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Research Letter

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Effect of Perioperative Hyperbaric Oxygen on Bruising in Face-lifts

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Hyperbaric oxygen (HBO) therapy has been used for wound healing for many years. It increases the ability of blood to upload, carry, and deliver oxygen to tissue. The mechanism by which oxygen acts on wound beds is multifactorial, but includes improved oxygen delivery to relatively hypoxic and avascular tissue and increases free radical scavengers to prevent and reduce oxidative stress and tissue injury. The final common pathway for wounds treated with HBO therapy is improved and more rapid wound healing.

Wound healing is a primary interest of both patients and the collective health care industry. Physicians modify surgical techniques, pharmaceutical companies spend millions of dollars on research and development, and patients use anecdotal home remedies in their care to facilitate a more rapid recovery. One of the most challenging aspects in evaluation of wound healing has been developing an inexpensive, easy-to-use, objective measure to assess outcomes. Subtle variability between photographs may be imperceptible to even the most trained eye, resulting in inaccuracies when grading outcomes.[1-3] Seeley et al[4] developed digital photographic analysis of ecchymosis of the skin flaps of patients who undergo face-lift procedures using nonsurgical internal skin controls to reduce intraobserver variability.

We present a prospective controlled trial using the digital photography computer model by Seeley et al[4] to analyze color variability and assess the effect of perioperative HBO on bruising in face-lift surgery.

Methods

Thirteen patients were entered into the study from the senior author's

practice (A.A.J.). All 13 patients were offered the opportunity to participate in the treatment arm. Informed consent was obtained from the 6 patients choosing to undergo HBO therapy. Drains and dressings were removed on postoperative day (POD) 1. All patients received routine postoperative care, which includes oral steroids, prophylactic antibiotics, the botanical *Arnica montana*, and bromalain. The treatment group received 5 perioperative HBO treatments at 2 atmospheres for 60 minutes administered on the 2 days prior to surgery and then again on PODs 3, 4, and 5. Standard digital photography was taken on PODs 1, 5, 7, and 10 for digital analysis.

Each photograph underwent digital analysis using Adobe Photoshop (Adobe Systems Inc, San Jose, California) in the CMYK (cyan, magenta, yellow, and black; see Seeley et al[4] for a detailed description) color mode from the image drop-down menu with the internal control of normal skin and the surgically treated cheek soft tissue evaluated.

The CMYK color mode was used as previously described by Seeley et al,[4] providing information on the difference between the internal control area and the cheek skin soft-tissue flap to assess 5 different characteristics: cyan, magenta, yellow, black, and luminosity. The control area was taken in order of preference from the earlobe skin, temple skin,

nasal skin, and cervical skin to compare an area that was uninvolved in the surgical field and is most similar to the cheek soft tissues. The cheek flap was independently evaluated (Figure 1).

Following collection of both the control and cheek soft-tissue data, color change was objectively quantified with a previously validated formula, $x = (\Delta C^2 + \Delta Y^2 + \Delta M^2 + \Delta K^2 + \Delta L^2)^{1/2}$, in which Δ represents the difference in the individual characteristic between the study area and the internal control area for each picture, resulting in a single unitless value, x. Following this, statistical analysis was performed for each postoperative point on PODs 1, 5, 7, and 10, using a paired t test assuming unequal variance.

Results

Thirteen female patients with a mean age of 59 years (age range, 47-71 years) were entered into the study, with 6 electing to undergo HBO therapy. Eleven patients underwent a deep plane face-lift, and 2 patients, 1 each in the control group and the treatment group, underwent an extended superficial musculoaponeurotic system face-lift. There were no surgical or medical complications. One patient in the control arm missed a single postoperative appointment on POD 5, with that value

unavailable for analysis. Overall, 102 photographs and 1020 data points were analyzed. On POD 1, the average degree of color change in the cheek soft-tissue flap in the HBO group was 38.5 and in the control group was 43.7. This difference was not statistically significant (P = .28). The degree of color change in the HBO group on POD 5 was 39.0 and in the control group was 45.6. Again, this difference was not statistically significant (P = .13). On POD 7, the average degree of color change in the treatment group was 27.5 and in the control group was 42.2 (P = .005), with a 35% reduction in color change in the treatment group over the control group. The average degree of color change on POD 10 was 22.0 in the treatment group and 31.6 in the control group (P = .03), with an average of 30% reduction in color change in the treatment group when compared with the control group. Figure 2 outlines the comparison between the patients undergoing HBO and the control patients.

Comment

A lot of research in homeopathy, surgical techniques, and adjunctive therapy has been performed to find newer, faster healing methods from surgical procedures.[5] Patients undergoing facial surgery desire faster recovery to return to work and their personal lives sooner. There is a plethora of directed marketing techniques advertising minimally invasive

surgery with short recovery periods to entice patients to undergo facial surgery, sometimes with unrealistic promises for exceptionally quick recoveries. Many homeopathy practitioners have used *A montana* owing to its multiple reported benefits, including improved healing, with contradicting results.[6-10] Seeley et al[4] objectively evaluated the effect of *A montana* on face-lift bruising, with their results demonstrating no statistically significant improvement in the degree of bruising postoperatively. As important to their reported results on the effect of *A montana* was the development of an objective, inexpensive, and easy-to-use computer model for assessing ecchymosis.

Hyperbaric oxygen therapy offers improved and faster wound healing in patients undergoing reconstructive surgery and those with chronic wounds. Recent research has demonstrated that HBO therapy improves wound neovascularization and epithelialization in vitro as well as blood flow to flaps and free composite graft and flap survivability in animal models.[11-13] It has also been shown to have a protective effect on ischemic reperfusion injury in animal models.[14] To our knowledge, there has been no report of the use of HBO therapy and its effect on postoperative ecchymosis or its use in cosmetic surgery. Hyperbaric oxygen therapy offers patients a statistically significant, perioperative adjunctive therapy that decreases bruising in patients undergoing

face-lift by 35% and 30% on PODs 7 and 10, respectively. Although the difference in color change on POD 5 was not statistically significant (*P* = .13), this most likely would become statistically significant with a larger sample size.

The major barrier to the use of HBO therapy is the time-consuming nature of this treatment as well as its cost. While there is a theoretical concern for postoperative bleeding with pressure changes in the chamber, our patients did not experience any postoperative hematomas by waiting until 48 hours after surgery for the first dive. At $225 per dive, the cost of this treatment would be approximately $1100 if our protocol were followed.

Hyperbaric oxygen therapy offers patients an additional option for quicker recovery in face-lift surgery and potentially other cosmetic procedures. It should be included in the discussion with patients with limited available recovery time as an option for faster resolution of postoperative ecchymosis.

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