Objective and Subjective Scar Aesthetics in Minimal Access vs Conventional Access Parathyroidectomy and Thyroidectomy Surgical Procedures

A Paired Cohort Study

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Objective: To determine if performing parathyroidectomy surgery through minimal access (MA) incisions has any notable aesthetic or quality-of-life impact on patients compared with conventional access (CON) techniques.

Design: Paired cohort with (1) a prospective MA incision and scar cohort and (2) a sex- and age-matched (within 3 years) retrospective CON incision and scar cohort.

Setting: Tertiary care center.

Patients: Fifteen patients enrolled in prospective study protocol over a 2-year period; 11 patients met inclusion criteria. A sex- and age-matched retrospective cohort of patients was selected from a patient population undergoing surgical treatment of thyroid neoplastic diseases using a CON approach. Inclusion criteria were use of MA incision for parathyroidectomy and return for long-term follow-up scar assessment.

Interventions: Minimal access parathyroidectomy surgery vs CON thyroidectomy surgical procedures, post-operative follow-up assessment of scar aesthetics by patient and naive viewers, and digital photography and analysis of the surgical incision site. All patients were followed for at least 8 months after surgery.

Main Outcome Measures: The Patient and Observer Scar Assessment Scale (POSAS), Vancouver Scar Scale, and photographic scar analysis by naive viewers.

Results: There was no significant difference in scar assessment scale scores between the MA and CON cohorts and no clinically significant difference in overall patient satisfaction with scars between cohorts (POSAS: Patient Scar Assessment Scale, \( P = .14 \), and Observer Scar Assessment Scale, \( P = .14 \); Vancouver Scar Scale, \( P = .76 \)). There was increased visibility of scars in the CON cohort to naive viewers.

Conclusions: Although they were more readily visible to naive viewers, CON (larger) cervical scars created in parathyroidectomy or thyroidectomy surgery do not translate into decreased patient satisfaction with their scar result. This may indicate a limited quality-of-life benefit in using MA approaches in transcervical surgical procedures.


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essement scales, or had a follow-up longer than 6 months postoperatively. Long-term cosmetic results following MA and CON transcervical surgical procedures are becoming more relevant as minimally invasive techniques are being increasingly promoted.6,11 The true effectiveness of MA-P and MA-T in improving postoperative scar cosmesis compared with CON techniques has yet to be fully elucidated because the use of validated scar assessment tools and patient satisfaction scales has not been applied in a systematic manner to these patients. Because the use of various techniques in MA-P and MA-T often requires increased capital costs, such as increased operating time (at least initially), as well as specialized equipment purchases, it is important that the validity of improving scar cosmesis is confirmed.6,12,13

PATIENTS AND STUDY DESIGN

A total of 35 patients underwent MA-P from September 2004 to March 2006 at our tertiary care center. All patients were followed up in a prospective manner by our head and neck, parathyroid, and thyroid surgery clinic. Fifteen patients agreed to enrollment in the prospective study protocol and were enrolled in an intent-to-follow protocol involving long-term postoperative scar analysis. Follow-up included an initial appointment 4 to 6 weeks after surgery followed by formal objective, subjective, and photographic analysis a minimum of 8 months after surgery. The cellular processes that underlie scar remodeling are most active during the first 6 months following the creation of a wound or incision. These wounds then undergo greatly reduced remodeling over the subsequent 6 months, with indefinite minimal remodeling that is lifelong. We used 8 months as the minimal postoperative follow-up time for formal scar analysis because the healing and remodeling process is largely completed by this time point, approximating the permanent long-term cosmetic result of the scar.14

Inclusion criteria for the prospective arm of the study was the use of an MA cervical incision for MA-P. An MA incision was defined as a unilateral cervical incision less than 35 mm in length. All patients in the MA-P group had incisions less than 35 mm in length. Exclusion criteria included previous thyroid or parathyroid surgery, previous head and neck irradiation, any mental or physical condition that would preclude the patient from long-term follow-up, and not returning for formal scar analysis at the long-term follow-up. At the time of enrollment, all patients were required to agree to long-term follow-up appointments for scar analysis. Once the appropriate sample size in the prospective limb was achieved, a sex- and age-matched (within 3 years) cohort of patients who had undergone CON-P and/or CON-T would then be contacted and asked to return to the clinic for identical long-term follow-up as for the MA-P group, including subjective, objective, and photographic scar analysis at a minimum of 8 months after surgery. The study design is a matched cohort analysis with identical numbers and sex- and age-matched (within 3 years) distribution in each arm of the study. Prior to the commencement of the study protocol, approval was obtained from our institution’s health research ethics board.

SAMPLE SIZE

Prior to patient enrollment, a random selection of 23 patients who had previously undergone thyroidectomy surgery at our center were contacted by telephone to determine the minimally impor-

The MA-P group underwent preoperative localizing studies consisting of a sestamibi scan and ultrasonography. All patients undergoing MA-P surgery were advised that the skin incision would be approximately 30 mm in length and would overlie the location of the hyperfunctioning gland as localized by preoperative imaging studies. All patients were also informed that if this MA incision was not sufficient to safely remove the hyperfunctioning gland or if the hyperfunctioning gland could not be localized through the incision, the MA-P incision would then be converted into a longer CON-P or CON-T incision.

An MA incision was created in the skin overlying the site of the hyperfunctioning gland. Prior to creating the incision, a marking pen was used to identify the length of the incision site; all incisions were designed to be less than 30 mm in length. Once the diseased gland was excised, surgical success was confirmed via serial intraoperative parathyroid hormone level testing. The incision was then closed in layers with dissolvable sutures. All patients undergoing CON-P or CON-T surgery had a CON incision created superior to the sternum extending between the medial borders of the sternocleidomastoid muscle. Care was taken to place the incision parallel to relaxed skin tension lines in a natural skin crease whenever possible. Once the thyroid or hyperfunctioning parathyroid glands had been successfully removed, the surgical site was closed in layers with dissolvable sutures and Steri-Strips (3M, St Paul, Minnesota). Patients in both treatment groups received postoperative instructions regarding standard wound care. The Steri-Strips were to be left intact until postoperative day 7, at which point they were removed by the patient. The patients were instructed to gently clean the incision site daily with mild soap and water. Patients were counseled regarding signs and symptoms of wound infections and instructed to contact the operating surgeon for reassessment if any concerns arose regarding infection. All patients were instructed to place sunscreen on the incision site if there was to be any extended sun exposure of the scar following surgery.

SCAR ANALYSIS

Prior to the commencement of the scar assessment, patient demographics, including sex, age, time from surgery, type of surgery, and Fitzpatrick skin classification, were recorded. Patients were questioned regarding their skin reaction to sun exposure; this, combined with their skin color, hair color, and eye color, was used to classify each person according to 1 of the 6 Fitzpatrick classification skin types:15 in type 1 (white skin with blond or red hair, blue eyes), extended sun exposure always results in sunburn. In type 2 (white skin with blond or red hair, blue, green, or hazel eyes), extended sun exposure usually results in sunburn and the person tans with difficulty. In type 3 (cream-colored or white skin, fair, with any eye or hair color), extended sun exposure results in gradual tan and some
times sunburn. In type 4 (olive-brown skin), extended sun exposure results in tan and rarely sunburn. Those of type 5 (dark brown skin) tan with ease and very rarely sunburn. Those of type 6 (black skin) never sunburn.15 (Sun exposure history prior to surgery and postoperatively was not recorded.)

Prior to any subjective (patient-directed) or objective scar assessment and obtaining photographic images, informed consent was obtained from patients per our institutional guidelines. Objective scar analysis by a single observer (D.A.O.) was performed prior to subjective scar analysis, with the results revealed to the patient following subjective scar analysis. Objective analysis was performed using 2 separate validated scar assessment scales. The Vancouver Scar Scale (VSS) is a commonly used assessment tool in clinical studies.16-20 This scale has 4 separate domains:

1. Vascularity
   - Normal (0)
   - Red (1)
   - Pink (2)
   - Purple (3)
   2. Pigmentation
   - Normal (0)
   - Hypopigmented (1)
   - Mixed (2)
   - Hyperpigmented (3)
   3. Pliability
   - Normal (0)
   - Supple (1)
   - Yielding (2)
   - Firm (3)
   - Ropelike (4)
   - Contracture (5)
   4. Height
   - Flat (0)
   - <2 mm (1)
   - 2-5 mm (2)
   - >5 mm (3)

The maximum score possible is 14, indicating the worst possible scar result, with a score of zero indicating normal skin. The second objective assessment tool was the Patient and Observer Scar Assessment Scale (POAS), another validated scar assessment tool that has been shown to be a reliable method for scar assessment when used by a single (or multiple) clinical observer(s).21 The POAS has 2 separate components, including both an objective score (Observer Scar Assessment Scale [OSAS]) and a patient-directed subjective score (Patient Scar Assessment Scale [PSAS]) (Figure 1). The OSAS score includes 5 domains, all graded on a 10-point scale, with 1 indicating normal skin and 10 indicating the worst scar imaginable. A summary score of 5 indicates normal skin, with 50 being the worst possible scar result. After scoring the domains, the observer then rates the overall scar appearance on a visual analogue scale corresponding to a 10-point scale. The PSAS has 6 domains (Figure 1). All domains are graded by the patient on a 10-point scale; 1 indicates the best or most normal result, and 10 indicates the worst or most disfiguring result. A summary score of 6 corresponds to normal skin, and 60 is the worst scar imaginable to the patient. After these domains were scored, the patients are asked to rate their overall satisfaction with their scar using a visual analogue scale also corresponding to a 10-point scale.

PHOTOGRAPHIC ANALYSIS AND NAIVE VIEWERS

To determine if naive viewers were more readily able to detect scars created during CON-P or CON-T surgical procedures compared with those created during MA-P surgery, all patients had multiple digital images of their scar site photographed at their long-term follow-up visit and filed for later analysis (Figure 2 and Figure 3). A digital camera (Dimage Z10; Konica Minolta, Tokyo, Japan) (focal length, 36-290 mm) was used for all photographic images. All images were taken with a telephoto setting (focus range, 0.02-1.57 m) with a tripod for stabilization. Lighting, flash exposure, f-stop, and background were standardized for all images. Three separate angles were photographed at a standardized distance (0.91 m) with images obtained at 2 magnifications ($\times 5$ and $\times 10$). Front-on view (Figure 2A and B and Figure 3A and B), right oblique (Figure 2C and D and Figure 3C and D), and left oblique (Figure 2E and F and Figure 3E and F) views were obtained at focal lengths of 145 mm and 290 mm for a total of 6 images per patient (Figure 2B-F and Figure 3A, C, and E; image at 0.91 m, focal length 145 mm; Figure 2A, C, E, and Figure 3B, D, and F; image at 0.91 m, focal length 290 mm). All images were then placed in a standardized order with each patient’s images placed in separate image files. All patients were assigned random identification numbers. These image files were then viewed by 2 naive viewers, individuals who work as administrative assistants at a surgical practice that does not expose them to parathyroidectomy or thyroidectomy surgery or to the subsequent scars on a regular basis. They were blinded as to what type of operation each patient had undergone (MA vs CON) as well as to any expected outcomes regarding patient satisfaction and scar cosmesis. Image files were randomized to ensure that MA-P and CON group files were viewed in a random order. The 2 viewers were then asked to examine each image on a 17-inch computer monitor and answer the following questions regarding the images: (1) Is the scar visible on the first image (image at 0.91 m; focal length, 145 mm; Figure 2A and Figure 3A)? All subsequent images (Figure 2B-F and Figure 3B-F) were then viewed, and the following question was addressed: (2) Please grade the following factors: (a) the color of the scar compared with the color of normal skin (no difference vs slight difference vs gross mismatch), (b) the contour of the scar compared with normal skin (flush with the surrounding skin vs indented), and (c) distortion of the scar (none vs mild vs gross deformity).

OUTCOME MEASURES AND STATISTICAL ANALYSIS

The primary outcome measure was overall patient satisfaction with scar cosmesis assessed by a visual analogue scale corresponding to a 10-point Likert scale. A lower score corresponds to a better cosmetic result. Secondary outcome measures include VSS summary score, POSAS summary score (PSAS

Table 1: Observer Scar Assessment Scale (OSAS)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Score</th>
<th>Example</th>
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<tbody>
<tr>
<td>Vascularity</td>
<td>0-10</td>
<td>Normal</td>
</tr>
<tr>
<td>Pigmentation</td>
<td>0-5</td>
<td>Normal</td>
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<tr>
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<td>0-5</td>
<td>Normal</td>
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<tr>
<td>Height</td>
<td>0-5</td>
<td>Normal</td>
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Table 2: Patient Scar Assessment Scale (PSAS)

<table>
<thead>
<tr>
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Figure 1. The Patient and Observer Scar Assessment Scale.
and OSAS components), overall objective scar rating, and naive viewer assessments of scar visibility and impact on normal skin appearance.

Statistical analysis was performed using SPSS statistical software (version 12.0 for Windows; SPSS Inc, Chicago, Illinois). The mean differences for continuous data were assessed using the Mann-Whitney test, and the Fisher exact test was used for comparisons of categorical data. The \( \kappa \) statistic was used to assess interobserver variability between the naive viewers’ scar assessments.

**RESULTS**

Thirty-five patients underwent MA-P surgery during the study period, and 15 of them agreed to enrollment in the study protocol. The remaining 20 patients were unable to confirm willingness to return for long-term follow-up following their initial postoperative assessment at 4 to 6 weeks following surgery and therefore did not meet inclusion criteria. There was no significant difference in the sex \( (P = .99) \) or age \( (P = .90) \) distribution of these patients compared with the study population. Two of the 20 excluded patients were of East Asian ethnic origins, and 1 was of South Asian descent. All 15 patients included in this study population were white. Four patients did not return for their long-term follow-up visit. Multiple attempts were made in all cases to arrange further follow-up, without success. Therefore, 11 patients met inclusion criteria in the prospective MA-P cohort.
and subsequently 11 sex- and age-matched (within 3 years) patients in the CON group were enrolled in the retrospective cohort. The total study population comprised 22 patients. All of the 11 patients who had undergone MA-P had single hyperfunctioning parathyroid adenomas. Of the 11 patients in the CON group, 2 patients underwent CON-P, whereas 9 patients underwent CON-T. Both patients who underwent CON-P required 4 gland exploration owing to an inability to localize the hyperfunctioning gland preoperatively. Of the 9 patients who underwent CON-T, 5 patients had multinodular goiter, 2 had benign follicular adenoma, and 2 had papillary thyroid carcinoma. None of the patients in the CON group required incisions that were drastically longer than what had been discussed with them in preoperative counseling. No recurrent laryngeal nerve injury or persistent postoperative hypocalcemia was noted in either the MA or CON surgery groups. No patients in either group reported or were treated for any form of malnutrition, vitamin deficiency, chronic corticosteroid use, or uncontrolled diabetes mellitus during the study period.
Comparison of the scar length showed a significant difference between the MA-P and CON groups ($P < .001$). The mean scar length in the MA-P group was 33.6 mm (median, 34 mm; range, 23-35 mm) compared with a mean of 75.8 mm (median, 75 mm; range, 57-89 mm) in the CON group. Analysis of overall patient satisfaction with scar cosmesis between the MA-P group and the CON group revealed a statistically significant difference between the means of the groups ($P = .008$). The MA group had a mean (SD) overall satisfaction score of 2.1 (1.2) (median, 2; range, 1-5) compared with the CON group’s satisfaction score of 1.1 (0.3) (median, 1; range, 1-2). Comparison of the secondary outcome measures, including summary scores for both the VSS and the POSAS (including both the OSAS and PSAS components), for the MA vs CON surgery groups showed no significant difference (see Table 2 for $P$ values). Analysis of the separate domain scores (see the VSS in the “Scar Analysis” subsection of the “Methods” section and Figure 1) in both the VSS and POSAS between MA-P and CON groups showed no significant difference in any of the separate domains save for question 5 of the POSAS (Figure 1). The MA group reported a mean (SD) score of 2.09 (1.14) (median, 2; range, 1-4), whereas the CON group reported a mean (SD) score of 1.09 (0.30) (median, 2; range, 1-4) in rating the domain dealing with subjective scar thickness. Overall objective scar rating comparisons between the MA-P group (2.2 [0.9]; median, 2; range, 1-4) and CON group (2.6 [1.0]; median, 2; range, 1-4) also lacked significant difference ($P = .35$). None of the individual domain scores showed statistical significance except question 5 of the PSAS ($P = .02$); in this case, the MA-P group found their surgical scars to be thicker compared with those of the CON group.

Naive viewers’ assessments of the digital images of both MA and CON surgery scars are summarized in Table 3. The 2 viewers were consistently able to localize CON scars more frequently than MA incisions. The $k$ analysis showed a good correlation between the 2 viewers’ assessments of the visibility of cervical scars in the MA group (0.74) as well as the CON group (0.81). All other parameters showed an increased deviation from normal skin in the CON group compared with normal skin in the MA group (Table 3).
The scar assessment outcomes reported in this study suggest that in the study population, there was no significant difference in virtually all parameters of scar analysis between scars created for MA-P surgery vs scars created in CON-T or CON-P surgery (Table 2). The scar length is considerably different between the MA and CON surgery groups owing to the nature of the incision created in each type of surgery. More important, the data reported herein show that patients undergoing CON surgical procedures in the neck are more satisfied with their scar result at their subsequent long-term follow-up assessment (Table 2). This study also shows that naive viewers are consistently able to detect CON scars more readily than MA scars when viewing images of transcervical surgical scars. Also, when comparing the scar color, shape, and degree of distortion with normal skin, naive viewers also consistently rated MA scars as being more like normal skin.

These findings are in stark contrast to most of the current literature regarding cervical surgical scar cosmesis. Multiple studies report increased patient satisfaction with overall scar appearance when MA techniques (including both mini-incision and endoscopic techniques) were used for parathyroidectomy or thyroidectomy procedures. Studies by both Miccoli et al. and Bellantone et al. although not solely dedicated to scar cosmetic analysis, included assessments of patient satisfaction with their scar appearance. Miccoli et al. in comparing scar satisfaction in video-assisted thyroidectomy and parathyroidectomy vs CON techniques, used a nonvalidated verbal response scale as well as an 11-point Likert scale to assess overall patient satisfaction at 1 month after surgery. Bellantone et al. in comparing video-assisted vs CON thyroid lobectomy scar sites, asked patients to rate their overall satisfaction with their scar using a 10-point scale at 3 and 6 months after surgery. However, the numerical results were then grouped into 3 broad categories (very satisfied, moderately satisfied, and fairly or barely satisfied) for further analysis, a method that has not been shown to be a validated technique of scar or patient satisfaction assessment. Also, 2 of the 3 studies had a minimal follow-up time of 1 month after surgery for inviting patients to review their scars, even though those scars were still actively remodeling and had yet to reach their final appearance.

The VSS and the POSAS are both validated tools for scar assessment. Visual analogue scales have also been validated as accurate tools for assessing patient satisfaction and overall appearance of scars. To our knowledge, this study is the first to use validated outcome measures to assess overall patient satisfaction and scar aesthetics when comparing surgical scars created in MA-P with CON-T and CON-P surgical procedures.

A possible explanation for why patients undergoing CON-P or CON-T surgery have increased overall satisfaction with their scar result compared with those with MA-P scars is the lack of symmetry created by the MA incision. A small unilateral cervical scar is possibly more noticeable to the patient compared with a larger symmetrical cervical scar centered on the neck. However, it is important to note that a difference of 1 on a 10-point Likert scale, although statistically significant (P<.008), is likely not clinically significant. A random sample of patients who had undergone CON-T surgery reported that a mean minimum of a 5-point improvement on a 10-point scale would be required before they believed they would have any increased satisfaction with their scar result. This indicates that there is likely no clinical significance in patient scar satisfaction between the 2 study groups. Therefore, the findings of the current study, most notably in overall patient satisfaction as well as all other validated measures of scar cosmesis, show there are no clinically significant differences in the scars created by MA-P compared with CON-P or CON-T surgery in our study population. These findings are supported by a study from the German literature that examined long-term cos-
metric results following thyroidectomy. The authors found that more than 90% of the patients assessed believed their scar cosmesis to be excellent or good. Another study examining the QOL in patients with thyroid cancer following CON-T surgery showed that 121 of 141 patients noticed very little or no impact of their surgical scar on their appearance, whereas 122 of 141 patients noticed very little or no impact of their surgical scars on their social relationships. With such excellent cosmetic results and minimal QOL impact following CON-P or CON-T surgery, it would be difficult to improve scar cosmesis enough to result in a clinically significant change to the patient.

The findings regarding patient satisfaction with scar cosmesis reported in this study are not intuitive. One would expect that patients undergoing MA surgery would have increased satisfaction with their scar cosmesis and not the opposite, as was found in our study population. The results of the naive viewers’ scar assessment observations support the fact that to naive objective viewers, CON scars seem to have a greater impact on overall appearance. Both naive viewers were able to detect CON scars more frequently, and both indicated that CON scars had more of an impact on overall skin appearance on the neck compared with MA scars. It is important to note that there is no correlation between the naive viewers’ observations and the overall patient satisfaction with their scar result. It is possible that objective viewers have extrapolated their ability to more readily detect CON scars to correlate with a decreased overall patient satisfaction with scar cosmesis and therefore with a decreased QOL.

One of the major driving forces behind the use of MA and endoscopic techniques is the ability to improve objective scar cosmesis and therefore the perceived ability to increase overall patient satisfaction and QOL. This reason is often cited to justify the increased capital costs of specialized equipment purchases for performing MA-P or MA-T surgery, as well as the potentially increased surgical time involved in utilizing these techniques. This reasoning is not supported by the findings in the current study that show no clinically significant difference in patient satisfaction with scar result following CON-T or CON-P surgery.

An acknowledged weakness with the current study is that the study population was composed entirely of white participants. The Fitzpatrick skin classification was used to categorize the skin type of our patients, with most of the patients in both the MA and CON groups being classified as type 2 or type 3 (Table 1). Lower classification numbers (on a scale of 1-6) are associated with better scar cosmesis. It is possible that if our study population included patients with higher classification numbers, the scar assessments would not have been as favorable. Further studies involving patients with higher Fitzpatrick classification numbers (eg, people of African or East Asian descent) would further increase our understanding on the effectiveness of MA-T and MA-P surgery and its effect on patient satisfaction and scar cosmesis in these populations. Also, our MA cohort included only patients undergoing MA-P. It is possible that patients undergoing MA-T surgery may have different scar assessment scores or overall satisfaction. This is, however, believed to be unlikely because the MA-P incision is similar in size and placement to the MA-T incision site(s) in currently described techniques.

Of the 35 patients undergoing MA-P during the study period, only 15 agreed to participate in the study. All patients undergoing MA-P were enrolled in an intent-to-follow protocol that included long-term follow-up for a minimum of 8 months after surgery. Attempts were made to enroll the patients into the study population prior to their surgery date, even on the day of surgery. All patients were enrolled in an intent-to-follow protocol, and all patients agreed on an initial postoperative follow-up visit 4 to 6 weeks after surgery. However, only 15 of the 35 patients agreed to long-term follow-up. The 20 excluded patients simply did not wish to commit to a long-term follow-up visit for the sole purpose of aesthetic analysis of their surgical scar.

The small sample size of our study does open the results to possible criticism regarding this study’s validity as a thorough analysis of patient satisfaction with scar cosmesis following MA-P and CON-T or CON-P surgery. The purpose of the prestudy telephone survey of patients who had previously undergone CON-T surgery was to determine the MICD for each patient that would have a substantial impact on that patient’s QOL and overall satisfaction when subjectively rating their incisional scar, as well as to allow for a priori power calculation for the study itself. The mean response was that an improvement of 5 points on a 10-point scale would be the minimum amount needed before they would notice any impact on their overall satisfaction and QOL. The responses regarding MICD did range from 3 to 9 points. To incorporate all patients’ responses from the telephone survey, the MICD was set at a 3-point difference on a 10-point scale. Using 3 as the MICD, to maintain a power of 0.8 with an α of .05, 9 patients in each cohort were required. To account for an attrition rate of up to 40%, 15 patients were enrolled in the MA-P cohort. Eleven patients met inclusion criteria in the MA-P cohort, and subsequently 11 patients were enrolled in the CON-P or CON-T cohort. The total study population of 22 patients translates into a study that is overpowered by 2 patients in each arm of the study. Because this study is appropriately powered, the findings regarding patient satisfaction with scar cosmesis following MA-P and CON-P or CON-T surgery reported herein can be deemed valid.

Controversy still exists regarding the definitions of MA-P and MA-T according to incision length. Brunaud et al attempted to define these variables as MA-P being performed through an incision smaller than 25 mm, and MA-T as being performed through an incision smaller than 30 mm. However, the lengths of these incisions created in the MA-P and MA-T groups reported in their study ranged from 25 to 40 mm (mean [SD], 28 [2.0] mm) for the MA-P group and 30 to 80 mm (46 [2.0] mm) for the MA-T group, with all incisions in all groups being measured with a ruler prior to creation of the incision. These threshold incision lengths were representative of the smallest incisions in each group, not the overall mean incisions created by the surgeons. We acknowledged that current CON techniques would enable surgeons to per-
form CON-P and CON-T through incisions ranging in size from 35 to 50 mm (and, of course, larger incisions). In our study population, all patients in the MA group had cervical scars less than 35 mm in length. The rate of patient satisfaction was so high in the MA group (the mean score was 2.09 on a 10-point scale) that it is unlikely that further reduction in incision size to less than 25 mm in a similar patient population would result in any clinically significant improvement in overall patient satisfaction and QOL. Interestingly, the MA incisions, when measured at long-term follow-up, were found to be longer by a mean of 3.8 mm compared with their initial preoperative measurement. This may be a result of intraoperative retraction and subsequent lengthening of the incision. Because most of the literature comparing MA with CON incisions in cervical surgery relies on preoperative measurements, the actual final scar length following complete remodeling remains unclear.21 It is possible that any vigorous retraction during MA surgery may lead to a lengthening of the incision and final scar to those initially mapped out during MA-T and MA-P surgery.

In conclusion, the current study represents the first attempt to use validated assessment scales to examine overall patient satisfaction and long-term scar cosmesis in patients undergoing MA-P compared with those undergoing CON-P and CON-T. The results reported herein show that in our study population, MA-P or MA-T surgery provides no cosmetic advantage in terms of improving overall long-term patient satisfaction compared with CON-P and CON-T techniques. In patient populations similar to the one described herein, improved scar cosmesis should not be acknowledged as an advantage of performing MA-T or MA-P surgery. Overall patient satisfaction regarding long-term scar cosmesis in the non-white population has yet to be definitively elucidated.

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Author Contributions: Drs O’Connell, Diamond, Seikaly, and Harris had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: O’Connell and Harris. Acquisition of data: O’Connell and Harris. Analysis and interpretation of data: O’Connell, Diamond, Seikaly, and Harris. Drafting of the manuscript: O’Connell and Diamond. Critical revision of the manuscript for important intellectual content: O’Connell, Diamond, Seikaly, and Harris. Statistical analysis: O’Connell and Diamond. Administrative, technical, and material support: O’Connell, Seikaly, and Harris. Study supervision: Harris.

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REFERENCES