

# Acupuncture in the treatment of hand paresis in chronic and acute stroke patients – improvement observed in all cases

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This study reports the effect of acupuncture on the treatment of hand paresis in stroke patients who had no other proximal arm or leg paresis following stroke. The location of the area of infarction on a chronic CT scan was analysed in all cases.

Eight chronic stroke patients were treated with acupuncture beginning after six months to eight years following stroke; and three acute stroke patients were treated with acupuncture beginning after two months following stroke. Patients received 20 or 40 acupuncture treatments over a two- or three-month period.

All patients had good response defined as improvement on at least four of six hand tests after 20 or 40 acupuncture treatments. Among the eight chronic cases, significant improvement was observed in timed hand dexterity tests, as well as pinch and grip strength tests. Most of the improvement was sustained for at least two months after the completion of acupuncture treatments. All patients had lesion in only half, or less than half of the motor pathway areas on CT scan.

Results suggest that acupuncture may be an additional beneficial treatment modality for stroke patients with hand paresis, even when started as late as five to eight years following stroke. The CT scan findings and results from this study support those from our previous acupuncture research with stroke patients where good response was observed in patients with lesion in less than half of the motor pathway areas and in patients with only mild/moderate hemiparesis. More controlled research with a larger number of patients appears warranted.

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## Introduction

The World Health Organization has listed acupuncture as a possible treatment for paresis after stroke,<sup>1</sup> and some uncontrolled studies have reported that it is useful.<sup>2-5</sup> One study from China suggested that acupuncture performed on the scalp increases cerebral blood flow after stroke; but not in normal controls.<sup>4</sup> We have conducted one controlled study on the use of real versus sham acupuncture to treat paralysis in acute stroke patients.<sup>6</sup> That investigation demonstrated a possible role for acupuncture in the recovery of some portions of motor function in patients with mild/moderate hemiparesis. Improved movement was most commonly observed for knee flexion and knee extension. Also, patients with some, even if minimal, voluntary finger/hand movement prior to treatment were likelier to have improvement in shoulder abduction or forearm supination following treatment, than cases with no voluntary finger/hand movement. The positive effect of acupuncture was only observed in cases in which there was damage to less than half of the motor pathway areas on CT scan. The critical lesion site on CT scan was the degree of damage in the deep periventricular white matter area (PVWM) at the level of the body of the lateral ventricle. This PVWM area contains descending pyramidal tract pathways as well as multiple intra- and inter-hemispheric pathways.

In our previous investigation of acupuncture, we only studied patients with substantial hemiparesis and assessed only proximal movements for the arm and leg. We now report the results of a study of acupuncture for the treatment of *hand* weakness after stroke in patients with hand paresis, but *without* additional upper or lower extremity paresis. (Only one patient from the previous study involving hemiparesis was included in the present study.) The primary emphasis in the present study was on the treatment of hand paresis in *chronic* stroke patients, even several years after the stroke.

## Methods

### Subjects

The patients participating in this study were randomly entered from consecutively evaluated

patients in the Aphasia Clinic at the Boston University Aphasia Research Center, Boston DVA Medical Center, who met the study criteria. The study criteria for entry included a unilateral hemisphere stroke with resulting hand paresis (but without substantial arm or leg paresis), between the ages of 30 and 70, and availability for treatment during a two- to three-month period. The patients were not selected for specific stroke characteristics, but because they were entered from an aphasia clinic, all subjects in this study had left hemisphere strokes. No cerebral haemorrhage cases were included among the acute patients treated in this study.

Eleven patients agreed to participate (Table 1). All patients had suffered a left hemisphere stroke and had right-hand paresis. Ten patients were right-handed. One patient was left-handed (case PP), who had a severe aphasia and left ideomotor apraxia after a left hemisphere stroke. Eight patients were at least six months post stroke and were considered to be in the *chronic* phase, poststroke. Three patients were two months post stroke and were considered to be in the *acute* phase, poststroke.

None of the chronic patients was receiving physical therapy (PT) or occupational therapy (OT) for the hand during the study. All chronic patients had received PT and OT during earlier phases of their treatment, and were considered to have reached a plateau in their treatment. Only one of the three acute patients (case GD) was still receiving OT during the study. Case GD was the single case who had also been studied in our previous acupuncture research study where paresis of the arm and leg was examined, but not hand paresis.

### Controls

The eight chronic patients served as their own controls, as they were studied beyond the period of greatest spontaneous recovery, i.e., the first three to six months post stroke onset (MPO).<sup>7,8</sup> Due to the small number of acute patients available for study ( $n = 3$ ), there were no controls for the three acute hand cases. (The data are analysed separately for the chronic patients alone, and the chronic and acute patients, combined.)

In addition, we studied two chronic stroke patients who received no acupuncture treatments (Table 1). These patients also had right-hand

paresis due to a left hemisphere stroke. Due to problems with transportation, it was not possible for these patients to return to the hospital two or three times per week for outpatient acupuncture treatments. They were available for examination, however, at six-month intervals. They were examined two times, over approximately a six-month period to investigate the stability of hand paresis in chronic stroke patients. None of these chronic control patients was receiving PT or OT during the study.

**Motor evaluation**

Six hand tests were used, including two timed dexterity tests and four pinch and grip strength tests. The two timed dexterity tests were taken from the Jebson and Taylor Hand Function Test<sup>9</sup>: (1) time to pick up six small common objects (two

pennies, two paper clips, two bottle caps) and place them into a large coffee can; and (2) time to turn over five index cards. The four finger/hand strength tests were administered with a pinch meter and a dynamometer: (1) tip pinch (index finger opposing thumb); (2) three-jaw chuck (second and third fingers opposing thumb); (3) lateral pinch (thumb opposing side of index finger); and (4) hand grip strength. In addition, the time to copy the sentence, 'Fish take air out of the water' was also recorded at each testing time, for the patients without significant aphasia that otherwise might interfere with the task. The patients were tested once at each testing time, for example before the acupuncture treatments were begun, and after the 20th treatment and after the 40th treatment, and at follow-up testing, explained below.

**Table 1** Age; months postonset (MPO); number of improved hand tests; and CT scan extent of lesion data for chronic and acute cases receiving acupuncture or no acupuncture

	Age enter study	MPO enter study	Total no. acupuncture treatments	Total no. improved hand tests	Total lesion extent in PVWM (slices SM+1 and SM) (20 = complete lesion; 10 = half lesion)
<i>Acupuncture</i>					
<i>Chronic</i>					
FD	69	6	20	4 GR	5
SE	66	17	40	9 GR	10.5
SH	72	20	20	4 GR	6.25
BW	59.5	25	20	4 GR	0
LW	66	60	40	6 GR	0 (hippocampus area and possible lesion deep to sensory cortex)
ZS	59	72	40	5 GR	0 (incomplete fingers motor cortex area lesion)
PP	69.5	74	40	9 GR	10.25
CE	61	102	40	5 GR	0
<i>Acute</i>					
CT	68	2	40	9 GR	0
KL	60	2	20	5 GR	0
GD	68.5	2	20	4 GR	0 (incomplete hand motor cortex area lesion)
MPO test times					
<i>No acupuncture</i>					
<i>Chronic</i>					
BH	43	143/159	0	2 PR	7
KM	63	52/59	0	3 PR	10

GR = good response; PR = poor response

Testing was performed by occupational therapists who were blind to acupuncture treatment status. They only knew that some patients were receiving acupuncture, and some were not. They did not know when the 20 or 40 treatments were begun, or finished. They merely tested each patient, when an appointment was made for this study. They tested each patient using the same protocol that they used in the clinical setting at that time, that is one observation per test item, at each test time.

The 11 patients receiving acupuncture were tested a few days prior to the first treatment, and within a few days after completing the 20th and 40th treatments. Follow-up testing was also performed at two and four months following the last acupuncture treatment if the patient was available. The two chronic control patients not receiving acupuncture were tested two times, over approximately a six-month period.

Improvement on a *timed dexterity test* was defined as a decrease of at least one second at post-testing. Improvement on a *finger/hand strength test* was defined as an increase of at least one pound at post-testing. These were arbitrarily determined after plotting the scores for a series of patients examined with these tests. *Good response* was defined as improvement on a majority of the six hand tests (i.e., at least four of the six hand tests). *Poor response* was defined as improvement on only half, or less than half, of the six hand tests (i.e. zero to three of the six hand tests).

Two of the chronic patients treated with acupuncture had chronic poststroke pain syndromes of the right side of the body (cases FD, LW). One chronic patient treated with acupuncture had bilateral foot pain secondary to peripheral neuropathy of unknown aetiology (case CE). The pain in these three cases had been present ranging from six months to over two years, prior to the initiation of the acupuncture. These patients completed pain maps before and after the series of acupuncture treatments. They received no other treatment for pain during the treatment interval.

Language data were collected on one patient pre- and postcompletion of the course of acupuncture treatments (case BW).<sup>10,11</sup> This patient was not receiving any speech therapy during the course of the study. (Language data were not collected on the other patients because most were

receiving group, or individual speech therapy sessions.)

### Treatment

Informed consent was obtained prior to acupuncture treatment. Chronic patients received two or three treatments per week as outpatients over two or three months. Acute patients received five daily treatments per week as inpatients, for one or two months. Disposable, one-time use only, 34-gauge acupuncture needles were inserted into a limited number of standard acupuncture points on the right side: LI 4, 11; distal Baxie points; TW 5 and 9, located on the arm; and St 36 and Liv 3, located on the leg. Definitions of these acupuncture points and the rationale for their selection can be found in modern acupuncture texts.<sup>12</sup>

Low-frequency electrical stimulation (1–2 Hz) from an Electro Acupunctoscope WQ-10B from China was used on the needles in three pairs of points (LI 4 and 11; TW 9 and Baxie near index finger; and TW 5 and Baxie near middle finger) for 20 minutes per treatment session. The intensity of stimulation was controlled by the patient and maintained at a comfortable level. The maximum output, 200 mA, was never reached. Needles were also inserted into a few points on the left side (LI 4, 11; St 36) and the ears (Shenmen). The selection of additional acupuncture points was determined on an individual case by case basis using traditional Chinese methods.<sup>12</sup>

All patients received a minimum of 20 acupuncture treatments. Patients received a total of 40 acupuncture treatments based solely upon whether patient transportation could be arranged. Five patients received 20 treatments, and six patients received 40 treatments (Table 1).

### CT scan lesion site analysis

CT scans were performed at two months post onset or later, in order to better visualize the final borders of the infarct. The CT scans were analysed in a retrospective manner, after the entire study had been completed. The persons performing the CT scan analysis were blind regarding the severity of hand paresis, the pre- versus post-testing results, and whether the patient had received acupuncture or no acupuncture (control cases). Two persons experienced in analysing CT

scans performed the analysis; conferenced data were used.

The neuroanatomical areas on CT scan containing the hand motor pathways are listed in the last column in Table 2, and diagrammed in Figure 1. Each neuroanatomical area on CT scan containing the *hand* motor pathways was visually assessed for extent of lesion (degree of damage) using the same 0 to 5 point rating scale applied in our previous study<sup>6</sup> where 0 = no lesion; 3 = half of area has lesion; and 5 = total area has complete lesion. The total lesion extent in the periventricular white matter area (PVWM) on CT scan for each patient is listed in Table 1, last column.

In our previous acupuncture study, we observed the PVWM area to be the most important neuroanatomical area to carefully examine in relationship to potential for good response versus poor response to acupuncture treatment for arm/leg paralysis.<sup>6</sup> There are two quarters in the PVWM area on CT scan slice SM which are relevant to arm/leg paralysis, and two quarters in the PVWM area on CT scan slice SM+1 which are relevant to arm/leg paralysis

(see arrows on bottom row of CT scan slices in Figure 1). Thus, a total lesion extent rating for the PVWM area which was 20, would indicate complete lesion in all four quarters of the PVWM area, that is a maximum rating of 5 (complete solid lesion) in each of the four quarters. A total lesion extent rating for the PVWM area which was only 10, would reflect lesion in only half of the PVWM area; and a rating of less than 10, lesion in less than half of the PVWM area. Our previous acupuncture research observed that most patients with total lesion extent ratings of less than or equal to 10 in the PVWM area had good response to acupuncture treatment for arm/leg paralysis.

## Results

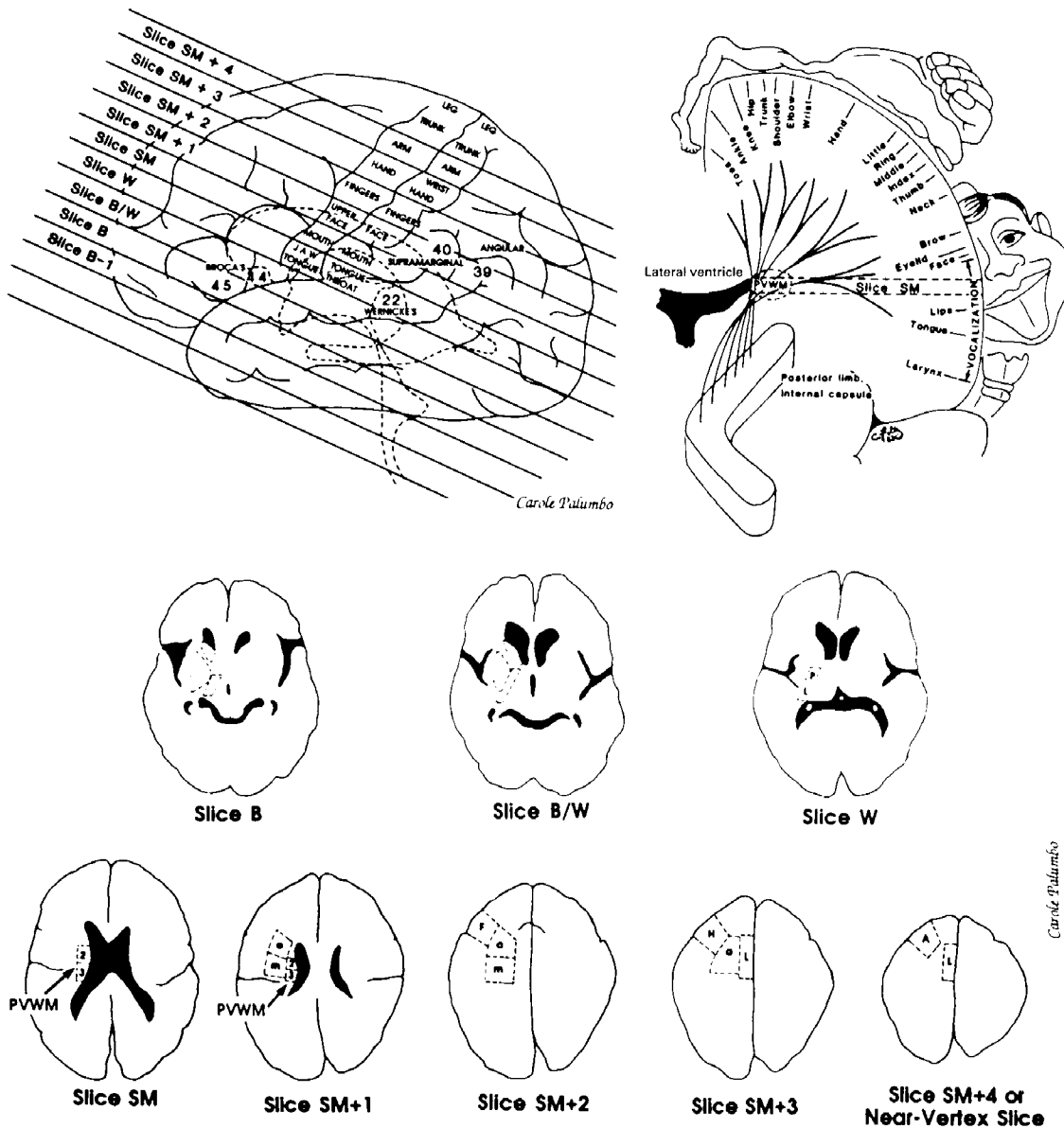
The total number of improved hand tests for each patient is presented in Table 1. All 11 chronic and acute patients receiving acupuncture had good response. There was no significant correlation between months post onset at entry and total number of improved tests ( $r = 0.23$ , NS,  $n = 11$ ); nor between age at entry and total number of improved tests ( $r = 0.087$ , NS,  $n = 11$ ). Five of the eight chronic patients who had good response to acupuncture entered the study from two years to eight years post stroke (Table 1). There was a highly significant correlation between the total number of acupuncture treatments (20 or 40) and the total number of improved tests ( $r = +0.725$ ,  $p < 0.01$ ,  $n = 11$ ).

The two chronic control patients receiving no acupuncture improved on either two of six tests (case BH) or three of six tests (case KM). Both were considered to have 'poor response'. (See bottom of Table 1.)

Every patient: chronic treated; acute treated; and chronic untreated, had damage in only half or less than half of the PVWM area on CT scan slices SM and SM+1 (Table 1, last column). In addition, no patient had PVWM lesion that was immediately adjacent to the body of the lateral ventricle. When lesion was present in the hand motor cortex area, the lesion was incomplete and portions of that area were spared (cases ZS and GD). Thus, these stroke patients with only mild hand paresis had lesion which was considered to involve only half, or less than half of the motor pathway areas for the hand on CT scan.

**Table 2** Hypothetical location of leg, arm and hand descending pyramidal tract pathways on separate CT scan slices. These CT scan areas were visually assessed for extent of lesion for each patient. (See also Figure 1.)

CT scan slice level	Neuroanatomical area	Leg	Arm	Hand
Slice SM +4	Leg motor cortex area	+		
Slice SM +4	Arm motor cortex area		+	
Slice SM+3	Leg motor cortex area	+		
Slice SM+3	Hand motor cortex area			+
Slice SM+3	Anterior white matter		+	+
Slice SM+2	Finger motor cortex area			+
Slice SM+2	Anterior white matter		+	+
Slice SM+2	Middle white matter	+	+	
Slice SM+1	Anterior white matter			+
Slice SM+1	Middle white matter		+	+
Slice SM+1	2nd Quarter PVWM	+	+	+
Slice SM+1	3rd Quarter PVWM	+	+	+
Slice SM	2nd Quarter PVWM	+	+	+
Slice SM	3rd Quarter PVWM	+	+	+
Slices W.B/W.B	Posterior limb internal capsule	+	+	+
	Cerebral peduncle	+	+	+
	Caudate			
	Putamen			



**Figure 1** Lateral, coronal and cross-sectional diagrams showing location of neuroanatomical areas visually assessed for extent of lesion (degree of damage) on CT scan. These areas contain, in part, descending pyramidal tract pathways. The deep, subcortical periventricular white matter area (PVWM) is outlined in the upper right coronal diagram and shown on CT scan slices SM and SM+1 (arrows on bottom row of CT scan slices). The total extent of lesion in the second and third quarters of the PVWM area was related to good response following acupuncture. Key to abbreviations: L = leg cortex area; A = arm cortex area; H = hand cortex area; F = fingers cortex area; a = anterior white matter area; m = middle white matter area; 2 = second quarter PVWM; 3 = third quarter PVWM; PL = posterior limb, internal capsule (continues on slices B and B/W). The head of the caudate and putamen were also assessed for extent of lesion. (The CT scan angle is approximately 20° to the cantho-meatal line.) The neuroanatomical areas on CT scan containing the hand motor pathways are listed in the last column of Table 2. (Reproduced with permission.<sup>6</sup>)

**Improvement in specific hand tests**

Paired *t*-tests (one-tail) were used to assess differences between pre- and postacupuncture test scores on each of the six hand tests. If a patient could not perform a *strength* test at the pre-acupuncture testing due to severity of hand paresis, a score of zero was entered for that pre-test score. The pre- versus post-test change in pounds was then computed against a pre-test score of zero for that patient for that test.

If a patient could not perform a *timed dexterity* test at pre-acupuncture testing due to severity of hand paresis, no pre-test timed dexterity score could be entered, and no pre- versus post-test change in seconds could be computed for that patient for that timed dexterity test. No data could be entered for that patient for that test for paired *t*-test analysis. Thus, the number of subjects with complete test data that could be subjected to paired *t*-test analysis in this study varies across the six hand tests.

For the *eight chronic patients* there was a significant improvement postacupuncture in four of the six hand tests: (1) the number of seconds required to *turn over five index cards* ( $p < 0.05$ ) following 40 treatments (mean decrease of seven

seconds, SD 7.1,  $n = 5$ ); (2) the number of seconds required to *pick up six small common objects* ( $p < 0.05$ ) following 20 treatments (mean decrease of 3.2 seconds, SD 3.7,  $n = 6$ ); (3) *tip pinch strength* ( $p < 0.04$ ) following 40 treatments (mean increase of 3 lbs, SD 2.7,  $n = 5$ ); and (4) *three-jaw chuck strength* ( $p < 0.01$ ) following 20 treatments (mean increase of 3.1 lbs, SD 2.9,  $n = 8$ ). (Tables 3 and 4, and Figure 2.)

When *all 11 patients* (eight chronic and three acute) were considered together, there was a significant improvement postacupuncture on all six hand tests: (1) the number of seconds required to *turn over five index cards* ( $p < 0.04$ ) following 40 treatments (mean decrease of six seconds, SD 6.8,  $n = 6$ ); (2) the number of seconds required to *pick up six small common objects* ( $p < 0.01$ ) following 20 treatments (mean decrease of 3.3 seconds, SD 3.2,  $n = 8$ ); (3) *tip pinch strength* ( $p < 0.02$ ) following 20 treatments (mean increase of 2.5 lbs, SD 3.5,  $n = 11$ ) and ( $p < 0.01$ ) following 40 treatments (mean increase of 3.5 lbs, SD 2.7,  $n = 6$ ); (4) *three-jaw chuck strength* ( $p < 0.002$ ) following 20 treatments (mean increase of 3.8 lbs, SD 3.6,  $n = 11$ ) and ( $p < 0.04$ ) following 40 treatments (mean increase of 3 lbs, SD 3.4,  $n =$

**Table 3** Paired *t*-test results comparing pre- versus post-acupuncture *timed dexterity* test scores for seven chronic stroke patients with right-hand paresis

		Pre- acupuncture Tx	Post- 20 Tx	Change pre-20 Tx	Pre- acupuncture Tx	Post- 40 Tx	Change pre-40 Tx	Change 20-40 Tx
	<i>n</i>	7	7	7	5	5	5	5
<i>Turn over five index cards</i>	Mean sec	19.3	16.1	-3.1	19	12	-7	-2.2
	SD	15.7	13.4	5.2	16.4	9.9	7.1	2.8
	Min/Max	5/47	6/36	+1/-11	5/47	5/29	0/-18	0/-7
	<i>p</i> -value	-	-	0.08	-	-	0.05*	0.419
No. of cases who improved by at least one second	-	-	4/7	-	-	4/5	4/5	
<i>Pick up six small common objects†</i>	Mean sec	19.5	16.3	-3.2	15.8	12	-3.8	-2
	SD	12.1	9.1	3.7	9.7	7.4	6.5	3.9
	Min/Max	7/39	7/31	+2/-8	7/26	7/23	+2/-13	+2/-7
	<i>p</i> -value	-	-	0.05*	-	-	0.17	0.37
No. of cases who improved by at least one second	-	4/6	-	-	3/4	2/4		

\*Missing data for this test for one additional subject, thus,  $n = 6$  for pre- versus post-20 Tx and  $n = 4$  for pre- versus post-40 Tx.

Txs = acupuncture treatment.

\*significant at the  $p < 0.05$ .

6); (5) *lateral pinch strength* ( $p < 0.04$ ) following 20 treatments (mean increase of 1.6 lbs, SD 2.8,  $n = 11$ ); and (6) *grip strength* ( $p < 0.03$ ) following 20 treatments (mean increase of 9.8 lbs, SD 15.8,  $n = 11$ ).

#### Stability of improvement over time

To assess the stability of improvement in hand function after acupuncture, six patients were re-evaluated at two and four months after the last acupuncture treatment. At two months post-treatment, 10% of the improved scores were the same, 62% were further improved, and 28% were worse. At four months post-treatment, 10% were

the same, 37% were further improved, and 53% were worse. Thus, although most of the improvement in hand function was sustained at two months following the last acupuncture treatment, not all gains in hand function were present at four months after the last treatment.

#### Case examples

Two CT scans for two patients with right-hand paresis and lesion in less than half of the motor pathway areas are shown in Figure 3. Patient ZS (Figure 3, top) had lesion in the *motor cortex* area for the fingers (CT scan slice SM+2). Patient FD (Figure 3, bottom) had lesion in

**Table 4** Paired *t*-test results comparing pre- versus post-acupuncture *hand strength* test scores for eight chronic stroke patients with right-hand paresis

		Pre-acupuncture Tx	Post-20 Txs	Change pre-20 Txs	Pre-acupuncture Tx	Post-40 Txs	Change pre-40 Txs	Change 20-40 Txs
	<i>n</i>	8	8	8	5	5	5	5
<i>Tip pinch</i>	Mean lbs	6.4	8.3	1.9	9.2	12.2	+3	+2.4
	SD	4.1	3.7	3.5	1.1	1.9	2.7	2.7
	Min/Max	0/10	0/12.1	-1.5/+9	8/10	10/15	0/+7	-2.1/+5
	<i>p</i> -value	-	-	0.09	-	-	0.04*	0.06
No. of cases who improved by at least one pound	-	-	4/8	-	-	4/5	4/5	
<i>Three-jaw chuck</i>	Mean lbs	11.9	14.9	+3.1	14.6	17	+2.4	-0.2
	SD	6.3	5.1	2.9	8	2.2	3.4	3.6
	Min/Max	0/21	0/22	+0.9/+9.5	8/21	14/20	-1/+6	-4/+5
	<i>p</i> -value	-	-	0.01**	-	-	0.09	0.45
No. of cases who improved by at least one pound	-	-	7/8	-	-	3/5	2/5	
<i>Lateral pinch</i>	Mean lbs	15.8	16.6	+0.73	19.4	19.9	+0.5	+0.8
	SD	7.2	5.3	2.5	6.5	4.2	2.7	1.4
	Min/Max	6.5/24.5	10/23	-4/+3.9	8.2/24.5	12.5/22	-2.5/+4.3	-1/+2.5
	<i>p</i> -value	-	-	0.22	-	-	0.36	0.13
No. of cases who improved by at least one pound	-	-	4/8	-	-	2/5	3/5	
<i>Grip strength</i>	Mean lbs	48	56.6	+8.6	64	64.5	+0.4	+0.6
	SD	31	25	18	27.7	24.9	5.2	4.1
	Min/Max	14.3/96.8	23.1/90	-6.8/+51.7	24.2/96.8	27.5/88.7	-8.1/+5.5	-6/+5.5
	<i>p</i> -value	-	-	0.11	-	-	0.43	0.38
No. of cases who improved by at least one pound	-	-	6/8	-	-	3/5	1/5	

Txs = acupuncture treatments.

\*significant at the  $p < 0.05$  level.

\*\*significant at the  $p < 0.01$  level.

