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Hypertension

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Background—Arterial hypertension is a prime cause of morbidity and mortality in the general population. Pharmacological treatment has limitations resulting from drug side effects, costs, and patient compliance. Thus, we investigated whether traditional Chinese medicine acupuncture is able to lower blood pressure.

Methods and Results—We randomized 160 outpatients (age, 58 ± 8 years; 78 men) with uncomplicated arterial hypertension in a single-blind fashion to a 6-week course of active acupuncture or sham acupuncture (22 sessions of 30 minutes' duration). Seventy-eight percent were receiving antihypertensive medication, which remained unchanged. Primary outcome parameters were mean 24-hour ambulatory blood pressure levels after the treatment course and 3 and 6 months later. One hundred forty patients finished the treatment course (72 with active treatment, 68 with sham treatment). There was a significant ($P<0.001$) difference in posttreatment blood pressures adjusted for baseline values between the active and sham acupuncture groups at the end of treatment. For the primary outcome, the difference between treatment groups amounted to 6.4 mm Hg (95% CI, 3.5 to 9.2) and 3.7 mm Hg (95% CI, 1.6 to 5.8) for 24-hour systolic and diastolic blood pressures, respectively. In the active acupuncture group, mean 24-hour ambulatory systolic and diastolic blood pressures decreased significantly after treatment by 5.4 mm Hg (95% CI, 3.2 to 7.6) and 3.0 mm Hg (95% CI, 1.5 to 4.6), respectively. At 3 and 6 months, mean systolic and diastolic blood pressures returned to pretreatment levels in the active treatment group.

Conclusions—Acupuncture according to traditional Chinese medicine, but not sham acupuncture, after 6 weeks of treatment significantly lowered mean 24-hour ambulatory blood pressures; the effect disappeared after cessation of acupuncture treatment. (***Circulation***. 2007;115:3121-3129.)

Key Words: hypertension ■ risk factors ■ life style

Arterial hypertension is the most frequent cardiovascular disease, affecting roughly one third of the adult population of North America and Europe.[1] Arterial hypertension is a well-recognized risk factor for myocardial infarction and stroke, the first and the third most frequent causes of death in these countries, respectively, and correlates closely with vascular morbidity. Blood pressure can be lowered by several classes of drugs and by such lifestyle changes as weight loss, salt intake restriction, and exercise. Lifestyle interventions, however, are difficult to achieve and even more difficult to maintain, and drug therapy is costly, fraught with compliance problems, and accompanied by unwanted side effects.

Acupuncture, an ancient treatment technique anchored in traditional Chinese medicine, has been reported to have potential for treating cardiovascular diseases, including arterial hypertension.[2,3] However, evidence of efficacy in lowering blood pressure from controlled trials, particularly in the setting of a Western society, has been scant.[4] Several features of acupuncture make it a potentially attractive therapeutic

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alternative; when administered carefully by competent medical personnel, side effects are relatively rare.[5,6] Its perceived character as "holistic" and "soft" medicine, as opposed to conventional drug therapy, is attractive to many patients and may increase compliance to therapy in a disease notorious for low patient compliance with drug regimens.

As a result of the cooperation between the university in Nanjing (People's Republic of China), a regional German hospital (Klinikum Ottobeuren), and a university clinic (Med Klinik 2, Universitätsklinikum Erlangen), we had the unique opportunity to test the therapeutic potential of acupuncture administered by Chinese experts to Western hypertensive outpatients.

The study hypothesis was that acupuncture would reduce blood pressure in outpatients with uncomplicated mild to moderate hypertension, both untreated or on stable medica-

tion. The primary end points were average systolic and diastolic blood pressure levels measured by ambulatory blood pressure. Ambulatory blood pressure is unaffected by white coat hypertension and appears to be prognostically superior to office blood pressure readings.[7–9] To the best of our knowledge, this is the first report of a rigorous, randomized trial of acupuncture for arterial hypertension in a Western environment.

Methods

Patients

Recruitment of patients was promoted through direct contact with hypertensive outpatients at the Med Klinik, Klinikum Ottobeuren, from January 2001 to May 2004.

Patients were screened for participation if they fulfilled all of the following inclusion criteria: mild or moderate arterial hypertension (grade 1 or 2 of the European Society of Hypertension–European Society of Cardiology Guidelines 2003,[10] corresponding to systolic pressures ranging from 140 to 179 mm Hg and diastolic pressures ranging from 90 to 109 mm Hg) documented by at least 2 blood pressure readings ≥140/90 or a history of hypertension with current use of antihypertensive medication; age 45 to 75 years; and unchanged antihypertensive medication during the previous 2 months or no previous antihypertensive medication at all.

Eligible patients who expressed interest in participating in the study underwent physical examination, including blood pressure measurement on both arms, ECG recording, ambulatory and exercise blood pressure measurements, routine laboratory examination (creatinine, electrolytes, blood glucose, lipids, thyroid-stimulating hormone), echocardiography, and renal ultrasound, including maximal blood flow velocity of the renal arteries.

Patients were excluded if they had peak systolic/diastolic blood pressure on 24-hour ambulatory blood pressure monitoring >220/115 mm Hg, creatinine >1.5 mg/dL, proteinuria >0.5 g/24 h, evidence of renal hypertension or hyperthyroidism, diabetes mellitus, atrial fibrillation, at least moderate valvular heart disease, a history of stroke, angina or myocardial infarction, malignant disease, or a life expectancy <6 months.

The remaining patients interested in the study read and signed a written consent form. The study was approved and was found to be in accordance with the declaration of Helsinki of 1964 by the ethics committee of the university of Erlangen. Participation in the study was free for the patients; because all patients had full health insurance, there was no financial incentive to participate. If patients were on antihypertensive medication, they were instructed to continue this medication but to abstain from changing the type or dosage of drugs, and their medications were checked at each of the 3 follow-up visits.

After randomization, patients were excluded from further study if blood pressure recordings, serum creatinine, or proteinuria exceeded the above given limits; if intervening severe disease necessitated hospitalization; or if antihypertensive medication was changed.

Main Outcomes Measures

The primary end points defined at the outset of the study were average systolic and average diastolic blood pressure levels on 24-hour ambulatory blood pressure monitoring. Secondary end points were average daytime and nighttime systolic and diastolic blood pressures and a reduction in blood pressure at peak stress during bicycle stress testing.

Study Protocol

Patients were randomly assigned to a 6-week period of active or sham treatment (see below). The block randomization was stratified by premedication status and used variable block sizes within the strata to achieve a proper balance between the 2 groups. Treatment started as soon as possible and within 2 weeks of randomization in all patients. After treatment, patients returned for 3 follow-up visits:

the first (immediate) posttreatment follow-up visit occurred within 3 working days after finishing the treatment period; the second, 3 months after finishing treatment; and the third, 6 months after finishing treatment. Each visit included a physical examination, blood pressure measurement, ambulatory blood pressure measurement, and exercise blood pressure measurement.

Blood Pressure Measurements

Auscultatory cuff blood pressure measurements with calibrated instruments were used. After 5 minutes of rest with the patient sitting and the manometer at heart level, the systolic blood pressure was taken at the appearance of the first Korotkoff sound and diastolic blood pressure at the disappearance of Korotkoff sounds. Exercise blood pressure readings were taken at peak submaximal upright bicycle exercise with a stepwise exercise protocol with 25-W workload increases. Before randomization, each patient had blood pressure measured on both arms to exclude differences of >10 mm Hg.

Ambulatory blood pressure measurements were performed with an oscillometric device (Tracker NIBP, Reynolds Medical, Feucht, Germany) programmed to take 76 measurements during each 24-hour monitoring period. Measurement intervals were 15 minutes during daytime (8 AM to 10 PM) and 30 minutes during nighttime (10 PM to 8 AM). Average 24-hour systolic and diastolic blood pressures, average daytime systolic and diastolic blood pressures, and average nighttime systolic and diastolic blood pressures were calculated. Exercise blood pressure was measured before treatment and at each follow-up visit and was compared at the highest workload that a given patient had achieved during all 4 follow-up exercise tests to exclude the effect of differing maximal workloads.

Acupuncture

Acupuncture was administered by Chinese physicians trained and accredited at the Nanjing School of Traditional Chinese Medicine (Nanjing, People's Republic of China). All Chinese physicians had at least 5 years of training in traditional Chinese medicine, combined with 5 years of training in Western medicine, with additional practice of acupuncture of several years. Patients included in the study were assigned to 1 of 4 types of hypertension according to criteria of traditional Chinese medicine[11] (see Figure 1)[12] by a Chinese physician unaware of randomization. Assignment was based on a bilingual questionnaire, a physical examination, and further history taking by an interpreter. Then, 1 of 7 Chinese physicians delivered active or sham treatment according to the randomization code transmitted in a closed envelope, without indicating the assignment to patients; none of the physicians spoke German. Patients underwent a total of 22 sessions over 6 weeks. Each session lasted ≈30 minutes. During the first 2 weeks, 5 sessions were administered weekly, and in the following 4 weeks, 3 sessions were administered weekly. During each session, 3 acupuncture points were needled bilaterally (except single points like Taiyang) for 20 minutes after local disinfection (disposable 25- to 50-mm-long, 0.25-mm-diameter Shenzou acupuncture needles, Suzhou, People's Republic of China). In the active treatment group, the needling points were chosen according to the Chinese type of hypertension, and angle, depth, and type of manipulation of needling conformed to typical prescriptions.

Sham treatment consisted of an identical number, distribution, and duration of sessions by 1 of the 7 Chinese physicians and was identical regardless of Chinese hypertension type. Needling was performed with the same technique as for active treatment, but needling points without relevance for blood pressure lowering according to traditional Chinese medicine concepts were used (designated Pl1, Pl2, and Pl3 in Figure 1). Sham acupuncture needling points needled bilaterally were as follows: Pl1, dorsolateral forearm between traditional acupuncture points SI 7 and 8 on the small intestine meridian; Pl2, lateral thigh between acupuncture points Gb 32 and 31 on the gallbladder meridian; and Pl3, lateral lower limb between acupuncture points Gb 34 and 35 on the gallbladder meridian.
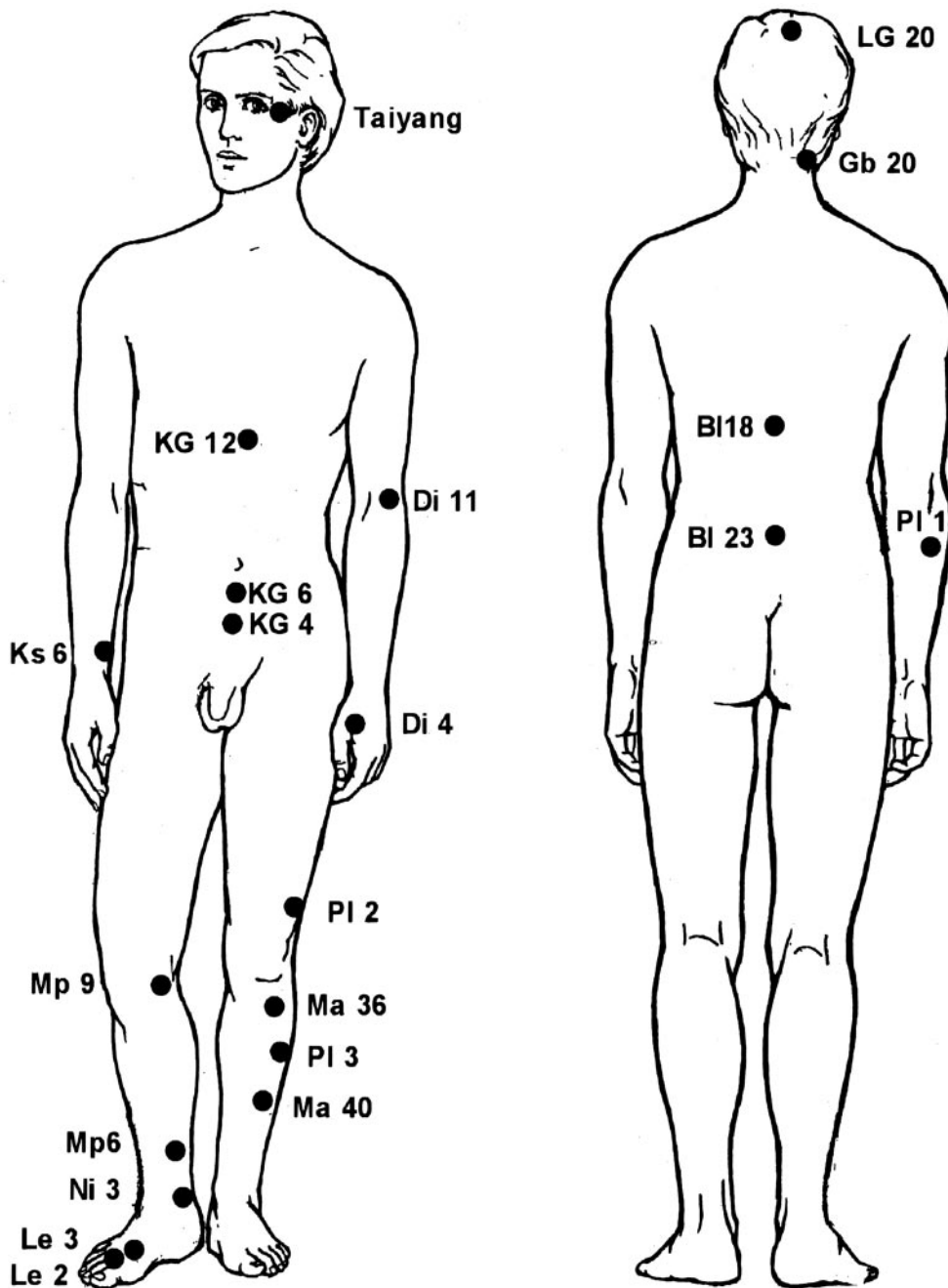
Figure 1. Needling points for active and sham acupuncture. See text for details. Adapted from Stux et al[12] with permission from Springer. Copyright 1999.

Statistical Analysis

The sample size calculation of the study was based on pilot data suggesting that at least 64 patients are required in each group for the final analysis to achieve a power of 80% to demonstrate a reduction of 5 mm Hg resulting from acupuncture, with an SD of 10 mm Hg, at a 2-sided significance level of 5%. Given a projected dropout rate of 20%, we aimed to recruit 160 patients for the study.

Differences between patients' characteristics in the 2 groups before treatment were descriptively evaluated. Blood pressure changes over time were assessed 2 ways. First, the 2 randomized treatment groups were compared using 3 separate ANCOVA models with blood pressure parameters at the various posttreatment follow-up visits as the outcome, baseline blood pressure as covariate, and treatment group as the factor of interest. Furthermore, we also longitudinally assessed between-group differences in this approach on the basis of the complete data of all posttreatment blood pressure values per patient in a (joint) repeated-measurement ANCOVA model. Second, we looked for changes in blood pressure parameters within each treatment group and evaluated them by paired t tests. The effect size resulting from treatment, ie, the magnitude of blood pressure changes, also was computed in both approaches and was accompanied by its 95% CI. All analyses were performed according to the intention-to-treat principle. The primary analyses are based on the available data without imputation of missing values, but additional analyses were performed on a completed data set in which all patients who did not start treatment or were lost to follow-up were included with their baseline values or last observation during follow-up.
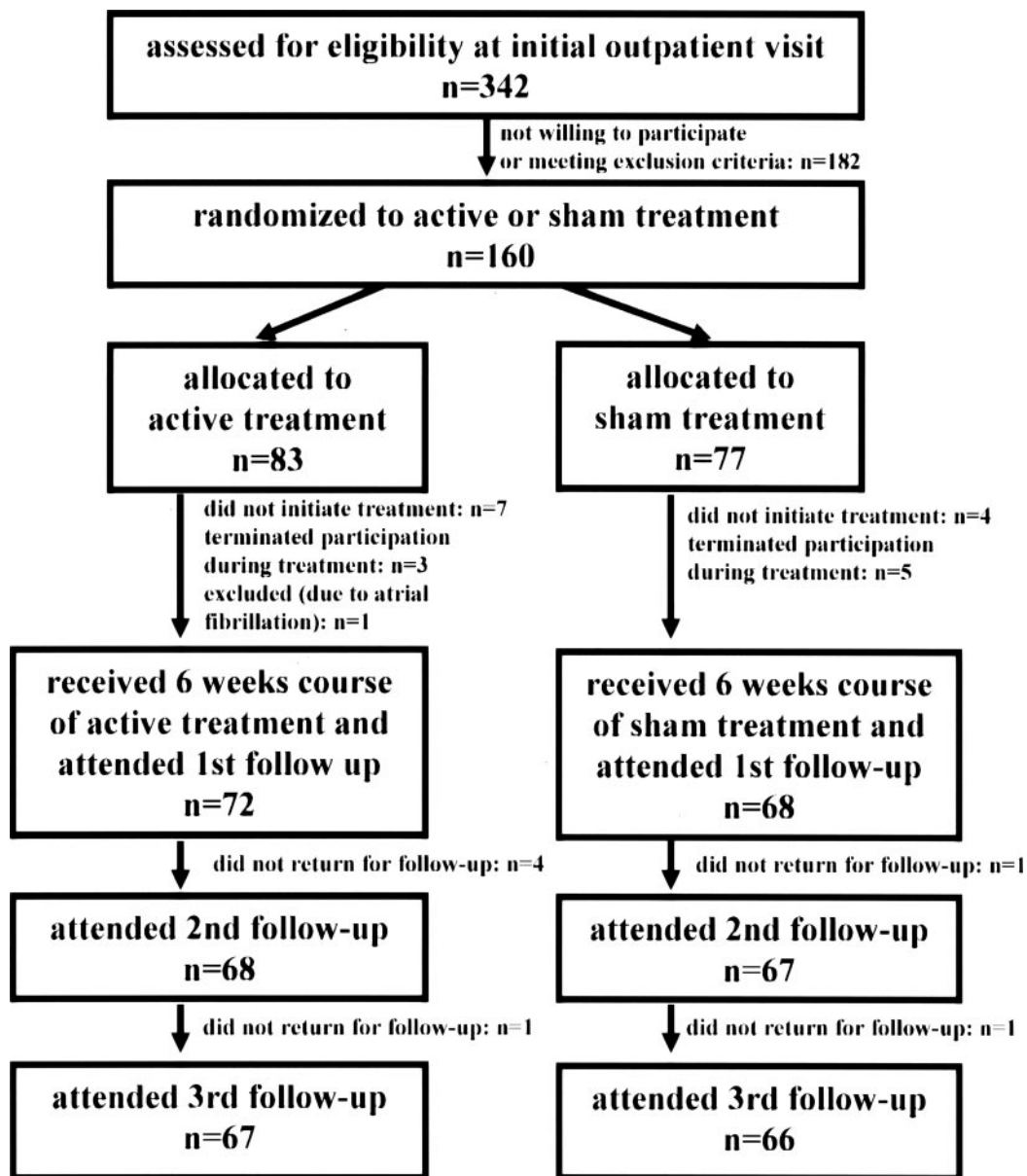
Figure 2. Flow diagram of the study cohort in Consolidated Standards of Reporting Trials format. See text for details.

A statement concerning any result of the analysis is labeled as statistically significant if the corresponding 2-sided probability value is <0.05. No correction for multiple statistical testing has been applied. Statistical analyses were performed with SAS software version 9.1.3 (SAS Institute Inc, Cary, NC).

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Patients

During the recruitment period, 342 hypertensive patients were screened during an initial outpatient visit. Of these, 160 were eligible according to inclusion and exclusion criteria, gave written consent to the study, and were subsequently randomized to active treatment (83 patients) or sham treatment (77 patients). Of those enrolled, 11 were lost in the 2 weeks between randomization and the initiation of treatment,

and 9 terminated their participation during the treatment course. Altogether, 140 completed treatment and the first posttreatment follow-up visit (72 active, 68 sham treatment). One hundred thirty-five patients attended the second visit (68 active, 67 sham treatment), and 133 attended the third visit (67 active, 66 sham treatment). See Figure 2 for a flow diagram.

Of those who discontinued treatment, 2 did so because they found acupuncture painful (both were in the active treatment group). One patient developed atrial fibrillation during the treatment course and was excluded because of the necessity of anticoagulation; this patient was in the active treatment group. The other patients discontinuing the study stated difficulty in keeping the time schedule, advice from their family practitioner, or no reason for discontinuation. During the duration of the study, no patient developed unstable angina, myocardial infarction, neurological events, need for

TABLE 1.   Baseline Demographic and Clinical Characteristics of the 140 Study Patients Who Completed Follow-Up

	Active Treatment (n=72)	Sham Treatment (n=68)
Age, y	58.8±8.2	58.0±7.9
Male/female, %	54/46	40/60
Body mass index, kg/m^2	28.0±5.0	28.9±5.8
Smoking, %	18	5
Medication, %		
β-Blockers	43	44
Calcium antagonists	24	25
Angiotensin-converting enzyme inhibitors	32	29
Angiotensin receptor blockers	17	25
Diuretics	19	31
α-Blockers	3	10
>1 Antihypertensive agent	44	47

Values are mean±SD when appropriate; group-specific relative frequencies are given in percent.

revascularization, or other major life-threatening diseases, including cancer. No patient died during the study. No patient had to be excluded because blood pressures during the study exceeded the prespecified limits.

The active treatment and sham treatment groups were well matched with regard to demographic variables and premedication (Table 1), as well as baseline blood pressures (Table 2). The subgroup already taking antihypertensive medication, nearly 80% of the total study group, continued their antihypertensive treatment without a change in dosage or type of medication. No patient was taking nonprescription or herbal drugs.

Blood Pressure
Ambulatory Blood Pressure Monitoring
Changes Between Baseline and Immediate Posttreatment Follow-Up Visit

The comparison of changes in blood pressure parameters from baseline to first follow-up visit between active treatment group and sham treatment group controlling for baseline levels in ANCOVA analyses revealed significant differences in 24-hour systolic, 24-hour diastolic, daytime systolic, daytime diastolic (all $P<0.001$), and nighttime systolic ($P=0.049$) pressures but only a negligible difference for nighttime diastolic pressure ($P=0.14$) (see Tables 2 and 3 and Figures 3 and 4). The most pronounced difference was observed in daytime systolic blood pressure, with an adjusted mean difference of 7.3 mm Hg (95% CI, 4.2 to 10.5). Between-group differences for the primary end points, 24-hour systolic and diastolic blood pressures, were 6.4 mm Hg (95% CI, 3.5 to 9.2) and 3.7 mm Hg (95% CI, 1.6 to 5.8), respectively.

Although in the sham treatment group none of the blood pressures parameters changed significantly between baseline and immediate posttreatment visit or throughout later follow-up, some part of between-group difference stems from a slight increase in blood pressure parameters in the sham treatment group. In the active treatment group, the 24-hour ambulatory average systolic and diastolic blood pressures decreased significantly from baseline to the first posttreatment follow-up visit by 5.4 mm Hg (95% CI, 3.2 to 7.6) and 3.0 mm Hg (95% CI, 1.5 to 4.6), respectively (both $P<0.001$). Daytime systolic and diastolic blood pressures also decreased significantly by 6.5 mm Hg (95% CI, 4.1 to 8.8) and 3.8 mm Hg (95% CI, 2.2 to 5.4), respectively (both $P<0.0001$).

TABLE 2.   Blood Pressures During the Study Period

Blood Pressure	Treatment	Pretreatment Blood Pressure (n=160), mm Hg	Posttreatment Blood Pressure (n=140), mm Hg	Blood Pressure at 3 mo (n=135), mm Hg	Blood Pressure at 6 mo (n=133), mm Hg
24-h Syst	Active	131±13	125±12‡	128±12	130±13
24-h Syst	Sham	129±9	130±11	130±11	129±11
24-h Dia	Active	81±9	78±9†	80±8	80±9
24-h Dia	Sham	80±8	80±9	79±9	79±8
Day syst	Active	136±13	129±12‡	132±12	133±13
Day syst	Sham	133±10	134±11	134±12	131±13
Day dia	Active	84±9	80±9‡	82±8	82±9
Day dia	Sham	82±9	82±9	82±10	82±9
Night syst	Active	120±14	117±14*	119±15	122±16
Night syst	Sham	120±12	120±12	120±12	120±14
Night dia	Active	73±10	72±10	73±9	74±10
Night dia	Sham	73±8	74±9	73±8	75±15
Ex syst	Active	220±26	214±24	208±34	210±27
Ex syst	Sham	221±23	217±22	216±22	213±20
Ex dia	Active	108±14	106±12	105±11	104±14
Ex dia	Sham	108±13	107±15	107±15	107±12

Values are mean±SD. Syst indicates systolic; Dia, diastolic; Day, daytime; Night, nighttime; and Ex, exercise at the maximal comparable workload.

*$P<0.05$, †$P<0.001$, ‡$P<0.0001$ vs pretreatment; all other within-group comparisons were nonsignificant.

TABLE 3. Differences* Between and Changes Within Treatment Groups in Blood Pressure From Pretreatment to Immediately After Treatment

Blood Pressure, mm Hg	Active (n=72) Versus Sham (n=68)*	Changes Within Active Group (n=72)	Changes Within Sham Group (n=68)
24-h Syst	6.4 (3.5 to 9.2)	5.4 (3.2 to 7.6)	−1.6 (−3.7 to 0.6)
24-h Dia	3.7 (1.6 to 5.8)	3.0 (1.5 to 4.6)	−1.1 (−2.7 to 0.5)
Day syst	7.3 (4.2 to 10.5)	6.5 (4.1 to 8.8)	−1.8 (−4.3 to 0.7)
Day dia	4.0 (1.8 to 6.2)	3.8 (2.2 to 5.4)	−0.7 (−2.4 to 1.0)
Night syst	3.4 (0.1 to 6.7)	3.2 (0.4 to 5.9)	0.1 (−2.3 to 2.5)
Night dia	1.8 (−0.6 to 4.3)	0.8 (−1.1 to 2.6)	−1.0 (−2.8 to 0.8)
Ex syst	3.7 (−3.8 to 11.2)	4.8 (−1.9 to 11.4)	0.6 (−5.8 to 6.9)
Ex dia	0.2 (−4.2 to 4.6)	1.0 (−2.3 to 4.4)	1.2 (−3.0 to 5.5)

Values are expressed as mean (95% CI). Syst indicates systolic; Dia, diastolic; Day, daytime; Night, nighttime; and Ex, exercise at the maximal comparable workload.

*Adjusted mean differences were derived from ANCOVA models including baseline values of the corresponding blood pressure variable as covariate. The 95% CIs were calculated from the ANCOVA modeling based on the distributional assumption of a normal distribution.

The differences between treatment groups stayed significant but were marginally reduced to 5.4 mm Hg (95% CI, 2.8 to 8.0) for 24-hour systolic blood pressure and to 3.3 mm Hg (95% CI, 1.4 to 5.1) for diastolic 24-hour blood pressure when all 20 patients who did not start their treatment or terminated their participation during the treatment course were included in the analysis with their baseline values. Only for nighttime systolic blood pressure did the reduction in the difference from 3.4 to 2.7 mm Hg (95% CI, −0.3 to 5.7) render the difference not statistically significant ($P=0.07$).

Thirty-five study subjects (19 receiving active, 16 sham treatment) were not taking antihypertensive medication when enrolled in the trial. In this rather small subgroup that is, however, well balanced with respect to baseline characteristics because of the stratified randomization, we observed a very similar pattern of results over time. Interestingly, however, the absolute reduction in blood pressure parameters from baseline to first posttreatment follow-up visit in the active treatment group was slightly stronger compared with the total study group (6.6 mm Hg [95% CI, 1.3 to 11.9; $P=0.018$] and 3.7 mm Hg [95% CI, 0.5 to 7.0; $P=0.027$] for 24-hour ambulatory average systolic and diastolic blood pressures, respectively), whereas in the sham treatment group, all blood pressure parameters increased by ≈2 mm Hg ($P=0.32$ to 0.60 for the different blood pressure parameters). The heterogeneity of the findings between this small subgroup and the rest of the study population already taking antihypertensive medication is compatible with chance variation.

Changes During Further Follow-Up
The reductions in blood pressures seen in the active treatment group between the baseline and first (immediate) follow-up visit disappeared during further follow-up. There were no
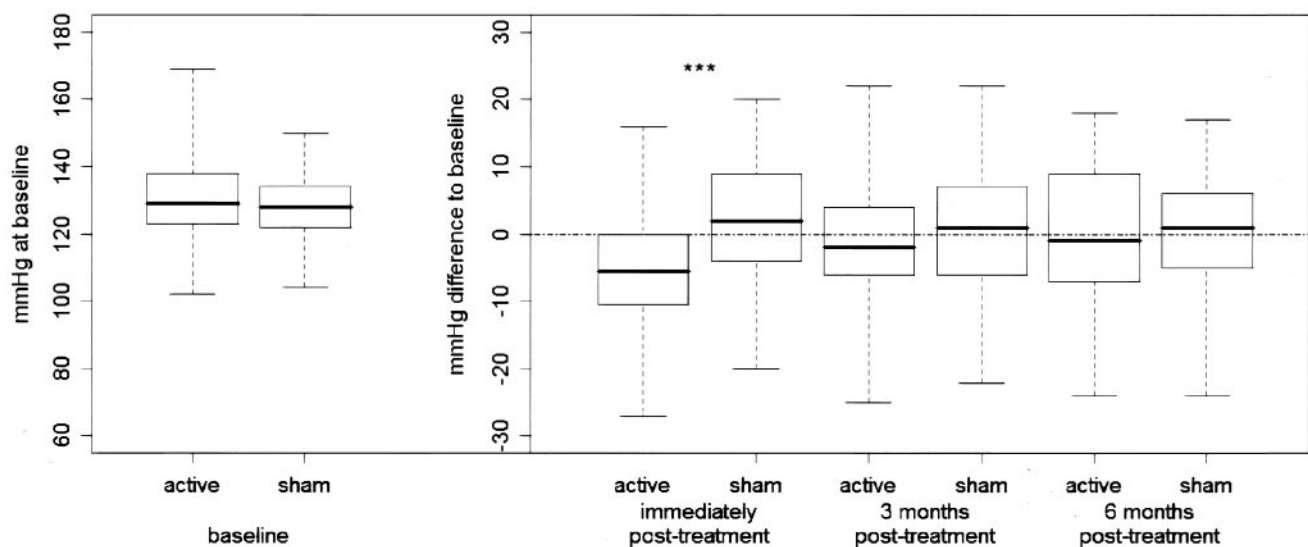

Figure 3. Box plots of the distribution of average 24-hour ambulatory systolic blood pressure in active and sham groups at baseline (left) and of the changes vs baseline in both treatment groups during the study period (right). ***$P<0.0001$ for testing differences between treatment groups; all other between-group comparisons were nonsignificant.

Figure 4. Box plots of the distribution of average 24-hour ambulatory diastolic blood pressure in active and sham groups at baseline (left) and of the changes vs baseline in both treatment groups during the study period (right). ***$P<0.0001$ for testing differences between treatment groups; all other between-group comparisons were nonsignificant.
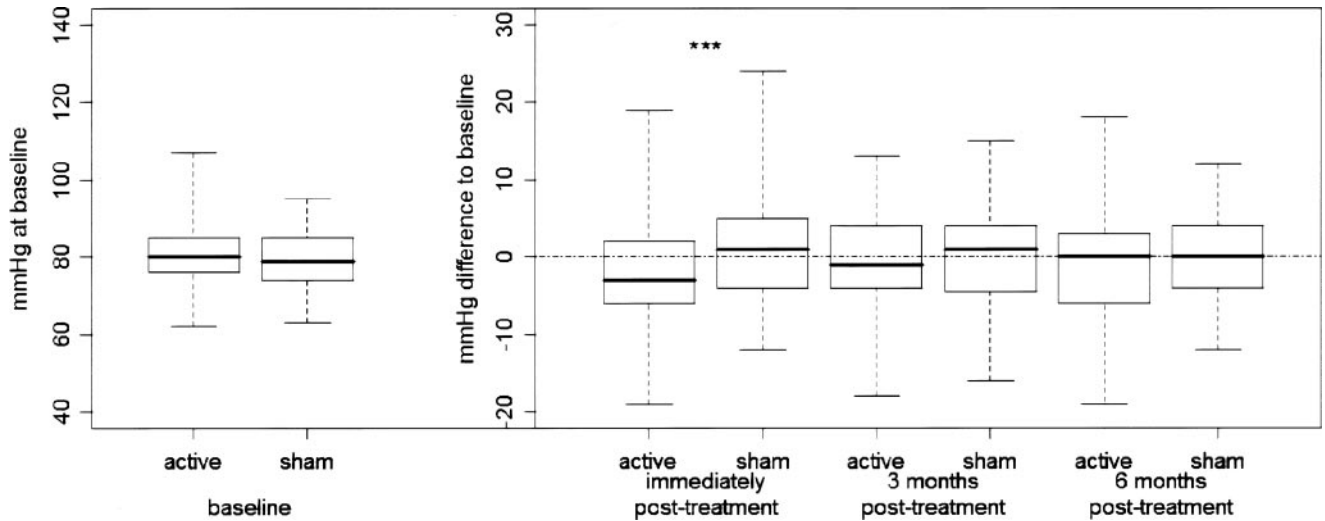
significant differences in blood pressures between the active and sham treatment groups at the second and third follow-up visits or between visits within each group.

Peak Exercise Blood Pressure
In the active treatment group, there was a nonsignificant decrease from baseline to first posttreatment visit in systolic and diastolic blood pressures at the largest workload achieved during in all exercise tests (4.8 mm Hg: 95% CI, −1.9 to 11.4; 1.0 mm Hg: 95% CI, −2.3 to 4.4, respectively) (see Tables 2 and 3). In the sham treatment group, the corresponding values were 0.6 mm Hg (95% CI, −5.8 to 6.9) and 1.2 mm Hg (95% CI, −3.0 to 5.5), yielding adjusted mean differences between the 2 treatment groups of 3.7 mm Hg (95% CI, −3.8 to 11.2) and 0.2 mm Hg (95% CI, −4.2 to 4.6). No significant changes occurred in both treatment groups during further follow-up.

Side Effects of Acupuncture

No local complications such as bleeding, hematoma, perforation, infection, or others necessitating treatment were seen. The most frequent complaint about acupuncture therapy concerned the time demand for the treatment sessions. Two patients terminated study participation, complaining that acupuncture was too painful to continue.

Discussion

Acupuncture lowered 24-hour ambulatory blood pressures during treatment. For the prespecified primary end points (24-hour mean systolic and diastolic blood pressures), the moderate reduction within the active acupuncture group and the difference from the sham acupuncture group were statistically significant. Secondary end-point blood pressure parameters also were significantly reduced during active treatment except for nighttime diastolic pressure, which was low in both groups from the outset, and exercise blood pressure. The reduction in exercise blood pressure levels in the active group was not statistically significant, perhaps because of the

much larger variation of exercise blood pressure readings compared with 24-hour ambulatory measurements. In the control group, there were no significant changes in any blood pressure parameters over time.

The antihypertensive effect of acupuncture did not last longer than the treatment. Blood pressure levels of patients undergoing active acupuncture treatment returned to pretreatment levels between the first and the second follow-up visits, ie, within 12 weeks after termination of treatment. Blood pressure levels were indistinguishable between active treatment and sham groups at the second and third follow-up visits. The magnitude of the difference in blood pressure reduction between treatment groups (6.4 and 3.7 mm Hg for 24-hour systolic and diastolic blood pressures, respectively) was similar to the effects reported from large randomized, placebo-controlled trials of angiotensin-converting enzyme inhibitors and calcium antagonists showing clinical benefit.[13] For example, in the Heart Outcomes Prevention Evaluation (HOPE) study, 10 mg daily of ramipril produced a reduction in mean systolic and diastolic blood pressures from 139/79 mm Hg at baseline to 133/76 mm Hg at 1 month.[14] The blood pressure reductions achieved in studies with lifestyle interventions such as substantial weight reduction, salt intake limitation, or vigorous exercise also are of this order of magnitude.[10,15]

Importance of the Present Findings

Arterial hypertension, which affects about one third of the adult population in North America and Europe, causes enormous morbidity and, mediated mainly by coronary heart disease and stroke, mortality. Antihypertensive drug therapy is efficient and reduces morbidity and mortality.[13,16] However, such treatment is costly and causes undesirable side effects in some patients. Furthermore, because hypertension by itself rarely affects a patient's well-being, poor compliance is a recognized problem in pharmacological antihypertensive treatment.

As shown in the present study, acupuncture may offer an alternative antihypertensive therapeutic option. Acupuncture effectively lowered systolic and diastolic blood pressures during the treatment period with no or minimal side effects. Patients with mild or moderate hypertension who want to avoid drug therapy or are attracted to the spiritual foundations of acupuncture may therefore be candidates for such a therapy. This modality might also serve as an additional option together with drug therapy. However, several issues concerning this therapeutic modality deserve emphasis. First, acupuncture requires a substantial commitment of time from the patients. Acupuncture sessions were scheduled 3 to 5 times per week and took ≈30 minutes each, with additional time necessary for transportation. This may severely limit its attractiveness to many potential candidates. Second, acupuncture was delivered by Chinese experts with extensive training; on average, the physicians involved had practiced acupuncture for 6 years. Results may differ if less or differently trained persons administer acupuncture therapy. Finally, in the present study, acupuncture was delivered at no cost to the patients. The extensive training required for delivering expert acupuncture may render this therapy costly even compared with drug therapy.

Study Limitations

Most patients included in the present study were on antihypertensive drug therapy because it was not possible to recruit only hypertensive patients not taking antihypertensive medication. However, great care was taken to instruct the patients not to change medication throughout the study period or to use over-the-counter nonprescription drugs or herbal drugs. However, it is not possible to entirely exclude that such changes might have occurred. Subgroup analysis of patients not taking antihypertensive drugs revealed no significant differences in the effect of active acupuncture compared with all patients. No attempt was made to control for physical activity or salt intake. For ethical and practical reasons, only patients with mild or moderate hypertension were included. Furthermore, the patients were relatively young and healthy; thus, the results of the present study may not apply to other populations, eg, the elderly, patients with long-standing, severe hypertension, or diabetics, who were not included in the present study.

Our study end points were blood pressure levels, not clinical outcomes. However, current knowledge indicates that similar blood pressure reductions lead to similar reductions in clinical end points, regardless of the underlying therapy.[16] The duration of therapy in the present study was short (6 weeks), and the treatment effect did not substantially outlast its administration. Longer trials are necessary to test the durability of the blood pressure–lowering effect of acupuncture.

Twenty-seven of 160 patients (17%) originally enrolled dropped out before or during treatment or during follow-up. The number of dropouts was similar in both groups, and their baseline characteristics were nearly identical to those who stayed in the trial. We cannot rule out that the dropouts influenced the outcome of the study. However, in an additional sensitivity analysis including all dropouts with their baseline values, we observed only a marginal reduction of the treatment effect, which stayed significant. The dropouts in our trial underline that compliance problems are not exclusive to antihypertensive drug therapy.

Therapeutic effects of acupuncture in pain conditions also have been seen during sham acupuncture, raising the question of the specificity of the traditional acupuncture points for eliciting therapeutic responses.[17] In the present study, sham acupuncture was used in the control group. However, a clear-cut effect on blood pressure was observed in the active treatment group only, not in the sham acupuncture group.

The mechanism by which acupuncture lowers blood pressure remains speculative.[17,18] Analgetic effects of acupuncture have been ascribed to the release of endogenous analgesic factors triggered by needling.[19] Cardiovascular depressant effects of electroacupuncture in an animal model have been described and attributed to stimulation of afferent nerves, leading to an autonomic reflex.[20] An effect on renin secretion also has been reported.[3]

Conclusions

In this randomized, single-blind trial, a 6-week course of acupuncture delivered by experts in traditional Chinese medicine lowered 24-hour ambulatory systolic and diastolic blood pressures significantly by a mean of 5.4 and 3.0 mm Hg, respectively. The difference in changes in these blood pressure parameters during the treatment course compared with the sham acupuncture group was 6.4 and 3.7 mm Hg, respectively. No serious side effects were observed. The effect did not outlast the duration of treatment. Thus, acupuncture appears to be an effective and safe therapeutic modality for the treatment of mild to moderate hypertension in otherwise healthy patients in the age range of 45 to 75 years.

Disclosures

None.

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CLINICAL PERSPECTIVE

Arterial hypertension is a key risk factor for major cardiovascular events, including stroke, myocardial infarction, and cardiovascular death. Arterial hypertension also is an eminently treatable disease, with several classes of drugs efficiently and safely lowering elevated blood pressure. Lifestyle changes such as exercise and weight reduction also can reduce blood pressure but are notoriously difficult to maintain over time. However, control of hypertension in clinical practice remains disappointingly imperfect, with adequate control achieved only in a minority. One important and well-described reason for this situation lies in the nature of the disease, which per se causes few or no symptoms before complications occur. The lack of perception of the disease on the patient's part, together with the necessity of multidrug regimens in most patients, frequently results in low compliance with the medication. Traditional Chinese acupuncture, an ancient system of medical knowledge and skills, may offer an alternative therapeutic approach for some hypertensive patients, although the mechanism by which acupuncture lowers blood pressure remains entirely unclear at present. In this randomized trial, a modest but clinically meaningful reduction in systolic and diastolic ambulatory blood pressures (by 5.4 and 3.0 mm Hg, respectively) was achieved by three 30-minute sessions of acupuncture per week. Side effects (pain from needling) were few. It should be emphasized that this treatment requires substantial time on the part of the patient and expertise on the part of the acupuncturist. Thus, the setting of our study involving acupuncture by Chinese experts was unique and will have to be replicated under more widely applicable conditions. Nevertheless, acupuncture appears to offer an alternative therapeutic approach at least in the population studied here, ie, patients 45 to 75 years of age with uncomplicated mild to moderate hypertension.