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Effect of Topical Oxygen Therapy on Wound Healing in Diabetic Patients with Fournier's Gangrene.

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Abstract

Background: Diabetic patients presenting with Fournier gangrene have the highest mortality rate of all at-risk populations.

Objective: To compare the efficacy of adjuvant topical oxygen therapy methods and conventional methods in the management of diabetic patients having Fournier's gangrene.

Methodology: This was a comparative cross-sectional study, in Surgical unit 3, Allied Hospital, Faisalabad, from 1st January to 30th June 2020. A total of 120 cases were included by systematic random sampling in the study, who were admitted either through OPD or the Emergency ward. In Group A, Topical Oxygen Therapy was given along with conventional methods. In Group B only conventional methods of wound care were applied. In group A, 100% oxygen was given in a bag with a routinely available oxygen cylinder exposing the whole affected part of the body or limb. Oxygen in the chamber was given for a maximum of one and a half hours twice daily in one sitting for 7 to 10 days. In the interval between cycles, the wound was covered with a soaked antiseptic dressing. After clinical improvement, the patient was discharged and called for follow-up in outdoor on weekly intervals initially and then fortnightly for up to 6 months.

Results: Mean age was calculated as 36.45±10 and 35.38±9 years in Group-A and B respectively. Comparison of the efficacy of adjuvant topical oxygen therapy and conventional methods in the management of Fournier's gangrene showed that 44 (73.3%) in Group-A and 29 (48.3%) in Group-B had efficacy (p=0.00).

Conclusion: Efficacy of adjuvant topical oxygen therapy is significantly higher when compared with conventional methods in the management of Fournier's gangrene.

Keywords: Diabetes mellitus, Fournier gangrene, Topical oxygen therapy

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Introduction

Diabetes mellitus is the most common metabolic disorder due to micro and macroangiopathy and neuropathy, leading to chronic infections and has a higher risk of developing Fournier's gangrene (FG).[1] The disorder specifically affects diabetic and immunocompromised people, but patients having major comorbidities like morbid obesity, use of an intravenous drug and alcoholics are at very risk too.[2] Diabetic patients presenting and showing up with Fournier's gangrene are having the maximum mortality rate of all at the risk in populations.[3]

Fournier's gangrene (FG) is an infection having synergistic characteristics of gangrenous infection of the area in the perineum, the scrotum, and the penis, which is mainly categorized by the obliterative endarteritis among the subcutaneous arteries and causing the gangrene of the subcutaneous tissue and the skin around the area.[1] It is rapidly advanced, destructive, and associated with high morbidity and mortality.[2] Fournier's Gangrene represents one of the most complicated, severe, and serious life-threatening and necrotizing infections of the soft tissue in the perineum area. Bacteriology is the most frequently polymicrobial, and although it is a monomicrobial disease at times. The occurrence of the FG has not been altered mainly over the past many years, it is remaining around the 1000 cases per year in the United States, as per literature.[4,5] As the

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practices of the surgery, and the ICU resuscitation, and the techniques of the soft tissue coverage have enhanced, so the prevalence overall mortality rate caused by the FG has reduced. The evidence reported shows that the FG series have given overall mortality at 25%-35%.[3] However, as per more recent analysis reported by the American College of Surgeons National Surgical Quality Improvement Program proposed a mortality rate which was nearer to 10%, and with very highly skilled tertiary care hospitals and the centers, which are depicting the lowermost mortality rates reported.[4,5]

The death rate after Fournier's gangrene can be lessened with multimodal methods and initial belligerent surgical debridement. In debridement, all dead tissue is excised up to healthy tissue.[6] Wound wash is most frequently carried out with normal saline, hydrogen peroxide, and pyodine solutions. Consistent dressings with chemicals act by the mechanism of chemical debridement.[6] Topical oxygen applied as therapy is using hundred percent oxygen to open wound which is in addition to atmospheric pressure. That pressure leads to direct oxygenation of the scars, growing local cellular oxygen level, which improves wound healing by different methods like angiogenesis, fibroblast stimulation, up-regulation of growth factors. It also Destroys anaerobes and stops the development of species of gram-negative and positive microbes. It also aids in neutrophil-mediated microbialkilling.[7,8]

Lundahl and his contemporaries, in their study, have revealed that the practice of topical oxygen therapy in patients of diabetic Fournier's gangrene has caused fast wound curing as matched to conventional means(52% vs 29%).[9] A fresh review of the topical oxygen therapy literature established that the value of the evidence assessing the efficiency of topical oxygen therapy as an assistant to usual treatment for people with non-healing diabetics with Fournier gangrene is little, and the consequences are unpredictable.[10] The basis of my study is to compare the wound healing in patients of Fournier's gangrene in diabetics with the usage of adjuvant Topical oxygen therapy with traditional methods in our hospital. This study may offer endorsements to help patients about their prompt healing and lessening morbidity. The objective of this study was to compare the efficacy of topical oxygen therapy as adjuvant and the conventional methods in the management of diabetic patients, who have Fournier's gangrene.

Methodology

Study Design: Comparative cross-sectional study. Setting: Surgical unit 3, Allied Hospital Faisalabad. Duration of Study: 1st January to 30th June 2020.

Sample Size was calculated by using WHO sample size calculator applied for two proportions, and we used expected proportion one as 52% [1] and expected proportion two as 29%[1,] and the Power of study taken as 80% and the level of significance was taken as 5%. Overall sample size came out to be 120, with equally dividing 60 in each group. Sample Technique: Systematic random sampling. Inclusion Criteria: All diabetic patients of both gender between 15 and 60 years of age having infected scrotal wounds (Fournier's gangrene). Exclusion Criteria: Advanced malignancy, patients refusing to take part in the study, and patients with co-morbid conditions like multi-organ failure. Efficacy: It was measured in terms of wound healing. Wound Healing: The presence of all of the following features i-e, granulation, contraction, and epithelisation were labeled to have wound healing after three months of treatment. Diabetes Mellitus: A metabolic disorder due to diminished or no insulin resulting in disturbed metabolisms of carbohydrates, lipids, and proteins labeled as having documented history of having diabetes.

All the patients who were included in the study were admitted either through OPD or the Emergency ward. Regarding the ethical issues, after taking permission from the hospital's ethical committee, patients were explained about nature, benefits, and drawbacks if any of the procedures and informed consent was taken and each patient was included in groups A or B randomly by using a computer-generated random number table. Group A was given Topical Oxygen Therapy and in Group B the only conventional methods of wound care were applied. All of the patients were given intravenous single-dose of antibiotics, infused half-hour before the induction of the anesthesia. All of the patients having diabetes were given regular insulin according to the sliding scale at the beginning and then fixing the units in the next 48 hours, according to the checked

level of blood glucose. Good debridement of the wound was done, removing all dead tissue. In Group A, 100% oxygen was given in a bag attached with a commonly available oxygen cylinder, after exposing the whole of the affected part of the body or limb. Oxygen in the chambers was also given for a maximum of a duration of one and half hours, and twice daily in the one sitting for a duration of seven to ten days.

After the clinical improvement a patient was assessed and then discharged and thereafter was called for a follow-up in the outdoor and on the weekly interval initially and then thereafter fortnightly up to a duration of three months. We assured that the mobile contact number ensured to be taken from all the patients. All the information was recorded on a specially designed proforma. The data were obtained and were entered in analyzed in SPSS version 20. P-value ≤ 0.05 was taken as significant.

Results

Among 120 patients, the mean age in years was 35.92±10 years, and the mean duration of diabetes was 6.07±2.9 years. In group A, the mean age in years was 36±10, and the mean duration of disease in years was 5±2, while in group B, the mean age in years was 35±9 and the mean duration of disease in years was 6±3. Between 15-30 year age group, there were 30% patients in group A and 21% patients in group B. Between 31-45 year age group there were 55% in group A and 51.7% in group B. Between 46-60 year age group, there were 15% in group A and 13.3% in group B (p=0.839). Regarding sex distribution, 44% were male in group A, and 53.3% were males in group B. (p=0.361).

Regarding the duration of diabetes; 46.7% of patients in group A and 46.7% in group B were having a duration of disease less than five years, and 53.3% in group A, and 53.3 % in group B had a disease duration of more than five years (p=1.0). Regarding complete wound healing (efficacy) 73.3% of patients in group A, and 48.3% in group B were having complete healing, while 26.7% in group A and 51.7% in group B were having no healing, with p=0.005. (Table-I) Regarding complete healing in age groups; between 15-30 year age group, 83.3% of patients in group A and 52.4% of patients in group B were having complete healing while 16.7% in group A and 47.6% in group B had no healing, and it was statistically significant (p=0.04) Between 31-45 year age group,69.7% of patients in group A and 54.8% of patients in group B were having complete healing while 30.3%% in group A and 45.2%in group B had no healing, and it was statistically significant (p=0.22). Between 46-60 year age group,66.7% of patients in group A and 12.5% of patients in group B were having complete healing while 33.3%% in group A and 87.5%in group B had no healing, and it was statistically significant (p=0.02). Regarding sex distribution and complete healing; 81.5% of male patients in group A and 43.8% of male patients in group B were having complete healing, while 18.5% of male patients in group A and 56.2% of male patients in group B were having no healing, both showing statistical significance (p=0.00) and 66.7% of female patients in group A and 53.6% of female patients in group B were having complete healing while 33.3% of female patients in group A and 46.4% of female patients in group B were having no healing; this table also shows that healing rate is more in males (p=0.29).

Regarding the duration of disease and complete healing; 85.7% of patients in group A and 60.7% in group B having a duration of disease less than five years were having complete healing while 14.3% of patients in group A and 39.3% in group B having a duration of disease less than five years had no healing (p=0.03), and 62.5% in group A and 37.5 % in group B having disease duration of more than five years were having complete healing while 37.5% in group A and 62.5 % in group B having disease duration of more than five years were having no healing (p=0.04). (Table-II)

Table-I: Comparison of complete wound healing (efficacy) of topical oxygen therapy and conventional therapy in two groups

Complete Wound Healing (Efficacy)	Group		Total	P-value
	Group A	Group B		
Yes	44 (73.3%)	29 (48.3%)	73 (60.8%)	0.005
No	16 (26.7%)	31 (48.3%)	47 (39.2%)	
Total	60	60	120	

Table-II: Comparison of complete wound healing in both groups according to gender

Sex	Complete Wound Healing (Efficacy)	Group		Total	P-value
		Group A	Group B		
Male	Yes	22 (81.5%)	14 (43.8%)	36 (61%)	0.003
	No	5 (18.5%)	18 (56.2%)	23 (39%)	
Female	Yes	22 (66.7%)	15 (53.6%)		0.29
	No	11 (33.3%)	13 (53.6%)		

Discussion

Diabetes mellitus is one of the important problems reported by health organizations and overall a universal danger of public health significance that has been amplified drastically over the period of the past two decades.[10,11] Patients who have DM are at an increased risk of many health problems and complications which include the diabetic foot, and ulcers. In spite of the wonderful advantages of the process of debridement, the satisfactory debridement of the wound should always be preceding, the use of a topical healing agent for the wound, a dressing, and adequate wound closure procedures.[12]

We scheduled this study with the opinion to compare wound healing in diabetic patients with the usage of the adjuvant application of topical oxygen therapy (TOT) and with the conventional methods in our hospital. Native data is deficient, and this is not in practice locally. This study may make available endorsements to help patients regarding their prompt healing and lessening morbidity.

In our study, mean age was calculated as 36±10 years and 35±9 years in the Group-A and B respectively, 27 (45%) in Group-A and 32 (53.3%) in Group-B were male while 33 (55.0%) in Group-A and 28 (46.7%) in Group-B were females, comparison of the effectiveness of adjuvant topical oxygen treatment and conventional methods in the management of Fournier gangrene displayed that 44 (73.3%) in Group-A and 29 (48.3%) in Group-B had effectiveness, the p-value which was calculated to be as 0.005 showing a noteworthy difference between the groups.

We related our outcomes with the Blackman study, which favors the profits of topical oxygen therapy where the topical oxygen therapy patients have major advantages when matched with conventional methods with a p-value of 0.013.[11] Also, studies undertaken earlier have depicted that TOT therapy confers better results in the care of wounds due to diabetes, tuberculosis, venous ulcers, burns, and gangrenous lesions.[12]

The latest reported evidence, which indeed revealed a fact that the oxygen is not only just the primary reason and source of the energy, but also produces so many numerous ROS, and which may act as an intracellular messenger in the normal cell and signal transduction in the cell cycling. Mutluoglu et al.,[13] conducted a randomized controlled trial, which was completed on the patients having chronic diabetic foot ulcers (DFUs), showed and established the findings by showing that the patients who were given continuous TOT for a period of four weeks have had meaningfully large wound size as paralleled with those patients who have undergone standard wound care as a treatment alone [87% (range 55.7%–100%) vs 46% (15%–99%); $p < 0.05$]. The variation reported in the change in the cytokine (IL-6, IL-8) and the proteinase (MMP-1,-2,-9, TIMP-1) levels in between these groups in fact reinforced these findings of the results ($p < 0.01$). TOT adversaries which were commonly mentioned that a randomized controlled study which was piloted by Matera et al, as vibrant confirmation of that TOT is not a satisfactory.[14]

Kessler et al[15] conducted a study on hospitalized 28, diabetic patients, who had a protracted non-healing type of wounds. The macrovascular type of the disease was omitted among all patients. He displayed and showed that the application of the topical oxygen therapy coupled with the mean healing rate among nonischemic chronic foot ulcers in selected diabetic patients.

Abidin et al[16] conducted a study and they randomized 18 diabetic patients having ischemic ulcers and who gave them 100% oxygen for a period of 90 minutes daily for overall 30 treatments. They found a thorough healing in one year resulted after treatment and was followed in 5 of 8 subjects in the group of topical oxygen therapy and overall 1 of 8 subjects in the selected control group. The relative risk reported among the non-healing among the control group was 2.3 (95% CI, 1.1–4.7). There was reported a

substantial reduction in the percentage of the wound area in the oxygen treated group matched with the control group. These conclusions are similar to the findings of our results. However, additional studies in our people are necessary to authenticate these findings.

Conclusion

We concluded that the efficacy, as wound healing, of the topical oxygen therapy as an adjuvant was statistically significantly better when it was compared with the conventional methods of the management of the Fournier's gangrene in the patients having diabetes.

Authors Contribution: ABS: Conception of work and Drafting. **AA:** Conception of work Interpretation of data and revising. **RM:** design of work and revising. **JI:** Analysis of data and drafting.

All authors critically revised and approve its final version.

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References

1. Chen CY, Wu RW, Hsu MC, Hsieh CJ, Chou MC. Adjunctive hyperbaric oxygen therapy for the healing of chronic diabetic foot ulcers. Journal of Wound, Ostomy and Continence Nursing. 2017 Nov 1;44(6):536-45
2. Chen D, Parker N, Main L, Catterwell R, Barrett T, Lloyd M et al. Mortality secondary to Fournier's gangrene can be reduced with a multimodal approach and early, aggressive surgical debridement. Bju International 2014 Mar 1 (Vol. 113, pp. 75-75). 111 RIVER ST.
3. Kiwanuka F. Hyperbaric Oxygen Therapy: Indications, Benefits and Nursing Management. International Journal of Caring Sciences. 2019;12(1):567-71.
4. Kruse M, Nielsen S, Berg A, Kaul S. Use of adjuvant hyperbaric oxygen therapy in a patient with traumatic inoculation of mucormycosis resulting in extremity amputation. Trauma Surgery & Acute Care Open. 2020 Jan 1;5(1).
5. Driver VR, Reyzelman A, Kawalec J, French M. A Prospective, Randomized, Blinded, Controlled Trial Comparing Transdermal Continuous Oxygen Delivery to Moist Wound Therapy for the Treatment of Diabetic Foot Ulcers. Ostomy Wound Manage. 2017 Apr;63(4):12-28
6. Zhao D, Luo S, Xu W, Hu J, Lin S, Wang N. Efficacy and safety of hyperbaric oxygen therapy used in patients with the diabetic foot: a meta-analysis of randomized clinical trials. Clinical therapeutics. 2017 Oct 1;39(10):2088-94
7. Lipsky BA, Peters EJ, Berendt AR Semeville E, Bakker K, Embil JM, et al.; International Working Group on Diabetic Foot. Specific guidelines for the treatment of diabetic foot infections in 2011.Diabetes Metab Res Rev. 2012;28Suppl 1:234-5.
8. Earley M. Wounds, tissue repair, and scar. In: William NS, Bulstrode CJK, O'Connell PR, editors. Bailey & Love's short practice of surgery. 26th ed. Boca Raton: CRS Press; 2013. p. 24-32.
9. Löndahl M, Katzman P, Nilsson A, Hammarlund C. Hyperbaric oxygen therapy facilitates healing of chronic foot ulcers in patients with diabetes. Diabetes Care 2010; **33**: 998– 1003.
10. Mehl AA, Filho DCN, Mantovani LM, Grippa MM, Berger R, Krauss D, et al. Management of Fournier's gangrene: an experience of a university hospital of Curitiba. Rev Col Bras Cir 2010;37(6):435e41.
11. Blackman E, Moore C, Hyatt J, Railton R, Frye C. Topical wound oxygen therapy in the treatment of severe diabetic foot ulcers: a prospective controlled study. Ostomy Wound Manage.2010 Jun;56(6):24-31.
12. Santema KT, Stoekenbroek RM, Koelemay MJ, Reekers JA, Van Dortmont LM, Oomen A, Smeets L, Wever JJ, Legemate DA, Ubbink DT. Hyperbaric oxygen therapy in the treatment of ischemic lower-extremity ulcers in patients with diabetes: results of the DAMO2CLES multicenter randomized clinical trial. Diabetes Care. 2018 Jan 1;41(1):112-9
13. Mutluoglu M, Cakkalkurt A, Uzun G, Aktas S. Topical oxygen for chronic wounds: a pro/con debate. Journal of the American College of Clinical Wound Specialists. 2013 Dec 1;5(3):61-5.
14. Matera DV, Smith B, Lam B. Revisiting the expanded use of hyperbaric oxygen therapy for the treatment of resistant migraines.Medical Gas Research. 2019 Oct 1;9(4):238.
15. Kessler L, Bilbault P, Ortega F, Grasso C, Passemard R, Stephan D, et al. Hyperbaric oxygenation accelerates the healing rate of nonischemic chronic diabetic foot ulcers: A prospective randomized study. Diabetes Care.2003;26:2378–82.
16. Abidin A, Laden G, Kuhan G, Johnson BF, Wilkinson AR, Renwick PM, Masson EA, McCollum PT. The role of hyperbaric oxygen therapy in ischaemic diabetic lower extremity ulcers: a double-blind, randomized controlled trial.Eur J VascEndovasc Surg.2003 Jun;25(6):513-8.