Comparison of a Series of Superficial Chemical Peels With a Single Midlevel Chemical Peel for the Correction of Facial Actinic Damage

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Background: Chemical facial peels are common cosmetic procedures that have gained in popularity over the last decade. The aim of this study was to compare the efficacy and morbidity of a series of superficial glycolic acid (GA) peels with those of a midlevel trichloroacetic acid (TCA) peel.

Methods: We conducted a split-face study of 7 female patients, comparing the benefits of a single 35% TCA peel with those of a series of 5 30% GA peels performed at monthly intervals. Throughout the study, we performed noninvasive biophysical measurements, optical imaging, and expert and naïve image evaluations and conducted subject-group discussions so that we might objectively quantify and compare the treatments over time. An additional objective of the research was to use quantitative objective measurements of skin condition and actinic damage to establish these techniques as biologically based standards for treatment evaluation.

Results: Skin elasticity and hydration increased during the course of the study but were not significantly different between the 2 treatment modes. Overall improvement with both treatments was relatively small as judged by expert evaluations of digital images taken at baseline and 3 months after treatment. No important differences were perceived when naïve judges were asked to evaluate the images. Digital-image analysis of wrinkles in the cheek region revealed significantly greater improvement in wrinkles with the TCA peel. In patient-group discussions, TCA peels were associated with greater improvement but also with more discomfort; GA peels were associated with a high degree of satisfaction, although their effect on quantitative technical measures of actinic damage was not dramatic.

Conclusions: Although a single TCA peel produced more improvement than a series of superficial peels, the differences were small, and the TCA peel was associated with significantly greater discomfort. (Aesthetic Surg J 2003;23:339-344.)
enrolling in the study. All subjects were provided with a skin care regimen consisting of a cleanser, moisturizer, sunscreen (BioMedic, Phoenix, AZ), and retinoic acid (0.05% Renova; Ortho Dermatological, Skillman, NJ) and instructed to begin using it after the first visit and for the duration of the study. The product regimen was used on both sides of the face to establish a consistent baseline skin condition.

**Peel procedures**

After 4 weeks, the patients were randomly assigned to undergo a series of superficial GA peels on the right or left side of the face. The opposite side served as the control for the first part of the study. The peel procedures were performed by a qualified nurse in accordance with the recommendations of the manufacturer (BioMedic): First, the skin was cleansed and degreased with acetone. The outermost level of the stratum corneum was carefully removed with a dermaplaning blade. A solution of 30% GA was applied to the skin. After 2 minutes, the GA was neutralized by light brushing of the face with dry ice. After the procedure, moisturizer and sunblock were applied to the skin. Five peels were performed, at monthly intervals.

One month after the fifth superficial peel, a midlevel 35% TCA peel was performed on the other side of the face by a qualified plastic surgeon. Cold packs were used to provide analgesia. The TCA solution was applied to the face to yield a uniform white frost on the skin that lasted 30 to 40 minutes. Moisturizer (BioMedic) was supplied to cover the face during the exfoliation process. After the procedure, moisturizer and sunblock were applied to the skin. Five peels were performed, at monthly intervals.

Measurements

Noninvasive measurements of skin condition and actinic damage were performed at baseline, just before each peel procedure, and once a month for 3 months after the TCA peel. The assessments were made to evaluate and compare the effects of the skin care regimen (compared with the baseline condition), the series of superficial peels (compared with the regimen-only side), the single TCA peel (compared with the regimen over time), and the superficial peels compared with the TCA peel.

**Digital photography and image analysis**

Digital images of the face were captured with the wrinkle-imaging system (WIS) developed by the Procter and Gamble Co. (Cincinnati, OH). The system uses lighting that enhances textural features of the face. Images are calibrated, and repositioning of the subject’s face at each time point is controlled to minimize any variation not resulting from treatment. The images were analyzed 3 ways: by expert judges, by naive judges, and with a computer algorithm.

Images paired for each subject in the group, baseline and 3 months after peel (ie, baseline vs serial GA peels and baseline vs TCA peel), were evaluated in a paired comparison format by 4 expert judges. They rated the differences in eye-area wrinkles and cheek-area texture on a scale of 0 to 4 (0 = no difference; 4 = large difference). A positive value indicated an improvement in the postpeel image compared with the baseline image. A negative value indicated worsening of the skin feature.

A panel of 20 naive (untrained) female consumers (judges) was recruited from an agency (J&R Coordinating Services, Inc., Cincinnati, OH). The judges viewed the image pairs and selected the image that “looked better overall.” They rated the difference on a scale of 0 to 4 (0 = no difference; 4 = much better). A positive value indicated an improvement in the “after” image compared with the baseline image. A negative value indicated worsening of skin appearance.

In algorithm judging, images were masked in the eye and cheek areas. An algorithm (Optimas; Media Cybernetics, Baltimore, MD) that determined all lines in the comparison format by 4 expert judges. They rated the differences in eye-area wrinkles and cheek-area texture on a scale of 0 to 4 (0 = no difference; 4 = large difference). A positive value indicated an improvement in the postpeel image compared with the baseline image. A negative value indicated worsening of the skin feature.

**Biophysical evaluation of skin condition**

The electrical capacitance of each skin site was measured, as an indicator of hydration level, with a Corneometer (Courage & Khazaka Electronic GMBH, Cologne, Germany).

Skin-surface replicas were taken on each cheek at each time point with SilFlo dental-impression material (Flexco-Development Ltd., Potters Bar, UK). The area of the cheek-skin surface sampled was 314 mm². We analyzed the finished replicas with the use of moire interferometry to calculate the root mean square (Rq) of the replica plane. A reduction in Rq indicated a smoother surface.

Elasticity of the skin was evaluated with a hand-held ballistometer (Diastron Ltd., Hampshire, UK). Measures of the mean CoR (coefficient of restitution) were taken.
on the cheek and on the forearm for each side. The ratio of the mean CoR on the cheek to that of the forearm was calculated for each time point. The volar forearm served as an untreated control.

Patient group discussions

Four months after their TCA peels, 6 of the 7 women provided qualitative information about the 2 treatment strategies in a group discussion led by an experienced moderator (Nancy Dawes, Procter and Gamble). Respondents also completed a brief questionnaire rating the differences between how their skin looked and felt before they participated in the study and again on the day of the discussion. They were asked to rate their satisfaction with the results and changes in various attributes of their skin. After completing the questionnaire, each patient viewed 2 sets of their own facial images: (1) baseline and 3 months after the last GA peel and (2) baseline and 3 months after the TCA peel. The pictures were labeled “before” and “after” and identified by treatment. Each patient then completed a second questionnaire to rate the differences she noted after looking at the images.

Statistical analysis

We compared the measurements of baseline skin condition with those 3 months after the TCA peel for each of the 2 peel treatments using paired t tests (SigmaStat Software; Jandel Scientific, San Rafael, CA). The measurements of skin condition for the serial GA peels compared with those from the TCA peel were evaluated with paired t tests. Changes over time for the serial peels and for the TCA peel were evaluated with repeated-measures analysis of variance procedure (SigmaStat). We considered P values of .05 or less statistically significant.

Results

The results of the digital-image analysis are provided in the Table. The expert judges observed significant reduction in wrinkles in both the eye (1.93 of a possible 4) and cheek (0.89 of a possible 4) areas treated with TCA. However, the expert judges did not observe as much improvement in the side of the face treated with GA. The difference in the expert evaluations of the GA and TCA treatments demonstrates a trend, but it is not statistically significant. The naive judges found no improvement in overall appearance of either the side of the face treated with GA acid (mean of 0.18 on a scale of 0 to 4) or the side treated with TCA (0.19).

Image analysis with the computer algorithm demonstrated a reduction of 15.3 line area/mm² in the GA-treated side and a reduction of 22.9 line area/mm² in the TCA-treated side when the lateral canthal area was evaluated. This finding was not statistically significant. However, a statistically significant difference was found between the cheek area treated with GA (Figure 1; increase of 1.29 line area/mm²) and that treated with TCA (Figure 2; reduction of 32.8 line area/mm²).

Hydration

Skin hydration increased on both sides during the course of the study (Figure 3). The TCA-peeled side demonstrated directionally lower skin hydration than the GA-peeled side from the second pretreatment time point to the 1-month postpeel time point. The hydration data suggest that the serial GA peels increased moisture or prevented the dryness attributable to the irritant effects and resulting hyperproliferation caused by Renova. No difference in the 2 peel treatments was observed by the end of the study. However, the baseline measurements
were taken in December, and the final measures were made the following June. Participants were supplied with moisturizing products for daily use, and increased moisturizer use may explain the initial increase in hydration.

**Skin surface replicas**

Both sides of the face demonstrated an initial decrease in skin topography during the initial Renova treatment. The GA side’s topography continued to decrease after the first few peels but increased thereafter, with a return to baseline values 3 months after the last peel. The TCA side exhibited some accommodation to the Renova after 4 months of use and before the TCA peel was actually performed. The skin surface texture, as measured by the skin surface replicas, returned toward baseline between months 3 and 4 after an initial improvement in surface texture (Figure 4).

**Elasticity**

The elasticity ratio increased on both sides, indicating that the skin became firmer. The initial changes may have been a result of Renova use in combination with the GA peels. The two sides demonstrated similar increases in elasticity from before the TCA peel to 3 months after it (Figure 5).

**Qualitative skin evaluation**

In the group discussion, 5 of the 6 respondents indicated that their skin condition had improved a little, and 1 said that her skin’s appearance improved a great deal after the series of GA peels. All 6 respondents indicated that color tone, texture, softness, and smoothness were the attributes of that had improved. Qualitatively, they stated that they saw more differences in the first days after the peel and that these changes diminished before the next treatment. The GA peels were universally viewed as relaxing and pleasant experiences, with minimal irritation. The TCA peel, on the other hand, was associated with significant pain and disruption of social and work routines for 1 week. The improvements were considered significantly greater on the TCA side than on the GA side. However, patients were disappointed that the visual improvements in wrinkle appearance were not large enough for naive judges to notice.

After the study, 5 of the 6 patients chose to undergo follow-up treatment with a series of GA peels. All of the
patients said that their overall skin condition had improved as a result of their participation in the study. One patient with multiple freckles observed differences in pigmentation and noticeable lightening on the TCA-peeled side compared with the GA-peeled side. However, she elected to treat this discrepancy with a series of GA peels.

**Discussion**

Statistics from the American Society for Aesthetic Plastic Surgery indicate that 495,415 chemical peels were performed in 2002. The chemical peel is among the top 5 cosmetic procedures performed in the United States. There has been an increasing trend toward the use of more superficial chemical peels in the treatment of actinic damage and pigmentation. Moy et al compared the effects of 25% and 50% TCA peels with those of high levels of GA (50% and 70%) in a minipig model. They found that collagen deposition was directly related to the amount of inflammation and that GA appeared to have a greater effect on collagen than might be predicted by the amount of inflammation. Gutling reported that chemical peels in general were useful for removing dyspigmentation, improving texture, and reducing fine wrinkles but that the specific effects were dependent on the skills and experience of the surgeon. Tse et al evaluated the effects of a combination of 70% GA and 35% TCA compared with 35% TCA alone on patients with actinic keratoses, solar lentigines, and fine wrinkles. The combination peel was slightly more effective in treating actinic keratoses than the TCA-only peel and caused more neoleastogenesis. Butler et al used the Skh:HR-1 hairless mouse model to quantitatively evaluate 50% GA, 30% TCA, and 50% TCA peels. Colorimetric evaluation of glycosaminoglycan and histologic assessment of dermal thickness were the quantitative endpoints. The peels were found to reorganize the dermal structure and increase the dermal volume as a function of peel depth. There were no reports in the literature on the effects of midlevel TCA (35%) compared with serial applications of lower levels of GA. Furthermore, the reports in the literature did not use quantitative noninvasive imaging and biophysical assessments of skin condition to determine effects on dyspigmentation, texture, and wrinkling.

We conducted this study to ascertain the improvement in skin condition and actinic damage from 2 treatments: a series of superficial GA peels and a single midlevel TCA peel. We also evaluated the effects of serial peels compared with those of the single TCA peel, using a paired-comparison format. The obvious advantages of the series of GA peels are lesser morbidity and shorter down time.

The overall results indicated a slight but quantitative advantage for the TCA peel with regard to texture and wrinkle improvement compared with the GA peels, as detected with objective image analysis techniques. This improvement was also observed by expert judges and demonstrated by a decrease in the quantitative measure of skin topography ($R_q$). However, the differences between the GA and TCA treatments were not detected by the naive judges. The patients, however, did observe differences between the treatments and were disappointed that these improvements were not detected by the naive judges, who, to them, represented friends, colleagues, and family. The patients were able to evaluate all aspects of the treatments, including tactile effects (softness, smoothness), impact on makeup application, and effect on skin tightness. In contrast, the expert and naive judges were limited to visual assessments of skin condition. The apparent disparity between the subjects and the judges may indicate that the other effects, (eg, tactile) substantially influence outcome and satisfaction compared with visual assessments alone. The two procedures differed considerably in the amount of pain, discomfort during healing, and effects on social and work activities. Notably, almost all of the subjects elected to continue

### Table. Digital image analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>GA vs baseline</th>
<th>TCA peel vs baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert eye (0–4)</td>
<td>1.14</td>
<td>1.93*</td>
</tr>
<tr>
<td>Expert cheek (0–4)</td>
<td>−0.07</td>
<td>0.89*</td>
</tr>
<tr>
<td>Naïve judge (0–4)</td>
<td>0.18</td>
<td>0.19</td>
</tr>
<tr>
<td>Digital eye</td>
<td>−15.26</td>
<td>−22.9</td>
</tr>
<tr>
<td>Digital cheek</td>
<td>1.29</td>
<td>−32.8†</td>
</tr>
</tbody>
</table>

* Indicates significant difference versus baseline skin condition ($P < 0.05$).
† Indicates directional differences versus baseline skin condition ($P < 0.10$).
with GA peels in spite of the evidence that the TCA peels were more efficacious.

The biophysical parameters used in this study are commonly employed by the skin care industry to document small changes in skin parameters. Both hydration and elasticity increased over the course of the study, but, again, we detected no difference between the GA- and TCA-treated sides. These improvements may have been caused by seasonal changes; the study ran from December to June. Another possible explanation for these increases is the use of moisturizers and Renova, which were started at the beginning of the study.

**Conclusion**

A single TCA peel delivers a greater improvement in skin condition than a series of 5 30% GA peels. The biggest differences were seen in the cheek area, as evidenced by topography and image analysis. However the magnitude of the improvement was small for both treatments, as judged on the basis of expert evaluation of the images 3 months after the peel. No improvement was perceived when naive consumers judged the images.

Both hydration and elasticity increased during the course of the study, but these improvements may have been associated with seasonal changes or the result of increased use of moisturizers and Renova rather than the peels. The study patients noted greater improvement in wrinkles on the TCA-treated side but felt that the downtime and discomfort were significant. In fact, none of them had elected to have a TCA peel on the side of the face treated with GA, and most of them continue to undergo GA peels, in spite of minimal improvements.

The results of this research indicate that the features of actinic damage (eg, wrinkling, dyspigmentation, and color uniformity) can be objectively quantified with the use of noninvasive and digital imaging techniques. These methods are useful techniques for standardizing treatment modalities, for establishing outcome benchmarks within currently available restorative technologies, and for establishing targets for future treatments.

**References**


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