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CASE REPORT

Use of Hyperbaric Oxygen as Adjunct in Salvage of Near-complete Ear Amputation

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Summary: There have been several cases of microvascular repair of traumatically avulsed or amputated ears in the literature. It seems that, if possible at the time of operation, microsurgical techniques yield the best results. However, because of the nature, complexity, and acuity of traumatic injuries, this option is not always feasible. Although the possibility of microsurgical repair exists, the small size of these vessels is often prohibitive, even for a skilled microsurgeon. Here, we present the case of a 4-year-old boy with almost complete amputation of the left ear attached by an inferior narrow skin pedicle after a dog bite. He was treated with primary repair and postoperative hyperbaric oxygen therapy (HBOT) with good results. This case is another example that even a narrow skin pedicle can contain artery and vein that can supply a large segment of the auricle, making primary repair feasible because of the vascular anatomy and communicating helical arcade. Also, this case demonstrates the successful use of HBOT with a pediatric patient as an adjuvant postoperative therapy. (*PRS GO 2013;1:e1; doi: 10.1097/GOX.0b013e31828c2416; Published online 3 April 2013.*)

CASE REPORT

The patient in this case was a 4-year-old boy who presented approximately 1 hour after being attacked by a pit bull. He presented with several soft tissue injuries to the face, including a laceration of the right eyelid, a large stellate laceration of the frontal scalp, and an almost complete amputation of the left ear. The ear was attached by an anterior skin bridge at the level of the tragus and lobule of approximately 30 mm (Figs. 1 and 2). After further examination in the operating room under general anesthesia, it was decided that this skin bridge would be sufficient and that the remaining tissue would be viable enough to try and repair the ear primarily. The ear was minimally debrided to healthy bleeding tissue. A 4-0 Vicryl suture was then used to close the cartilage layer, reattaching the pinna to the external auditory canal cartilage. The same suture was used to close the deep layer of the pinna, attaching it to the scalp, and then 5-0 and 6-0 interrupted Prolene sutures were used to close the skin. The external auditory canal skin was closed with a 5-0 chromic suture, and cotton balls coated with bacitracin were packed into the ear canal. After closure, all areas were washed with sterile saline, and a sterile dressing was applied and wrapped around the head after application of bacitracin to all suture lines.

Postoperatively, the patient was started on IV clindamycin. On postoperative day (POD) 1, the patient was found to have venous congestion of the superior half of the pinna but did have capillary blanch and capillary refill (Figs. 3 and 4). At this point, it was decided to start the patient on HBOT in hopes of improving wound healing. On POD 1, the patient received a treatment of 90 minutes of 100% O_2 through an oxygen hood over the patient's head at 2.4 atm in a 12-person multiplace chamber. He subsequently underwent the same treatment twice daily for the next 6 days. Marked improvement was already seen halfway through the treatments by POD 4 (Fig. 5). He was then discharged on POD 7 (Fig. 6). He was brought back to the hospital on POD 11 for suture removal under IV sedation (Fig. 7). At that time, he was found to have some small areas of necrosis on the anterior helix, and it was decided to continue dressing changes and healing by secondary intention. At the time of submission, the patient has been reviewed as an outpatient for 2 months with excellent take. On POD 33, there was a small open area on the superior helix where the previous necrosis was noted; however, some skin islands were seen, and it was thought that this area would reepithelialize over time (Fig. 8). The patient was sent home with instructions to keep the open area covered and in antibiotic ointment. The most

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Fig 1. Left ear preoperatively with intact skin bridge.

Fig 3. Superior view of left ear on POD 1.

recent follow-up on POD 53 was that the ear was found to be almost completely healed with a tiny eschar on the superior helix (Fig. 9).

DISCUSSION

Subtotal ear amputation can be approached in a variety of ways in the acute setting. Much of this depends on the situation surrounding the injury, the extent of the injury, and the extent of the surgeon's experience with such an injury. Park et al,[1,2,3] the first to successfully perform microvascular anastomoses of the ear in 1980, suggested that the ear can survive via a single vessel, either a posterior pedicle or a superior pedicle. Here, we present a case where a narrow skin pedicle bridge remains after traumatic injury due to dog bite. In the literature, reports of subtotal ear amputations supplied by narrow pedicles are scarce. We found 4 cases that describe subtotal amputation provided by superior pedicles[4–6] and 5 cases with the ear attached by inferior pedicles, similar to our case.[7–9] Of these 5 cases, 4 were repaired primarily and 1 was repaired with postauricular artery anastomoses.

In the cases of anterior pedicles, 2 of the 4 resulted in the lobule becoming congested and necrosed. We also found 1 case with ear attached by small superior and inferior skin bridges[10] and 1 case where the attachment was not described, but from the image in the article it appeared that the ear was attached by a superior pedicle attached at the helix.[11]

Park et al[2,3] demonstrated the detailed anatomy of the arterial supply of the posterior and anterior aspects of the auricle in fresh cadavers. Two arterial networks originating mainly from the superficial temporal artery and posterior auricular artery were shown to share enormous communicating branches between them. More recently, Erdmann et al[12] at Duke demonstrated a

Fig 2. Preoperative view of left ear defect.

Fig 4. Lateral view of ear on POD 1.

Fig 5. Lateral view of ear on POD 4.

helical arcade in cadaver studies, a vascular arcade found along the helical rim proceeding through watershed areas of communication with branches of the postauricular artery. The postauricular artery has the greatest impact on auricular blood flow, and consequently a better chance of survival is expected, provided that the postauricular arteriovenous system is preserved at the posterior aspect of the auricle. The study by Park et al[3] noted that the earlobe consistently contained a perforator from the posterior auricular artery measuring on average 0.7 mm in diameter. This is the system that we believe may have remained intact in our case.

Many adjunct postoperative therapies have been applied after ear reattachment to augment tissue perfusion and survival of the tissue; however, there is no consensus on use of one therapy over another. Methods that have been applied include administration of heparin, aspirin, dextran, prostaglandin, leeches, and HBOT. Of the cases reviewed above, 2 applied the use of HBOT to their postoperative treatment.[10, 11] The first one described a case of primary repair of traumatically sheered ear supplied by a 4- and 7-mm skin pedicle at the helical root and lobule, respectively. Postoperative care of this patient consisted of a combined therapy with leeches, dextran-40, vitamin E, and HBOT at 2 atm for 90 minutes twice a day for 6 days while in the hospital and 5 additional days as an outpatient. The result was a completely viable ear on POD 18 with a small 10-mm area of necrosis at the helical root.[10] The second case described a significant avulsion injury to the left ear in a motor vehicle accident. After surgical replacement of the ear without microvascular anastomosis, ischemic changes were seen near the inferior pole. After 24 hours, no capillary refill was detectable, and HBOT was initiated twice daily for a total of 10 treatments given over a 5-day period. The result was improved perfusion at the end of the treatments. In this case, this article shows only an image of the ear at 1 year postoperatively without comments, in which the ear appears to have healed completely without tissue loss.[11] Although details of this article are lacking, it seems that a hyperbaric protocol similar to the one used in our case has been used.

Hyperbaric oxygen is demonstrated to increase neovascularization, enhance oxygen delivery, and stimulate granulation tissue formation and collagen deposition.[13] A study[14] on HBOT in 2010 reviewed the mechanisms of wound healing associated with hyperbaric oxygen. The increase in atmospheric pressure increases the concentration of reactive oxygen and nitrogen species. This increase promotes neovascularization by increasing growth factors such as vascular endothelial growth factor among others and mobilization and differentiation of bone marrow stem/progenitor cells to form vessels de novo.[14]

Fig 6. Lateral view of ear on POD 7.

Fig 7. Lateral view of ear on POD 11.

Fig 8. Lateral view of ear on POD 33.

Hyperbaric oxygen can also reduce tissue edema; it causes constriction of blood vessels in normal tissues without creating hypoxia. It does not, however, cause vasoconstriction in previously oxygen-deprived tissues because of the reflex vasodilatation that occurs after an ischemic insult.[15] This peripheral arteriolar vasoconstriction caused by hyperbaric oxygen can reduce tissue edema and may be useful in the treatment of acute traumatic ischemia. The blood flow that contributes to increased edema seems to be reduced while maintaining oxygen delivery to the compromised tissues through the tremendous amounts dissolved in plasma.[11]

Complications of HBOT are rare, especially if sessions are limited to 90 minutes at no greater than 2.5 atm.[11]

CONCLUSIONS

The decision regarding the management of a near-total ear avulsion should be made at the time of presentation based on the viability and condition of the ear, surgeon's experience and expertise, hospital resources,

Fig 9. Lateral view of ear on POD 53.

and associated injury or morbidity. Primary closure without microsurgery of the nearly avulsed ear is possible with good results as long as there is a small skin pedicle intact. Anatomic studies have shown that there is an extensive helical arcade that can supply perfusion to the majority of the ear through an inferior or superior pedicle.

Even after successful reattachment, the postoperative course can be hindered by poor circulation and edema. Although there is no absolute consensus for the postoperative care of reattachment of the auricle after traumatic injury, here we demonstrate a case with successful use of HBOT in the immediate postoperative period. Though this is an anecdotal case report, it shows that hyperbaric oxygen may play a role as an overlooked clinical tool that can help improve outcomes. In this case, hyperbaric oxygen proved effective with minimal risk of side effects associated with medicinal therapy and ease of use in a pediatric patient.

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