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Application of Digital Planimetry: A Novel Technique of Wound Measurement, in Diabetic Foot Ulcers (DFU)

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Abstract

Diabetic foot ulcer is almost always associated with reconstructive challenges because of associated morbidities. Involvement of multiple systems and organs makes the disease more complex in nature hence a multidisciplinary team approach is required for its management. Owing to raised blood sugar, micro angiopathy and neuropathy the healing is usually delayed and prolonged wound bed preparation is needed before definitive reconstruction. Wound assessment is mandatory in such long duration wounds to continue or change the treatment plan according to the response of the wound. Subjective assessment of wound may not be an accurate measurement of the wound response hence an objective and accurate assessment technique is mandatory for monitoring the wound behavior. Through this article we present role of digital planimetry as an effective and accurate technique for wound measurement in diabetic foot ulcer.

Keywords: Diabetic; Wound; Digital Planimetry.

Introduction

Incidence and prevalence of diabetes is found to be increasing due to changing life and increase in sedentary life style. Almost 25% of patients diabetes are affected with foot ulceration during their lifetime [1]. According to WHO 32 million people had diabetes in the year 2000 [2,3] while 69.9 million Subjects are predicted to be affected by the year 2025 (Figure 1).

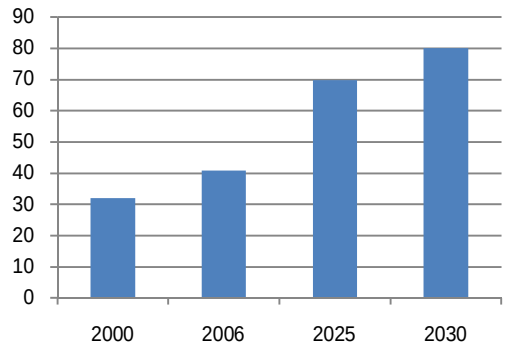

Fig. 1: Estimated number of diabetics in India (in millions)

Diabetes mellitus is the most common cause of Charcot neuropathy which is preventable by awareness, careful observation and planned treatment hence a well organized multidisciplinary team approach can not only prevent the condition to occur but also can provide effective treatment plans to avoid dreaded complications like disability or even amputation [4,5,6].

According to Chennai Urban Population Study (CUPS) and CURES the prevalence of coronary artery disease is higher in diabetics as compared to non diabetics (21.4 per cent and 9.1 per cent respectively). Increased thickness of carotid intima and medial thickness as well as increase in the number of components of metabolic syndrome causes serious complications in diabetes. Similarly the prevalence of peripheral vascular disease (PVD) is also high in diabetics as compared to non diabetics (6.3 per cent and 2.7 per cent respectively), and these figures are lower than the prevalence reported in western populations. DFU can be classified as Neuropathic, Ischemic, or Neuroischaemic depending on the

involvement of nervous system, vascular system or both, respectively [7]. Wound related complications of diabetes can impact significantly on social, mental, physical, psychological and economical prospective. Careful wound management protocol with effective techniques of wound measurement can prevent serious complications and hence can improve patient's quality of life. Through his article we would like to emphasize on use of digital planimetry as an effective technique of wound measurement.

Methodology

This study was conducted in the department of plastic surgery, JIPMER, Pondicherry, India. This is a retrospective study done during the period of March 2013 to June 2013. 12 cases of diabetic foot were analyzed in whom digital planimetry was used as a technique for wound measurement during the process of wound bed preparation. Ulcer was categorized (neuropathic / ischemic / neuroischemic), wound was graded according to Wagner's grading system [8].

Thorough limb examination was performed. Documentation of ulcer was done according to digital planimetry software at the time of presentation and was repeated weekly to access the condition of the wound [15].

After thorough initial workup and documentation, wound bed preparation was started along with other treatments related to primary pathology. We used TIME concept for systematic and and step wise wound bed preparation (Figure 2) [9].

Wound bed preparation (WBP) by "TIME" concept

T- Tissue management

I-Infection and inflammation control

M- Moisture balance

E- Epithelial (edge) advancement

Fig. 2: TIME concept of WBP

Radiofrequency and Hydrojet technologies [10] were used for Surgical and nonsurgical debridement was done for all wounds. Dressing modalities were chosen according to the wound status. Biological dressings, silver dressings, absorbent dressings and negative pressure dressings were various modalities used for wound cover. Weekly or SOS (depending on soakage and need of change of dressing) wound assessment was done and documented. We used digital planimetry for wound measurement. We followed the procedure described by Shetty R. et al [11] for calculation of wound surface area by using image J software, the procedure of calculation of wound area was as follows-

Step1- wound was cleaned to define the surroundings.

Step 2- Sterilized grid of 4x4 cm area was kept along the side of the wound (Figure 3, 4)

Step 3- Good quality photograph was taken and saved to the computer. The photograph was analyzed using Image J™ free open source software (Figure 5).

Step 4- The edges of the wound were marked and area was calculated. As the area of grid was known i.e. 16 cm2 the number of pixels falling under the square marker and the marked wound were calculated (Figure 6, 7).

Step 5- wound area was calculated according to following formula

Area of wound = 16 (wound measurement / grid measurement)

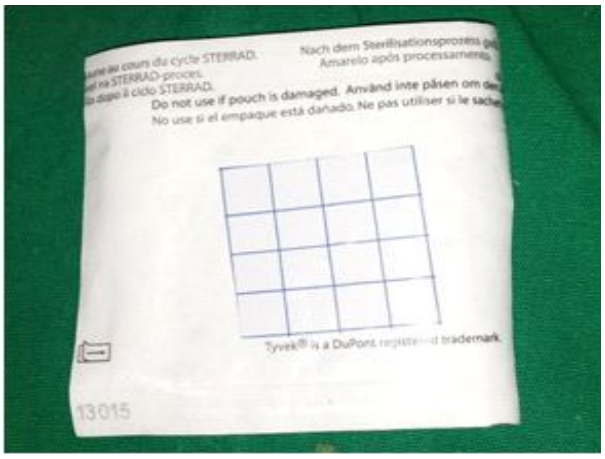

Fig. 3: Sterile grid used for digital planimetry

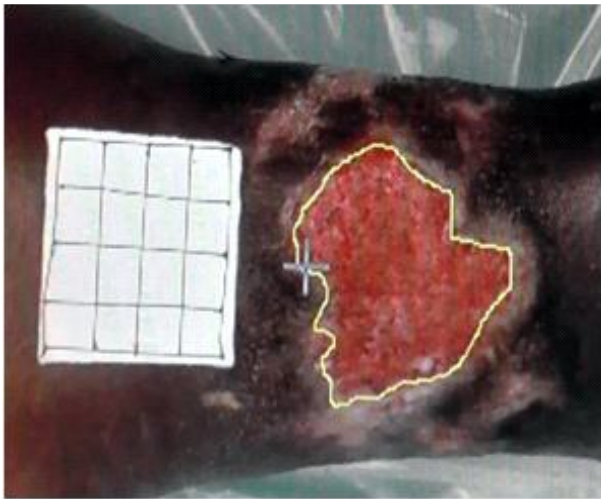

Fig. 4: Grid kept on the side of the wound

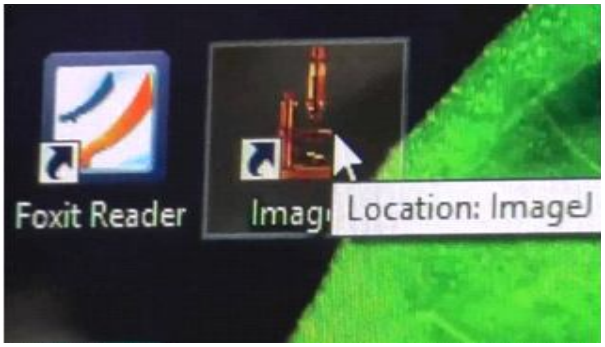

Fig. 5: Image J software being used

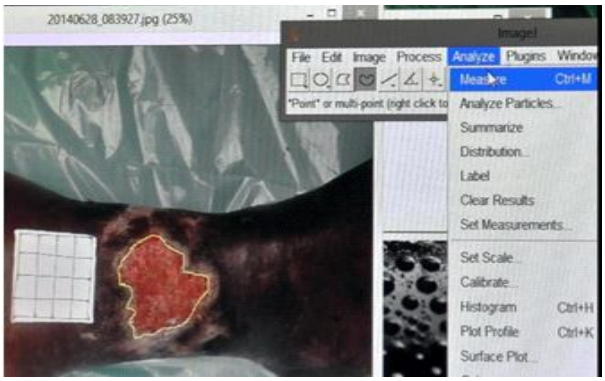

Fig. 6: Wound edge outlined

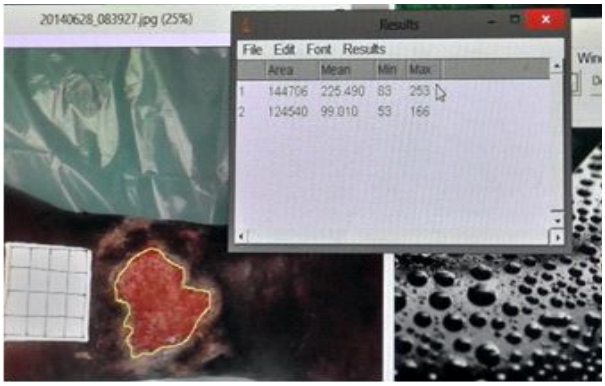

Fig. 7: Wound area being calculated

Result

Twelve patients were included in this study. The mean age was 49.16 years with male to female ratio of 6:1. In 7 patients (58.33%) blood sugar was uncontrolled. The most common co-morbidity was anemia, in 8 patients (66.66 %), followed by hypertension, in 5 patients (41.66 %) and 3 Patients (25 %) were found to have associated renal diseases. Osteomyelitis was present in 2 patients (16.66%). The most common etiology was spontaneous, in 7 patients (58.33 %) and next most common etiology was trivial trauma, in 4 patients (33.33%). Most common site of wound was distal foot. Mean duration of wound was 11.75 weeks. 9 Patients (75 %) were on injectable insulin and 3 patients (25 %) were on oral hypoglycemic drugs. 1 patient (8.33 %) presented with associated cellulitic changes. Image J was used in all wounds for area measurement. The most common organism grown in tissue culture was pseudomonas, in 4 cultures (33.33%). Methicillin Resistant Staphylococcus Aureus (MRSA) was positive in 1 case (8.33 %). The average duration of systemic antibiotic was 10 days to 3 weeks. The mean duration of wound bed preparation (WBP) was 3.83 weeks.

Autologous Platelet Rich Plasma (APRP) was given in all the 12 cases (100 %). Autologous Lipoaspirate Therapy (ALAT) was used in 2 patients (16.66 %), Autologous Bone Marrow Aspirate Therapy (ABMT) was used in 2 patients (16.66%) and External Tissue Expansion Wound Closure (ETEWC) using rubber bands and hooks were used in 1patients (8.33%) (Figure 11a, b). In 2 patient wound was reconstructed with reverse Sural artery flaps (Figure 12) In one patient Wounds was reconstructed with split thickness skin graft (SSG) (Figure 13a, b) while in 9 patients wound was managed without any surgery (Figure14a, b, c). Average duration of wound healing was 10 weeks. No complications were noted in 6 months follow up period (Table 1).

Fig. 11a: Pre operative

Fig. 11b: ETEWC

Fig. 12: Reverse Sural artery flap

Table Case summary

S. NO.	AGE/GENDER	SITE	DURATION	BJ STORE	WOUND MEASUREMENT	ORGANISM GROWN	CO MORBIDITY	OSTEOMYELITIS	WBP	Method of wound measurement	DURATION OF ANTIBIOTICS	DURATION OF NPWT	APRP	ALAT	ABMAT	SURGERY
1	40 yr / M	Distal third of foot	8 weeks	30	6×4 cm	E. coli, staph aureus	Anemia, HTN	no	5 wk	Digital plannimetry(DP)	5 wk	5 wk	yes	No	No	Nil
2	35 / M	Distal third of foot	6 weeks	36	4.5×7 cm	sterile	nil	no	4 wk	DP	3 wk	4 wk	Yes	No	No	Nil
3	45 / M	Distal third of foot	12 weeks	24	3×3 cm	Pseudomonas	Anemia	no	5 wk	DP+BJ(Bates jensin) Score	4 wk	5 wk	Yes	Yes	Yes	Nil
4	45 / M	heel	16weeks	28	2.5×5 cm	sterile	Anemia	no	weeks	DP	3 wk	3 wk	Yes	No	No	nil
5	56 / M	Distal third of foot	21 weeks	26	3.5×3.5 cm	Pseudomonas	Anemia, HTN	yes	4 wk	DP+BJ Score	12 wk	4 wk	Yes	No	No	Nil
6	50 / M	Al and third of foot	18 weeks	30	18×8 cm	E. coli	Anemia, Hypo proeinemia	yes	4 wk	DP+BJ Score	10 wk	4 wk	Yes	yes	Yes	regional ? ap
7	48 / M	Distal third of foot	20 weeks	29	5×5 cm	MRSA	Anemia, HTN, MRO	yes	5 wk	DP	10 wk	5 wk	Yes	No	No	Nil
8	55 / M	Distal third of foot	6 weeks	25	4.5×4 cm	Staph aureus	nil	no	3 wk	DP	2 wk	3 wk	Yes	No	No	Nil
9	56 / M	Distal third of foot	4 weeks	27	4×4 cm	sterile	HTN, MRO	no	2 wk	DP	4 wk	2 wk	Yes	No	No	Nil
10	48 / M	Distal third of foot	10 weeks	25	3.5×3.5 cm	Pseudomonas	Anemia, HTN	no	4 wk	DP	3 wk	4 wk	Yes	No	No	Nil
11	60 / M / M	heel	8 weeks	28	4×4 cm	Pseudomonas	Anemia, HTN, MRO	no	3 wk	DP	4 wk	3 wk	Yes	No	No	graft
12	52 / M	heel	12 weeks	28	4.5×5 cm	E. coli	nil	no	weeks	DP+BJ Score	3 wk	4 wk	yes	No	No	? ap


Fig. 13a: Preoperat ive

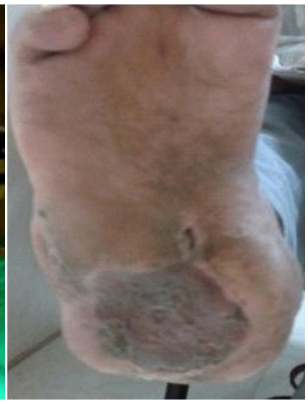
Fig. 13b: SSG


Fig. 14a: Distal foot ulcer


Fig. 14b: After debridement


Fig. 14c: Wound healed

Discussion

Wound measurement is an important step in its management. It helps the clinician in understanding the behavior of the wound and to take necessary actions to prevent the increment and enhance the healing. Wound measurement gives an idea for deciding the current treatment efficacy and for changing / stepping up the current treatment.

Need for Accurate Wound Measurement

Wound measurement is an integral part of management. Any increase or decrease in wound area indirectly provides information about wound healing or efficacy of current treatment. Continuation of ineffective treatment plan and hence prolonged hospital stay can be avoided by tracking the wound correctly. Hence an objective technique of accurate measurement and documentation is needed for wound management.

Image J Versus Traditionally used Methods

Traditionally used wound measurement techniques are photographic record comparison, ruler method, graph methods. Ruler method can give false high measurements when wound area is calculated by multiplying length and width, especially in irregular wounds. Graphical method provides nearly accurate results but is very cumbersome for regular use. Clinical photography is being used by most of the plastic surgeons as a part of record keeping and tracking the progress of the disease / wound. This is relatively simple and easy method but being a subjective assessment, documentation is not possible for the use of further visits [12,13]. Bates-jenson wound scoring system is another tool used by clinician in modern practice [14]. It gives satisfactory information about the nature and severity of wound but calculation of accurate wound area is lacking.

A study conducted by Mayrovitz HN showed efficacy of computerized planimetry in wound measurement [15]. Another study conducted by Wang Y showed comparison of digital planimetry and other methods. They found digital planimetry as an effective alternative [16].

Image J is an easy, freely available and effective tool for measurement of wound surface area in clinical practice. However inability of three dimensional measurements is disadvantage of this technique. Diabetic foot ulcer is one of the commonest forms of cutaneous ulcer in India. The DFU needs multidisciplinary approach and usually takes relatively longer duration for management due to associate co morbidities and complications. Sometimes patients are not fit for anesthesia and surgery due to associated co morbidities. Hence wound measurement plays an important role in management of DFU. Accurate measurement and

careful approach can prevent serious complications, deformities, disabilities and limb loss in patients with diabetic foot ulcer. Through this article we are highlighting the use of image J software as an effective tool for wound measurement in DFU. However a large sample size, controlled study would be helpful for more significant results.

Conclusion

Image J is a simple, easy and cost effective technique of accurate wound management in diabetic foot ulcer.

Conflicts of interest - None

Source of funding - None

Disclosures - None

References

1. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcer in patients with diabetes. JAMA. 2005; 293: 217-228
2. 2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care. 2004; 27: 1047-53.
3. 3. Sicree R, Shaw J, Zimmet P. Diabetes and impaired glucose tolerance. In: Gan D, editor. Diabetes Atlas. International Diabetes Federation. 3rd ed. Belgium: International Diabetes Federation. 2006; p. 15-103.
4. Assal JP, et al. Patient education in diabetes. In: Recent Trends in Diabetic Research, Stockholm: Almqvist and Wiksel International. 1982; 276-89.
5. Thomson FJ, et al. A team approach to diabetic foot care: the Manchester experience. Foot 1991; 1: 75-82
6. Boulton AJM. The diabetic foot: from art to science: the 18th Camillow Golgi lecture. Diabetologia. 2004; 47: 1343-1353.
7. International Working Group on the Diabetic Foot. International consensus on the diabetic foot and practical guidelines on the management and the prevention of the diabetic foot. Amsterdam, the Netherlands, 2011.
8. Wagner FW Jr. The dysvascular foot: a system for diagnosis and treatment. Foot Ankle. 1981; 2: 64–122.
9. Chittoria RK, kumar P, Bajaj SP, Singh AK, Gupta DK. General clinical guidelines for wound management: redefining acronym SWCR. Journal of SWCR. 2014; 7(1): 2-7.
10. Luedtke-Hoffmann KA, Schafer DS. Pulsed lavage in wound cleansing; Phys Ther. 2000; 80(3): 292-300.
11. Shetty R, H. Sreekar, Lamba S, Gupta A. A novel and accurate technique of photographic wound measurement: Indian J Plast Surg. 2012 May-Aug; 45(2): 425–429.
12. Haghpanah S, Bogie K, Wang X, Banks P, Ho CH. Reliability of electronic versus manual measurement techniques. Arch Phys Med Rehabil. 2006; 87: 1396–402.
13. Majeske C. Reliability of wound surface area measurements. Phys Ther. 1992; 72: 138–41.
14. Bates-Jensen B M. The Pressure Sore Status Tool a few thousand assessments later. Advances in Wound Care. 1997; 10(5): 65-73.
15. Mayrovitz HN, Soontupe LB. Wound Areas by computerised Planimetry of digital Images. Adv Skin Wound Care. 2009; 22: 222–29.