OBJECTIVE: To assess several measures of the long-term outcome of magnetic resonance–guided focused ultrasound surgery for symptomatic uterine leiomyomata.

METHODS: Data on 359 women completing 24-month follow-up in all clinical trials of magnetic resonance–guided focused ultrasound surgery for uterine leiomyomata were analyzed. Quality of life outcomes, measured by the symptom severity score of the Uterine Fibroid Symptoms Quality Of Life Questionnaire were assessed for 24 months after treatment. Clinical endpoints, including uterine shrinkage, the need for additional leiomyoma treatment, and the time to additional leiomyoma treatment, were all assessed. The nonperfused volume ratio after treatment, calculated from the gadolinium-enhanced magnetic resonance imaging after treatment and the best measure of tissue necrosis after treatment, was used to assess outcome based on completeness of leiomyoma ablation.

RESULTS: Women undergoing magnetic resonance–guided focused ultrasound surgery for symptomatic uterine leiomyomata have durable symptom relief, as measured by the symptom severity score at 24 months, with significantly greater improvement with more complete ablation ($P<.001$). Survival analysis demonstrates a significant reduction in the percentage of women undergoing additional leiomyoma treatment ($P=.001$) in women in the high nonperfused volume group. The mean shrinkage and mean residual nonperfused volume ratio are both significantly above zero at 6 months in the high nonperfused volume group ($P<.001$). The incidence of adverse events is low. However, for women with minimal treatment, the risk of additional procedures is high.

CONCLUSION: Magnetic resonance–guided focused ultrasound surgery is an effective treatment for uterine leiomyomata and results in sustained symptomatic relief.

LEVEL OF EVIDENCE: III

Uterine leiomyomata (leiomyomas or fibroids) are an important gynecologic problem and cause a significant expenditure of health care dollars.1–3 Magnetic resonance imaging–guided focused ultrasound surgery (MRgFUS) is approved by the U.S. Food and Drug Administration (FDA) for the treatment of premenopausal women with symptomatic leiomyomata and no desire for future fertility. Magnetic resonance imaging–guided focused ultrasound surgery provides outpatient therapy for women with significant symptomatic leiomyomata. Improved quality of life, as measured by the disease-specific instrument, the Uterine Fibroid Symptoms Quality of Life Questionnaire, has been the chief outcome measure reported after treatment with this technique and the key measure of treatment response leading to approval of this technology.1 Improved quality of life has been reported...
for 6–12 months after MRgFUS treatment.\textsuperscript{5,7} The current report was designed to assess clinical efficacy at 24 months in women undergoing MRgFUS by assessing quality of life and additional clinically significant endpoints, including the need for subsequent additional leiomyoma treatments, uterine shrinkage, and improvement in hematocrit levels.

Magnetic resonance–guided focused ultrasound surgery is a novel surgical modality pioneered for the treatment of uterine leiomyomata. Unlike previous alternatives to hysterectomy, MRgFUS does not require insertion of an endoscope, catheter, or needle into the body and is thus noninvasive. The energy from multiple elements of the phased array transducer passes through the anterior abdominal wall and causes coagulative necrosis only at the focal volume where the ultrasound waves converge. However, because lower levels of energy proximal and distal to the focus have the potential to damage normal tissue, real-time monitoring of the entire beam path is required. Magnetic resonance imaging of treatment is able to provide this imaging of the intended target (the leiomyoma) and other organs where nontarget treatment could lead to complications (bowel, bladder, and pelvic nerves) because treatment takes place inside the magnetic resonance imaging machine. Imaging before, during, and after each ultrasound treatment volume, termed a sonication, is required and standard. Additionally, magnetic resonance imaging has temperature-sensitive parameters, which allow for real-time thermometry, so that the treating physician can adjust power to achieve adequate temperatures at the target to reliably cause necrosis while limiting decreased efficacy from temperatures that are too low or injury to normal tissue from too high a temperature. This magnetic resonance thermometry provides instant feed-back as to the thermal dose delivered during each sonication.

In contrast to uterine artery embolization therapy, where embolic particles flow from the uterine arteries to both leiomyomata and normal myometrium, MRgFUS is a leiomyoma-specific therapy. Specific leiomyomata are targeted for treatment with MRgFUS, sparing myometrium, yet some leiomyomata may go untreated due to time limitations or safety problems in targeting, thus adding a potential variable in treatment outcome.

Initial clinical experience, including a feasibility study using treatment of women undergoing subsequent hysterectomy, and the pivotal clinical trial of this treatment modality for fibroids have all been reported.\textsuperscript{5,6,8,9} A recent publication examined the effect of a change in operator skills with time, the so-called learning curve, and changes in treatment guidelines, with decreased restrictions on treatment parameters, as the technology proceeded through Food and Drug Administration review.\textsuperscript{7} This analysis showed that more complete treatment was associated with improved quality of life at 6- to 12-months and a decreased incidence of adverse events.\textsuperscript{7}

The durability of the patient’s response to MRgFUS therapy in large cohorts has not yet been established. In this study we examined all patients undergoing treatment protocols reported to or mandated by the FDA to assess clinical endpoints up to 24 months.

**MATERIALS AND METHODS**

De-identified clinical data on all women completing sponsored trials of MRgFUS (N=359, Table 1) was collected by using a Web-based electronic system, (ClickFind, Bryan, TX). Patients were treated under local institutional review board approved protocols, and all data were audited by the contributing sites and the appropriate regulatory agencies in the United States and abroad.

Three of the four trials that were part of the phase 3 evaluation of the MRgFUS technology had identical inclusion and exclusion criteria (Table 1). All women in these studies were premenopausal, at least 18 years old, had significant leiomyoma symptoms (as defined by a transformed symptom severity score greater than 41 out of 100 points on a validated leiomyoma-specific quality of life measure (Uterine Fibroid Symptoms Quality of Life Questionnaire),\textsuperscript{4} and did not desire future childbearing. Exclusion criteria included women with uteri larger than 24 weeks gestational size, a hematocrit less than 25%, a positive pregnancy test, major medical disease, or contraindication to magnetic resonance imaging such as a pacemaker or weight over 250 pounds. The fourth study, a post-marketing study in African-American women, was mandated by the FDA and required treatment candidates to be “consistent with product labeling,” thus making the same enrollment criteria implicit rather than explicit (Table 1).

A pretreatment magnetic resonance imaging scan was required for treatment planning to assess the accessibility of leiomyomata to treatment without injury to the bowel, bladder, or pelvic nerves, exclude adenomyosis or lesions suspicious for uterine sarcomas, and demonstrate pretreatment vascularization of the leiomyoma by using the intravenous contrast agent gadolinium. One non–United States site, contributing 33 patients, performed pretreatment magnetic resonance imaging but did not use gadolinium-enhanced imaging due to local practice.
Table 1. Description of Protocols and Summary of Mean Data

<table>
<thead>
<tr>
<th>Study Description</th>
<th>Patients Enrolled (n)</th>
<th>Patients Completing Protocol (Reasons for Exclusions)</th>
<th>Follow-up Period (y)</th>
<th>Age (y)</th>
<th>BMI (kg/m²)</th>
<th>Symptoms Severity Score</th>
<th>Total Fibroid Load (mL)</th>
<th>Enrollment Period</th>
<th>Race (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 3 pivotal study—global</td>
<td>109</td>
<td>102 (3 had adenomyosis and 4 missing data)</td>
<td>3</td>
<td>45.3±4.8 (32–58)</td>
<td>25.8±5.1 (18.6–43.9)</td>
<td>61.4±15.4 (25–100)</td>
<td>371±236 (32–1,143)</td>
<td>02/2002–11/2002</td>
<td>White (80)</td>
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<td>Hispanic (1)</td>
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<tr>
<td>Phase 3 continued access in Europe</td>
<td>65</td>
<td>44 (13 were not measured and 8 missing data)</td>
<td>2</td>
<td>43.9±6.4 (26–55)</td>
<td>25.2±4.6 (16.9–36.9)</td>
<td>60.6±12.3 (40.6–87.5)</td>
<td>260±195 (47–917)</td>
<td>05/2002–08/2003</td>
<td>White (84)</td>
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<td>Asian (7)</td>
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<tr>
<td>Phase 3 continued access in United States</td>
<td>160</td>
<td>152 (1 adenomyosis, 6 missing data, 1 not measured)</td>
<td>3</td>
<td>46.4±4.4 (36–58)</td>
<td>25.3±4.2 (18.7–39.5)</td>
<td>61.5±16.2 (28.1–96.9)</td>
<td>405±281 (18–1,589)</td>
<td>04/2003–01/2005</td>
<td>White (91)</td>
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<td>Hispanic (1)</td>
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<tr>
<td>Post-market African-American Study in United States</td>
<td>82</td>
<td>61 (18 not measured yet, 1 missing data, 2 treatment failures)</td>
<td>3</td>
<td>44.1±5 (34–53)</td>
<td>28±5.1 (20.1–40.7)</td>
<td>65.8±18.5 (21.9–96.9)</td>
<td>277±209 (16–738)</td>
<td>01/2005–03/2006</td>
<td>White (4)</td>
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<tr>
<td>Total</td>
<td>416</td>
<td>359</td>
<td></td>
<td>45.4±5 (26–58)</td>
<td>25.9±4.8 (16.9–43.9)</td>
<td>62.1±16 (21.9–100)</td>
<td>358±254 (16–1,589)</td>
<td>02/2002–03/2006</td>
<td>White (73)</td>
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<td>Hispanic (1)</td>
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BMI, body mass index.
Data are expressed as mean±standard deviation (range) unless otherwise specified.
Treatment protocols were relaxed by the FDA on April 30, 2004, so that patients treated after that date in the phase 3 continued-access protocol and the post-market study, both in the United States and abroad (n=64 and 61, respectively, overall 34%), were allowed to have more extensive treatment (Table 1). Allowed treatment volumes were increased from 33% of all leiomyomata to 50% for all leiomyoma except submucosal ones, and maximal treatment volume was increased to 150 mL per leiomyoma. Treatment time was increased from 120 to 180 minutes, and the restriction of treatment borders to 1.5 cm from the endometrium and 0.5 cm from the leiomyoma capsule to the serosal surface was eliminated. Finally, two treatment sessions were allowed if performed within a 14-day period.

All MRgFUS treatments were performed with the ExAblate 2000 system software versions 2.3 and 2.4, as previously described. The MRgFUS system (ExAblate 2000, InSightec, Haifa, Israel) works in conjunction with a standard 1.5 tesla MR system (General Electric Health Care, Milwaukee, WI). The therapeutic treatment ultrasound beam has a frequency range of approximately 1–1.5 MHz, which is on the lower spectrum of diagnostic ultrasonography. A phased array transducer delivers ultrasound pulses of thermal energy to a discrete volume of targeted tissue, as an individual sonication, which is approximately the size of a jelly bean. The treatment volume is mapped on the T2-weighted magnetic resonance images. Real-time thermal mapping based on the proton resonance frequency shift generated by tissue heating is used to monitor and adjust treatment parameters to optimize target temperature. The goal is to induce coagulative necrosis by producing a target temperature of 65–85°C. An initial test pulse using low power (10–70 watts for 10–20 seconds) is used to confirm targeting accuracy before therapeutic pulses.

Immediately after treatment the intravenous administration of gadolinium to assess the leiomyomata’ sizes and nonperfused volume, allowing calculation of the nonperfused volume ratio, was performed on the day of treatment and at 6, 12, and 24 months after treatment. For patients enrolled in the phase 3 pivotal study and continued access study in the United States, a hematocrit was obtained before treatment and at 6 months (n=226).

This analysis examines the relation between nonperfused volume ratio immediately after treatment and the following important clinical outcomes: improvement in symptoms severity score of the Uterine Fibroid Symptoms Quality of Life Questionnaire; the proportion of subjects undergoing additional leiomyoma treatment and the time to any additional intervention; the shrinkage of the leiomyoma; and the change in hematocrit after treatment.

The symptoms severity score of the Uterine Fibroid Symptoms Quality of Life scale is a new measure of patient-reported symptoms specific to uterine leiomyomata, used first in studies of uterine artery embolization and the primary outcome measure in approval of MRgFUS technology. The symptoms severity score uses eight questions assessed on a 5-point Likert scale to assess both bleeding and bulk-related symptoms due to uterine leiomyomata. Thus, the maximal raw score for the symptoms severity score is 40 points. However, the transformed

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score is typically reported on a single 100-point scale, with 100 points indicating maximal symptomatology. In validation studies normal women have an average transformed symptom score of approximately 20 points, and women with uterine leiomyomata have an average score of 40 points.

Additional leiomyoma treatments were defined as myomectomy, hysterectomy, uterine artery embolization, or any type of hormonal treatment. It also included a second MRgFUS treatment that was done more than 6 months after the first treatment. Because all subjects remained in FDA-mandated follow-up, with frequent contact with site investigators and coordinators, the reporting of additional interventions was felt to be comprehensive. Shrinkage was assessed as the difference between the baseline magnetic resonance–based volumetric measures and follow-up measurements as described by the sum of the imaging slices methods.

For the analysis of the symptoms severity score, patients were first stratified into two groups based on the mean nonperfused volume ratio immediately after treatment. Group 1 had a nonperfused volume ratio of 20% or less (mean 8.9%, n = 204), and group 2 had nonperfused volume ratio greater than 20% (mean 38.0%, n = 155). To deal with missing data in the symptoms severity score and to avoid reporting only good outcomes when patients dropped out to undergo additional leiomyoma therapies, we used the last observation carried forward imputation. Thus, patients who had poor symptoms severity score and changed treatments as a result were not removed from the analysis at subsequent time points.

Because our previous studies have demonstrated a substantial change in symptoms in the first 3 months, followed by a more subtle change, a “Mixed Model” of analysis was also undertaken examining two linear segments (0–3 months and 3–24 months), which connect at 3 months, for the average changes in symptoms severity score for each group (SAS 8.0 for Windows, SAS Institute Inc, Cary, NC). The dependence between observations from the same patient (repeated measures) was handled by using a random intercept and slope model for each patient.

Two different approaches were used to assess the risk of additional treatment for patients at 6, 12, and 24 months posttreatment. First, logistic regression analysis was used to assess the probability of additional treatment as a function of the nonperfused volume ratio. To deal with the issues of lost and missing data in the logistic regression analysis, patients who were lost to follow-up, or had not yet reached the appropriate time point, had their state imputed using multiple imputation (SAS MI Procedure, SAS Institute Inc). This methodology overcomes the possible bias that may result from patients having varying follow-up times. The imputed values took account of the patient’s earlier states, as well as her baseline nonperfused volume, which was coded into one of six intervals.

Secondly, survival analysis was used to analyze the time to undergoing an additional leiomyoma treatment. In this approach, a proportional hazards regression model was used to test whether increased nonperfused volume ratio reduces the risk of an additional therapy, and Kaplan-Meier survival analysis was used to create a life-table analysis examining the intervention-free survival based on the same two groups of nonperfused volume ratio (20% or less and more than 20%).

For the analysis of leiomyoma volume reduction or shrinkage, the core laboratory data at 6 months (n = 298 leiomyomata) and at 12 months (n = 182 leiomyomata) were included on all treated leiomyomata. Cubic regression of shrinkage and residual nonperfused volume ratio (the nonperfused volume ratio as measured at the follow-up time), as a function of the nonperfused volume ratio on the day of treatment, was performed. For the analysis of hematocrit levels, the two groups were compared by using the nonparametric Wilcoxon signed rank test, and for the analysis of patients lost to follow-up, a two-sample t test assuming unequal variance was used.

Statistical analysis was performed by TechnoStat Ltd (Kfar Saba, Israel) with SAS 8.0 (SAS Institute Inc). Data are reported as mean values, and the measure of dispersion reported is the standard deviation.

RESULTS

Patients treated under all protocols were typical women with uterine leiomyomata. Subjects in each protocol had mean ages in the mid-to-late 40s (range of means: 43.9 ± 6.4 to 46.4 ± 4.4 years), increased body mass index (BMI, range of means: 25.2 ± 4.6 to 28.0 ± 5.1 kg/m²) and substantial leiomyoma volume as determined by the total leiomyoma load in milliliters (range of means: 260 ± 195 to 371 ± 236 mL) (Table 1). Most women in the phase 3 studies were white (range: 80–91%). After inclusion of the study for African-American women, this rate decreased to 73%, with African-American women representing 20% of the total cohort. Women in all protocols had significant leiomyoma symptoms, with a mean pre-
treatment symptoms severity score of over 60 points (range of means: 60.6±12.3 to 65.8±18.5 points). All protocols followed subjects for a minimum of 24 months.

To verify that there was no difference between the group of patients lost to follow-up and the group of patients continuing the follow-up period, we compared the patient data between the two groups and found them to be similar. The mean age (45.3±4.8 versus 45.4±5.0 years, P=.86), mean BMI (25.9±4.1 versus 25.8±4.9 kg/m², P=.86), mean total leiomyoma load (384±267 versus 353±263 mL, P=.34), and mean baseline symptom severity score (61.7±16.1 versus 62.1±16.0 points, P=.57) were not significantly different. Posttreatment parameters also did not differ between groups, including both the mean treated leiomyoma volume (328±247 versus 290±232 mL, P=.21) and the mean ratio of the nonperfused volume as a percentage of the total leiomyoma load (19.9±17.2% versus 21.9±18.7%, P=.28).

Most women had limited treatments, with 57% of women having a nonperfused volume of 20% or less and 63.5% having an nonperfused volume of 30% or less. Fewer than 3% of women treated with MRgFUS in this series had a nonperfused volume ratio of 70% or greater.

The use of 20% nonperfused volume ratio to dichotomize analysis was based on the median level of nonperfused volume attained during treatment. Analysis was also conducted with a 30% nonperfused volume ratio cutoff and yielded similar results (data not shown).

For both nonperfused volume ratio groups (20% or less and more than 20%), the symptom severity score 3 months after the treatment was significantly reduced from baseline (Fig. 1). The mixed model analyses demonstrated that the nonperfused volume ratio has a very significant effect on the symptom severity score, both at 3 months and beyond 3 months. At 3 months, the high nonperfused volume ratio group (n=155, mean nonperfused volume 38±15.3%) had an average improvement of 6 points on the symptom severity score over the low nonperfused volume ratio group (n=204, mean nonperfused volume 8.9±6%) (P<.001). Beyond 3 months, the high nonperfused volume ratio group maintained this improvement and had a slight increment of improvement that remained significant for up to 24 months (P<.001).

At both 12 and 24 months after MRgFUS, there was a significant effect of nonperfused volume ratio on the number of women undergoing additional leiomyoma treatment (P=.012 and P<.001, respectively, Fig. 2). No such effect was seen at 6 months, likely due to the low number of alternative treatments at that point of time (only 13 of 358 cases).
A proportional hazards regression model (survival analysis) shows that there is significant evidence that an increased nonperfused volume ratio reduces the risk of undergoing additional leiomyoma treatment ($P < 0.001$). A nonparametric life test procedure shows statistically significant differences between the subjects undergoing treatment with an nonperfused volume greater than 20% compared with those with less complete treatments ($P < 0.001$). Figure 3 displays the results of the two survival curves. The subjects with the high nonperfused volume ratio group (continuous line) have the higher probability of intervention-free survival that becomes evident at 12 months after MRgFUS treatment.

The fitted mean values of the cubic regression for shrinkage (broken line) and of residual nonperfused volume ratio (continuous line) vary inversely over all treatment nonperfused volume ratios at 6 and 12 months (Figs. 4 and 5). For treatment nonperfused volume ratios above 20%, the mean shrinkage and mean residual nonperfused volume ratio are both significantly above zero at 6 months ($P < 0.001$). With treatment nonperfused volume ratios of 10% or less, no shrinkage is seen, and in fact there is a trend toward growth.

There was no significant difference in hematocrit when all patients were examined ($n = 226$, average hematocrit was 37.6 at treatment day and also at the 6-month follow up). However, when the analysis was restricted to women with pretreatment anemia (hematocrit less than 35), a statistically significant increase in hematocrit was seen with increasing nonperfused volume ratio after treatment (Table 2).

Women were queried at each follow-up visit to see if a change in menstrual status had occurred. At 12 months after treatment, 91% of women were still premenopausal. By 24 months, 23% of the women who were premenopausal at the previous visit had now transitioned to perimenopausal status, and 9% were menopausal. These women with a change in menstrual status at 24 months were older (49.4 ± 4.4 years versus 45.7 ± 3.5 years) and had both a higher symptom severity score at baseline (64.4 ± 15.3 points versus 60.1 ± 16.1 points) and a higher and a lower nonperfused volume ratio (19.3 ± 13.7 versus 23.0 ± 18.9) than women remaining premenopausal at this time point.

The incidence of serious adverse events after MRgFUS is low and appears to decrease with increasing physician experience.6,7 No new serious adverse events were observed in the new subjects reported in this manuscript.

DISCUSSION

Given the high baseline rate of leiomyoma recurrence after alternatives to hysterectomy, where up to one
third of women have additional procedures over short follow-up intervals, demonstrating the durability of new treatment options is important.14–18 This is true with every new treatment where there may be a steep learning curve as physicians learn the technique, and the characteristics of ideal treatment candidates are identified. This is especially true of a novel treatment such as MRgFUS where there are no predicate procedures, and initial trials are designed to optimize safety and not to maximize efficacy. With NRgFUS, there is accumulating data that, with adequate treatment, sustained symptomatic relief can be obtained. This compares favorably with other alternatives to hysterectomy, including abdominal and laparoscopic myomectomy and uterine artery embolization.14–18

A strength of the current analysis is that multiple measures of clinical improvement are concordant. Thus, improvement is manifest in a quality of life measure, volume reduction, a lower probability of additional interventions, and improvement of preoperative anemia.

A limitation of the study design is the absence of a concurrent control group. The fact that there is limited evidence-based medicine on both the natural history of leiomyoma symptoms and other leiomyoma treatments similarly limits the ability to compare MRgFUS with historical controls.19

These limitations are especially significant with newer measures, such as the Uterine Fibroid Symptoms Quality of Life scale, where guidelines for thresholds and use are not established. For example, in one large nonrandomized study, only the health-related quality of life scores are reported, unlike the symptom severity scores in this report.20 In the large uterine artery embolization leiomyoma treatment registry report, mean symptom severity scores were somewhat lower at baseline but reached a mean level of close to 20 points at 12 months, which is somewhat lower than seen in the current study.21

Because data from uterine artery embolization suggest that complete devascularization is important for longer-term success, trying to safely extend the nonperfused volume ratio beyond the modest levels seen in this study should be a priority.22 The MRgFUS technology is also improving to allow larger volumes of ablation per sonication, which should be very helpful in achieving this goal. Likewise, aiming to make all leiomyomata accessible to MRgFUS or understanding the relationship between specific leiomyomata and the symptomatology of this disease are important goals. However, the significant difference in mechanism (ischemic necrosis for uterine artery embolization versus thermal coagulative necrosis of MRgFUS) may indicate that different guidelines apply.

The inverse relationship between the residual nonperfused volume at 6 and 12 months and the amount of shrinkage suggests that the volume of tissue coagulated at the time of treatment is broken down and absorbed with time. It also appears that, with adequate treatment, volume reduction similar to that seen with uterine artery embolization can be achieved.

### Table 2. Hematocrits of Women With Pretreatment Anemia After Focused Ultrasound Surgery

<table>
<thead>
<tr>
<th>NPV Ratio (%)</th>
<th>Patients (n)</th>
<th>Mean NPV Ratio (%)</th>
<th>Pretreatment Hct (%)</th>
<th>Hct at 6 Months (%)</th>
<th>Mean Hct Change</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 or less</td>
<td>28</td>
<td>10.7</td>
<td>32.6</td>
<td>33.6</td>
<td>1</td>
<td>.302</td>
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<tr>
<td>More than 20</td>
<td>20</td>
<td>40.4</td>
<td>31.2</td>
<td>34.3</td>
<td>3.2</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

NPV, nonperfused volume; Hct, hematocrit.
It is reassuring that long-term efficacy does not appear to be gained at the risk of an increase in adverse events. Previous significant adverse events, including a transient sacral neuropathy due to heating beyond the focal volume and a skin burn seen in a case of commercial treatment, appear to be able to be mitigated with treatment planning and physician experience.\textsuperscript{6,23}

It appears that MRgFUS has now demonstrated a durability of treatment equivalent to other accepted leiomyoma treatments. Optimizing all treatments and decreasing future interventions is now the important task for all myoma treatments.

REFERENCES


APPENDIX

The following were contributing members of the magnetic resonance imaging–guided Focused Ultrasound for Uterine Fibroid Group during one or more of the treatment protocols:

- Brigham and Women's Hospital and Harvard Medical School: Fiona Fennessy, MD, PhD, Nathan McDannold, PhD, Kullervo Hynynen, PhD, Ferenc A. Jolesz, MD, Minna J. So, MD, Alisa Suzuki, MD, Louise Greenberg, MS, Frank J. Rybicki, MD, PhD, Elena Yanushpolsky, MD, Xiangtao Yin, PhD
- Insightec Inc Core Laboratory: Reuven Shreiber, MD
- Johns Hopkins University Hospital and School of Medicine: Michael A. Jacobs, PhD
- Mayo Clinic and Mayo Medical School: Gina Hesley, MD
- North Texas Uterine Fibroid Institute: Phyllis Gee, MD
- Saint Mary’s Hospital and Imperial College of Medicine: Wladyslaw M. Gedroyc, MD, Jonathan Hindley, MD, Olivia Smart, MD
- Sheba Medical Center: Yael Inbar, MD, Shlomo Cohen
- Eylon, MD, Ronit Mechtinger, MD
- Sightline of Houston: Denise R. Nebgen, MD, PhD
- South Jersey Radiology Associates and Virtua Health System: P. Curtis, MD, M. Delaurentis, MD