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Research Submission

A Randomized, Controlled Trial of Acupuncture for Chronic Daily Headache

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Background.—Approximately 4% of adults experience headaches nearly every day. Nonpharmacologic interventions for frequent headaches may be appropriate because medical management alone is often ineffective.

Objective.—To assess the efficacy of acupuncture as an adjunct to medical management for chronic daily headache (CDH).

Methods.—We conducted a randomized, controlled trial of 74 patients with CDH that compared medical management provided by neurologists to medical management plus 10 acupuncture treatments. Primary outcome measures were daily pain severity and headache-related quality of life (QoL).

Results.—Patients who received only medical management did not demonstrate improvement in any of the standardized measures. Daily pain severity scores trended downward but did not differ between treatment groups ($P = .60$). Relative to medical management only, medical management plus acupuncture was associated with an improvement of 3.0 points (95% CI, 1.0 to 4.9) on the Headache Impact Test and an increase of 8 or more points on the role limitations due to physical problems, social functioning, and general mental health domains of the Short Form 36 Health Survey. Patients who received acupuncture were 3.7 times more likely (CI, 1.7 to 8.1) to report less suffering from headaches at 6 weeks (absolute risk reduction 46%; number needed to treat 2).

Conclusion.—Headache-specialty medical management alone was not associated with improved clinical outcomes among our study population. Supplementing medical management with acupuncture, however, resulted in improvements in health-related QoL and the perception by patients that they suffered less from headaches.

Key words: chronic daily headache, acupuncture, quality of life

Abbreviations: CDH chronic daily headache, UNC University of North Carolina, GCRC General Clinical Research Center, TCM Traditional Chinese Medicine, HIT Headache Impact Test, SF-36 Short Form 36 Health Survey, version 2

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Chronic daily headache (CDH) is a clinical syndrome characterized by the occurrence of headache 15 or more days per month.[1] This condition affects approximately 3% to 5% of the general adult population[2,3] and is responsible for up to 80% of new patient complaints in headache-specialty clinics.[4,5] Most cases of CDH arise from episodic migraine or tension-type headaches that gradually transform into daily or near-daily headaches.[6,7] Medications commonly used to treat headache, such as acetaminophen, aspirin,

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nonsteroidal anti-inflammatory drugs, triptans, narcotics, or barbiturates, can have problematic side effects and paradoxically contribute to the transformation of episodic headaches to CDH.[8-14] Given the limitations of medical therapy for CDH, nonpharmacological interventions may be useful.

Acupuncture is a promising nonpharmacological treatment for frequent headaches. A recent meta-analysis concluded that acupuncture is more effective than sham acupuncture for the treatment of migraine headaches.[15] Another systematic review identified 27 clinical trials of acupuncture for various headache disorders; of these, 23 were considered "positive," 1 was "negative," and 3 were equivocal.[16] More recently, a randomized clinical trial demonstrated that a series of up to 12 acupuncture treatments was associated with 22 fewer days with headache, 15% less medication use, 25% fewer visits to general practitioners, and 15% fewer work days missed due to illness over 1 year among patients who experienced frequent headaches.[17]

The published literature does little, however, to inform healthcare providers and their patients with CDH about what to expect from a combination of medications and acupuncture. We conducted a randomized clinical trial to determine whether a 6-week course of acupuncture treatments could improve clinical outcomes beyond that which would be expected from medical management alone among patients with CDH.

METHODS

Patients.—Patients were recruited from a neurology-based headache clinic at the University of North Carolina (UNC) Hospitals. We sent an information packet describing the study to all 699 patients seen in the clinic during the 4 months prior to two study start dates (February 20 and September 15, 2003). Two-hundred and one patients consented to be screened for eligibility through telephone. Inclusion criteria were the occurrence of headache 15 or more days in the previous month, age greater than or equal to 18 years, and the ability to speak, read, and write English. Patients with a known intracranial lesion, a history of head or neck surgery in the previous 3 months, or treatment with acupuncture in the 6 weeks prior to enrollment were excluded. One-hundred and twelve patients met eligibility criteria; of these, 74 (66%) were enrolled (Figure 1).

Informed consent was obtained at the time of the baseline evaluation. The UNC School of Medicine's Committee on the Protection of the Rights of Human Subjects approved the study protocol. The trial was conducted through the General Clinical Research Center (GCRC) at UNC Hospitals. Patients were paid $80 upon completion of the headache diaries and follow-up assessments.

Randomization.—Personnel not otherwise involved in the trial used a computer-generated randomization sequence to assign consecutive study identification numbers to either of the two treatment groups. They then prepared sealed, opaque envelopes that contained randomization allocation information for each identification number. Treatment arm allocation was revealed for each patient upon completion of the baseline evaluation.

Interventions.—We randomly allocated study patients to receive either medical management only or medical management plus a series of 10 acupuncture treatments during a 6-week intervention period. All patients received medical management as provided by their personal healthcare providers and by a neurologist at the headache clinic at UNC Hospitals. The headache clinic is staffed by three neurologists with extensive experience in headache management. The headache clinic neurologists were aware of the trial but did not know which of their patients were participating. Patients were asked not to inform their healthcare providers of their participation in the trial unless necessary for medical reasons and were encouraged to continue taking their medications as directed by their providers.

Patients assigned to the acupuncture group were given their first acupuncture treatment on the day of the baseline evaluation and were scheduled for nine additional acupuncture treatments over the subsequent 6 weeks. All acupuncture treatments were administered by an experienced physician and acupuncturist trained in Traditional Chinese Medicine (TCM) in the People's Republic of China. The study acupuncturist is a Diplomate of the National Certification

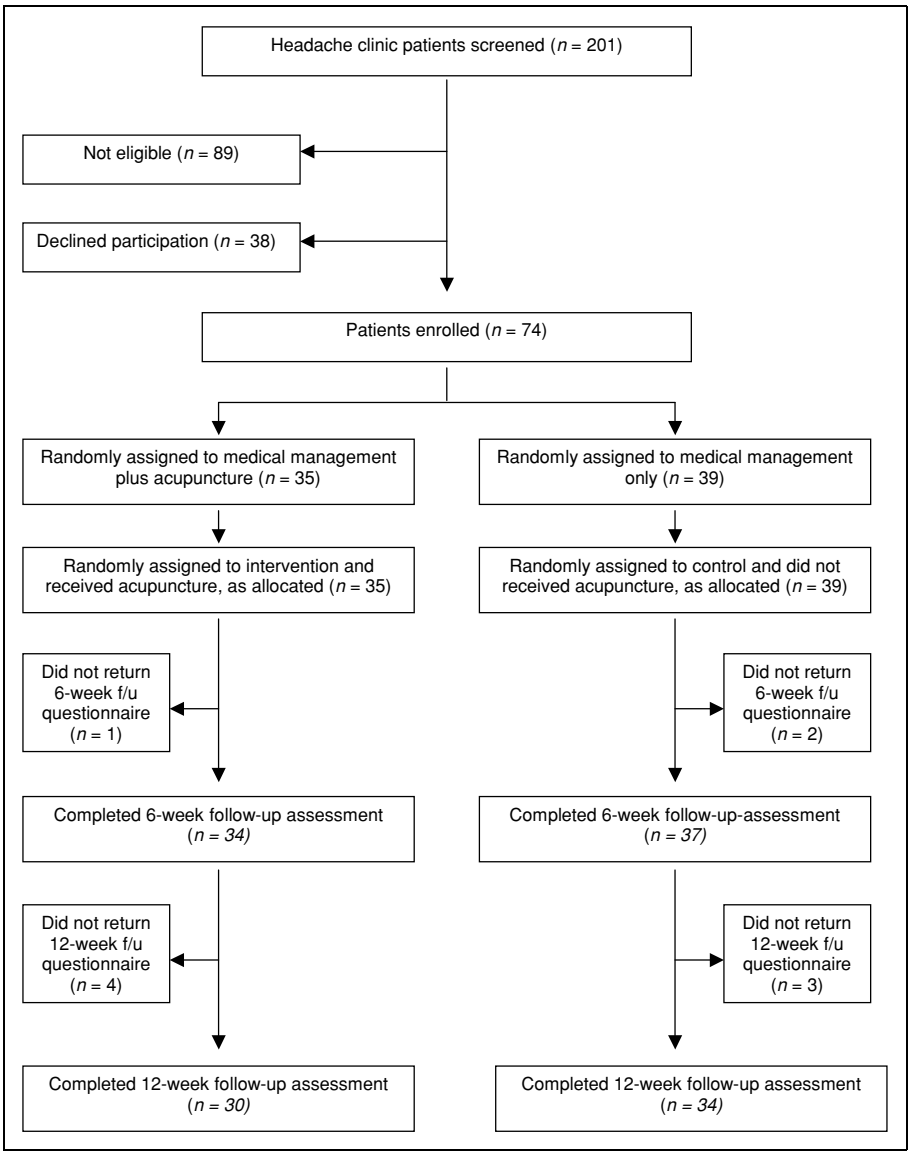

Fig 1.—Flow of patients through the study.

Commission for Acupuncture and Oriental Medicine. His medical degree was certified by the United States Educational Commission for Foreign Medical Graduates. The study acupuncturist interviewed and examined each patient prior to randomization. He selected the bodily locations in which to insert the acupuncture needles for each patient according to TCM "pattern diagnoses." The acupuncturist also needled tender points at or near the site of maximal headache pain, when indicated. The study acupuncturist reassessed patients at each visit and modified the acupuncture points needled whenever clinically indicated. Up to 30 acupuncture needles were inserted and left in place for approximately 30 minutes at each treatment.

Baseline Measures.—A study physician assessed patients' sociodemographic and clinical characteristics on the day of study enrollment, prior to randomization. Headache clinic neurologists had previously ascribed headache diagnoses in accordance with the 1988 International Headache Society classification system[18] as part of the routine care provided in the headache clinic.

Health-related quality of life (QoL) was assessed using the Headache Impact Test (HIT), which is a

standardized, six-item questionnaire designed to assess headache burden from the patient's perspective in the previous month.[19] Items include questions such as, "in the past 4 weeks, how often did headaches limit your ability to concentrate on work or daily activities" and "when you have headaches, how often is the pain severe?" HIT scores range from 36 to 78, with scores above 59 reflecting severe impairment in headache-specific QoL.[19] This instrument was found to be reliable and valid among a heterogeneous population of people with headache.[20,21]

Patients were asked to approximate the number of days they experienced a headache in the month prior to enrollment and to estimate the average severity of those headaches using a scale from 1 to 10, with 10 representing "very severe pain." Headache frequency and severity, thus assessed, were included as covariates in the linear regression model for the primary analysis. Health status was assessed with the Short Form 36 (SF-36) Health Survey, version 2.[22] The SF-36 is a commonly used instrument that generates 8 health domain scores: physical functioning, role limitations due to physical problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and general mental health. Health domain scores range from 0 to 100, with lower scores reflecting more impaired health status. The 21-item Beck Depression Inventory[23] was used to assess symptoms consistent with major depression.

Outcome Measures.—We selected two primary outcome measures prior to enrolling patients: (1) change in HIT scores from baseline to the 6-week follow-up assessment and (2) daily pain severity during the 6-week intervention period. We were unable to find a validated headache diary for patients with CDH; we consequently designed a diary specifically for this study and asked patients to record a number from 0 ("no headache") to 10 ("very severe pain") to indicate "the pain severity of the worst headache that day" each day during the 6-week intervention period.

Patients completed the HIT, SF-36, and Beck Depression Inventory questionnaires at 6 and 12 weeks after the baseline assessment. Perceived clinical change was assessed at the 6-week follow-up with four questions commonly used for this purpose[24-27] that were modified slightly for this study: (1) "Compared to 6 weeks ago, my headache condition is ... much better, somewhat better, about the same, somewhat worse, much worse, or don't know"; (2) "Compared to 6 weeks ago, my overall health is ... much better, somewhat better, about the same, somewhat worse, much worse, or don't know"; (3) "I suffer less from headache now than I did 6 weeks ago ... true or false"; and (4) "I am healthier now than I was 6 weeks ago ... true or false." Patients in the intervention group were instructed to report and describe adverse events, defined as "any unpleasant or undesirable symptoms or events that you think may have been caused by an acupuncture treatment" on a form that was returned by mail with the 6-week follow-up questionnaire.

Statistical Analysis.—Data were analyzed according to the treatment group to which patients were assigned even if acupuncture treatments were discontinued prematurely. We used multiple linear regression for outcomes with continuous values, with the follow-up score as the main outcome, treatment group allocation as the exposure, and baseline score as a covariate, in accordance with recommendations by clinical trial methodologists.[28] Because we suspected that headache frequency and severity at baseline might be predictive of outcome, and because it has been recommended that clinically prognostic characteristics should be included in regression analyses for randomized trials,[29] we included these two variables as covariates in our statistical models. We used chi-square analysis to compare variables with five or fewer possible values and paired Student's *t*-tests to compare baseline and follow-up scores of continuous variables within a single treatment group. We plotted mean values of each of the 42 daily pain severity scores during the 6-week intervention period against time and compared the slope of the regression lines for each treatment group to 0 (to assess whether daily pain scores changed over time within a given treatment group) and to each other (to assess whether changes in daily pain scores differed between treatment groups). We used the statistical software program Stata, version 8 (Stata, College Station, TX, USA) for data analysis.

RESULTS

Seventy-four patients were enrolled; 35 were assigned to the intervention group (medical management

plus acupuncture) and 39 to the control group (medical management without acupuncture). Data from the 34 patients in the intervention group and the 37 patients in the control group who completed the 6-week follow-up assessment (97% and 95%, respectively) were included in the primary analysis. Five patients in each treatment group did not return the 12-week follow-up questionnaires (Figure 1).

Every patient assigned to the intervention group received at least one acupuncture treatment. Twenty-nine patients (83%) received 9 or 10 acupuncture treatments, three (9%) received 6 to 8 treatments, and three (9%) received 3 or fewer treatments. One patient elected to discontinue acupuncture after her seventh treatment because of worsening headaches. The other patients who returned for fewer than nine treatments cited transportation barriers or time constraints as reasons for not presenting to all of the scheduled treatments; none cited adverse events, lack of efficacy, or dissatisfaction with the acupuncturist as reasons for discontinuing acupuncture treatments prematurely.

The sociodemographic and clinical characteristics of the patients at baseline were similar in the two treatment groups (Table 1). Patients were predominately female; this is consistent with the patient population of headache clinics. More than 80% of the patients had experienced daily or near-daily headache for at least 1 year. Sixty patients (81%) were diagnosed by the headache clinic neurologists as having one or more migraine diagnosis, 22 (30%) were diagnosed as having tension-type headaches, 12 (16%) had headache with facial pain associated with disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth, or other facial

Table 1.—Baseline Characteristics

Characteristic	Medical Management Plus Acupuncture (n = 35)	Medical Management, No Acupuncture (n = 39)
Demographics		
Mean age (range), years	44 (19 to 61)	47 (20 to 83)
Female, no. (%)	27 (77)	33 (85)
Married, no. (%)	25 (74)	20 (51)
Employed, full-time or part-time, no. (%)	19 (54)	19 (49)
Headache diagnosis,* no. (%)		
Migraine	27 (77)	32 (82)
Tension-type	13 (37)	10 (26)
Other	14 (40)	16 (41)
Duration of chronic daily headache, no. (%)		
1 to 11 months	4 (11)	4 (10)
1 to 5 years	18 (52)	14 (36)
More than 5 years	9 (26)	18 (46)
Don't know	4 (11)	3 (8)
Days with headache in the past month, mean (range)	24 (15 to 31)	24 (15 to 30)
Average monthly pain severity, mean (SD)	6.7 (2.0)	5.9 (2.0)
Headache Impact Test score	64.7 (6.3)	64.2 (5.7)
SF-36 health domain scores, mean (SD)		
Physical functioning	66 (27)	68 (30)
Role limitations due to physical problems	46 (28)	49 (30)
Bodily pain	40 (21)	37 (21)
General health	56 (22)	48 (24)
Vitality	37 (23)	36 (21)
Social functioning	50 (28)	54 (26)
Role limitations due to emotional problems	63 (31)	64 (30)
General mental health	57 (17)	59 (15)
Beck Depression Inventory score, mean (SD)	16 (13)	15 (13)

*Thirty-eight patients had more than one headache diagnosis.

or cranial structures, 8 (11%) had headache associated with substances or their withdrawal, 4 had headache associated with head trauma, and 5 patients (7%) had one or more other headache diagnoses in accordance with the 1988 International Headache Society classification system.[18]

Outcome Measures.—We were primarily interested in assessing the extent to which receiving acupuncture resulted in changes in clinical outcomes, relative to not receiving acupuncture; these data were generated by linear regression analysis and are reported in Table 2. We were also interested in absolute changes in outcomes within each treatment group; these data are reported in Table 3. Medical management plus acupuncture was associated with a decrease of 3.0 points (CI, 1.0 to 4.9) on the HIT relative to medical management without acupuncture at the 6-week follow-up (Table 2). Eliminating headache pain severity and frequency as covariates in the linear regression model did not significantly affect the magnitude of the decrease in the HIT scores associated with having received acupuncture (3.1 points; CI, 0.8 to 5.4). Daily pain severity decreased slightly during the intervention period for both groups (Figure 2), but the slopes of the regression lines were not statistically significant between the two groups ($P = .60$).

Relative to medical management only, medical management plus acupuncture was associated with an increase of 8 or more points in the role limitations due to physical problems (CI, 0.3 to 17.5), social functioning (CI, 2.7 to 22.6), and general mental health (CI, 3.1 to 13.5) domains of the SF-36 and a decrease of 3.5 points (CI, 0 to 7.0) on the Beck Depression Inventory at the 6-week follow-up (Table 2). Some of the benefits associated with acupuncture persisted for at least 6 weeks after the treatments were discontinued; at the 12-week follow-up, mean SF-36 scores for the role limitations due to physical problems, vitality,

Table 2.—Changes From Baseline to Follow-Up Associated With Acupuncture

	Score Change Mean (95% CI)	*P* Value
6-week follow-up		
Headache Impact Test	−3.0 (−4.9, −1.0)	.003
SF-36 health domains		
Physical functioning	2.1 (−5.3, 9.6)	NS
Role limitations—physical problems	8.9 (0.3, 17.5)	.04
Bodily pain	4.9 (−2.9, 12.8)	NS
General health	1.3 (−5.8, 8.3)	NS
Vitality	6.3 (−2.8, 15.6)	NS
Social functioning	12.6 (2.7, 22.6)	.01
Role limitations—emotional problems	3.3 (−6.1, 12.8)	NS
General mental health	8.3 (3.1, 13.5)	.01
Beck Depression Inventory	−3.5 (−7.0, 0)	.05
12-week follow-up		
Headache Impact Test	−2.5 (−5.7, 0.6)	NS
SF-36 health domains		
Physical functioning	5.2 (−1.9, 12.3)	NS
Role limitations—physical problems	15.8 (5.1, 26.4)	.01
Bodily pain	2.9 (−7.5, 13.3)	NS
General health	−3.0 (−11.0, 5.1)	NS
Vitality	8.6 (0.5, 16.7)	.04
Social functioning	10.9 (0.7, 21.1)	.04
Role limitations—emotional problems	7.8 (−1.8, 17.3)	NS
General mental health	1.7 (−2.8, 6.3)	NS
Beck Depression Inventory	−2.1 (−5.7, 1.5)	NS

NS = not significant ($P > .05$).
Linear regression model: $T2 = a + b_1G + b_2T1 + b_3F + b_4S + e$, where T2 = score at Time 2; G = treatment group (acupuncture = 1, control = 0); T1 = score at Time 1; F = headache frequency at baseline; S = headache severity at baseline; e = error term.

Table 3.—Changes in Outcomes From Baseline to Follow-Up Within Treatment Groups

	Medical Management Plus Acupuncture		Medical Management, No Acupuncture	
	Mean (95% CI)	*P* Value	Mean (95% CI)	*P* Value
6-week follow-up				
Headache Impact Test	−3.9 (−6.5, −1.2)	.006	−0.4 (−1.8, 1.0)	NS
SF-36 health domains, mean				
Physical functioning	3.7 (−1.0, 8.3)	NS	−0.8 (−7.2, 5.5)	NS
Role limitations—physical problems	7.5 (0.8, 14.1)	.03	−2.9 (−10.2, 4.3)	NS
Bodily pain	4.8 (−0.7, 10.2)	NS	0.7 (−5.5, 6.9)	NS
General health	1.4 (−3.7, 6.5)	NS	1.8 (−2.7, 6.3)	NS
Vitality	3.2 (−3.5, 9.9)	NS	−2.8 (−10.4, 4.8)	NS
Social functioning	11.4 (4.1, 18.7)	.003	−2.7 (−10.1, 4.7)	NS
Role limitations—emotional problems	8.1 (1.7, 14.4)	.01	3.3 (−4.7, 11.3)	NS
General mental health	4.5 (1.2, 7.8)	.008	−4.2 (−8.7, 0.4)	NS
Beck Depression Inventory	−2.6 (−5.4, 0.1)	NS	0.6 (−1.9, 3.1)	NS
12-week follow-up				
Headache Impact Test	−2.6 (−4.2, −1.1)	.001	−1.7 (−3.6, 0.3)	NS
SF-36 health domains				
Physical functioning	5.5 (−0.5, 11.5)	NS	0 (−3.9, 3.9)	NS
Role limitations—physical problems	10.8 (2.9, 18.8)	.009	−3.8 (−13.4, 5.8)	NS
Bodily pain	5.6 (0.7, 10.5)	.03	5.4 (−3.7, 14.5)	NS
General health	−0.1 (−5.7, 5.4)	NS	4 (−1.3, 9.3)	NS
Vitality	7.7 (2.7, 12.8)	.004	−0.6 (−7.3, 6.0)	NS
Social functioning	14.2 (7.7, 20.6)	<.001	3.6 (−4.8, 12.1)	NS
Role limitations—emotional problems	11.2 (4.1, 18.4)	.003	3.7 (−4.6, 12.2)	NS
General mental health	1.7 (−1.8, 5.3)	NS	−0.2 (−3.2, 2.8)	NS
Beck Depression Inventory	−1.8 (−4.1, 0.6)	NS	−0.3 (−3.1, 2.5)	NS

NS = not significant ($P > .05$).

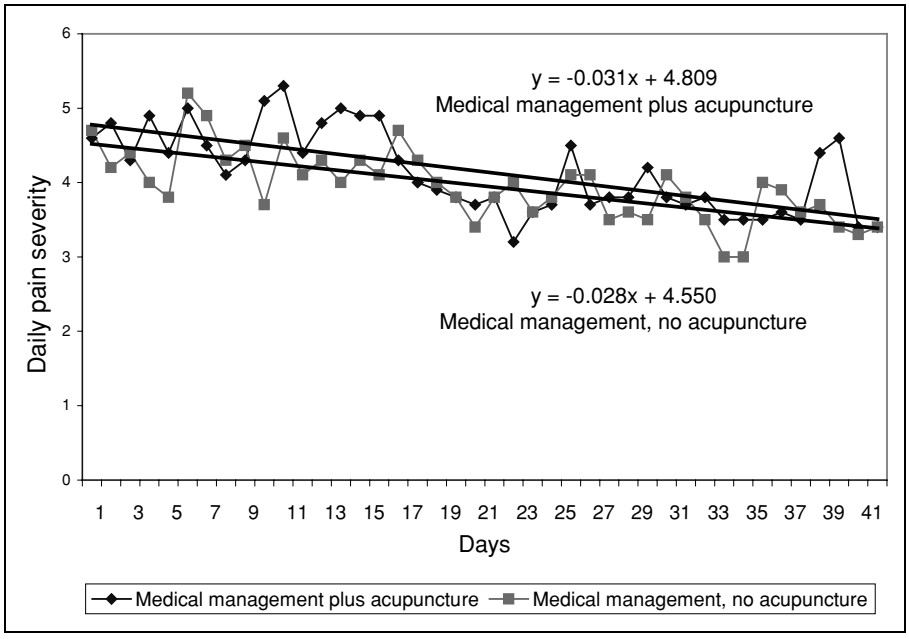

Fig 2.—Daily pain severity, by treatment group.

Table 4.—Perceived Clinical Change at 6 Weeks, by Treatment Group

	Medical Management Plus Acupuncture, Number (%)	Medical Management, No Acupuncture, Number (%)	*P* Value
Compared to 6 weeks ago, headache condition is:			
Much better	5 (15)	2 (5)	
Somewhat better	18 (53)	5 (14)	
About the same	10 (29)	21 (57)	<.001
Somewhat worse	1 (3)	5 (14)	
Much worse	0 (0)	4 (11)	
Change in overall health:			
Much better	5 (15)	2 (5)	
Somewhat better	18 (53)	5 (14)	
About the same	10 (29)	21 (57)	<.001
Somewhat worse	1 (3)	5 (14)	
Much worse	0 (0)	4 (11)	
Suffer less from headache than 6 weeks ago:			
True	21 (62)	6 (16)	
False	13 (38)	31 (84)	<.001
Healthier now than 6 weeks ago:			
True	8 (24)	6 (16)	
False	26 (76)	31 (84)	.40

and social functioning domains were 7 or more points higher in the intervention group.

Patients who received acupuncture reported a lower mean score on the HIT at 6 weeks and improvements of 7 or more points on the SF-36 health domains of role limitations due to physical problems, social functioning, and role limitations due to emotional problems at both the 6-week and 12-week follow-up times. In contrast, patients who did not receive acupuncture did not demonstrate statistically significant improvements in any of the outcomes measured at either follow-up time (Table 3).

Responses to the four items that assessed patients' perceptions of clinical change during the 6-week intervention period are reported in Table 4. Twenty-one patients (62%) in the intervention group reported suffering less from headaches at the 6-week follow-up period, compared to only 6 (16%) in the control group ($P < .001$). This corresponds to a 3.7-fold increase (CI, 1.7 to 8.1) in the likelihood of suffering less from headaches at 6 weeks, an absolute risk reduction of 46%, and a number of patients needed to treat with acupuncture to achieve a reduction in the perception of suffering from headaches of 2.

Of the 34 patients in the intervention group who completed the 6-week assessment, 12 (35%) reported one or more adverse events possibly attributable to acupuncture. Of these, 9 reported symptoms (eg, headaches, soreness in the neck, or difficulty sleeping), 4 reported discomfort associated with needle insertion, and 4 reported spot bleeding or mild bruising at needle sites.

Surprisingly, headache diagnosis did not predict clinical response at the 6-week follow-up assessment. HIT scores, SF-36 health domain scores, and Beck Depression Inventory scores did not change significantly when the presence of either a migraine diagnosis or tension-type headache diagnosis was included as a covariate in the linear regression model. Our sample size was not sufficiently large to identify predictors of clinical response just among patients who received acupuncture or just among patients who received medical care only.

COMMENTS

To our knowledge, this is the first randomized clinical trial to evaluate the efficacy of acupuncture as an adjunct to headache-specialty care in the treatment of CDH. Patients whose neurology-specialty medical

care was not supplemented with acupuncture failed to demonstrate significant improvement in any of the outcomes assessed upon completion of the 6-week intervention period, with the exception of a weak trend of decreasing daily pain severity. Those who received acupuncture, however, demonstrated improvements in most of the study outcomes, including headache-related QoL, several SF-36 health domains, and Beck Depression Inventory scores. Patients who received acupuncture were also more likely to report a reduction in the perception of suffering from headaches at the end of the intervention period. Acupuncture did not improve subjective daily pain severity, however.

Our findings corroborate those of a recent clinical trial in which a 3-month course of acupuncture treatments improved health status and headache scores compared to no acupuncture.[17] Both studies included patients who experienced frequent headaches, but ours included only patients who met criteria for CDH and who received headache-specialty medical care. Interestingly, in both studies acupuncture was associated with significant improvements in the SF-36 health domains of vitality and role limitations due to physical problems long after the acupuncture treatments had been discontinued, whereas neither study demonstrated between-group changes in the bodily pain domain.

Strengths of this study include the high follow-up rate (96%) for the primary analysis, the use of validated and clinically pertinent outcome measures, and broad inclusion criteria for a common problem associated with a significant burden of suffering. One of the greatest strengths is that we asked and answered a relevant question; the findings from this study inform healthcare providers, patients, and policy makers about clinical outcomes that might be expected from a brief course of acupuncture treatments as an adjunct to medical management for the treatment of CDH.

The unblinded study design combined with the use of subjective outcomes introduces the potential of significant bias; patients who received acupuncture may have been compelled to exaggerate claims of clinical improvement because they wanted to convince themselves or the investigators that they were helped by acupuncture. Conversely, patients knew that their responses to the follow-up questionnaires would not be made available to their providers and they did not expect future interactions with the investigators. In either case, the bias inherent to this unblinded study design may not be dissimilar to the tendency to overreport improvement in a clinical setting. Patients in the acupuncture group clearly reported greater clinical improvement, on average, than patients who did not receive acupuncture; there is no compelling reason to believe that these same patients would have reported markedly different outcomes had they received the same interventions in a nonclinical-trial setting.

Perhaps, the greatest limitation of this study is that we did not isolate acupuncture, *per se*, as the single, causal variable. Rather, our experimental design evaluated the efficacy of a complex therapeutic package that included acupuncture treatments, the time and attention of an experienced and caring clinician, the credibility of investigators conducting a research study sponsored by the National Institutes of Health, patients' probable hope that an "exotic" treatment approach may help their suffering, and a variety of other factors that may have contributed (positively or negatively) to the outcomes observed.

We were aware of this limitation when we designed this study, and we agree with arguments made by others that placebo-controlled trials of complementary or alternative medical interventions (including acupuncture) are feasible and essential.[30] Nonetheless, we intentionally did not use a sham acupuncture comparison in this study. We set out to answer the clinically relevant question, "does acupuncture improve outcomes among patients with CDH, compared to no acupuncture?" This is substantially different from the question, "does acupuncture improve outcomes compared to an invasive procedure that appears to be similar to, but isn't really, acupuncture?" Sham acupuncture is not an inert procedure; the insertion of needles bodily in locations not known to correspond to traditional acupuncture points may effect a physiologic response,[31] thereby complicating the interpretation of sham-controlled trials. Sham-controlled clinical trials may ultimately be necessary, but we believe it is appropriate to first determine whether the "therapeutic package" associated with a series of acupuncture treatments is associated with meaningful clinical change for any given clinical condition before

expending resources on expensive and difficult-to-interpret sham acupuncture trials.

Patients in the control group did not, as a group, demonstrate clinical improvement over the course of the 12-week trial. This finding can be explained by the possible presence of bias inherent in the study design, including: (1) patients who had previously not experienced clinical improvement from medical management may have been more likely to choose to participate in this study or (2) patients who were not offered acupuncture may have underestimated their clinical improvement because they knew they were not in the intervention group. We have no reason to believe (nor do we have any way of assessing if) that the care provided by the three neurologists deviated from the standard of care. Because this study was not designed to evaluate the efficacy of medical care as provided by the three study neurologists, our findings should not be used as evidence that usual medical management is not efficacious in the treatment of CDH.

Our findings demonstrate that a course of acupuncture treatments can improve clinical outcomes among patients with CDH beyond that which would be expected from headache-specialty medical management alone. Additional research is needed to elucidate the extent to which placebo effects associated with acupuncture contribute to clinical benefit, to identify clinical characteristics that predict favorable response to acupuncture, to explore which acupuncture traditions and protocols are most effective for treating the various causes and manifestations of CDH, and to determine whether acupuncture is a cost-effective approach to the treatment of frequent headaches.

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