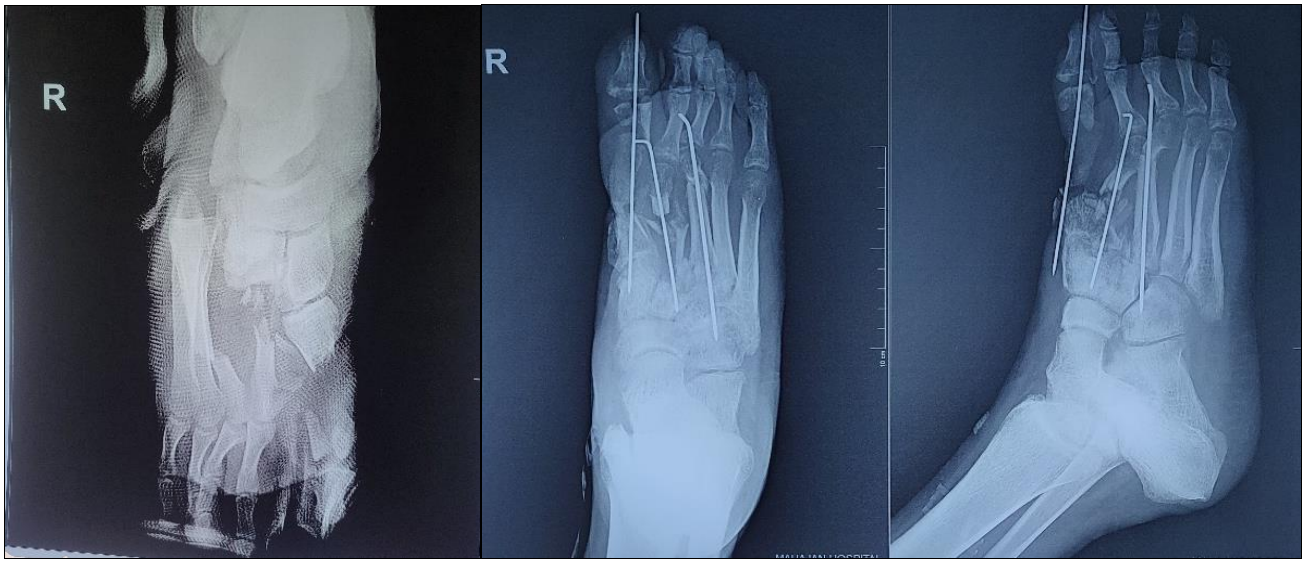
Fig 3a: Post 2 months foot healing (Front view)

Fig 3b: Post 2 months Foot healing (side view)

(a) **(b)**

Fig 4a: Post 4 months Foot healing (side view)

Fig 4b: Post 4 months foot healing (Front view)



(a) **(b)**

Fig 5a: X-ray of right foot on day 1

Fig 5b: X-ray of right foot at 4 months

Comminuted displaced, separated fracture of 1st, 2nd and 3rd metatarsals with dislocation seen at 3rd, 4th and 5th tarso-metatarsal joints. The soft tissue spaces show swelling over the foot.

K-wire are noted in the 1st, 2nd and 3rd metatarsal for the fracture, alignment as shown. K-wire is also noted in cuboid bone. Joint spaces appear normal. The soft tissue spaces show mild swelling over the foot.

4. Discussion

The lower extremities are most frequently affected by direct physical trauma and compression that cause a crush injury to the human body [6]. Dysfunction of mitochondrial is linked to the pathogenesis of chronic wounds [7].

It has long been known that plasma levels of insulin vary rhythmically and that this periodicity reflects the pulsatile release of the hormone from the pancreas. Results in a periodic depolarization with influx of Ca^{2+} in the Langerhans islets' β-cells. Within the islets, the cells' inherent rhythmicity is coordinated both through cell contact and via extracellular messengers, primarily ATP. The adaptation of the different islets in the pancreas to the same oscillatory phase occurs via nerve impulses from autonomic ganglia [8].

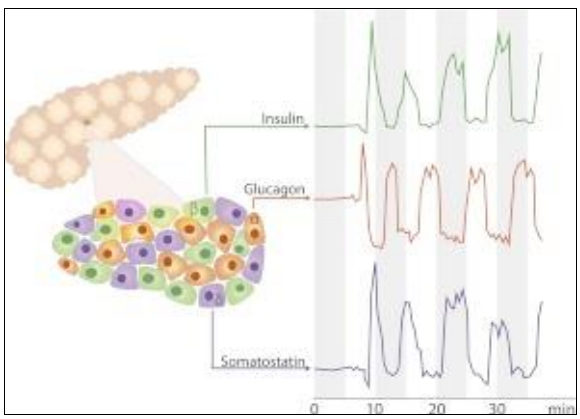


Fig 6: Schematic representation of the pulsatile nature and temporal relationships of insulin, glucagon, and somatostatin secretion by glucose stimulated human β-cells [10]

BIONICA-MDI (pulsatile insulin therapy) involves pulsatile bursts of intravenous insulin infusion at repeated intervals of 6 mins for 3 hours. It strives to restore normal physiological variations of insulin in the liver. This can occur through stimulation of the pulsatile component in hormone release from existing β-cells and rhythmic delivery of insulin to the portal vein [8].

BIONICA-MDI mimics normal pancreas stimulation of the liver (with insulin); which is essential for the release of enzymes that mediate the ATP production for each organ in the body. It results in normalized carbohydrate and lipid metabolism. It stops and reverses complications by reducing the damage from high lipid metabolism & restoring missing cellular energy. Suppressing the free fatty acid reduces the byproducts of improperly high lipid metabolism. Inhibiting the proinflammatory cytokines improves the retention of nitric oxide, suppresses inflammatory repair (growth) factors, upregulates metabolic enzymes of glycolysis and the Krebs cycle, provides additional ATP [9]. Pulsatile Bursts of Insulin maintains peripheral insulin receptor activity and peripheral glucose uptake [8].

The integration of BIONICA-MDI therapy in the management of this complex traumatic foot crush injury with bone fractures and joint dislocations and skin and soft tissue injury case provided a significant turning point in the patient's recovery [7, 8, 9]. BIONICA-MDI therapy, combined with conventional wound care and systemic management, facilitated tissue regeneration, infection control, and functional improvement; ultimately avoiding amputation. This case highlights the potential of pulsatile insulin administration as a transformative adjunct in managing traumatic crush injury with bone injuries.

5. Conclusion

A key component of this treatment was the use of BIONICA-MDI therapy which greatly enhanced cellular repair and tissue regeneration. BIONICA-MDI therapy boosts mitochondrial function, improves carbohydrate and lipid metabolism, reducing inflammation and speeding up healing. Its ease of administration also supports greater patient compliance and more effective healthcare delivery.

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References

1. Akrivos VS, Koutalos A, Stefanou N, Koskiniotis A, Arnaoutoglou C. Crush injury and crush syndrome: A comprehensive review. EFORT Open Rev. 2025 Jun 1;10(6):424-430. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC12139709/
2. Usuda D, Shimozawa S, HT, Kako Y, Sakamoto T, Shimazaki J, *et al*. Crush syndrome: A review for prehospital providers and emergency clinicians. J Transl Med. 2023 Aug 31;21(1).
3. Lim TKY, Rone MB, Lee S, Antel JP, Zhang J. Mitochondrial and bioenergetic dysfunction in trauma-induced painful peripheral neuropathy. Mol Pain. 2015 Aug 28;11:s12990-0150057.
4. Erecińska M, Silver IA. Ions and energy in mammalian brain. Prog Neurobiol. 1994 May;43(1):37-71.
5. Cheng L, Zheng Q, Qiu K, Ker DF, Chen X, Yin Z. Mitochondrial destabilization in tendinopathy and potential therapeutic strategies. J Orthop Transl. 2024 Nov;49:49-61.
6. Kate N, Henry G, Philippa B, Heath T, Nicholas S. Mechanisms and outcomes after crush injuries of the foot. Int J Foot Ankle. 2021 Jun 10;5(2).
7. Hunt M, Torres M, Bachar-Wikström E, Wikström JD. Multifaceted roles of mitochondria in wound healing and chronic wound pathogenesis. Front Cell Dev Biol. 2023 Sep 11;11.
8. Hellman B, Gylfe E, Grapengiesser E, Dansk H, Salehi A. Insulin oscillations--clinically important rhythm. Antidiabetics should increase the pulsative component of the insulin release. Läkartidningen. 2007 Sep 8;104(32-33):2236-2239.
9. Aoki TT, Grecu EO, Arcangeli MA, Benbarka MM, Prescott P, Ahn JH. Chronic intermittent intravenous insulin therapy: A new frontier in diabetes therapy. Diabetes Technol Ther. 2001;3:111-123.
10. Wahren J, Kallas Å. Loss of pulsatile insulin secretion: A factor in the pathogenesis of type 2 diabetes? Diabetes. 2012 Sep 1;61(9):2228-2229. Available from: https://diabetes.diabetesjournals.org/content/61/9/2228

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