CLINICAL CASE REPORT

Successful replantation of amputated penis with adjuvant hyperbaric oxygen therapy

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ABSTRACT

Successful penile replantations are rarely reported in the literature and are associated with significant complications. We present a case of a patient who auto-amputated his penis. Delayed microvascular replantation was performed approximately 14 hours following injury. He was treated with a phosphodiesterase inhibitor postoperatively, and adjuvant hyperbaric oxygen (HBO_2) therapy was started 58 hours after replantation; 20 treatments at 2.4 atmospheres absolute (ATA), twice daily for eight days, followed by once daily for four days. Perfusion of the replanted penis was serially assessed using fluorescent angiography. With some additional surgical procedures including a split- thickness skin graft to the shaft due to skin necrosis he has made a complete recovery with return of normal urinary and sexual function. This unusual case illustrates the potential benefit of HBO_2 therapy in preserving viability of a severed body part. Fluorescent angiography may have potential utility in monitoring efficacy of HBO_2.

INTRODUCTION

Penile amputation is a rare genitourinary tract injury. The majority of cases are the result of self-mutilation in psychiatric patients [1-3]. Though rare, successful replantation of penile amputations has been reported in the literature with and without using microvascular techniques and adjuvant treatments, but are associated with significant complications. A standardized therapeutic approach for penile replantation does not exist. Hyperbaric oxygen therapy (HBO_2) is an approved adjuvant treatment for individuals with compromised grafts and flaps and has been advocated for patients with decreased blood flow due to inadequate inflow and/or outflow.

CASE REPORT

The patient is a 22-year-old man with a history of depression and self-injury who auto-amputated his penis 2 cm from the base of the shaft using a knife. He was found by first responders approximately three hours after injury. The severed penis was located, placed in a clean plastic bag containing saline-soaked gauze and immersed in ice for transport with the patient to the hospital. The scrotum and testicles were intact. There was an adherent hematoma covering the penile stump without active bleeding.

Replantation was performed approximately 14 hours following injury. Direct primary reanastomosis of the corpora and urethra were performed first with insertion of 14-French Foley catheter across the anastomosis. Microvascular anastomosis was then done, with repair of two large-caliber deep dorsal veins using grafts harvested from the right forearm and coaptation of three dorsal nerves. There were no identifiable arteries that could be anastomosed.

Buck's fascia was repaired and primary skin closure was performed with placement of Penrose drains. Intraoperative transcutaneous Doppler studies signals were found over the repaired veins. Fluorescent angiography (indocyanine green) was also performed postoperatively using the SPY imaging system (Novadaq® Technologies Inc.) and showed no perfusion of the penis (Figure 1). However, there was active bleeding from the skin margins and oozing from the dorsal veins throughout the procedure. Active bleeding was also noted from the glans at the completion of surgery without evidence of venous congestion.

KEYWORDS: fluorescent angiography; hyperbaric oxygen; hyperbaric oxygen therapy; penis; replantation

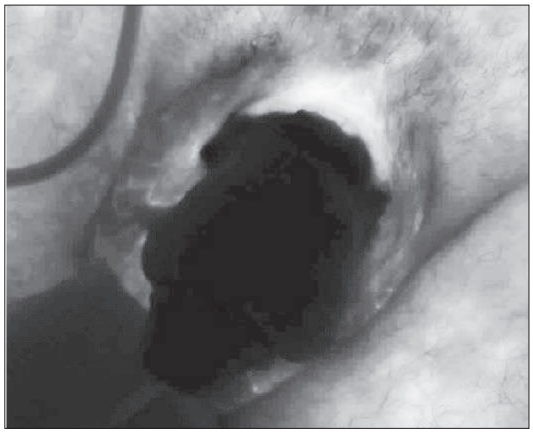

Figure 1. Postoperative fluorescent angiography performed prior to initiation of HBO_2 therapy showed no perfusion in the replanted penis distal to the anastomosis.

Figure 2. The left image shows the attached replant prior to first HBO_2 treatment. The image on the right is the appearance after the first HBO_2 session. The tissue is pinker due to hyperoxygenation. The blisters present are ischemic blisters.

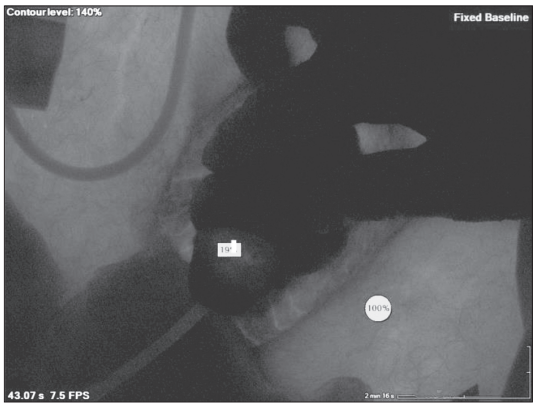

Figure 3. Fluorescent angiography after first day of HBO_2. 19% perfusion was noted in the glans compared to baseline (skin of thigh, 100%).

Figure 4. Skin necrosis of the shaft.

The patient was treated postoperatively with the phosphodiesterase inhibitor tadalafil (Cialis, registered trademark Eli Lilly and Company) at 10 mg once daily, and HBO_2 therapy. Monitoring the viability of the replanted penis was done by clinical examination. Figure 2 shows the appearance of the replant prior to and following the first HBO_2 treatment on postoperative day 2. HBO_2 was started 72 hours after amputation and 58 hours after replantation. Treatments were performed with 100% oxygen at 2.4 atmospheres absolute (ATA). The patient received a total of 20 treatments, twice daily for eight days followed by once daily for four days, until a plateau in the clinical appearance of the replant was achieved. Fluorescent angiography (SPY) was also repeated after the first day of HBO_2 treatment on postoperative day 3 (Figure 3).

Progressive reduction in swelling improvement of color was noted during the course of HBO_2 therapy. Diffuse superficial skin necrosis of the shaft developed, with formation of eschar (Figure 4).

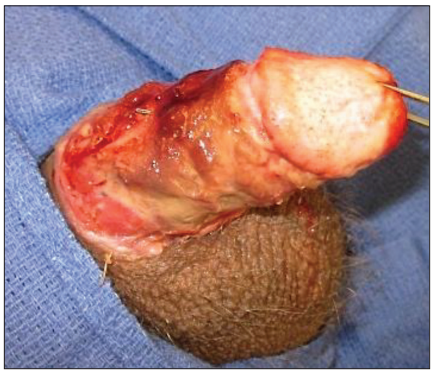

Figure 5. Debridement of necrotic skin *(above)* followed by split -thickness skin graft to the shaft of the replant *(right)*.

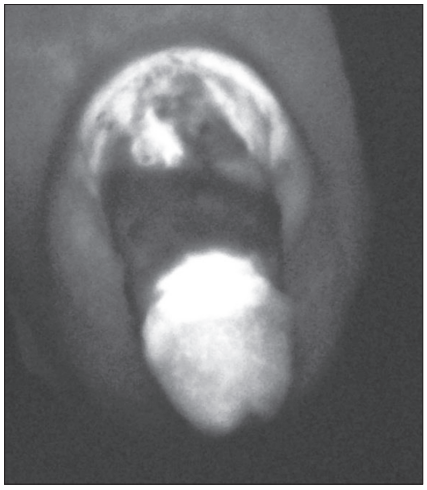

Figure 6. Fluorescent angiography after completion of HBO_2 therapy shows restoration of normal flow to the glans and base of the shaft *(left)*.

Debridement of the eschar was done 20 days after replantation and a split-thickness skin graft was performed (Figure 5). HBO_2 therapy continued after the skin graft to the shaft. A meatal stenosis also developed which was corrected. Figure 6 is an image from the fluorescent angiography study performed after completion of HBO_2 therapy.

At four months after injury, the patient was able to urinate normally, achieve an erection and ejaculate. There is partial recovery of sensation and good aesthetic result (Figure 7).

DISCUSSION

Major self-mutilation (MSM) is a rare but catastrophic complication of severe mental illness and often results in permanent loss of an organ or its function. MSM of the external genitals is also known as Klingsor syndrome [1,2]. The majority of patients are Caucasian and in their third or forth decade of life [3]. The testicles are the most commonly amputated organ, followed by the penis [3]. This patient was typical: age 23 with history of major depression and cutting. It was his first attempt at major self-mutilation.

Because penile amputation is an unusual injury, a standardized approach to management does not exist. The

Figure 7. Appearance of replant four months after surgery.

first documented case of penile replantation was reported in 1929 by Ehrich, who realigned the penile structures without anatomizing vessels or nerves [4]. Graft survival in non-microvascular anastomosis depends on corporal sinusoidal blood flow and has been associated with significant complications, including skin necrosis (most common), fistula formation, urethral stricture, permanent loss of sensation and impotence [2, 7]. Treatment of penile amputation has been improved by application of microvascular surgical technique, which provides earlier restoration of blood flow. The first microvascular replantations were reported by Tamai, et al. and Cohen, et al. in 1977 [5, 6], with at least 30 cases of successful microvascular replantation subsequently reported in the literature.

Clinical evaluation, including observation of visual changes of skin color, is a practical component of the care for these patients. Other factors contributing to positive clinical outcome include degree of injury, type of injury and duration of ischemia. Hypothermia has been shown to prolong the ischemia time and tissue survival. The amputation should be immersed in ice without direct contact between the tissue and ice, as was done in this case [7]. Another critical factor for successful replantation appears to be the adequacy of venous outflow to reduce post-operative edema and necrosis [8, 9].

The use of non-surgical adjuvant therapies that optimize blood flow and tissue oxygenation to preserve viability has rarely been reported [10-13]. One modality employed in this case was tadalafil, 10 mg once daily. Tadalafil is a cGMP-specific phosphodiesterase type 5 inhibitor most commonly used for treatment of erectile dysfunction. In the presence of nitric oxide, tadalafil increases levels of cGMP, which results in smooth muscle relaxation and increased blood flow in the corpus cavernosum.

HBO_2 therapy was another adjuvant therapy utilized in this case. HBO_2 promotes wound healing and tissue viability through several mechanisms. In addition to increasing plasma and tissue oxygen partial pressures, HBO_2 reduces edema and effects of reperfusion injury by reducing free radical formation. Another mechanism by which HBO_2 acts is to stimulate angiogenesis. Although the HBO_2 treatment was started 72 hours after injury in this case the therapy should be started as soon as possible post injury to facilitate wound healing.

Both early intervention with HBO_2 and early referral to a multidisciplinary team will allow for more successful organ replantation. Of unique interest in this case was demonstration of progressive restoration of blood flow during HBO_2 by the technique of fluorescent angiography despite the fact that an arterial anastomosis could not be performed during surgical replantation. In cases where venous congestion is a concern, other modalities such as leech therapy can be utilized [14].

CONCLUSIONS

This unusual case illustrates the potential benefit of HBO_2 in preserving viability of a severed penis following replantation. We attribute successful healing with regain of function in this unusual case of a replantation of an auto-amputated penis to the multidisciplinary treatment approach including microvascular surgical techniques as well as adjuvant pharmacologic and HBO_2 therapies. Proposed mechanisms of HBO_2 efficacy in this case include reduced swelling and reperfusion injury, increased tissue oxygen concentration and tension as demonstrated by fluorescent angiography. Our recommendation, based on this case and the previous high incidence of complications following penile replantation with no arterial anastomosis, is the routine use of HBO_2 in cases where decreased blood flow is a concern.

HBO_2 therapy should be continued despite superficial necrosis of penile replants. Fluorescent angiography may have potential utility in monitoring efficacy of and quantifying response to HBO_2 therapy.

Conflict of interest statement

The authors have declared that no conflict of interest exists with this submission.

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