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Background: Closed dressings are thought to promote postoperative wound healing after laser skin resurfacing; however, quantitative data are lacking.

Objective: To compare postoperative healing after combination carbon dioxide and erbium:YAG full-face laser skin resurfacing in patients who were treated with a silicone occlusive dressing (Silon-TSR; Bio Med Sciences, Inc, Bethlehem, Pa) vs open-wound care consisting of soaks and ointment application.

Design: Thirty-five patients with closed dressings compared retrospectively with 35 control subjects with open-wound care. In a prospective evaluation, 27 patients with closed dressings were then compared with 27 historical controls matched by age, sex, skin type, and treatment technique. Erythema, crusting, swelling, pain, pruritus, purpura, long-term complications, and dressing comfort were evaluated.

Setting: Referral-based academic practice.

Results: Prospectively, closed-dressing and open-wound care groups differed significantly in maximum erythema severity (1.8 vs 2.0 on a scale of 0-3; $P=.03$), noticeable erythema duration (15.4 vs 31.1 days; $P=.04$), and time until complete erythema resolution (41.8 vs 96.1 days; $P=.02$). Swelling resolution was more rapid in the dressing group (12.1 vs 29.5 days; $P=.02$). Crusting was limited to uncovered areas in the dressing group, and crusting duration was shorter (5.0 vs 9.1 days; $P<.001$). Pain was more likely to be reported prospectively, but severity was mild, in the closed-dressing group. Other short- and long-term complications did not differ significantly. Subjective patient attitudes toward the dressing were positive.

Conclusions: Occlusive silicone dressing application decreases immediate postoperative morbidity with significantly reduced severity and duration of erythema and decreased duration of swelling and crusting. Long-term results and complication rates remain unchanged.

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IN THE PAST decade, laser skin resurfacing (LSR) for the treatment of facial rhytids, solar damage, and acne scarring has become an increasingly common cosmetic procedure. The optimal wound care regimen for resurfacing has been the subject of widespread discussion. A number of closed dressings have become available for postoperative wound care. However, the advantage of using such dressings compared with open-wound care with compresses and lubricants remains largely anecdotal.

Dressings provide a semioclusive environment that protects the wound from exogenous bacteria and provides a moist environment for the exchange of oxygen and water vapor. Drainage of wound exudates via the dressing also prevents excess crust formation. Proposed advantages of closed dressings after LSR include reduced postoperative pain, decreased erythema, increased rate of epithelialization, and simplified wound management.^{1,2} On the other hand, hypothetical disadvantages of closed dressings include increased susceptibility to infection if bacteria are trapped under the barrier and impaired wound surveillance

while the dressing is in place. In addition, dressings may create a restrictive or claustrophobic environment.^{3,4}

The purpose of this study was to compare postoperative healing, complications, and subjective attitudes retrospectively and prospectively in patients receiving a silicone occlusive dressing vs open-wound care after combination carbon dioxide (CO₂) and erbium (Er):YAG full-face LSR. The dressing evaluated was considered representative of semioclusive polymer films, a silicone dressing with a polytetrafluorethylene inner polymer network (Silon-TSR; Bio Med Sciences, Inc, Bethlehem, Pa). Open-wound care consisted of frequent soaks and application of healing ointment (Aquaphor; Beiersdorf, Inc, Norwalk, Conn).

RESULTS

The retrospective study included 35 patients in the closed-dressing group and 35 patients in the open-wound care group. The mean (\pm SD) age of patients was 50.1 \pm 13.6 years in the closed-dressing group and 49.4 \pm 12.0 years in the open-wound care

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PATIENTS, MATERIALS, AND METHODS

To gather preliminary data, a retrospective analysis was first performed. Patients who underwent full-face combination CO₂-Er:YAG LSR from July 1, 1998, through July 31, 1999, at the Beth Israel Deaconess Medical Center Cosmetic Surgery and Laser Center, Chestnut Hill, Mass, were eligible for inclusion in the study. Thirty-five patients who had the silicone dressing placed for 3 days postoperatively were selected randomly and retrospectively compared with 35 randomly selected patients treated during the same period with open-wound care. Comparable groups were picked that were similar in age, sex, skin type distribution, and treatment technique.

Patients were treated preoperatively with 0.025% retinoic acid cream or 10% glycolic acid cream for at least 6 weeks. Therapy with dicloxacillin sodium, 250 mg twice a day, or if allergic, azithromycin, 250 mg once a day, was started 24 hours before the procedure and continued for 10 days. Therapy with valacyclovir hydrochloride, 500 mg twice a day, was started 24 hours before the procedure and continued for 7 days. Patients underwent full-face LSR with 2 to 3 passes of a CO₂ laser with a computer pattern generator used at standard facial and eyelid settings (UltraPulse laser; Coherent Medical Group, Palo Alto, Calif). Patients then underwent 1 to 2 full-face passes with an Er:YAG laser (Continuum Biomedical, Santa Clara, Calif). Patients' skin was gently cleaned with isotonic sodium chloride solution between passes of the CO₂ laser, and debris were removed using sterile gauze.

The procedure was performed using intravenous sedation with propofol, midazolam hydrochloride, and fentanyl citrate administered by an anesthesiologist. Local and regional nerve blocks were performed for facial anesthesia.

After the procedure, in-study subjects who had the dressing placed, the face was blotted dry and the silicone occlusive dressing was applied. The polymer film comes in a transparent face mask design with perforations to allow drainage of excess fluid. The mask was held in place by drawstrings tied behind the head. Openings were cut for the eyelids, nose, and central lips, and a smaller patch of dressing was applied to cover the nose bridge. Gauze 4 × 4-in (10.2 × 10.2-cm) dressings were applied over the mask to absorb exudates and held in place by means of tube gauze. Patients were seen on the first postoperative day, and the tube gauze and 4 × 4-in gauze were removed. The resurfaced area was inspected through the mask, and accumulated exudate or crust was removed from the uncovered areas using isotonic sodium chloride solution. Patients were instructed to begin soaks with ice water through the mask for 20 to 30 minutes at 2- to 3-hour intervals while awake. Patients returned again at the third postoperative day, and the dressing was removed. Patients continued soaks at 3- to 4-hour intervals, followed by application of healing ointment. By 7 to 10 days after the procedure, soaks were replaced with gentle cleansing, and patients switched to application of a moisturizer-sunscreen.

The postoperative regimen for control patients in the study consisted of open-wound care without any placement of an occlusive dressing. After the procedure, patients began 20- to 30-minute soaks with ice water at 2- to 3-hour intervals immediately followed by application of healing ointment. The frequency of the soaks and ointment application decreased as reepithelialization progressed; soaks were stopped once reepithelialization was complete. The use of ointment was then tapered until replaced by lighter moisturizer-sunscreen. Patients are seen at the first and third days postoperatively on identical appointment regimens as those patients receiving the dressing.

Erythema, swelling, crusting, pain, pruritus, purpura, and complications in the closed-dressing and open-wound care groups were all evaluated based on retrospective chart review.

Since the retrospective analysis was limited in the amount of information that could be derived and by the inherent statistical bias in retrospective data,¹ we undertook a prospective study of postoperative occlusive dressing in patients undergoing the combination CO₂-Er:YAG LSR procedure. We included for prospective evaluation 27 consecutive patients who underwent the procedure at the Beth Israel Deaconess Cosmetic Surgery and Laser Center from August 1, 1999, through October 31, 1999, and had the silicone occlusive dressing placed. No patient refused to participate in the study. These patients were compared with 27 historic controls treated with open-wound care who underwent LSR from July 1, 1998, through July 31, 1999, and were matched by age, sex, skin type, and treatment technique. The laser technique, anesthesia, and methods of postoperative care were the same as previously described for the retrospective analysis.

Variables evaluated prospectively included the severity and duration of erythema, swelling, crusting, pain, pruritus, and purpura. Severity was measured on a scale of 0 to 3 by 1 of 3 clinicians (R.S.B., C.J., and L.H.) who had previously discussed guidelines for classification; uniformity of evaluation was corroborated by a clinician who saw all patients (J.S.D.). Data were also collected on requirement and dosage of pain medications and antihistamines for pruritus. The progress of epithelialization was evaluated prospectively, and complications including acne flare, milia, hyperpigmentation, and hypopigmentation were noted. Patients were asked their subjective experience with the closed dressing at each visit, including comfort, claustrophobia, discomfort in covered and uncovered areas, and work intensiveness of soaks. All responses were scored on a 4-point scale, where 0 indicates none; 1, mild; 2, moderate; and 3, extreme.

We used commercially available software (Microsoft Excel; Microsoft Corp, Redmond, Wash) for data compilation and management, and a software package (Stata, Version 6.0; Stata, Inc, College Station, Tex) for statistical testing. Results from pairs analysis were compared using 2-sample *t* tests for independent samples assuming equal population variances. A 2-tailed *P* value of less than .05 was considered significant.

group ($P = .83$). There were 33 women and 2 men in the closed-dressing group and 32 women and 3 men in the open-wound care group.

The mean maximum severity of erythema in the closed-dressing group was significantly less than that in

the open-wound care group (1.8 vs 2.0; $P = .048$). The duration of noticeable erythema was shorter in the closed-dressing group (17.3 vs 35.4 days; $P = .01$), as was the time until complete resolution (49.5 vs 96.6 days; $P = .005$). In the retrospective analysis, swelling severity and

Table 1. Comparison of Erythema and Swelling in Closed-Dressing and Open-Wound Care Groups

Groups	Patient Group, Mean ± SD		P†
	Closed-Dressing	Open-Wound Care	
Erythema			
Maximum severity*	1.8 ± 0.4	2.0 ± 0.3	.03
Noticeable duration, d	15.4 ± 11.3	31.1 ± 36.5	.04
Days until complete resolution	41.8 ± 12.4	96.1 ± 67.5	.02
Swelling			
Maximum severity*	1.4 ± 0.5	1.6 ± 0.5	.18
Noticeable duration, d	5.1 ± 3.2	9.3 ± 5.9	.002
Days until complete resolution	12.1 ± 8.1	29.5 ± 34.8	.02

*Severity was measured on a scale of 0 to 3, where 0 indicates none and 3, extreme.

†Indicates 2-tailed *P* value.

duration did not differ significantly between the closed-dressing and open-wound care groups. Mean severity of swelling grade was 1.5 vs 1.6 in the closed-dressing group compared with the open-wound care group ($P = .64$); the duration of noticeable swelling, 8.2 vs 9.4 days ($P = .33$); and the time until complete resolution of swelling, 24.2 vs 29.8 days ($P = .41$). Crusting was limited to the areas not covered by dressing in the closed-dressing group, and the duration of crusting was significantly shorter at 6.8 days, compared with 9.1 days in the open-wound care group ($P = .005$). In the closed-dressing group, pain was noted 34% of the time, compared with 40% of the time in the open-wound care group. Although this difference was not significant ($P = .63$), clinicians subjectively noted the severity to be less. The duration of pain was 3.6 days in the closed-dressing group compared with 4.7 days in the open-wound care group ($P = .47$). There were no significant differences in incidence or duration of pruritus, purpura, acne flare, or infection. The most common complication in both groups was hyperpigmentation, with 9 cases in the closed-dressing group and 6 cases in the open-wound care group, but this difference was not significant ($P = .24$).

After gathering preliminary data in the retrospective comparison, a prospective study of 27 patients who had the silicone occlusive dressing placed was conducted compared with 27 historical controls treated using open-wound care and matched by age, sex, skin type, and treatment technique. The mean age (\pm SD) in the closed-dressing group was 50.4 \pm 0.8 years compared with 49.9 \pm 10.9 years in the open-wound care group ($P = .87$). As in the retrospective study, the maximum severity, duration, and time until complete resolution of erythema were significantly less in the closed-dressing group compared with the open-wound care group. These results are summarized in **Table 1**. In the prospectively studied group, although the severity of swelling was similar, duration of swelling and time until complete resolution were significantly shorter (Table 1). Crusting was limited to the areas not covered by dressing, as seen in the **Figure**, and the duration was significantly shorter in the closed-dressing group (5.1 vs 9.3 days; $P = .002$). The mean time until complete reepithelialization was 7.7 days in the

closed-dressing group. There were no significant differences in the incidence or duration of purpura, acne flare, infection, or other short- or long-term complications between groups.

The mean severity of pain was 1.2 in the closed-dressing group. In the prospective comparison, 22 patients (81%) reported pain compared with 12 (44%) of the historical controls. The mean duration of pain in the closed-dressing group was 3.3 days compared with 5.1 days in the open-wound care group, but this difference was not significant ($P = .18$). Among patients undergoing the procedure, 23 (85%) required pain medications, including self-prescribed over-the-counter drugs, with a mean duration of medication use of 2.9 days postoperatively. The most common prescription regimens were a combination of acetaminophen and codeine phosphate (Tylenol with Codeine) or of acetaminophen and hydrocodone bitartrate (Vicodin), 1 to 2 tablets twice a day.

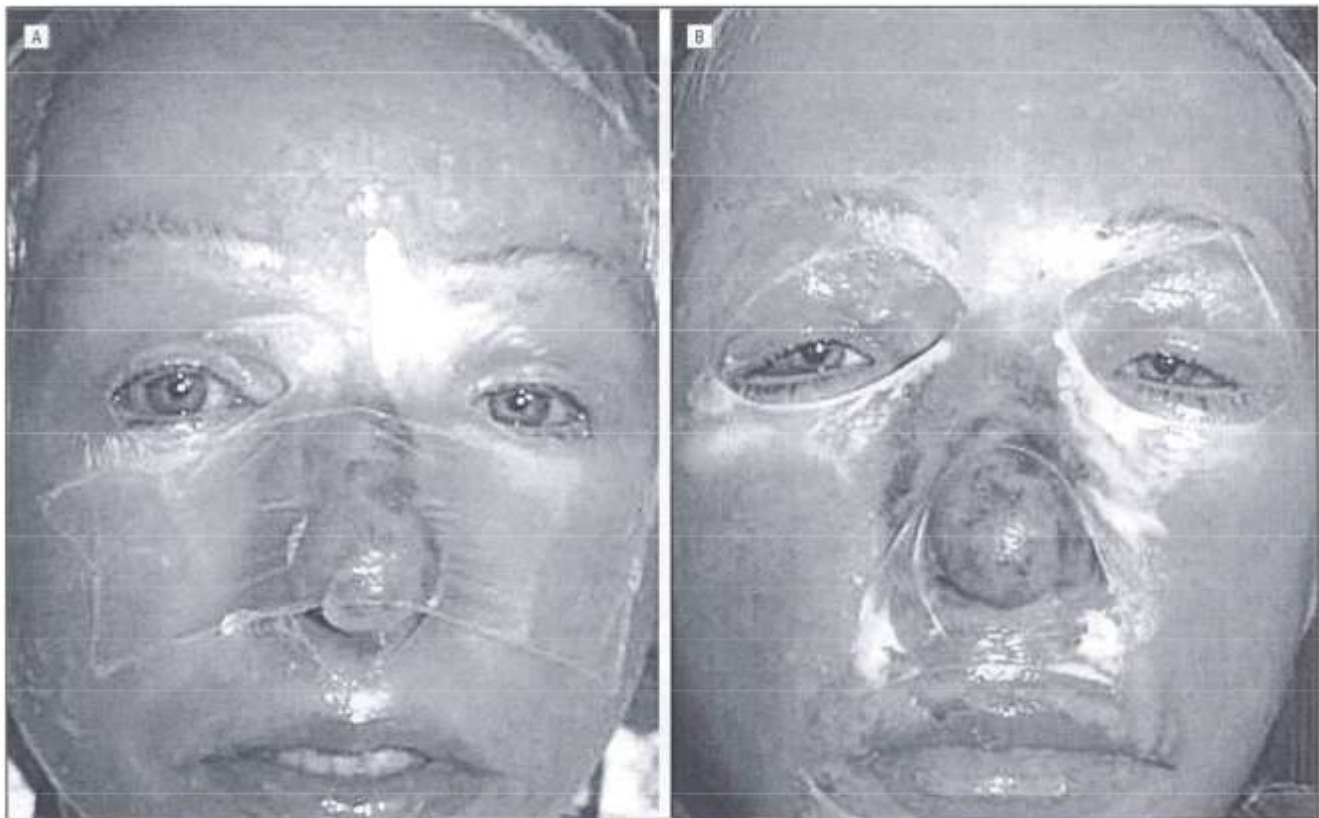
Mean severity score for pruritus was 1.6. In the closed-dressing group, 25 patients (93%) reported pruritus prospectively vs 19 (70%) of historical controls. The closed-dressing and open-wound care groups noted pruritus at 10.7 days. In the closed-dressing group, 14 patients (52%) surveyed prospectively required antihistamines. The most common over-the-counter drug was diphenhydramine hydrochloride, 25 to 50 mg every night, and those requiring prescription medication took hydroxyzine hydrochloride, 25 mg 2 to 3 times daily.

Patients were surveyed prospectively regarding the comfort and acceptability of the dressing, with the results given in **Table 2**. There was a significant difference in discomfort in covered areas compared with those not covered by the dressing (0.5 vs 1.9; $P < .001$).

COMMENT

Animal and human studies have shown the benefits of a moist environment in epidermal wound healing, since dry crust or scab impedes keratinocyte migration.⁶⁻⁸ Experts agree that the superficial thermal injury produced by LSR heals more quickly and with a markedly reduced risk for scarring under occlusion; however, debate still exists as to the superiority of postoperative open-wound care with occlusive ointments vs a closed-dressing method with semi-occlusive dressings.⁹⁻¹¹ Histologically, differences have been observed in the healing process after LSR between the closed- and open-wound care techniques.¹² With open-wound care, the level of slough after LSR occurs at the base of the basophilic-staining zone, whereas with closed dressings, more basophilic-staining collagen is retained, the level of sloughing is more superficial, and there is less acute inflammation.¹²

The use of closed occlusive dressings after LSR, based on studies in burn literature,^{13,14} has increased largely based on anecdotal evidence with little quantitative evaluation. Recent comparative studies of closed dressings after LSR have been difficult to interpret since skin types, lasers, and number of passes differed among patients in different study groups.^{1,2} This study sought to quantify and assess the differences in clinical progress between the open-wound and closed-dressing care techniques. Skin



Difference in crusting and erythema between areas covered and not covered by closed dressing. A, Day of procedure. The patient underwent pulsed dye laser treatment of nose followed by combination carbon dioxide and erbium:YAG full-face laser skin resurfacing. The silicone occlusive dressing was placed immediately postoperatively. Openings cut for the eyes, nose, and mouth were small, and an additional dressing piece was placed over the nose bridge to provide uniform coverage. B, Postoperative day 3. The openings cut for the eyes and lips have been widened, and the dressing piece covering the nose bridge has been removed. Those areas not covered by the closed dressing have markedly increased crusting and erythema compared with those areas covered by the dressing.

Table 2. Patients Attitudes Toward the Dressing

Attitudes	Patient Score*
Dressing comfort	2.0 ± 0.5
Dressing claustrophobia	0.8 ± 1.1
Work intensiveness of soaks	1.9 ± 0.7
Covered areas discomfort	0.5 ± 0.5
Uncovered areas discomfort	1.9 ± 0.6†

*Scores were assigned on a scale of 0 to 3, where 0 indicates none and 3, extreme.

†For covered vs uncovered areas discomfort, $P < .05$ (2-tailed).

types, lasers, and treatment technique were uniform and matched to minimize confounding and to focus on the postoperative effect of the dressing alone.

Our data indicate that the application of an occlusive silicone dressing significantly decreases immediate postoperative morbidity. There was a clinically and statistically significant reduction in the severity of erythema after the procedure in patients who had the dressing placed, and the duration of noticeable erythema and time until complete resolution were approximately halved in the closed-dressing group. In addition, the duration of swelling was significantly shorter in the closed-dressing group, with less than half the time until complete resolution. Crusting in the closed-dressing group was limited to only the uncovered areas and

resolved in slightly more than half the time than in the open-wound care group.

Complication rates and long-term results were unchanged by the application of the closed dressing. The most common complications were the development of 1 or more milia in approximately two thirds of patients and self-limited hyperpigmentation, which occurred in approximately one third of patients. These complications did not differ significantly between groups and have also been reported in other studies.^{15,16} Although the use of a closed occlusive dressing after LSR has been suggested to increase the risk for infection,³ there was no difference in the incidence of infection between the open-wound and closed-dressing groups in this sample. In the retrospective study, vesicles from herpes simplex virus developed in 1 patient in each group, for a total rate of 2.9%. This is comparable to rates of infection in other studies.^{3,4,17} In the prospective study, no infections developed after the procedure. This was likely due to increased instruction in semisterile technique for patients' self-wound care and greater emphasis on the importance of prophylactic antibiotic and antiviral therapy.

Occlusive dressings have been subjectively noted by clinicians to decrease the severity and duration of pain in patients undergoing LSR, but the amount of reduction and the actual pain medications required by patients have not been quantified.^{18,19} We found that 81% of patients with the dressing surveyed prospectively noted pain, whereas

only 44% of the historical open-wound care group did. However, the prospective patients reported mild pain, whereas the retrospective controls complained of more intense pain. This finding yielded the following insight into patient psychology: a patient asked about pain at each visit was much more likely to respond affirmatively, for even minimal symptoms, than one who had to independently volunteer the complaint. The mean severity of the pain in the closed-dressing group was mild to moderate, and 85% of patients used some form of pain medication. This is a larger percentage than in previous retrospective studies, in which the clinician was unlikely to be aware of patients' self-medication with over-the-counter drugs.¹⁶ Patients in the closed-dressing group used pain medications for a mean of 2.9 days.

A similar detection bias existed in prospective patient reporting of pruritus, ie, 93% in the closed-dressing group compared with 70% of historical controls, rates consistent with those of previous studies.¹⁶ Patients in both groups on average reported mild to moderate pruritus with nearly identical durations of approximately 10.7 days. About half of patients required antihistamines, which were important to prevent potentially scarring excoriations. These results suggest that pruritus is likely secondary to intrinsic aspects of reepithelialization that were not affected by the placement of a dressing.

A proposed drawback of occlusive dressings is that they create an uncomfortable, constraining environment that may be claustrophobic and unacceptable to some patients.^{4,9} Our experience revealed that patients found the dressing tolerable and thought it increased their comfort. Patients rated the dressing very comfortable (2 on a scale of 0-3), and were unlikely to consider it claustrophobic (0.8 on a scale of 0-3). Subjectively, patients found the work of soaks after the removal of dressing to be fairly onerous, rating it a 1.9 of 3, and expressed relief that during the initial days with the dressing, they had not needed to wake for soaks during the night. This convenience was considered a major advantage of the dressing. The discomfort in areas covered by the dressing was significantly less, which was consistent with the experience of Weinstein et al⁹ of patients "begging" to convert open-wound care areas to closed-dressing care for comfort.

A limitation of our study was the use of historical controls for comparison of the open-wound care technique. Although this method decreased the amount of data that could be gathered and was subject to inherent statistical bias, it still yielded valuable comparisons, since patients were matched by age, sex, skin type, and treatment technique. In addition, since all patients underwent treatment with the same lasers by the same surgeon, there was no interoperator variability to correct for when interpreting the data. Although other studies have attempted to compare several different types of dressings,^{1,2} we limited our study to a single dressing that we believed was representative of closed occlusive dressings to minimize the variability that could be attributed to a particular dressing construction.

CONCLUSIONS

Laser skin resurfacing has revolutionized the approach to facial skin rejuvenation. Optimal postoperative care

has been the subject of a number of articles in the aesthetic surgery literature in the past decade. Although experts agree that postoperative care is as important as intraoperative technique, controversy persists between open-wound and occlusive closed-wound care techniques. Our data provide quantitative evidence that an occlusive silicone dressing after LSR significantly reduces severity and duration of erythema as well as duration of swelling and crusting compared with open-wound care. Patient comfort was increased and patients tolerated the closed dressing well. Delayed wound healing, infection, and scar formation can ruin the results of excellent intraoperative technique. The proper use of a closed dressing can avoid these complications and help patients to achieve reepithelialization with markedly reduced immediate postoperative morbidity.

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