IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 6 Ver. III (Jun. 2015), PP 01-05
www.iosrjournals.org

Recent Advances in the Treatment of Diabetic Foot

Dr. Ravichandra Matcha, M.S.,
Assistant professor of surgery, Andhra Medical College, Visakhapatnam, India

Abstract: *As number of Diabetic patients is increasing, different chronic complications of diabetes are also increasing; Chronic Diabetic Foot Ulcer is one of the very important but most neglected complications of Diabetes. Foot ulcers in diabetic patients are not uncommon. Approximately 14% of diabetic ulcers lead to amputation & in most of the cases it is trivial foot ulcer which ultimately leads to amputation. More than 80,000 amputations are performed each year on diabetic patients in India, and around 50% of the people with amputations will develop ulcerations and infections in the contra lateral limb within 18 months. An alarming 58% will have a contra lateral amputation 3-5 years after the first amputation. In addition, the 3-year mortality after a first amputation has been estimated as high as 20-50%, and these numbers have not changed much in the past 30 years, despite huge advances in the medical and surgical treatment of patients with diabetes. But prompt treatment of chronic non healing Diabetic Foot Ulcer with multidisciplinary approach can overall change the clinical outcome in nonhealing DFU .Recent technological advancement combined with better understanding of the wound healing process have resulted in a myriad advanced wound healing modalities in the treatment of diabetic foot ulcers. A wide variety of advanced treatments for diabetic foot ulcers, such as Ultrasonic debridement, Topical growth factors, Bioengineered skin grafts(BATs), VAC(Vacuum Assisted Closure) Therapy, and hyperbaric oxygen therapy(HBOT), are available commercially now in India, and grafts(BATs), VAC(Vacuum Assisted Closure) Therapy, and hyperbaric oxygen therapy(HBOT), are available commercially now in India, and clinical studies of these products have shown some evidence of improved wound healing compared to standard wound care. During the prolonged healing process of a chronic wound, rapid and accurate evaluation of the healing progress is critical so that unsuccessful treatments can be discontinued and alternate treatments be initiated as soon as possible. Though recent advances in the management of Diabetic Foot Ulcers have increased our abilities to salvage the lower limb, the best management still remains prevention. This can only follow with intense patient education about foot care and a proactive role in treating the factors which lead to these foot problems.*

I. Introduction

Foot ulcers in diabetic patients are common. It is estimated that 15% of diabetes patients will develop Diabetic foot ulcer once in their life time and approximately 14% of diabetic ulcers lead to amputation1 Unless a prompt, rational, multidisciplinary approach to therapy is taken. Diabetic patients are 4 times more likely to develop Peripheral Vascular Disease (PVD) With 5 times greater risk of developing Critical Limb Ischemia. Ischemic changes can contribute to ulceration. Nerve damage in diabetic foot may result from the direct effect of sugars on the nerve & formation of sorbital via the polyol pathway. Neuropathy contributes to ulceration in 3 ways.1.Sensory Neuropathy- loss of sensivity to pain. Trauma can occur without the patient feeling any change. 2. Autonomic Neuropathy: The skin becomes anhydrotic loosing elasticity. Subsequent cracking of skin creates a portal of entry of infection.3.Motor Neuropathy: Muscle imbalance in the foot may cause deformity and clawing of toes. These changes increase the load on metatarsals, promoting callus formation and cavitations of deeper tissues. Interstitial fluid ruptures to the skin surface allowing bacteria to enter and infection to develop.

Factors that affect development and healing of diabetic patient's foot ulcers include the degree of metabolic control, the presence of ischemia or infection, and continuing trauma to feet from excessive plantar pressure or poorly fitting shoes. Appropriate wound care for diabetic patients addresses these issues and provides optimal local ulcer therapy with debridement of necrotic tissue and provision of a moist wound healing environment.

A wide variety of advanced treatments for diabetic foot ulcers, such as topical growth factors, bioengineered skin grafts, VAC (vacuum Assisted Closure) Therapy, and hyperbaric oxygen therapy (HBOT), are available commercially now in India, and clinical studies of these products have shown some evidence of improved healing compared to standard wound care2. During the prolonged healing process of a chronic wound, rapid and accurate evaluation of the healing progress is critical so that unsuccessful treatments can be discontinued and alternate treatments be initiated as soon as possible3, 4.

Management Of Dfu Can Be Discussed By Following Headings
A. Microbiological Control
B. Wound Control
C. Metabolic Control
D. Vascular Control
E. Mechanical Control
F. Educational Control

A. Microbiological Control

Certain principles should be followed while giving antibiotics when diabetic foot infection cases are suspected. Most of the Diabetic Foot Infections are poly microbial5. So broad spectrum Antibiotic are to be used for longer duration. Because of Immunopathy there is a Poor immune response in diabetics hence normal skin commensals can cause serious Infection.Wide spectrum of antibiotics should always be used even at initial presentation because it is Impossible to predict type & no. of microorganisms clinically, there is no way of predicting-rapidly ascending or Life threatening Diabetic Foot Infection and Triopathy of DM reduces local resistance to invading bacterias6.

B. Wound Control

After exposing the wound you should irrigate the wound with saline or diluted solution of Povidone iodine. Never use concentrated solution of Povidone iodine which damages normal granulation tissue.

VASHE Wound Cleansing Solution

VASHE is solution of Hocl (Hypochlorous Acid) .It Kills important wound pathogens like Gram +ve, Gram -ve bacteria, Anaerobes &Fungi. Gauze soaked in VASHE solution is wrapped around wound for 10-15 mnts, which cleans, irrigates, moistens & debrides the wound

Debridement (Removal Of Devitalized Tissue From Ulcer)

Once you have cleaned the wound, it should be debrided thoroughly. There are different ways of debridement like sharp, blunt, Surgical, Chemical & Auto debridement but I'm going to discuss here only two new modalities i.e. Ultrasonic debridement & Biodebridement (also known as Maggot Rx).

Ultrasonic Debridement

With ultrasonic debrider there is Ultrasonic formation & collapse of vapor bubbles who fragments & emulsify the necrotic tissue without Disturbing the viable tissue. Ultrasonic debridement is effective in removal of particulate matter. This type of debridement is particularly useful in handling deep and Tunneling wounds where debridement with other technique is difficult8.

Biodebridement Or Maggot Rx

Medicinal maggots of Lucilia sericata (Green Bottle fly) are used for debriding the dead necrotic & infected tissue of wound.

Lucilia sericata (Green Bottle fly) is used in this treatment Indications for Maggot's Rx
Contraindications for Maggot's Rx

These maggots don't eat or disturb normal host tissue. Benefits of Maggot's therapy are good debridement with removal of dead necrotic tissue and elimination of infection9. Shortcomings of Maggot's therapy are that Medicinal maggots are Costly & difficult to get. They have short shelf life, pt. can have uncomfortable crawling sensation & once move out of dressing. Maggots can create lot of neusense.

VAC (Vaccum Assisted Closure)/ Npwt (Negative Pressure Wound Therapy)

VAC4. Computerized Rx Unit After cleaning & debriding the wound a special granufoam dressing is applied over wound which is connected to special Computerized Rx unit with plastic tubing. This Computerized Rx Unit applies 125mmHg negative pressure to wound which draws exudates etc. into a special canister attached to Unit. VAC therapy helps in reducing edema, exudates and bacterial load & also helps in regeneration of granulation tissue & neo vascularisation10.

Autologel-Autologus Platelet Rich Plasma (Prp) Gel

This new modality for wound healing is based upon principle of platelets containing components & properties for wound healing & plasma containing fibrin matrix. Procedure- Depending upon the size of ulcer, around 5 to 30 ml Patient's blood is centrifuged & Platelet Rich Plasma is separated. This PRP is taken into a

syringe having different reagents [Thrombin (CaCl2) & Vita C], who activate platelets & make gel consistency. This is known as Autologel.

This gel like material is applied over wound twice a week for 12 Weeks & it was observed by Vickie R. Driver etal, that 68.4% of those wounds which were treated with Autologel healed in Comparison to 42.9% of Control wounds11.

O2 MISLY

After Cleaning & Debriding the wound pt. puts his lower limb in a Canister of O2 Misly machine & wound is exposed to 4 Cycles of 100% O2 (5 mnt.each) alternatively with Vapor of water & antibiotic (10 mnt.each).

This therapy is given twice a week for 12 to 20 weeks. Ubbink DT et al found that in comparison to standard wound care proportion of healed Wounds with use of **O2 Misly** were 200% better at 12 to 20 week12.

LLLT (Low Level Laser Therapy)

LASER is Light Amplification by Stimulated Emission of Radiation. There has been lot of medical indications of using Laser & one

LLL unit

Indication is nonhealing Diabetic Foot Ulcer. Wound is exposed to Low Level Laser Therapy which activates

microcirculation & Macrophages leading to Anti-inflammatory, analgesic, regenerative, bacteriostatic & bactericidal clinical effects on wound. Martinez-Sanchez G et al. found Low Level Laser Therapy Very effective in healing of Chronic Nonhealing diabetic Foot Ulcer13.

Growth Factors

The term growth factor refers to a naturally occurring protein capable of stimulating cellular proliferation and cellular differentiation .There are different types of Growth Factors which are involved in wound healing.

Growth Factors involved in wound healing

US FDA has so far approved only two types of growth factors for use in chronic wounds. They are Platelet derived growth factor (PDGF) and epidermal growth factor (EGF). Most commonly used Plermin (rh PDGF BB, Recombinent human Platelet derived growth Factor) has Chemo tactic, mito genic, angio genic and stimulatory effects and helps in wound healing if used in noninfected superficial wounds14.

Ozone Therapy

Ozone is "active oxygen". It is triatomic allotrope of oxygen formed by recombination of oxygen atoms. It is a Colorless pungent-odor gas. Ozone disinfects, oxidizes, deodorizes and decolorizes. Ozone is very strong oxidant and is found to be more than 3000 times powerful disinfectant than chlorine. Peripheral Ozone Therapy is very effective for badly-infected and Non-healing Ulcers like chronic Diabetic foot ulcers .Technique of

giving Peripheral Ozone Therapy is known as "Bagging" .That means after preparing the wound, limb is covered with a plastic bag & a tube from Ozone generator is tightly secured in upper portion of bag.

Wound is exposed to Ozone for 20 to 30 mnts.

Hyperbaric O2 (HBO) Therapy

Hyperbaric oxygen therapy means exposing pt. to 100% oxygen under increased atmospheric pressure. Two types of HBO chambers are available. Monoplace & Multiplace Chambers. In Monoplace chamber one person can lie down inside glass chamber and he is exposed to pressurized oxygen for a prescribed limit of time. While Multiplace chamber is like a big Oil-tanker in Which number of patients can simultaneously be exposed to HBO. Pt. is placed in Monoplace / Multiplace HBO Chamber & he breaths 100% oxygen under increased (2 to 3 times) atmospheric pressure for 90 to 120 mnts. This Increases tissue oxygen tension, angiogenesis, fibroblast proliferation, collagen deposition and enhanced bacterial killing32. This Rx is given for 5 days a week & total such 20 to 40 treatments are given depending upon size & severity of wound. Improved wound healing & reduced rate of amputations were observed in significant no. of cases of DFU by Stone JA et al.33

Skin Grafts –APLIGRAF

Whenever size of wound is large & it is superficial & well granulated, it needs skin grafting. Skin graft can be natural skin grafts or Apligraf Bioengineered grafts Apligraf is Bioengineered Epidermis & Dermis

Graft, developed from foreskin of Newborn. Indications of using Apligraf are Ch. Non Healing (non infected) DFU34 or Superficial Venous Ulcers35.

C. Metabolic Control

Controlling Blood sugar and other general parameters are equally important for comprehensive management of Ch. Non healing Diabetic Foot Ulcer. If wound is small & superficial one can use OHAs (Oral Hypoglycemic Agents) for controlling Blood sugar in Type II DM. Pt. should be put on Insulin if wound is large, Infected, necrotic & Patient has septicemia, looks toxic and or has Diabetic Keto acidosis. DKA should be treated & hydration should be maintained. Take care of pt's nutrition, if hypo proteinemia is present, treat it.

D. Vascular Control

Whenever pt of DFU comes always put your fingers on peripheral Arteries like DP, PT, Pop & femoral. If two or more than 2 arteries are impalpalpable & or ABI (Ankle Brachial Index) is low get Peripheral Vascular Doppler & Angiography done, if need arises. If arterial occlusion is less than 10 cm then different options available Are-Intra-arterial Thrombolysis, Endarterectomy & Angioplasty which can be conventional Balloon Angioplasty with or without Stents, Sub intimal angioplasty, Lasers Angioplasty and Rotablaters for hard plaque. If arterial occlusion is more than 10 cm then different types of Vascular Grafts (Natural or Synthetic) are applied to bypass the occlusion & to achieve good circulation distal to occlusion leading to healing of ulcer. In-flow vessel disease is common in diabetic patients. In-flow reconstruction can be achieved surgically with an aorto-bifemoral, or axillo-bifemoral bypass in cases of bilateral disease.Femoro-femoral crossover, or ilio-femoral bypass can be used in unilateral disease.

E. Mechanical. **TCC (Total Contact Cast)** is just like applying plaster around fracture of foot or leg.TCC can be made of Plaster of Paris (POP) or Fiberglass. Although best offloading is achieved by TCC (37) but it is Cumbersome, time consuming & needs expertise & one cannot follow the growth of wound. Most of these shortcomings of TCC can be overcome by using ITCC i.e. Instant Total Contact Cast which was developed by Dr. David G. Armstrong et al. of Chicago38.

Summary

Most Common Cause of hospitalization in Diabetics is Diabetic foot problems. Since no. of Diabetics is increasing hence different complications related to diabetes are also increasing including non healing diabetic foot ulcers. Minor ulcer can lead to Amputation. so one should be cautious since beginning. Newer & more advanced techniques are now available for better wound care including VAC therapy, Hyperbaric Oxygen Therapy, Growth Factors, Bioengineered Skin grafts, Maggot's therapy etc. If Diabetic Foot Ulcer is not improving one should refer case to Podiatrist or specialist. The holistic care of diabetic foot ulcer requires a multidisciplinary team approach. Apart from blood sugar control, treatment of ulcer involves debridement, offloading, appropriate dressings, vascular maintenance and Infection control.

References

[1]. Reiber GE, Lipsky BA, Gibbons GW. The burden of diabetic foot ulcers. Am J Surg. 1998; 176(2A Suppl):5S–10S.
[2]. Sibbald RG, Orsted HL, Coutts PM, Keast DH. Best practice recommendations for preparing the Wound bed: update 2006. Adv Skin Wound Care. 2007; 20(7):390–405.
[3]. Goldman RJ, Salcido R. More than one way to measure a wound: an overview of tools andTechniques. Adv Skin Wound Care. 2002; 15(5):236–243.
[4]. Jessup RL. What is the best method for assessing the rate of wound healing? A comparison of 3 Mathematical formulas. Adv Skin Wound Care. 2006; 19(3):138–146.
[5]. Lipsky BA, Clin.Infect.Dis.25:1318-1326, 1997.
[6]. Benjamin A. Lipsky, Levin & O'Neal's Textbook of "The Diabetic Foot"6th Edition, 2001:475-476.
[7]. Selkon, JB Cherry, GW Wison, JM & Huges MA (2006).Evaluation of Hypochlorous acid washes in The Tt.of Ch. Venous Ulcers. J.Wound Care, 15:33-37.
[8]. Martin E. Wendelken, et al. A Closer Look At Ultrasonic Debridement, Volume23-issue8-August2010.
[9]. Sherman RA. Cohort study of maggot therapy for treating diabetic foot ulcers. Diabetes Care.26(2):446-51; 2003.
[10]. Morykwas, M.J. et al: Stat of Basic Research & Physiologic Foundation, Plastic& Reconstructive Surgery. 1117 Supplement: 121S-126, 2006.
[11]. Vickie R. Driver; Jason Hanft;Carelyn P. Flyiing; Judy m. Beriou, Autologel Diabetic Foot UlcerStudy Group, Ostomy/wound Management 2006; 52:68-87.
[12]. Ubbink DT, Vermeulen H, Lubbers MJ, Local wound care: evidence based treatments& dressings. Ned Tijdscher Geneeskd 2006; 150:1165-72.
[13]. Martinez-Sanchez G, Al-Dalain SM, Menendez S, Re L, Giuliani A, Candelario-Jalil E, Alvarez H, Fernandez-M, Eur J Pharmacology. 2005 Sep 27.
[14]. David L. Steed MD, the Diabetic Ulcer Study Group and From the University of Pittsburgh, Presbyterian University Hospital, Pittsburgh, Journal of Vascular Surgery Volume 21, Issue 1 January1995, Pages 71-81.
[15]. Martinez-Sanchez G, Al-Dalain SM, Menendez S, Re L, Giuliani A, Candelario-Jalil E, Alvarez H, Fernandez-M, Euro J Pharmacology. 2005 Sep 27.

[16]. Millington JT, Norris TW. Effective treatment strategies for diabetic foot wounds. J Fam Pract 2000Nov; 49(11 Suppl):S40-8.
[17]. Cianci P, Hunt TK. Adjunctive hyperbaric oxygen therapy in treatment of diabetic foot wounds. In:Levin ME, O'Neal LW, Bowker JH, Eds. The Diabetic Foot. 5th ed. St Louis, Mo: Mosby-Year Book;1993.
[18]. Abidia A, Laden G, Kuhan G et al. (June 2003). "The role of hyperbaric oxygen therapy in ischemic Diabetic lower extremity ulcers: a double-blind randomized-controlled trial". Euro J Vasc Endovascular Surg 25 (6): 513–518. Doi:10.1053/ejvs.2002.1911PMID 12787692.
[19]. Kalani M, Jörneskog G, Naderi N, Lind F, Brismar K (2002). "Hyperbaric oxygen (HBO) therapyIn treatment of diabetic foot ulcers. Long-term follow-up". J. Diabetes Complicate. 16 (2): 153–158. Doi: 10.1016/S1056-8727(01)00182-9 PMID12039398.
[20]. Demello F.J., Hashimoto T., Hitchcock C.R., and Haglin J.J. The effect of hyperbaric oxygen on the Germination and toxin production of Clostridium perfringens spores. In Wada J. and Iwa J.T. (Eds): Proceedings of the Fourth International Congress on Hyperbaric Medicine. Baltimore: The Williams & Wilkins Co., 1970, p. 276.
[21]. Peirce E.C. II. Gas gangrene: a critique of therapy. Surg Rounds 7:17-25, 1984.
[22]. Escobar SJ, Slade JB, Hunt TK, Cianci P (2005). "Adjuvant hyperbaric oxygen therapy (HBO2) For treatment of necrotizing fasciitis reduces mortality and amputation rate "Undersea Hyperb Med 32 (6): 437–43. PMID16509286Retrieved 2008-05-16.
[23]. Strauss M.B. Refractory osteomyelitis. J Hyper Med 2:147-159, 1987.
[24]. Davis J.C., Heckman J.D., Delee J.C., and Buchwald F.J. Chronic non-hematogenous osteomyelitis Treated with adjuvant hyperbaric oxygen. J Bone Joint Surg 68:1210-1217, 1986.
[25]. Morrey B.F., Dunn J.M., Heimbach R.D., and Davis J. Hyperbaric oxygen and chronic Osteomyelitis. Clin Orthop 144:121-127, 1979.
[26]. Ducasse J.L., Izard P.H., Celsis P., and others. Moderate carbon monoxide poisoning: hyperbaric Or normobaric oxygenation? Human randomized study with tomographic cerebral blood flow measurement. In Schmitz J. and Bakker D. (Eds): Proceedings of the Second Swiss Symposium on Hyperbaric Medicine. Basle, Switzerland: Foundation for Hyperbaric Medicine, 1988.
[27]. Acott, C. (1999). "A brief history of diving and decompression illness "South Pacific Underwater Medicine Society Journal 29(2 ISSN0813-1988OCLC 16986801Retrieved 2008-03-18.
[28]. Neubauer R.A. and Gottlieb S.F. Stroke treatment. Lancet 337:1601, 1991.
[29]. Neubauer R.A. Protocol for the treatment of multiple sclerosis with hyperbaric oxygen. J Hyper Med 5(1): 53-54, 1990.
[30]. Yamada T., Hirayama K., Saito H., and others. Hyperbaric oxygen treatment for multiple sclerosis: Short-term and long-term therapy. Jpn J Hyper Med 21:215-219, 1986.
[31]. McFarlane RM, Wermuth RE (May 1966). "The use of hyperbaric oxygen to prevent necrosis in Experimental pedicle flaps and composite skin grafts". Plast. Reconstruct. Surg. 37 (5): 422–430.
[32]. Cianci P, Diabetes spectrum, 10:118-123, 1997.
[33]. Stone JA, HBO Rx facilitates healing of chronic foot ulcers in patients with diabetes. Diabetes Care. 2010 May; 33(5):998-100.
[34]. Attinger CE, et al: Clinical Approach to Wounds: Debridement and Wound Bed Preparation Including The Use of Dressings and Wound-Healing Adjuvants. Plast. Reconstr. Surg. 117 (Suppl.): 72S, 2006.
[35]. Alvarez OM, Fahey CB, Auletta MJ, Fernandez-Obregon A. A novel treatment for venous leg Ulcers. J Foot Ankle Surg. 1998 Jul-Aug; 37(4): 319-24.
[36]. Nick Martin etal Guide to offloading, the Diabetic Foot, Podiatry Today, Volume 18 - Issue 9 September 2005, Page-74.
[37]. David G. Armstrong, Off-Loading the Diabetic Foot Wound, A randomized clinical trial 10.2337/ Diacare.24.6.1019Diabetes Care June 2001 vol. 24 no. 6 1019-1022
[38]. David G. Armstrong, Stephanie Wu, off loading the Diabetic Foot Wound, Clinical Care of Diabetic Foot, ADA Publication, 2005, 52-60.