Does Acupuncture Improve Motor Recovery After Stroke? 
A Meta-Analysis of Randomized Controlled Trials

Frank Kai-hoi Sze, FRCP; Eric Wong, MA; Kevin K.H. Or, FRCP; Joseph Lau, MD; Jean Woo, FRCP

Background and Purpose—Acupuncture may be a promising treatment for poststroke paralysis. We conducted a meta-analysis, assessing the efficacy of acupuncture with and without stroke rehabilitation.

Methods—We identified randomized trials comparing acupuncture with no acupuncture within 6 months of stroke by searching MEDLINE, CINAHL, EMBASE, Cochrane Library, and Chinese medical literature databases. Two reviewers independently extracted data on study characteristics, patient characteristics, and impairment and disability outcomes. The outcome measures were internationally recognized or nationally approved. The fixed- and random-effects models were used to combine effect size and odds ratio across studies.

Results—Fourteen trials with 1213 patients met all the inclusion criteria. For the comparison of acupuncture with no acupuncture in addition to stroke rehabilitation, the pooled random-effects estimates of the change in motor impairment and disability were 0.06 (95% CI, −0.12 to 0.24) and 0.49 (95% CI, 0.03 to 0.96), respectively, with heterogeneity in disability measures (P=0.05, χ² test). For the comparison of real with sham acupuncture, the pooled random-effects estimate of the change in disability was 0.07 (95% CI, −0.34 to 0.48). For the comparison of acupuncture with no acupuncture without stroke rehabilitation, the pooled random-effects estimate of the change in motor impairment was 0.46 (95% CI, −0.20 to 1.12), and the pooled random-effects odds ratio for disability was 12.5 (95% CI, 4.3 to 36.2), with no statistically significant heterogeneity (P=0.97 and P=0.12, respectively, χ² test), but the study quality was poor.

Conclusions—This meta-analysis suggests that with stroke rehabilitation, acupuncture has no additional effect on motor recovery but has a small positive effect on disability, which may be due to a true placebo effect and varied study quality. The efficacy of acupuncture without stroke rehabilitation remains uncertain, mainly because of the poor quality of such studies. (Stroke. 2002;33:2604-2619.)

Key Words: acupuncture ■ meta-analysis ■ stroke

The modalities of treatment in stroke rehabilitation in Western countries are physiotherapy, occupational therapy, and speech therapy, in addition to skilled medical and nursing care. In this study this mode of care is referred to as conventional stroke rehabilitation. However, the majority of stroke patients in China do not have access to these therapies. They are often provided with acupuncture, together with routine medical and nursing care. In this study this routine medical and nursing care is referred to as conventional care. Rehabilitation workers in the West recognize that more than half of the stroke survivors remain severely disabled despite conventional stroke rehabilitation. This reality drives researchers to search for other modalities of treatment in an attempt to further improve outcome. Acupuncture has become a subject of major interest and one of the most popular complementary therapies in the West in recent years. Researchers started to design randomized controlled trials to assess the efficacy of acupuncture in poststroke paralysis in the early 1990s, and the results were inconsistent. Several review articles 5–10 have appeared on this subject. Although most of these authors commented that acupuncture might be a promising treatment for poststroke paralysis, none reached conclusions regarding its efficacy. Furthermore, these reviews have important limitations. First, most reviews were based on experts’ opinions. One systematic review has been published,10 but the author did not pool the data, claiming that the outcome measures were too heterogeneous. We believe that heterogeneity could have been improved if inclusion criteria for outcome measures had been set and outcome measures had been classified as impairment and disability measures. Second, all reviews mixed trials that compared acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone and trials that compared acupuncture plus conventional care with conventional care alone. Mixing conventional stroke rehabilitation and conventional care trials for review is not appropriate because stroke
patients who have been given conventional stroke rehabilitation may not gain further motor improvement after acupuncture if conventional stroke rehabilitation has maximized the recovery potential. In contrast, stroke patients on conventional care alone may still benefit from acupuncture for motor recovery. Third, most reviews included only a few trials that were done in China and were published in the English-language literature, leaving a large number of articles in the Chinese literature that were not reviewed. One review did search the Chinese literature, but it was not thorough. At least 7 randomized controlled trials comparing acupuncture with no acupuncture were missed within the search period. Finally, some randomized controlled trials in this area published in recent years were not covered by these reviews.

The objective of this meta-analysis was to determine whether acupuncture improves poststroke motor recovery in addition to stroke rehabilitation and whether acupuncture improves motor recovery without stroke rehabilitation.

Methods

Definitions of Acupuncture

Conventional acupuncture is defined as acupuncture performed at acupoints well documented in historical Chinese medical literature; it is further classified as conventional body acupuncture if acupoints located on the body are used and as conventional cranial acupuncture if acupoints located on the scalp or face are used. Nonconventional acupuncture is defined as acupuncture performed at sites other than these classic acupoints; it is also further classified as nonconventional body acupuncture and nonconventional cranial acupuncture, respectively. Acupuncture can be performed manually (manual acupuncture) or electrically (electric acupuncture).

Literature Search

The literature search was performed with the use of MEDLINE (January 1966 to March 2001), CINAHL (1982 to March 2001), PubMed (to March 2001), Embase (1980 to December 2000), and Cochrane Controlled Trials Register (Issue 1, 2001) in English by 2 reviewers (F.K.S. and J.L.) and with the use of Nanjing Traditional Chinese Medicine Database (January 1981 to January 2000) and JiangSu Provincial Science and Technology Information Research Institute Database (January 1989 to December 1999) in Chinese by 2 reviewers (F.K.S. and X.Y.). The key words used for the search were acupuncture and stroke/CVA/cerebrovascular accident/cerebral infarction/intracerebral hemorrhage/cerebral embolism. The types of publication searched were clinical trials and reviews. One of the reviewers (F.K.S.) also performed a manual search of Chinese Acupuncture and Moxibustion (1981 to December 2000), Journal of Shanghai Acupuncture and Moxibustion (1983 to December 2000), references from the retrieved trials and review articles, and acupuncture conference proceedings in China.

Inclusion Criteria

Two reviewers for the English literature (F.K.S. and E.W.) and Chinese literature (F.K.S. and X.Y.) independently reviewed the trials for inclusion. Any disagreements on inclusion were resolved through discussion. The inclusion criteria were the following: (1) randomized controlled trials, comparing acupuncture of any kind with no acupuncture (or sham acupuncture); (2) patients with stroke within 6 months (cerebral infarction, intracerebral hemorrhage, cerebral embolism, or unclassified stroke), diagnosed clinically and/or by CT scan or MRI; and (3) motor impairment and disability measures that are either internationally recognized or nationally approved by an academic body in China. Poststroke motor recovery beyond 6 months is known to be unlikely, and mixing patients with interval to stroke onset of <6 months and ≥6 months in 1 sample would make the assessment of the efficacy of an intervention methodologically unsound. Therefore, we planned to include in a subgroup trials that met all the other inclusion criteria but used a sample of patients whose interval to stroke onset ranged from <6 months and ≥6 months or was unreported.

Data Extraction

Data were extracted by 2 reviewers (F.K.S. and K.K.H.O.) independently. Once completed, any disagreements on data extraction and evaluation were resolved through discussion. Recorded data included study characteristics, patient characteristics, and outcomes. For motor impairment, measures recognized internationally include the Scandinavian Stroke Scale11 (SSS), Rivermead Mobility Index12 (RMI), Motor Assessment Scale13 (MAS), Brunnstrom Stages14 (BS), and Fugl-Meyer Assessment–motor score15 (FMAM); measures nationally approved in China include the Chinese Stroke...
TABLE 1. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Stroke Nature</th>
<th>Stroke Status</th>
<th>Severity on Entry</th>
<th>Interval to Onset</th>
<th>Age, y</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
</table>
| Hu et al (1993)         | Cerebral infarction MCA territory only | 1st stroke           | Moderate to severe | <36 h             |       | 1) Infarction in MCA territory  
2) With motor deficit                                                           | 1) Coma  
2) TIA  
3) Life-threatening illness  
4) Significant systemic disease  
5) On anticoagulants  
6) No limb weakness                                                             |
| Johansson et al (1993)  | Cerebral infarction                   | 1st stroke           | Moderate to severe | 4–7 d             | Median 76 | 1) Cooperative  
2) ADL partially dependent                                                       | 1) On pacemakers  
2) Previous ADL dependent                                                         |
| Sallstrom et al (1996)  | Cerebral infarction, ICH              | 1st stroke           | Moderate          | Median 40 d; range 15–71 d |       | 1) Mild to moderate aphasia                                                       | 1) SAH  
2) Severe comorbidity  
3) Severe aphasia                                                                 |
| Gosman-Hedstrom et al (1998) | Cerebral infarction, 1st and recurrent stroke | Moderate to severe | <7 d              |                   |       | M: weighted mean 76; F: weighted mean 76.3                                       | 1) Severe comorbidity  
2) Severe aphasia  
3) Unconsciousness  
4) On pacemakers  
5) Previous ADL dependent                                                         |
2) Medically uncomplicated  
3) With hemiplegia                                                               | Not reported                                                                 |
| Sze et al (2002)        | Cerebral infarction, ICH, cerebral embolism | Moderate to severe | 3–15 d           |                   |       | Mean 70.8, SD 8.8                                                               | 1) BI: 3–14  
2) Glasgow Coma Scale = 15  
3) Follow simple command                                                           |

Scale16 (CSS), Second National Cerebrovascular Diseases Conference 198617 Appendix I–the motor impairment score (Second NCDC impairment score), Guidelines on the Use of New Chinese Herbal Medicines in Stroke (UNCHMS guidelines),18 and Modified Edinburgh-Scandinavian Stroke Scale19 (MESSS). For disability, measures recognized internationally include the Barthel Index (BI) (2 versions: BI-10020 and BI-2021), Functional Independence Measure (FIM),22 and Sunnaas ADL Index (SADLI)23; measures approved nationally in China include the Second National Cerebrovascular Diseases Conference 198617 Appendix IV–disability score (Second NCDC disability score), UNCHMS guidelines,18 and National Traditional Chinese Medicine Conference on Diagnosis of Stroke and Assessment of Efficacy 1986 (Tai-An Conference 1986).24 If >1 eligible impairment and/or disability measurement score was reported, we extracted data from the internationally or nationally most widely used measure for the sake of data synthesis.

The Jadad scale25 was used to measure the quality of the included studies. This validated scale included the following criteria: method of randomization, double blinding, and reporting of withdrawal and dropouts. Because quality scales have their limitations, we also examined the individual components of study quality for each included randomized controlled trial, including, in particular, concealment of treatment allocation, assessor blinding, intention-to-treat analysis, dropouts, and sample size.

Data Synthesis

We combined the effect sizes for studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone and studies comparing acupuncture plus conventional care with conventional care alone in motor impairment and disability outcomes, respectively. Then we combined the effect size for studies comparing real acupuncture plus conventional stroke rehabilitation with sham acupuncture plus conventional stroke rehabilitation to estimate the magnitude of placebo effect. We also performed subgroup analysis according to the characteristics of the studies to assess the effect of study quality on the combined effect size. Data from randomized controlled trials whose interval to stroke onset was >6 months or unreported were synthesized separately.

For studies that reported continuous outcomes, the effect size was calculated. The effect size is a dimensionless metric that allows us to combine studies that used different outcome scales, but the interpretation of the result is less intuitive. The effect size is expressed by the
standardized mean change \((g)\), which is defined as the mean difference between pretest and posttest scores divided by the pretest standard deviation. The standardized mean change was first computed for the acupuncture and control groups in each study, and then the unbiased standardized mean change effect size \((d)\) and the corresponding variance were calculated according to the following formulas:\(^{26,27}\)

\[
d = \left(1 - \frac{3}{4n-9}\right) g \quad \text{and} \quad \text{Var}(d) = \frac{2(1-p)}{n} \cdot d^2 \cdot \frac{1}{2n}
\]

where \(n\) is the sample size for each group, and \(p\) is the correlation between the pretest and posttest scores.

When information for the size of the correlations was not directly available in the study, we either calculated it from the prescore, postscore, and gain score standard deviations given,\(^{28}\) or we imputed it by the available correlations. For studies that reported results in graphic forms, the graphic data were transformed into numerical data. For the sake of data synthesis with other similar studies using continuous outcomes, the logarithms of odds ratio were converted to effect size by dividing by 1.81.\(^{29}\) For studies testing the differences, \((\Delta = d_{\text{unbiased}} - d_{\text{conventional}})\) were pooled according to a fixed-effects model and a random-effects model.\(^{27}\)

For studies that reported dichotomous outcomes, the odds ratio was calculated and combined with the use of the Der Simonian and Laird random-effects model.\(^{30}\) We also calculated the results using the Mantel-Haenszel fixed-effects model\(^ {31}\) for comparison.

For both continuous and dichotomous outcomes, the test of homogeneity of effects across studies was performed with a \(\chi^2\) statistic, with \(P<0.1\) indicating heterogeneity. The test of homogeneity assesses whether the individual study results are likely to reflect a single underlying effect as opposed to a distribution of effects.

Sensitivity analysis was performed to assess the influential studies that might affect the pooled result by deleting each study in turn from the analysis and noting the degree to which the size and significance of the treatment effect change. The robustness of the pooled estimates was also assessed by repeating the meta-analysis on subgroups of the original data set.

We assessed publication bias using the funnel plot regression method\(^ {32}\) for studies comparing acupuncture plus conventional care with conventional care alone. If there was no publication bias, the regression slope would have an expected value of zero. A negative regression slope suggests that small negative studies are not published.

For studies comparing acupuncture plus conventional care with conventional care alone because publication bias is not affected by the interval to stroke onset.
In this meta-analysis, we used Comprehensive Meta Analysis (version 1.0.9; Biostat) for analysis and calculations of dichotomous data, and we calculated the results for continuous data using Microsoft Excel 2000 (Microsoft Corporation).

Results

Qualitative Findings

The English-language literature search identified 105 articles, the abstracts of which were reviewed. Then 35 full articles that were potentially relevant were reviewed further. Of the 35 studies, 13 were randomized controlled trials assessing the effect of acupuncture on poststroke motor recovery. Of the 13 randomized controlled trials, 9 compared acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone (Table 1), and 4 compared acupuncture plus conventional care with conventional care alone (Table 2), and 3 contained arms comparing real acupuncture plus conventional stroke rehabilitation with sham acupuncture plus conventional stroke rehabilitation (Tables 1 and 2).

The Chinese literature search identified 1116 articles, the abstracts of which were reviewed. Then 180 full articles that were potentially relevant were reviewed further. Of the 180 studies, 11 were excluded because of lack of randomization, 82 because of lack of control, and 57 because of comparison of 1 kind of acupuncture with another. Three studies were excluded because of injection of medication at the acupoints, 1 because of lack of statistical analysis, and 1 because of lack of motor assessment. Twelve studies were excluded because the outcome measures were not nationally approved. Eight studies used samples whose interval to stroke onset was >6 months or unreported but otherwise met the inclusion criteria, among which 7 randomized controlled trials compared acupuncture plus conventional care with conventional care alone, and 1 randomized controlled trial compared acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone (data were available on request). The remaining 5 studies comparing acupuncture plus conventional care with conventional care alone, met all the inclusion criteria (Table 2).
Therefore, the present meta-analysis included 14 studies\textsuperscript{2–4,16,19,33–37,50–53} of 1213 patients who met all the inclusion criteria and another 8 studies\textsuperscript{42–49} in a subgroup of 924 patients whose interval to stroke onset was >6 months or unreported but otherwise met the inclusion criteria. None of the 22 studies reported mixed patient populations, such as stroke with other neurological diseases.

We assessed the clinical heterogeneity of the 14 randomized controlled trials\textsuperscript{2–4,16,19,33–37,50–53} that met all the inclusion criteria. In terms of patient selection, 853 patients (11 studies) had first stroke, and 360 patients (3 studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone) had first or recurrent stroke. A total of 789 patients (11 studies) had moderate to severe stroke; for 424 patients (3 studies comparing acupuncture plus conventional care with conventional care alone), severity was not reported. In terms of intervention, 787 patients (10 studies) received acupuncture within 2 weeks,
and 426 patients (4 studies) received acupuncture within 90 days of acute stroke. A total of 543 patients (6 studies) received electric plus manual acupuncture, 164 patients (3 studies) received electric acupuncture, and 506 patients (5 studies) received manual acupuncture. Among the 506 patients, 400 were from studies comparing acupuncture plus conventional care with conventional care alone. All 14 studies described the acupoints in detail, but the selected acupoints varied significantly except acupoints LI4, LI10, LI11, and GB34, which were repeatedly selected. The acupuncture method also varied significantly, with conventional body acupuncture being the most common method, used in 464 patients (5 studies). The duration of acupuncture was 10 weeks in 4 studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone (438 patients), was 4 to 6 weeks in 7 studies (530 patients), was 2 weeks in 2 studies (181 patients), and was not reported in 1 study (64 patients). In terms of methodology, 3,33,36,37 (360 patients) of the 8 studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone reported concealment of treatment allocation and intention-to-treat analysis, whereas none of the 6 studies comparing acupuncture plus conventional care with conventional care alone did so. The 3 studies33,36,37 that reported intention-to-treat analysis also reported dropouts and death, which were included in the effect calculation. Of the 11 studies that did not report intention-to-treat analysis, 33,35 reported dropouts or death, but we could not be certain whether their scores were counted in the analysis.33,35,37,54 We found that 425 patients of the 8 studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone were assessor blinded, whereas none of the 6 studies comparing acupuncture plus conventional care with conventional care alone were assessor

### Table 1. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Dropout</th>
<th>Statistical Method</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hu et al (1993)</td>
<td>No dropout</td>
<td>Wilcoxon rank sum test</td>
<td>1) No details of standard rehab program, assuming PT, OT included. 2) With charts only; Jadad score: 2; SSS positive; BI negative</td>
</tr>
<tr>
<td>Johansson et al (1993)</td>
<td>At 3 mo: 3 dropouts in control arm; 5 dropouts in acupuncture arm</td>
<td>Mann-Whitney; Friedman’s; Kruskal-Wallis</td>
<td>1) Comparison between 2 groups at each time point using Mann-Whitney was improper 2) Reported QoL (NHP) results; Jadad score: 2; Motor negative; BI positive</td>
</tr>
<tr>
<td>Sallstrom et al (1996)</td>
<td>4 dropouts</td>
<td>ANCOVA</td>
<td>1) No rehabilitation detail, assuming PT, OT included 2) Also QoL (NHP) results; Jadad score: 3; MAS positive; SADLI positive</td>
</tr>
<tr>
<td>Gesman-Hedstrom et al (1998)</td>
<td>Deep acupuncture: 4 deaths, 2 dropouts; superficial: 10 deaths, 2 dropouts; control group: 5 deaths</td>
<td>Fisher’s permutation test?</td>
<td>1) Also QoL (NHP) and use of healthcare and social services; Jadad score: 5; SSS negative; BI negative</td>
</tr>
<tr>
<td>Wong et al (1999)</td>
<td>Not reported</td>
<td>t test, Mann-Whitney</td>
<td>Jadad score: 1; BS positive; FIM positive</td>
</tr>
<tr>
<td>Sze et al (2002)</td>
<td>14 dropouts (6 in acupuncture arm, 8 in control arm), no deaths</td>
<td>$\chi^2$ test, $t$ test, Mann-Whitney test</td>
<td>8 patients on TENS; 5 patients on FES; post hoc analysis: same negative results by excluding 13 patients; Jadad score: 3; FMAM negative; BI negative</td>
</tr>
</tbody>
</table>

**Figure 2.** Difference in disability outcome for the included studies comparing acupuncture plus conventional stroke rehabilitation (CSR) with conventional stroke rehabilitation alone.
blinded. In summary, between randomized controlled trials comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone and randomized controlled trials comparing acupuncture plus conventional care with conventional care alone, there were significant differences in patient selection, intervention, and methodology. On the whole, the methodological quality was reasonably good for studies comparing acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone but was poor for studies comparing acupuncture plus conventional care with conventional care alone.

We also assessed the clinical heterogeneity of the 8 randomized controlled trials\textsuperscript{12–49} whose interval to stroke onset was >6 months or unreported. Between these 8 randomized controlled trials and the 14 randomized controlled trials that met all the inclusion criteria, there was significant difference in patient selection, intervention, and, in particular, methodology. None of the 8 randomized controlled trials reported how the randomization was performed except 1 study,\textsuperscript{46} which used quasi randomization and did not report concealment of treatment allocation. None of the 8 randomized controlled trials reported assessor blinding, intention-to-treat analysis, and dropouts and death. Thus, the quality of the 8 randomized controlled trials whose interval to stroke onset was >6 months or unreported was very poor.

![Figure 3. Difference in impairment outcome for studies comparing acupuncture plus conventional care (CC) with conventional care alone whose interval to stroke onset was >6 months or unreported.](http://stroke.ahajournals.org/)

**TABLE 2.** Characteristics of Included Studies Comparing Acupuncture Plus Conventional Care With Conventional Care Alone (Naeser et al 1992\textsuperscript{35} and Johansson et al 2001\textsuperscript{36} Comparing Real Acupuncture Plus Conventional Stroke Rehabilitation With Sham Acupuncture Plus Conventional Stroke Rehabilitation

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Control</th>
<th>Size Estimate</th>
<th>Consent</th>
<th>Randomization Detail</th>
<th>Intention to Treat</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tang et al (1996)\textsuperscript{50}</td>
<td>63 (43M/22F)</td>
<td>30</td>
<td>33</td>
<td>No</td>
<td>No</td>
<td>Not reported</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Si et al (1998)\textsuperscript{16}</td>
<td>42 (33M/9F)</td>
<td>20</td>
<td>22 (18M/4F)</td>
<td>No</td>
<td>No</td>
<td>Not reported</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Jin et al (1999)\textsuperscript{51}</td>
<td>120 (74M/46F)</td>
<td>60</td>
<td>60</td>
<td>No</td>
<td>No</td>
<td>Not reported</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Li et al (1999)\textsuperscript{52}</td>
<td>64 (36M/28F)</td>
<td>30</td>
<td>34 (19M/15F)</td>
<td>No</td>
<td>No</td>
<td>Quasirandomization</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Zhang et al (1999)\textsuperscript{53}</td>
<td>241 (179M/62F)</td>
<td>145</td>
<td>96 (71M/25F)</td>
<td>No</td>
<td>No</td>
<td>Not reported</td>
<td>Not reported</td>
<td>No report</td>
</tr>
<tr>
<td>Chou et al (2000)\textsuperscript{19}</td>
<td>32</td>
<td>16</td>
<td>16</td>
<td>No</td>
<td>No</td>
<td>Quasirandomization</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Naeser et al (1992)\textsuperscript{35}</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>No</td>
<td>Yes</td>
<td>Not reported</td>
<td>Not reported</td>
<td>CT</td>
</tr>
<tr>
<td>Johansson et al (2001)\textsuperscript{36}</td>
<td>150 (14M/136F)</td>
<td>Group 1: 48; group 2: 51</td>
<td>51</td>
<td>Yes</td>
<td>Yes</td>
<td>Computer generated, closed envelope</td>
<td>Yes</td>
<td>CT and clinical</td>
</tr>
</tbody>
</table>

BMIT indicates Boston Motor Inventory Test. Other abbreviations are as defined in Table 1.
Quantitative Findings
The first main finding is that with stroke rehabilitation, acupuncture had no additional effect on motor recovery (pooled random-effects estimate of change, 0.06; 95% CI, 0.12 to 0.24) (Figure 1) but had a positive effect on disability (pooled random-effects estimate of change, 0.49; 95% CI, 0.03 to 0.96) (Figure 2). Heterogeneity was found among the included studies2-4,33,34,37 for disability outcome and was mainly due to differences in intervention and methodological quality among these studies, as shown above. Because the pooled estimated change of 0.49 is less intuitive, we converted it to the changes in BI20 in 1 of the included studies, assuming that all the other conditions were unchanged. To have an estimated change of 0.49, the BI score at 3 months in the acupuncture group would be 75 instead of 90.4, and the BI change at 3 months in the acupuncture group would be 29.9 instead of 45.3. Because the BI change at 3 months in the control group was 27.3, the difference in BI changes between the 2 groups would be 2.6 points, which is clinically a small effect.

The second main finding is that without stroke rehabilitation, acupuncture had a positive effect on motor recovery on

### Table 2. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Stroke Nature</th>
<th>Stroke Status</th>
<th>Severity on Entry</th>
<th>Interval to Onset</th>
<th>Age, y</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tang et al (1996)50</td>
<td>Cerebral infarction</td>
<td>1st stroke</td>
<td>No report</td>
<td>&lt;7 d</td>
<td>51–70</td>
<td>Not specified</td>
<td>1) Impaired consciousness</td>
</tr>
<tr>
<td>Si et al (1998)16</td>
<td>Cerebral infarction</td>
<td>1st stroke</td>
<td>Moderate</td>
<td>&lt;7 d</td>
<td>Acupuncture: mean 68 (SD 10); control: mean 67 (SD 8)</td>
<td>Hemiplegia with limb power grading 3/6</td>
<td></td>
</tr>
<tr>
<td>Li et al (1999)10</td>
<td>ICH</td>
<td>1st stroke</td>
<td>Moderate</td>
<td>≤2 d</td>
<td>52–75</td>
<td>Not specified</td>
<td>3) Epilepsy</td>
</tr>
<tr>
<td>Zhang et al (1999)53</td>
<td>ICH; cerebral infarction; SAH (n=4)</td>
<td>1st stroke</td>
<td>No report</td>
<td>&lt;43 d</td>
<td>35–85</td>
<td>Not specified</td>
<td>4) Acupuncture-related dizziness</td>
</tr>
<tr>
<td>Chou et al (2000)19</td>
<td>Cerebral infarction and hemorrhagic transformation</td>
<td>1st stroke</td>
<td>Moderate</td>
<td>2 d</td>
<td>Not reported</td>
<td>Not specified</td>
<td>5) Extensive ICH</td>
</tr>
<tr>
<td>Naeser et al (1992)25</td>
<td>Cerebral infarction</td>
<td>1st stroke</td>
<td>Moderate</td>
<td>1–3 mo</td>
<td>44–74</td>
<td>Significant right hemiplegia</td>
<td>Not reported</td>
</tr>
<tr>
<td>Johansson et al (2001)36</td>
<td>Cerebral infarction</td>
<td>1st/recurrent stroke</td>
<td>Moderate to severe</td>
<td>5–10 d</td>
<td>Weighted mean 76.3</td>
<td>BI ≥70; 9 hole peg &gt;60 s; walk 10 min with support</td>
<td>1) Previous neurological/psychiatric/other disorders; 2) Unable to comprehend; 3) Concurrently in another trial</td>
</tr>
</tbody>
</table>

**Figure 4.** Difference in disability outcome for the included studies comparing acupuncture plus conventional care (CC) with conventional care alone.

Test of homogeneity Q=5.78, d.f.=3, p=0.12
TABLE 2. Continued

<table>
<thead>
<tr>
<th>Author</th>
<th>Baseline Matched</th>
<th>Acupuncture Technique</th>
<th>Acupuncture Method</th>
<th>Details of Acupuncture (Acupoints, Frequency, Duration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tang et al (1996)50</td>
<td>No report</td>
<td>Manual</td>
<td>Nonconventional cranial acupuncture</td>
<td>From Baihui (GV20) through Qubin (G7); needling 200 times/min for 5 min, then rest for 5 min; repeat 3 cycles</td>
</tr>
<tr>
<td>Si et al (1998)51</td>
<td>Yes</td>
<td>Manual followed by electric</td>
<td>Conventional body acupuncture</td>
<td>Acupoints (DU20, DU24, LI4, P6, SP6, LI3) on paretic side; 30 min/session, 5 sessions/wk, from admission to discharge (mean 36 d); electric frequency 5/45 Hz, 3.0 mA</td>
</tr>
<tr>
<td>Jin et al (1999)52</td>
<td>Yes</td>
<td>Manual followed by electric</td>
<td>Conventional body acupuncture</td>
<td>Main acupoints: Renzhong (GV26), Shangxing (GV23), Baihui (GV20); subsidiary acupoints: Jianjing (G21), Jianyu (LI15), Bellu (LI14), Quchi (LI11), Waiguan (TE5), Huantiao (GB30), Chengfu (B36), Yinmen (B37), Yanglingquan (G34), Xuanzhong (G39), Taichong (Li3); 50 min/session, 5 sessions/wk; electric frequency 1/s; electric intensity 7.5 mA</td>
</tr>
<tr>
<td>Li et al (1999)53</td>
<td>Yes</td>
<td>Manual</td>
<td>Nonconventional cranial acupuncture</td>
<td>Nonclassic acupoints: points along a line between Baihui (GV20) and Qubin (G7); 30 min/session daily</td>
</tr>
<tr>
<td>Zhang et al (1999)54</td>
<td>No report</td>
<td>Manual</td>
<td>Nonconventional body acupuncture</td>
<td>Nonclassic acupoints on head and body of hemiplegic side; site of acupoints described; 40 min/session daily</td>
</tr>
<tr>
<td>Chou et al (2002)55</td>
<td>Yes</td>
<td>Manual</td>
<td>Conventional cranial acupuncture</td>
<td>Acupoints: GV20 through Tai Yang; needling for 3 min followed by 5 min rest for 2 cycles; 1 session daily for 20 d</td>
</tr>
<tr>
<td>Naeser et al (1992)56</td>
<td>No report</td>
<td>Electric</td>
<td>Conventional body and nonconventional cranial acupuncture</td>
<td>Acupoints: 1) area of specific decreased electric resistance on skin of body +2) conventional body acupoints (Li3, 4, 11, 15; TW5, 9; ST31, 36; GB34, 39; Shenmen) +3) along motor cortex line on scalp (no details); 20 min/session; 5 sessions/wk for 4 wk; electric frequency 1–2 Hz</td>
</tr>
<tr>
<td>Johansson et al (2001)57</td>
<td>Yes</td>
<td>Manual followed by electric</td>
<td>Conventional body and cranial acupuncture</td>
<td>Group 1: treatment A and B on alternate days; treatment A acupoints: LI4, ST36 on nonparetic side, +LI11, 4, EX28:2, ST36, 40, EX36:1 on paretic side; +LI11, 4, EX28:2, GB34, ST40, EX36:1 on paretic side +GV20 (scalp); electric frequency 2 Hz; 30 min/session; 2 session/wk; group 2: TENS, corresponding to LI4, 11, ST36, 40, GB34 electric frequency 2 Hz, 30 min/session, 2 sessions/wk</td>
</tr>
</tbody>
</table>

the basis of studies42–44,46,47,49 whose interval to stroke onset was >6 months or unreported (pooled random-effects estimate of change, 1.01; 95% CI, 0.79 to 1.22) (Figure 3) but not on studies16,19 that met all the inclusion criteria (pooled random-effects estimate of change, 0.46; 95% CI, −0.20 to 1.12). Without stroke rehabilitation, acupuncture also showed a positive effect on disability, either on the basis of studies50–53 that met all the inclusion criteria (pooled random-effects odds ratio, 12.5; 95% CI, 4.3 to 36.2) (Figure 4) or studies44,46,48 whose interval to stroke onset was >6 months or unreported (pooled random-effects odds ratio, 8.9; 95% CI, 3.5 to 22.3).

The third main finding is that there was no statistical difference between the real acupuncture plus conventional stroke rehabilitation group and the sham acupuncture plus conventional stroke rehabilitation group in either motor recovery33,35,36 (pooled random-effects estimate of change, −0.06; 95% CI, −1.24 to 1.12) or disability improvement33,36 (pooled random-effects estimate of change, 0.07; 95% CI, −0.34 to 0.48) (Figure 5).

Sensitivity and Subgroup Analyses
Sensitivity analyses for the 3 subgroups of randomized controlled trials that met all the inclusion criteria are shown in Table 3. For the 6 studies2–4,33,34,37 that compared acupuncture plus conventional stroke rehabilitation with conventional stroke rehabilitation alone in disability, when the study by Johansson et al3 or the study by Sallstrom et al4 was excluded, the pooled estimated change became statistically insignificant. After careful comparison, we were still uncertain of which patient or study characteristics in the 2 studies had influenced the pooled estimates.

We then performed subgroup analysis on these 6 studies2–4,33,34,37 according to the study quality (sample size ≥50 or <50, details of randomization, and assessor blinding). The pooled effects in motor impairment change and disability change are shown in Table 4. The significant differences in disability improvement between the acupuncture plus conventional stroke rehabilitation group and the conventional stroke rehabilitation alone group were
now seen only in studies\textsuperscript{2,3,34} with inadequate randomization and studies\textsuperscript{2–4,34} without assessor blinding.

**Publication Bias**

Only 7 studies\textsuperscript{44,46,48,50–53} had dichotomous disability data suitable for funnel plotting, which is shown in Figure 6. With the use of the funnel plot regression method, the slope of the regression was positive, with a predicted value of 0.01 ($P=0.10$).

**Discussion**

The study population well represented the general stroke population in terms of age and stroke nature. Most of the patients were within 15 days of stroke (64.8%) and had strokes that were moderate to severe (65.1%). Because motor recovery was most readily detectable in such patients, evaluation of the efficacy of acupuncture in them was appropriate, and the conclusion was likely to be applicable to the majority of stroke patients undergoing rehabilitation.

In the previous systematic review,\textsuperscript{19} the author failed to pool the data mainly because of the heterogeneity of outcome measures used in the studies. We took 2 measures to improve the homogeneity. First, we included only randomized controlled trials that used outcome measures that were internationally recognized or nationally approved. In China, the Ministry of Health delegates specialists to develop an outcome measure first, which is then discussed by a panel of experts and finally approved at a national academic congress after amendments. Therefore, outcome measures created by the author of a clinical trial without details of validation and reliability testing were excluded from this meta-analysis. Second, we classified outcome measures into impairment and disability measures, which are categorically different and whose data should not be pooled together. Impairment measures the degree of intrinsic recovery of a neurological deficit, whereas disability measures the degree of adaptation of a patient to the environment. Impairment is therefore much less likely to be affected than disability by nonspecific effects, also called true placebo effects, such as expectation, suggestion, and therapeutic relationship.

In addition to improving the homogeneity of outcome measures, we took 2 more measures to improve the overall homogeneity. One was to divide trials into those with and without stroke rehabilitation according to the background intervention. Conventional stroke rehabilitation is a mode of intervention with proven value, and therefore it is inappropriate to pool trials with and without conventional stroke rehabilitation together. Our meta-analysis confirmed clinical heterogeneity between randomized controlled trials comparing acupuncture plus conventional

**Figure 5.** Difference in disability outcome for the included studies comparing real acupuncture plus conventional stroke rehabilitation (CSR) with sham acupuncture plus conventional stroke rehabilitation.
stroke rehabilitation with conventional stroke rehabilitation alone and randomized controlled trials comparing acupuncture plus conventional care with conventional care alone. The second measure was to place trials whose interval to stroke onset was >6 months or unreported in a separate group for data synthesis. Our meta-analysis also confirmed significant clinical heterogeneity between this group of studies and studies that met all the inclusion criteria.

In this meta-analysis, we showed that with stroke rehabilitation, acupuncture had no additional effect on motor recovery but had a small positive effect on disability. We then further assessed this positive effect on disability by 2 means. The first means was to analyze the pooled effect size of studies comparing real acupuncture plus conventional stroke rehabilitation with sham acupuncture plus conventional stroke rehabilitation to see whether this effect could be a true placebo effect. In this analysis we found no difference in disability improvement between the real and sham acupuncture groups, suggesting that the positive effect on disability found in the previous analysis could be a true placebo effect. One study comments that procedures intimately involving the patient and those that are invasive, such as acupuncture, are associated with more powerful true placebo effects than oral drug treatment. Another review comments that various aspects of the physician-patient relationship may influence the effect of an intervention and that the quality of the communication between physician and patient may influence the patient’s adherence to treatment. Therefore, it is possible that stroke patients who have received acupuncture become more motivated and better adapted to the disability and therefore have a more favorable disability score, although the motor impairment may remain the same. The second means was to perform a subgroup analysis to see whether this effect was due to inclusion of studies with poor quality. In this analysis we found no difference in disability between the acupuncture plus conventional stroke rehabilitation and the conventional stroke rehabilitation alone groups, except in subgroups without adequate information regarding randomization or without assessor blinding. This suggests that the positive effect on disability found in the previous analysis could also be the result of inclusion of studies with poor quality.

![Figure 6.](image-url) Funnel plot of studies comparing acupuncture plus conventional care with conventional care alone in disability (by the funnel plot regression method). A regression of the treatment effect as the dependent variable (y axis) on sample size as the independent variable (x axis), weighted by the inverse of the pooled variance of each study, is shown. When there is no publication bias, the regression slope has a predicted value of zero, forming a horizontal regression line. A non-zero slope would suggest an association between the treatment effect and sample size. A negative slope would suggest that small studies with large effects are preferentially published and small studies with negative results remain hidden, possibly as a result of publication bias. In this study the slope of the regression line was positive, with a predicted value of 0.01, but was statistically not significant (P = 0.10), suggesting no evidence of publication bias.
For studies comparing acupuncture plus conventional care with conventional care alone, the results for the impairment outcome were inconclusive. Acupuncture was shown to be more effective only in studies whose interval to stroke onset was >6 months or unreported. Because the quality of these studies was very poor, no conclusion could be drawn safely. As for disability outcome, acupuncture was shown to be much more effective than no acupuncture in all studies comparing acupuncture plus conventional care with conventional care alone. However, we must consider 3 issues before we draw any conclusions. The first issue is publication bias. Because the funnel plot that did not show significant publication bias in this meta-analysis was based on only 7 randomized controlled trials and had many limitations, we did a post hoc analysis using the fail-safe method. Given the overall disability improvement rate of approximately 23% in the control group of studies comparing acupuncture plus conventional care with conventional care alone, it will require a single negative study of approximately 16,000 subjects with an odds ratio of 1.0 to nullify the positive result in this meta-analysis. This is a very unlikely scenario, and therefore the significant effect shown by the acupuncture group is unlikely to be due to publication bias. The second issue is the conversion of various disability measures into a dichotomous measure. The disability measures used in studies comparing acupuncture plus conventional care with conventional care alone were expressed in such categories as deterioration, no change, improvement, significant improvement, and almost recovered or the categories of no effect, with effect, significant effect, and almost recovered. For data synthesis, we adopted a dichotomous measure by combining the categories of deterioration, no change, and no effect as “no improvement” and the categories of improvement, significant improvement, with effect, significant effect, and almost recovered as “with improvement.” In so doing, the sensitivity of these measures might be compromised, but this was unlikely to have changed the

<table>
<thead>
<tr>
<th>Author</th>
<th>Results</th>
<th>Dropout</th>
<th>Statistical Method</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tang et al (1996)50</td>
<td>Not recognized impairment scale</td>
<td>Acupuncture 20/30; control: 8/33</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Si et al (1998)16</td>
<td>CSS control: pre: 25 (8.3), n=22; post: 19.9 (9.1), n=22; difference: 5.1 (3.4); acupuncture: pre: 24 (7.4), n=20; post: 15.8 (6.4), n=20; difference: 8.2 (3.4)</td>
<td>NA</td>
<td>Not reported</td>
<td>t test</td>
</tr>
<tr>
<td>Jin et al (1999)51</td>
<td>Not reported</td>
<td>Improved: 55/60 (acupuncture) (1 dead); improved: 34/60 (control) (2 dead)</td>
<td>Reported 3 deaths</td>
<td>t test</td>
</tr>
<tr>
<td>Li et al (1999)52</td>
<td>Not reported</td>
<td>Improved: 30/30 (acupuncture); improved: 17/34 (control)</td>
<td>Not reported</td>
<td>Not reported</td>
</tr>
<tr>
<td>Zhang et al (1999)53</td>
<td>Not reported</td>
<td>Improved: 145/145 (acupuncture); improved: 73/96 (control)</td>
<td>Not reported</td>
<td>χ²</td>
</tr>
<tr>
<td>Chou et al (2000)19</td>
<td>MESS acupuncture: pre: 21.74 (5.3); post: 11.17 (4.53); control: pre: 21.4 (3.72); post: 15.74 (3.61)</td>
<td>NA</td>
<td>Not reported</td>
<td>t test</td>
</tr>
<tr>
<td>Naesser et al (1992)35</td>
<td>BMIT: real acupuncture: 4/10 had good response &gt;10% change in &gt;2/7 of BMIT; sham acupuncture: 0/6 had good response</td>
<td>NA</td>
<td>Not reported</td>
<td>Fisher’s exact test</td>
</tr>
<tr>
<td>Johansson et al (2001)36</td>
<td>RMI: mean score (SD): acupuncture: pre: 2.96 (2.84); 3 mo: 7.25 (4.80); TENS: pre: 2.96 (2.47); 3 mo: 7.47 (4.49)</td>
<td>BI-100: mean score (SD): acupuncture: pre: 31.8 (18.4); 3 mo: 64.4 (31.2); TENS: pre: 35.4 (19.1); 3 mo: 65.9 (28.9)</td>
<td>Group 1: 2 died; Group 2: 1 die</td>
<td>Wilcoxon rank sum test</td>
</tr>
</tbody>
</table>

BMIT indicates Boston Motor Inventory Test. Other abbreviations are as defined in Table 1.
direction of the overall effects. Therefore, we think that the significant effect shown by the acupuncture group is not due to conversion of these outcome measures. The third issue is the quality of these studies. Studies comparing acupuncture plus conventional care with conventional care alone, particularly studies whose interval to stroke onset was >6 months or unreported, had poor methodological quality and small sample size. We believe that the overall
direction of the overall effects. Therefore, we think that the significant effect shown by the acupuncture group is not due to conversion of these outcome measures. The third issue is the quality of these studies. Studies comparing acupuncture plus conventional care with conventional care alone, particularly studies whose interval to stroke onset was >6 months or unreported, had poor methodological quality and small sample size. We believe that the overall

direction of the overall effects. Therefore, we think that the significant effect shown by the acupuncture group is not due to conversion of these outcome measures. The third issue is the quality of these studies. Studies comparing acupuncture plus conventional care with conventional care alone, particularly studies whose interval to stroke onset was >6 months or unreported, had poor methodological quality and small sample size. We believe that the overall
direction of the overall effects. Therefore, we think that the significant effect shown by the acupuncture group is not due to conversion of these outcome measures. The third issue is the quality of these studies. Studies comparing acupuncture plus conventional care with conventional care alone, particularly studies whose interval to stroke onset was >6 months or unreported, had poor methodological quality and small sample size. We believe that the overall
direction of the overall effects. Therefore, we think that the significant effect shown by the acupuncture group is not due to conversion of these outcome measures. The third issue is the quality of these studies. Studies comparing acupuncture plus conventional care with conventional care alone, particularly studies whose interval to stroke onset was >6 months or unreported, had poor methodological quality and small sample size. We believe that the overall
effect can be greatly affected by the quality and size of the included studies and that the possibility that this significant effect shown by the acupuncture group was due to methodological bias cannot be excluded. Therefore, we conclude that we are still uncertain about the efficacy of acupuncture when stroke rehabilitation is not available, and we recommend more properly designed randomized controlled trials comparing acupuncture with no acupuncture in settings in which stroke rehabilitation is not available.

Compared with the previous systemic review\(^\text{10}\) that concludes that there is no compelling evidence to show that acupuncture is effective in stroke rehabilitation, our meta-analysis has taken an additional step to conclude that there is reasonably good evidence to show that, with stroke rehabilitation, acupuncture has no additional effect on motor recovery but has a small positive effect on disability, which may be due to a true placebo effect and varied study quality. However, without stroke rehabilitation the efficacy of acupuncture remains uncertain, mainly because of the poor quality of such studies.

Acknowledgments

This study was supported by the Hong Kong Association for Health Care Ltd. We are particularly indebted to Xiang Yi, MD, for her participation in searching and reviewing the Chinese literature. We also wish to thank Kjell Asplund, MD, for provision of the raw data of their publication.

References


Does Acupuncture Improve Motor Recovery After Stroke?: A Meta-Analysis of Randomized Controlled Trials
Frank Kai-hoi Sze, Eric Wong, Kevin K.H. Or, Joseph Lau and Jean Woo

Stroke. 2002;33:2604-2619
doi: 10.1161/01.STR.0000035908.74261.C9

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2002 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/33/11/2604