Continuous topical oxygen therapy as part of the reconstructive ladder of limb salvage: a case series

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Introduction

- The term surgical wound dehiscence (SWD) has been defined as 'separation of the margins of a closed surgical incision that has been made in skin, with or without exposure or protrusion of underlying tissue, organs, or implants.'
- SWD is most likely to occur within 5 to 8 days post-op.
- After surgical intervention, skin strength gradually increases as the tissue repair process occurs.
- It has been estimated that at 1 week, post-op skin has only healed to the point of achieving 3% of its pre-incision breaking strength.
- There is not one singular "gold standard" therapy for managing SWD; the goal is expediting wound closure.
- Hence, clinicians should choose active wound therapies that promote an optimal wound-healing environment and support the wound-healing cascade across the continuum.
- One such treatment, continuous topical oxygen therapy (cTOT), has been proven to promote tissue healing in wounds of all etiologies.

Methods

- We conducted a single-center, retrospective analysis of lower extremity surgical wound dehiscence of the lower extremity treated with continuous topical oxygen therapy.
- A third party, not associated with the physician group, performed a retrospective chart review to collect data on lower extremity surgical wound dehiscence for a period of eight months, spanning January 2024-August 2024.
- Eligible patients were at least 18 years of age and had a history of a surgical wound dehiscence of least 1.0 cm diameter treated with cTOT to wound closure.
- All patient demographics, past medical history, smoking status, date of surgery, date of wound dehiscence, date of initial application of continuous topical oxygen therapy, and time to wound closure were documented.
- Each dehiscence was graded using the WUWHS SWD Sandy Grading System.
- All dehisced surgical sites were treated with the lead author's standard clinical care protocol to include wound cleansing, treatment of infection, tissue debridement when indicated, edema management, pain control, and appropriate offloading.
- Additionally, cTOT was applied directly to the surgical site dehiscence per manufacturer guidelines and covered with a semi-permeable dressing to maintain a moist wound environment.
- Patients were seen weekly for evaluation and assessment until complete wound closure.

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Results

Table 1: Patient Demographic Information and Surgical Procedure

Patient Number	Age	Gender	Past Medical History/ Other Comorbidities	Smoker	Surgery
1	35	M	Type II DM, HTN	No	TMA L (trans-metatarsal amputation)
2	55	M	Sleep apnea, high cholesterol, Type II DM, DPN	Former	Tailor's bunion L
3	73	M	High cholesterol	Former	Cavus foot recon R
4	61	F	Hypothyroidism	Former	Calcaneo-cuboid fusion
5	39	F	Depression, anxiety	Current	Radical plantar fasciotomy R
6	35	M	None	Current	Open reduction and internal fixation calcaneal fracture R
7	57	F	HTN, hypothyroidism	Current	Bunion correction L
8	42	F	Sleep apnea, kidney disease, kidney transplant	Current	Excision neoplasm L
9	76	F	DJD, sleep apnea, high cholesterol, anxiety, Alzheimer's, Type II DM, heart disease, asthma	Former	Bostrom Gould/Peroneal tendon repair/ arthroscopy R

- Nine patients, 4 males and 5 females, were included in this case review.
- The mean patient age was 52.6 years, ranging from 35 to 76 years.
- Surgical wound dehiscence occurred after a variety of interventions in the lower extremity as listed in Table 1.
- The most common comorbidity reported in the patients was being a current smoker (4), accounting for 44.4% of patients.
- Other comorbidities found included Type II DM (3), sleep apnea (3), and high cholesterol (3), which accounted for 33.3% of patients each. All the above demographics are outlined in Table 1.

Table 2: Wound Metrics by Patient

Patient Number	Grade	DTOT	Healed	Days from DTOT to Healed	Wound Measurement on DTOT (cm)	Estimated Wound Surface Area (cm^2)	Depth of Wound (cm)
1	4	3/7/2024	5/2/2024	56	3.0 x 3.0	9.0	0.3
2	4	3/7/2024	6/5/2024	90	3.0 x 2.0	6.0	0.3
3	4	6/4/2024	8/8/2024	65	3.0 x 3.0	9.0	0.4
4	3	3/20/2024	6/6/2024	78	5.0 x 5.0	25.0	0.3
5	3	2/21/2024	5/8/2024	77	12.0 x 6.0	72.0	0.4
6	3a	3/20/2024	5/20/2024	61	5.0 x 5.0	25.0	0.3
7	3a	5/1/2024	5/23/2024	22	3.0 x 1.0	3.0	0.2
8	3	5/8/2024	6/4/2024	27	7.5 x 2.5	18.8	0.2
9	3a	1/18/2024	6/20/2024	154	4.0 x 2.0	8.0	0.3

- All patients had a SWD grading of either 3 or 4, with some patients having specific subcategorizations of 3a.
- 66.6% of wounds (6) were graded at a 3, half of which (3) had signs of infection.
- The other 33.3% of wounds (3) were graded at a 4.
- The mean number of days from starting TOT to the SWD healing was 52.6 days, ranging from 22 days to 154 days.
- In addition, the average estimated wound surface areas based on the wound measurement at the start of delivering TOT was 19.5 cm^2, ranging from 3 cm^2 to 72 cm^2.

Case Example

Patient 5

- 39 y.o. female
- Smoker
- PHM: depression, anxiety
- Surgery: radical fasciotomy for a plantar fibroma
- SWD measurement: 12.0 cm x 6.0 cm x 0.4 cm

cTOT Device: NATROX® O_2

Discussion

- Surgical intervention in the lower extremity can lead to complications including infection, surgical site dehiscence, necrosis of the incision site, edema, hematoma, scarring, pain, and decrease of function.
- Thus, surgical wound dehiscence (SWD) is a common complication making the post-operative course more difficult for the patient and the surgeon to navigate.
- Additionally, prolonged care of the SWD may contribute to patient comorbidity and mortality leading to increased healthcare costs.
- Effective management of SWD incorporates prompt wound care to include infection control, wound hygiene, removal of devitalized tissue, offloading, and active treatments to support tissue repair and regeneration.
- The cTOT device used in this report is an innovative, easy-to-use, lightweight appliance that delivers continuous low-pressure oxygen directly to the wound bed at a rate of 11ml/hr.
- Additionally, the device is wearable thus oxygen delivery is maintained 24 hours a day, 7 days a week, allowing the patient to continue to perform activities of daily living uninterrupted, therefore increasing adherence to post-operative treatment protocols.
- Oxygen plays an important role in the immune response in wounds, supporting immune cell activity, cell migration, and bacterial killing via the reactive oxygen species.
- The SWD presented in this retrospective review did not need additional surgical intervention or hospitalization
- Given cTOT's mechanism of action, the authors believe that re-establishment of adequate blood and oxygen to the tissues, combined with the immunogenic properties of oxygen supported the rapid wound closure observed in these patients.

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