Acupuncture and Trager Psychophysical Integration in the Treatment of Wheelchair User's Shoulder Pain in Individuals With Spinal Cord Injury

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ABSTRACT. Dyson-Hudson TA, Shiflett SC, Kirshblum SC, Bowen JE, Druin EL. Acupuncture and Trager Psychosocial Integration in the treatment of wheelchair user's shoulder pain in individuals with spinal cord injury. Arch Phys Med Rehabil 2001;82:1038-46.

Objective: To determine the effectiveness of acupuncture and Trager® Psychophysical Integration (a form of manual therapy) in decreasing chronic shoulder pain in wheelchair users with spinal cord injury (SCI).

Design: A prospective clinical trial, with subjects randomized to acupuncture or Trager treatment condition. Subjects served as their own controls by including a 5-week pretreatment baseline period and a 5-week posttreatment follow-up period.

Setting: Rehabilitation hospital research department.

Participants: Eighteen subjects with chronic SCI and chronic shoulder pain who used manual wheelchairs as their primary means of mobility.

Intervention: Ten acupuncture or 10 Trager treatments over a 5-week period.

Main Outcome Measures: Changes in performance-corrected Wheelchair User's Shoulder Pain Index (PC-WUSPI) scores during baseline, treatment, and follow-up periods were assessed by using analysis of variance.

Results: The mean PC-WUSPI score ± standard deviation of the 18 subjects at entry was 48.9 ± 24.6 (range, 8.0–94). No significant change in mean PC-WUSPI scores occurred during the pretreatment baseline period. Mean PC-WUSPI scores decreased significantly during the treatment period in both the acupuncture (53.4%; 23.3 points) and Trager (53.8%; 21.7 points) treatment groups. The reduced PC-WUSPI scores were maintained in both groups throughout the 5-week posttreatment follow-up period.

Conclusion: Acupuncture and Trager are both effective treatments for reducing chronic shoulder pain associated with functional activities in persons with SCI.

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SHOULDER PAIN IS A COMMON secondary condition associated with spinal cord injury (SCI) and long-term disability, with the frequency of attacks and their duration increasing with time since onset of injury.[1,2] Cross-sectional studies reveal that 31% to 68% of people with chronic SCI have shoulder pain,[1-8] with some studies suggesting a higher prevalence in persons with tetraplegia[4,8] and in women with paraplegia.[9] Shoulder pain in the SCI population is believed to be a form of overuse syndrome resulting from wheelchair propulsion, transfers, and other activities of daily living (ADLs).[1-4,6,10] Because of lower extremity paralysis, individuals with SCI rely extensively on their upper extremities to perform ADLs. Any further loss of upper-extremity function because of pain could have adverse effects on mobility and functional independence,[11] as well as long-term health consequences.[12]

Although many pathologic conditions—including syringomyelia, cervical radiculopathy, and heterotopic ossification,[4,13,14]—produce shoulder pain in the SCI population, musculoskeletal causes, particularly injuries to the rotator cuff (often collectively called *impingement syndrome*), are the most common.[3,4,15] Other reported causes of musculoskeletal shoulder pain include overuse syndromes, myofascial pain, degenerative joint disease, capsulitis, and osteonecrosis.[3,4,13,14,16,17] Although the medical literature contains many reports on the prevalence and possible cause of shoulder pain in the SCI population, very little has been published on its treatment.[13,18-20]

Over the past decade, unconventional therapies have generated much interest in the United States.[21] Often described as alternative, unconventional therapies may, in fact, serve more as a complement to conventional medicine than as an alternative.[22] Acupuncture and Trager® Psychophysical Integration are 2 examples of unconventional therapies that may be categorized as manual healing and bodywork therapies (ie, any treatment technique that involves hands-on touch by the practitioner).[23] Although based on different theories, both may be effective in treating pain.

Acupuncture is a component of traditional Chinese medicine and has been used for the treatment of pain for thousands of years. Based on the premise that illness results from imbalances of energy flow (Qi) through the body, needle acupuncture uses the insertion of fine needles into specific points on the body to correct these imbalances.[24-26] Alternative theories to acupuncture's mechanism of action that conform more to the Western model of disease include activation of type II and type III muscle afferent nerves or Aδ fibers and release of endogenous opioids, neurotransmitters, and neurohormones.[24,25] Acu-

puncture is reported to be a potent analgesic and to possess anti-inflammatory effects, as well.[25] A recent National Institutes of Health Consensus Development Panel[26] concluded that acupuncture may be useful as an adjunct or acceptable alternative in the treatment of tendinitis and myofascial pain. Various studies[27-31] have reported it to be beneficial in the treatment of shoulder pain and rotator cuff tendinitis. Although several studies have addressed acupuncture for the treatment of pain in SCI,[25,32,33] we are unaware of any published to date detailing its use exclusively for shoulder pain in persons with SCI.

Trager Psychophysical Integration (also known as the Trager Approach or Trager) is a form of bodywork and movement reeducation.[34] Developed by Milton Trager, it is based on his theory that the mind, through the nervous system, contributes to pain by maintaining the muscles and other soft tissues in a chronically contracted and inflamed position. By using gentle, rhythmic, nonintrusive movements and touch, the Trager practitioner attempts to induce relaxation and release deep-seated physical and mental patterns of limitation in the patient. Trager is often considered a type of "movement reeducation" because it encourages patients to identify and correct movement patterns that may lead to pain. Anecdotal evidence and several case reports suggest that Trager may be effective in decreasing pain and improving range of motion (ROM) in a number of musculoskeletal disorders.[35-38] As with acupuncture, we found no studies detailing its use in the treatment of shoulder pain in persons with SCI.

The purpose of the present study was to determine if a 10-treatment course of either acupuncture or Trager would be effective in decreasing chronic shoulder pain associated with functional activities in individuals with SCI.

METHODS

Participants

A consecutive sample of both men and women (age range, 18–70yr) with chronic SCI were recruited from the Northern New Jersey Spinal Cord Injury System database and from the surrounding New York metropolitan area through advertisements and letters from May 1998 to May 1999. To be eligible for the study, participants had to have chronic shoulder pain of musculoskeletal origin (defined as musculoskeletal pain localized to the shoulder complex for $>$ 3mo), be at least 1-year post-SCI, and use a manual wheelchair as the primary means of mobility (ie, individuals with complete and incomplete SCI, between the levels C6–T12). Subjects were excluded if they had shoulder pain of nonmusculoskeletal origin, were pregnant, had a history of bleeding disorders, were using intravenous heparin, were using narcotic pain medications, or had a history of psychopathology that required hospitalization. In addition, subjects initially qualifying for the study were later excluded from further participation if they suffered severe upper-extremity trauma or experienced other medical problems that required hospitalization or surgery during their participation in the study.

After an initial phone screen, 24 individuals (18 men, 6 women; average age $\pm$ standard deviation [SD], 43.5 $\pm$ 11.1yr; range, 28–69yr) with chronic SCI (8 with tetraplegia, 16, with paraplegia; average time since injury, 14.9 $\pm$ 7.6yr; range, 5–33yr) met the inclusion criteria and were brought in for further evaluation. All subjects provided written informed consent before being included in the study in accordance with procedures approved by the institutional review board.

Outcome Measures

Intake questionnaire. A self-report questionnaire based on that developed by Curtis et al[20] was used to collect demographic data and medical history information and to assess the intensity of shoulder pain experienced during the performance of ADLs. The data collected included age, gender, ethnicity, marital status, education level, primary occupation, SCI cause and duration, and whether subjects were receiving any disability benefits based on their shoulder pain. We also collected information on activity level, including the frequency of wheelchair transfers per day and the hours spent weekly at work and/or school, driving, on household chores, personal care, social and recreational activities, and fitness-related activities (eg, weight training, stretching exercises, sports practice or training).

Weekly log. During the entire duration of the study, a weekly self-report questionnaire (similar to the intake questionnaire described earlier) was used to collect information on activity level and to assess the intensity of shoulder pain experienced during ADLs. Additionally, a medication log was provided for recording daily analgesic intake.

Wheelchair User's Shoulder Pain Index. Shoulder pain intensity was assessed weekly by using the Wheelchair User's Shoulder Pain Index (WUSPI), a 15-item self-report instrument that measures shoulder pain intensity in wheelchair users during various ADLs (eg, transfers, loading a wheelchair into a car, wheelchair mobility, dressing, bathing, overhead lifting, driving, performing household chores, sleeping).[12,39] Each item is scored by using a 10-cm visual analog scale (VAS) that is anchored at the ends with "no pain" (0) and "worst pain ever experienced" (10). Individual item scores are summed to arrive at a total index score, which ranges from 0 to 150. The WUSPI is reported to be a valid and reliable measure of shoulder pain during functional activities in wheelchair users.[39]

Numeric rating scale. Shoulder pain intensity was also assessed weekly by using a VAS in the form of a 10-point numeric rating scale (NRS). Subjects were asked to rate their average pain, most severe pain, and least severe pain during the past week by using a 10-point scale with 0 = no pain and 10 = worst pain ever experienced. Numeric rating scales are valid and sensitive to treatments known to impact pain intensity.[40]

Verbal rating scale. A 6-point verbal rating scale (VRS) was used as a clinical criterion to assess the magnitude of change in shoulder pain reported by subjects after the baseline, treatment, and follow-up periods. Items on the VRS were arranged vertically and anchored on the bottom by "much worse" and on the top by "cured" (ie, pain-free), with the middle point labeled "no change." It is common in clinical practice to use a retrospective assessment to judge changes in a patient's health.[41] Recently, Fischer et al[41] found that retrospective assessments were more sensitive to changes in pain and disability than serial assessments and correlated more strongly with patient satisfaction with change. An advantage of VRS instruments is that they are easy to comprehend and their adjectives are often similar to the verbal responses typically used by patients.[40] Another advantage is that, whatever his/her initial pain level, each respondent has the same magnitude of potential response.[42] VRS scores are reported to be sensitive to treatments that are known to impact pain intensity.[40]

Range of motion. Each subject's shoulder ROM was assessed by a physical therapist at 4 points during the study: (1) at intake; (2) on completion of the baseline period; (3) at end of the treatment period; and (4) at end of the follow-up period. Passive ROM of shoulder flexion, abduction, internal rotation, and external rotation were performed by using a large clear

plastic universal goniometer while subjects were supine on a mat, using methods described by Norkin and White.[43] Goniometric measurements of the glenohumeral joint are reliable and valid.[44] Both therapists were blinded to subject group assignment and did not have access to subjects' previous ROM data. We conducted a pilot study to establish the intrarater reliability of our goniometric measurements.

Procedures

Screening. To ensure that the source of the shoulder pain was musculoskeletal in nature, all subjects underwent a complete history and physical examination, including a neurologic examination and a focused examination directed at the neck and shoulders. The physical examination included assessment of ROM, manual muscle testing (MMT), and a series of provocative tests specific for shoulder pain and instability.[45,46] All subjects were given a shoulder pain diagnosis based on the results of the examination. No imaging studies were performed and no data from prior imaging studies were used; the diagnosis was based solely on history and physical examination. The physician was blinded to treatment group assignment.

The level and completeness of SCI for each subject was determined according to the 1996 International Standards for Neurological and Functional Classification of Spinal Cord Injury.[47] Neurologic level of injury is defined as the most caudal segment of the spinal cord with normal sensory and motor function on both sides of the body. This method of classification may be misleading in cases of asymmetric motor and sensory loss,[47] therefore, we also made note of the motor level (defined as the lowest key muscle with a grade of 3 on MMT, if the muscles above that level are graded 5 or normal). Marino et al[48] found that the motor level is a better indicator of functional abilities than neurologic level of injury in persons with complete tetraplegia.

Intervention. The total duration of the study was intended to be 15 weeks and consisted of 3 consecutive 5-week periods: a 5-week baseline period; a 5-week treatment period; and a 5-week follow-up period. Although every attempt was made to maintain the integrity of the 15-week study design, there was variability in the duration of the baseline period (range, 4–8wk) and the treatment period (range, 5–9wk) to accommodate scheduling conflicts and to ensure that each subject received a total of 10 treatments during the treatment period.

On entry into the study, all subjects completed intake questionnaires and were provided with a packet of weekly logs to be returned at the end of each week. All subjects were instructed to continue their usual daily activities throughout the entire duration of the study.

The baseline period began the week the subject entered the study. During this period, participants received no treatment. At the end of the baseline period, subjects returned for post-baseline shoulder ROM tests. All subjects completing the baseline were randomized consecutively by the investigators by using blocked randomization into either an acupuncture or a Trager treatment group. Subjects with a prior history of acupuncture or Trager were randomized separately by means of a coin toss. Subjects were unaware of treatment group assignment until the last week of their baseline period.

During the treatment period, all subjects received a total of 10 treatments over a 5-week period (range, 5–9wk). Neither subjects nor practitioners were blinded to the treatments they received or performed, respectively. Only evaluators were blinded to treatment group assignment. Treatments were given at no cost to subjects and consisted of acupuncture or Trager.

Acupuncture. Acupuncture treatments were performed by licensed acupuncturists. Each treatment session lasted approximately 20 to 30 minutes. Before each treatment, up to 6 local and 2 distal points were chosen for each painful shoulder. Acupuncture points were chosen from a list of those believed to relieve shoulder or upper extremity pain (table 1) and were based on traditional Chinese medicine methods.[49,50] Additionally, any *ashi* points (ashi or "ouch" points are local points of tenderness or sensitivity that do not correspond to classic acupuncture points) in the shoulder region were also needled (range, 1–4 points per treatment). During the acupuncture treatment, sterile acupuncture needles[a] (.20 × 40mm) were inserted into the skin to a depth of 1 to 3cm and were manually stimulated to acquire De Qi (ie, the arrival of the Qi sensation, often described as a feeling of heaviness, soreness, or numbness). Acupuncture needles were retained for a total of 20 minutes, with manual stimulation repeated once more during this time.

Table 1: Acupuncture Points Used for Treatment

Local points (chosen according to shoulder pain symptoms):
LI 14 Binao
LI 15 Jianyu
LI 16 Jugu
SJ 13 Naohui
SJ 14 Jianliao
SJ 15 Tianliao
GB 21 Jianjing
SI 9 Jianzhen
SI 10 Naoshu
SI 11 Tianzong
SI 12 Bingfeng
SI 13 Quyuan
SI 14 Jianwaishu
SI 15 Jianzhong
LU 1 Zhongfu
LU 2 Yunmen
PC 2 Tianquan
Distal points (chosen according to local points used):
LI 2 Erjian
LI 4 Hegu
LI 10 Shousanli
LI 11 Quchi
LI 18 Neck-Futu
SJ 3 Zhongzhu
SI 6 Yanglao
LU 3 Tianfu
DU 14 Dazhui
GB 20 Fengchi
BL 10 Tianzhu
BL 11 Dashu

Abbreviations: LI, large intestine; SJ, Sanjiao (Triple Energizer); GB, gallbladder; SI, small intestine; LU, lung; PC, pericardium; DU, Du Mai (Governor Vessel); BL, urinary bladder.

Trager Psychophysical Integration. Trager treatments were performed by a certified Trager practitioner. Each session lasted approximately 45 minutes and consisted of both tablework and Mentastics® exercises. Because Trager is considered an "approach" and not a technique or method, there was no set protocol or standardized procedure to follow. During the tablework portion of the treatment, the practitioner used gentle oscillatory and rocking movements to loosen joints, ease movement, and release chronic pain patterns in the upper extremities and surrounding soft tissues. The practitioners modified their movements and technique based on the subject response during the treatment sessions. At the end of each session, subjects in

the Trager group were also taught Mentastics exercises to perform outside the treatment sessions at their own discretion. Mentastics (a coined phrase for "mental gymnastics") is a system of simple, effortless movement sequences taught by Trager practitioners to reinforce and enhance the feeling of relaxation and pain-free movement experienced during the tablework portion of the treatment. Mentastics exercises are intended to increase one's awareness, allowing one to recognize movements or patterns of tension that may lead to pain.[36]

No additional medications or therapeutic exercises were prescribed during the treatment period. During the treatment period, subjects continued to mail us their weekly logs. At the end of the treatment period, subjects returned for a posttreatment evaluation of shoulder ROM.

After the treatment period ended, subjects were followed for an additional 5 weeks. During this time, the follow-up period, participants received no further treatment, but continued to mail us their weekly logs. At the end of the follow-up period, subjects returned for a final evaluation of shoulder ROM.

Data Analysis

The age, duration of SCI, duration of shoulder pain, and activity level of the 2 treatment groups were compared by using independent *t* tests. We compared medical history characteristics and shoulder pain diagnosis in the 2 groups by chi-square analysis.

The WUSPI was scored according to the methods described by Curtis et al.[8,20] Because some subjects did not perform all the activities listed on the WUSPI and marked them "not performed," a performance-corrected WUSPI (PC-WUSPI) score was calculated for all subjects. This score was generated by dividing the raw total WUSPI score by the number of activities performed and then multiplying by 15. This corrected score is reported to more accurately reflect the actual intensity of shoulder pain experienced during those activities performed than assuming equivalent activity levels in all subjects.[8,20] Investigators were blinded to the subject identification and the week number during the measurement of the WUSPI.

Because of variability in the duration of the baseline period for individual subjects, data points for this period were derived from the 4 weeks immediately preceding the start of treatment, thereby, providing 4 baseline period data points. Because the number of weeks it took people to complete 10 treatment sessions varied, adjacent data points were averaged, when necessary, to create 5 treatment period data points for each participant. No variability existed in the duration of the 5-week follow-up period, therefore, the 5 follow-up period data points were derived from the 5 weekly scores.

A repeated-measures analysis of variance (ANOVA) was used to compare both treatments' effect on PC-WUSPI scores. We made post hoc comparisons to determine when subjects experienced pain relief (ie, after baseline, treatment, follow-up). For both stages of analysis, 4 points were chosen from the 14 data points listed earlier. These 4 points were: first week of baseline (T0), last week of baseline (T1), last week of treatment (T2), and follow-up week 5 (T3).

Because the WUSPI was not well established as a pain scale, we used a 10-point NRS that measures average pain, most severe pain, and least severe pain, as a comparison scale. By using the 4 data points described earlier we performed a repeated-measures ANOVA to compare each treatment's effect on NRS scores.

The threshold for statistical significance was set at p less than .05. All data analyses were performed on a Hewlett Packard OmniBook 800CT Pentium 133 lap-top computer[b] by using SPSS, version 7.5, statistical software package.[c] Data are reported as mean $\pm$ SD, unless otherwise indicated.

RESULTS

Of the 24 subjects entering the study, 18 completed it. Four subjects (3 men, 1 woman; all paraplegic) withdrew during the first week of the baseline period, before treatment group randomization (1 for medical reasons; 3 for personal reasons). Two additional subjects (1 woman, 1 man; 1 tetraplegic, 1 paraplegic) withdrew during the treatment period because of unrelated medical conditions. Analysis using *t* tests revealed no significant differences in age, duration of SCI, activity level, or mean PC-WUSPI scores between those who withdrew and those who completed the study; however, a significant ($p < .05$) difference existed between the 2 groups in duration of shoulder pain (2.3 $\pm$ 1.3yr vs 5.8 $\pm$ 4.9yr, respectively). Final statistical analysis was performed on the 18 subjects who completed the entire study.

Demographic Data

The 18 subjects completing the study included 14 men and 4 women with an average age of 45.1 $\pm$ 11.4 years (range, 28–69yr) and consisted of 7 persons with tetraplegia and 11 with paraplegia. The cause of SCI included motor vehicle crashes ($n = 9$), falls ($n = 3$), gunshot wounds ($n = 2$), diving accidents ($n = 1$), and surgical or medical complications ($n = 4$). The average duration of SCI was 14.8 $\pm$ 8.0 years (range, 5–33yr). All subjects used a manual wheelchair as their primary means of mobility for an average of 13.6 $\pm$ 3.7 hours per day. At time of entry into the study, subjects reported performing 9.9 $\pm$ 5.0 wheelchair transfers per day and a weekly average of 21.5 $\pm$ 19.5 hours of work, 10.0 $\pm$ 5.7 hours of driving, 5.9 $\pm$ 6.5 hours of fitness-related activities, 15.7 $\pm$ 8.3 hours of social and recreational activities, 8.6 $\pm$ 3.7 hours of personal care, and 7.8 $\pm$ 8.1 hours of household chores. Seventy-eight percent of the subjects were employed or worked as volunteers. No subject participating in the study received disability benefits because of shoulder pain.

The average duration of shoulder pain was 5.8 $\pm$ 4.9 years (range, 4mo–20yr) and the mean PC-WUSPI score of the 18 subjects at time of entry into the study was 48.9 $\pm$ 24.6 (range, 8–94). None of the subjects had a history of shoulder pain before their SCI. Physical examination revealed 7 subjects with unilateral shoulder pain and 11 with bilateral shoulder pain.

The pretreatment *t* tests revealed no significant differences between the acupuncture and Trager groups in age, duration of SCI, duration of shoulder pain, activity levels, or the PC-WUSPI scores recorded at time of entry into the study (table 2). Chi-square analysis revealed no significant differences in medical and demographic data between the 2 groups. Three subjects had prior histories of acupuncture treatment. Through randomization, 2 were assigned to the acupuncture group and 1 was assigned to the Trager group.

WUSPI Scores

Analysis of the effect of treatment on PC-WUSPI scores by using a repeated-measures ANOVA of the points T0, T1, T2, and T3 (fig 1) revealed a significant effect of time for both the acupuncture ($p < .001$) and Trager ($p = .001$) groups (table 3). Follow-up *t* tests were performed to determine when significant changes occurred for each treatment group. Analysis of baseline data (T0–T1) revealed no significant changes in mean PC-WUSPI scores during the baseline period for subjects assigned to either the acupuncture ($p > .05$) or Trager groups ($p > .05$).

Table 2: Demographic Characteristics, Activity Levels, and PC-WUSPI Scores at Time of Study Entry in Acupuncture and Trager Subjects

	Acupuncture (n = 9)	Trager (n = 9)	Total (n = 18)
Age (yr)	49.6 ± 11.3	40.6 ± 10.1	45.1 ± 11.4
Sex (F/M)	2/7	2/7	4/14
SCI diagnosis (T/P)	3/6	4/5	7/11
Duration of SCI (yr)	16.2 ± 9.7	13.4 ± 6.2	14.8 ± 8.0
Duration of shoulder pain (yr)	7.7 ± 5.6	4.0 ± 3.5	5.8 ± 4.9
PC-WUSPI score (range, 0–150)	54.7 ± 27.2	43.0 ± 21.7	48.9 ± 24.6
Manual wheelchair use (hr/d)	14.1 ± 3.4	13.0 ± 4.1	13.6 ± 3.7
Wheelchair transfers per day	12.4 ± 4.8	7.4 ± 4.0	9.9 ± 5.0
Driving (hr/wk)	9.9 ± 5.4	10.2 ± 6.3	10.0 ± 5.7
Work/school (hr/wk)	18.8 ± 23.0	23.3 ± 16.4	21.1 ± 19.5
Social/recreational (hr/wk)	16.2 ± 8.3	15.2 ± 8.8	15.7 ± 8.3
Sports/fitness (hr/wk)	8.6 ± 7.3	3.2 ± 4.4	5.9 ± 6.5

NOTE. Values are mean ± SD (except ratio of women to men and tetraplegics [T] to paraplegics [P]).

During the treatment period (T1–T2), a significant reduction in mean PC-WUSPI scores occurred for both the acupuncture (p = .001) and Trager ($p < .05$) groups, with scores decreasing 23.3 points (53.4%) and 21.7 points (53.8%), respectively. Analysis of the data during the follow-up period (T2–T3) revealed that subjects in the acupuncture group experienced a slight, but not statistically significant, (p = .17) increase in pain with mean PC-WUSPI scores increasing 6.0 points by the end of the follow-up period. Meanwhile, subjects within the Trager group continued to experience an additional 8.3-point decline in mean PC-WUSPI scores, a result that neared statistical significance (p = .06). However, between-group analysis by using t tests revealed no significant difference between the 2 groups (p = .24) with respect to the final follow-up scores (T3). Overall, analysis of data from the beginning of the treatment period to the completion of the follow-up period (T1–T3) revealed a statistically significant reduction in mean PC-WUSPI scores for subjects receiving either acupuncture ($p < .05$) or Trager ($p < .05$).

To determine if 1 treatment was more effective than the other in relieving shoulder pain during the course of treatment, we compared mean weekly PC-WUSPI scores of subjects in the 2 groups. A repeated-measure ANOVA revealed no significant group × time interaction ($p > .05$), indicating that the acupuncture and Trager groups improved similarly. During the treatment period, we observed that mean PC-WUSPI scores dropped more rapidly in the acupuncture group than in the Trager group (see fig 1); however, these differences were not statistically significant ($p > .05$).

Variables that may have influenced mean PC-WUSPI scores during the study, such as analgesic (ibuprofen, acetaminophen, aspirin) intake (table 4) or activity level (wheelchair transfers per day, hours spent per week at work and/or school, driving, household chores, personal care, social and recreational activities, fitness-related activities), did not change significantly over time ($p > .05$).

Numeric Rating Scores

Analysis of the effect of treatment on NRS scores by using a repeated-measures ANOVA of the points T0, T1, T2, and T3, revealed a significant effect of time for both acupuncture and

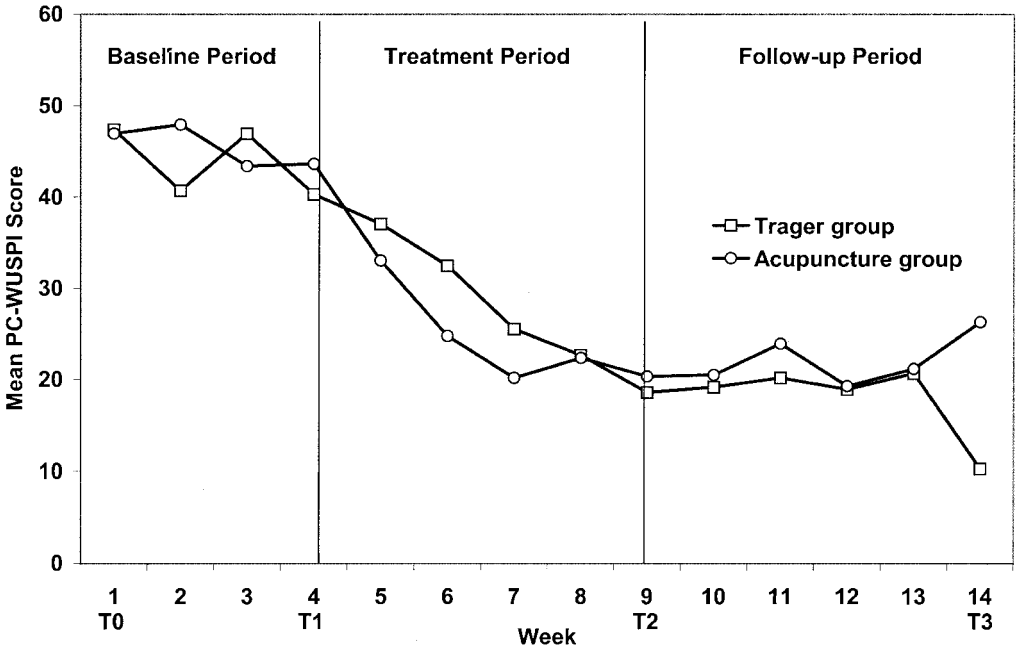

Fig 1. Mean weekly PC-WUSPI scores during the baseline, treatment, and follow-up periods in the acupuncture (n = 9) and Trager (n = 9) groups.

Table 3: Mean PC-WUSPI Scores from Baseline to Follow-Up in Acupuncture and Trager Subjects

Group	Baseline (T0)	Pretreatment (T1)	Posttreatment (T2)	Follow-Up (T4)	F*
Acupuncture ($n = 9$)	47.0 ± 28.2	43.6† ± 22.3	20.3† ± 31.4	26.3 ± 35.5	11.98*
Trager ($n = 9$)	47.4 ± 36.0	40.3‡ ± 30.1	18.6‡‖ ± 17.9	10.3‖ ± 14.4	8.46*

NOTE. Values are mean ± SD.
* $p < .001$
† Means differ at $p = .001$.
‡ Means differ at $p < .05$.
‖ Means differ at $p < .10$.

Trager groups for "average pain" ($p < .01$, $p < .01$, respectively) and "most severe pain" ($p < .01$, $p < .001$, respectively). Although only the acupuncture group experienced a significant reduction in the "least severe pain" ($p < .01$), the improvement in the Trager group neared statistical significance ($p = .06$). A repeated-measure ANOVA showed nonsignificant ($p > .05$) group × time interaction for average pain, most severe pain, and least severe pain, indicating that the acupuncture and Trager groups improved similarly. Because the results from the NRS were similar to the WUSPI (our other serial measure of pain intensity), we performed no further NRS data analysis.

Verbal Response Scores

Results of the VRS scores, by time period, are in figure 2. Analysis of the effect of treatment on VRS scores revealed a statistically significant effect of time for both the acupuncture ($p < .001$) and Trager ($p = .001$) groups. On completion of the baseline period, 88.9% (8/9) of the acupuncture and 88.9% (8/9) of the Trager subjects reported no improvement or worsened shoulder pain. This changed dramatically after treatment, with 88.9% (8/9) of the acupuncture and 100% (9/9) of the Trager subjects reporting improvement in shoulder pain. Follow-up *t* tests revealed that the significant changes occurred during the treatment period for both the acupuncture ($p < .01$) and Trager ($p < .001$) treatment groups. An ANOVA revealed no significant group × time interaction ($p > .05$), indicating that both the acupuncture and Trager subjects reported similar improvements in shoulder pain. Improved shoulder pain was maintained after the follow-up period in 77.8% (7/9) of the acupuncture and 88.9% (8/9) of the Trager subjects.

Range of Motion

Mean ROM data for baseline, pretreatment, posttreatment, and follow-up periods for the acupuncture and Trager groups is in table 5. Because of scheduling conflicts for ROM evaluations, not all 18 subjects participating in the study were assessed at baseline ($n = 17$; 9 acupuncture, 8 Trager), posttreatment ($n = 17$; 9 acupuncture, 8 Trager), and follow-up ($n = 14$; 8 acupuncture, 6 Trager) periods. As a result, we performed repeated-measures ANOVA of the treatments' effect on ROM on only 8 acupuncture and 5 Trager subjects. The results of this analysis revealed no significant time or group × time interaction for shoulder flexion, abduction, internal rotation at 90°, or external rotation at 90°, however, low power because of the small sample size in each group may have reduced our ability to detect small changes.

No adverse effects from acupuncture or Trager treatments were reported by subjects or practitioners during the course of the study.

DISCUSSION

Although a great deal has been reported in the medical literature on the prevalence and etiology of shoulder pain in individuals with SCI, very little has been published on effective treatments for this condition in this unique population. In a retrospective chart review of 511 individuals with SCI, Goldstein et al[19] identified only 5 individuals with paraplegia (6 shoulders) who had undergone surgery for rotator cuff tears. Only 1 of these patients, diagnosed with a partial tear limited to supraspinatus, had a successful outcome. None of the other repairs resulted in improved shoulder function or active ROM. In contrast, Robinson et al[18] reported successful outcomes after performing surgical decompression on 4 individuals with chronic paraplegia (6 shoulders) who were diagnosed with stage II and stage III subacromial impingement (based on arthrography). Although the investigators reported success in all 4 cases, the surgery required 5 to 7 weeks of postoperative hospitalization, and it was 2 to 4 months before wheelchair propulsion and transfers approached premorbid levels.

Because the outcomes for rotator cuff surgery in wheelchair users are in question, many investigators[3,19] advocate conservative therapies. These therapies generally focus on treating acute pain, optimizing function, and preventing injury.[13,19,51] Because wheelchair-using individuals with SCI rely extensively on their arms to perform many of their ADLs, effective therapies that allow them to maintain a high level of activity and independence are ideal. Recently, Curtis et al[20] reported that a regimen of exercises that stretched the anterior shoulder musculature and strengthened the posterior shoulder musculature was effective in decreasing shoulder pain intensity associated with functional activities in wheelchair users. They observed that subjects who performed this exercise protocol daily for 6 months decreased their PC-WUSPI scores by an average of 39.9% (9.3 points) versus 2.5% (0.3 points) in the control group. They also observed, however, that shoulder pain

Table 4: Mean Analgesic Intake (mg/wk) From Baseline to Follow-up in Acupuncture and Trager Subjects

	Acupuncture ($n = 9$)			Trager ($n = 9$)		
Period	Ibuprofen	Aspirin	Acetaminophen	Ibuprofen	Aspirin	Acetaminophen
Baseline	1516 ± 2350	65 ± 194	1028 ± 2040	1020 ± 1292	0 ± 0	28 ± 83
Treatment	824 ± 1823	0 ± 0	16 ± 48	443 ± 802	156 ± 417	0 ± 0
Follow-up	547 ± 1581	0 ± 0	67 ± 200	524 ± 1387	428 ± 1288	0 ± 0

NOTE. Values are mean ± SD. Statistical analysis was not performed on analgesic intake because many subjects cross-medicated.

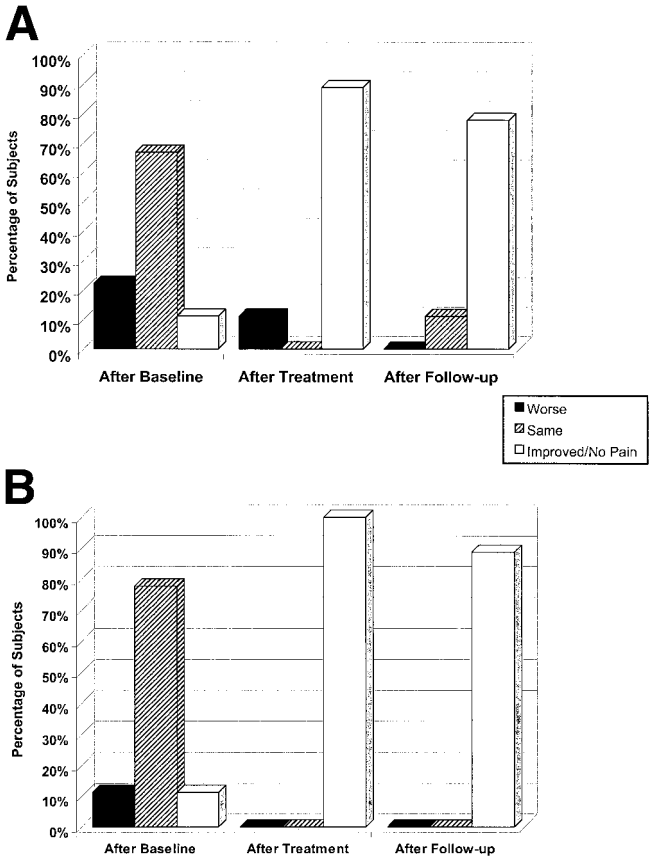

Fig 2. Changes in shoulder pain based on VRS scores in (A) acupuncture and (B) Trager groups after baseline, treatment, and follow-up periods: (follow-up period VRS data are missing for 1 subject in each group).

increased in the exercise group during the first 2 months before decreasing at the 4- and 6-month measurement points. Because shoulder muscle imbalances and anterior shoulder muscle tightness are believed to contribute to shoulder pain in wheelchair users, therapies aimed at correcting these deficits may serve an important role in the prevention and treatment of this condition.[20,52,53] Equally important for people suffering from shoulder pain are therapies that provide more immediate pain relief.[54]

In the present study, we found that both acupuncture and Trager were effective in decreasing shoulder pain in individuals with SCI, with mean PC-WUSPI scores decreasing 53.4% (23.3 points) and 53.8% (21.7 points), respectively. Decreases in mean PC-WUSPI scores occurred shortly after initiation of treatment in both groups and continued to decline throughout the treatment period (see fig 1). These observed changes in shoulder pain intensity were further supported by NRS scores and VRS scores, with 88.9% (8/9) of the acupuncture group and 100% (9/9) of the Trager group reporting improvement in shoulder pain since the baseline period (see fig 2). The reduced mean PC-WUSPI scores were maintained after treatment stopped and throughout the 5-week follow-up period. Again, this finding was supported by NRS scores and VRS scores, with 77.8% of the acupuncture group and 88.9% of the Trager group reporting maintained improvement in shoulder pain after completion of the follow-up period.

It is interesting to note that mean PC-WUSPI scores in the Trager group continued to decline during the follow-up period, a decline that approached statistical significance. Although this decline may represent the influence of Mentastics exercises performed during this period, we found no significant correlation between the frequency of exercises performed and PC-WUSPI scores. Another possible explanation for the observed decline in this group is Trager's role in promoting movement reeducation. Because shoulder pain in SCI is believed to be a form of repetitive use injury, therapies promoting the avoidance of deleterious movement patterns may be important to prevent and treat this condition.

Despite a significant decrease in shoulder pain intensity based on mean PC-WUSPI and VRS scores, neither treatment group experienced statistically significant changes in shoulder flexion, abduction, internal rotation, or external rotation. The observed lack of change in ROM may be explained by several factors. First, mean ROM values for subjects in the present study approximated normal values.[39] Any changes, unless negative, would be limited by a ceiling effect and not detectable given the small sample size available for analysis. Second, though goniometers are valid instruments for measuring joint ROM, they do not measure pain intensity. The relationship between pathology and physical measurements, such as ROM, and subjective reports of pain are not firmly established and appear to be only weakly correlated.[40]

One limitation of the present study was that it contained no placebo-control group and subjects were not blinded to the treatments they received. Because both treatments were moderately invasive, time consuming, and administered by an enthusiastic and empathetic therapist, the results we observed could be attributable to a placebo effect.[42] The fact that the observed reduction in shoulder pain was maintained during the follow-up period in both groups, after practitioner contact ceased, makes this less likely.

Unfortunately, the follow-up period in the present study was only 5 weeks long. During the last week of follow-up, mean PC-WUSPI scores increased 6.0 points in the acupuncture group and decreased 8.3 points in the Trager group. Although the within-group and between-group differences during this

Table 5: Mean Shoulder ROM From Baseline to Follow-up in Acupuncture and Trager Subjects

	Acupuncture				Trager			
	Flexion	Abduction	IR_{90}	ER_{90}	Flexion	Abduction	IR_{90}	ER_{90}
Intake	171.9 ± 9.3	168.1 ± 14.2	47.7 ± 8.8	90.0 ± 0.0	172.8 ± 13.5	167.7 ± 18.6	56.1 ± 15.0	86.0 ± 7.9
Pre-Tx	173.0 ± 8.8	168.2 ± 18.2	52.6 ± 9.7	90.0 ± 0.0	176.9 ± 7.5	173.6 ± 15.8	65.2 ± 13.9	89.3 ± 2.2
Post-Tx	176.9 ± 6.2	173.8 ± 12.6	50.6 ± 6.8	90.0 ± 0.0	175.5 ± 8.2	169.1 ± 15.2	61.5 ± 15.6	88.4 ± 2.9
Follow-up	176.4 ± 5.8	170.6 ± 13.4	47.4 ± 11.2	90.0 ± 0.0	180.0 ± 0.0	180.0 ± 0.0	60.5 ± 15.6	90.0 ± 0.0

NOTE. Values are mean ± SD. Statistical analysis was not performed because of the variability in the number of subjects with complete data from all 4 evaluation periods (acupuncture, $n = 8$; Trager, $n = 5$).
Abbreviations: IR_{90}, internal rotation at 90°; ER_{90}, external rotation at 90°; Pre-Tx, pretreatment ROM; Post-Tx, posttreatment ROM.

period were not statistically significant, we may have missed a continuing upward or downward trend in shoulder pain scores, signifying a return of shoulder pain or continuing improvement, respectively.

Another limitation is that the small sample size may have limited our ability to detect other smaller but potentially real differences and other factors that may have influenced treatment outcomes. For example, although most subjects were diagnosed with either impingement syndrome or impingement syndrome with instability, only 1 was diagnosed with multidirectional instability. This individual, who was assigned to the acupuncture group, experienced little variation in PC-WUSPI scores during the entire study (94.3 ± 6.1) and no improvement in shoulder pain during the treatment period. Although not reflected in the PC-WUSPI scores, he reported verbally that his shoulder pain had actually worsened during the treatment period and then returned to baseline levels during the follow-up period. He attributed the increase in shoulder pain to an increase in activity level, not to the treatments themselves. Individuals with instability of the static shoulder stabilizers may be particularly prone to shoulder pain from weight-bearing activities, especially those with muscle imbalances of the dynamic stabilizers, the rotator cuff muscles. These individuals may be resistant to many types of treatments unless they involve therapies that address the underlying instability.

Small sample size may have also limited our ability to detect the significance of neurologic level on treatment outcome. Curtis et al[20] noted in their study that PC-WUSPI scores decreased more in persons with paraplegia (−48.3%) than in those with tetraplegia (−27.2%). We also observed differences between these 2 groups, with posttreatment PC-WUSPI scores decreasing more in our paraplegic subjects than in those with tetraplegia after acupuncture treatments (−83.1% and −33.3%, respectively) and Trager (−65.5% and −40.0%, respectively). Curtis[20] postulated that the differences in their study may reflect variations in innervation of the C7 and C8 myotomes and the effect this may have on shoulder strength. The same may hold true for the present study. Sensory level itself may be an important consideration, especially in therapies such as acupuncture and Trager that are postulated to work through stimulation of the sensory afferents. This consideration was not a likely operative in the present study because our treatment protocols were directed at the shoulder and upper-arm region and all subjects had at least normal sensation in the C5 dermatomes. It may have an impact, however, in those instances when points distal to the sensory level are stimulated.

A major criticism of unconventional therapies has been the quality of evidence supporting their effectiveness.[23] Although nonsteroidal anti-inflammatory drugs (NSAIDs) and steroid injections are widely used and considered acceptable treatments for musculoskeletal shoulder pain, the evidence supporting their use is small[55-57] and considered by some to be no better than that for acupuncture.[26] Additionally, both NSAIDs and steroid injections may have deleterious side effects.[58,59] One advantage of acupuncture is that its incidence of adverse effects is lower than many drugs or other accepted medical procedures used for the same condition.[26] The reported incidence of adverse effects associated with the use of Trager is also low.[60] We found acupuncture and Trager to be effective in treating shoulder pain while causing no adverse effects.

Recommendations for Future Research

Further evaluation of acupuncture and Trager by using larger samples and sham control groups is warranted. A need exists for research into the effect of shoulder pain diagnosis and neurologic level on treatment outcomes. For this to happen, however, more research is needed to establish uniform methods for classifying shoulder pain in people with SCI. A classification system similar to that described by Jobe and Pink[61] may prove useful for wheelchair users because it takes into account the pathomechanics of shoulder pain. Classifying shoulder pain as they describe may prove more useful in guiding treatment and determining outcomes than a system that simply uses diagnoses such as tendinitis and bursitis.

CONCLUSION

The present study strongly suggests that acupuncture and Trager are effective treatments for chronic musculoskeletal shoulder pain in individuals with SCI. Both significantly decreased shoulder pain associated with functional activities while enabling individuals with SCI who used manual wheelchairs to maintain their high level of activity and functional independence. Either or both of these treatments, which are directed at more immediate pain relief, could be an important component of an integrated conservative treatment program that includes patient education and exercises aimed at balancing the shoulder musculature. We found the WUSPI to be a useful measure of shoulder pain intensity in wheelchair users and a useful way to follow weekly changes in shoulder pain during the course of our study.

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