ELSEVIER

Journal of Orthopaedic Research 21 (2003) 752–758

Journal of Orthopaedic Research

www.elsevier.com/locate/orthres

Acupuncture and arthroscopic acromioplasty

Barbara Gilbertson [a], Karl Wenner [b], Lisa C. Russell [c,*]

[a] *Klamath Pain Clinic, 2301 Mountain View Boulevard, Klamath Falls, OR 97601, USA*
[b] *Klamath Orthopedic and Sports Medicine Clinic, 2580 Campus Drive, Klamath Falls, OR 97601, USA*
[c] *Merle West Center for Medical Research, 1453 Esplanade Avenue, Klamath Falls, OR 97601, USA*

Received 11 June 2002; accepted 10 January 2003

Abstract

Background. Acupuncture alleviates acute and chronic shoulder pain. Yet it has not been determined whether acupuncture is useful following musculoskeletal surgery. Hypothesis: Compared to sham acupuncture, arthroscopic acromioplasty subjects who received real acupuncture would manifest significantly better recovery as demonstrated by: UCLA shoulder scale, improved range of motion, diminished pain, decreased need and duration of analgesic use, and enhanced patient satisfaction.

Methods. Forty arthroscopic acromioplasty patients were randomized to real or sham acupuncture. UCLA shoulder scale scores, pain intensity, analgesic use, range of motion, and quality of life were monitored for four months. Data were analyzed with the general linear model ANOVA for repeated measures.

Results. Thirty-five subjects completed the study. Real acupuncture subjects scored significantly better on UCLA shoulder scale ($p < 0.000$); pain intensity ($p < 0.022$); self-reported analgesic use ($p < 0.008$); angles of abduction ($p < 0.046$); and in six of eight health status questionnaire components.

Conclusions. Following arthroscopic acromioplasty, real acupuncture compared to sham acupuncture offered significantly greater improvement via: (1) lower pain level, (2) less analgesic use, (3) range of motion, and (4) patient satisfaction.

Introduction

Post-operative pain can severely complicate rehabilitation from musculoskeletal surgery. Pain hinders timely progress in physical therapy and consequently restricts recovery of function. Unfortunately, patients who do not tolerate analgesic medications may fail to reap the full benefits of stretching and strengthening during critical phases of recovery. Therefore, non-pharmaceutical treatment regimens that diminish the severity and length of post-surgical discomfort, thereby reducing the need for medication, can be especially helpful. Acupuncture is one such time-honored treatment for pain, with freedom from side effects that accompany many pharmaceuticals [3,4,23]. In addition, some analgesic tolerant patients have difficulty recovering from surgery in spite of appropriate medication and physical therapy. These patients may benefit from acupuncture as well.

Both physician acupuncturists and licensed acupuncturists commonly use acupuncture to treat painful, chronic or injury related musculoskeletal conditions [13,38,39]. However, whether acupuncture is useful for patients following surgical intervention for musculoskeletal pathology has not been determined. To examine this, it was essential to choose a common orthopaedic surgical procedure for which outcomes are well established and easily measured, and after which patients are available for treatment and monitoring. The shoulder provided a useful target, in part because shoulder pain ranks second only to back/neck pain in clinical frequency [37]. We chose arthroscopic acromioplasty (AA) because this patient population usually enjoys good to excellent recovery [1,11,33]. Furthermore, acupuncture has been applied successfully to alleviate both acute and chronic shoulder pain [3,4,21,24,34].

Historically, acupuncture needles have been stimulated manually. Electrical current was first used for stimulation of acupuncture needles in China in the 1930s. Its application has spread widely so that at present it is a standard method of stimulation [23,34,38]. The aim of the present study was to evaluate clinical

* Corresponding author. Tel.: +1-541-885-2000; fax: +1-541-883-3534.
E-mail address: cmr@mwmc.org (L.C. Russell).

0736-0266/03/$ - see front matter © 2003 Orthopaedic Research Society. Published by Elsevier Science Ltd. All rights reserved.
doi:10.1016/S0736-0266(03)00028-7

effectiveness of acupuncture in recovery from AA for impingement syndrome. Patients were randomized to receive either real acupuncture (RA) or sham acupuncture (SA). We hypothesized that, in comparison to SA subjects, subjects who received RA would manifest significantly better recovery outcomes as measured in pain scale and medication use scores; range of motion assessments in the affected shoulder; and enhanced patient satisfaction as measured by a quality of life questionnaire.

Materials and methods

Forty consecutive patients scheduled to undergo AA for treatment of shoulder impingement syndrome, and who would consent to participate in this study, were referred by two local orthopaedic surgeons. These 40 subjects represented 80% of all patients who were asked to participate. Each participating surgeon had more than ten years experience performing shoulder surgery. Thirty-nine of the patients were treated by one co-author (KW) and one was treated by another surgeon. Twenty-four women and 16 men, ranging in age from 20 to 62 years, entered the study. Both groups consisted of subjects within the same age range (Table 1). Sixteen subjects in each group underwent both concomitant AA and distal claviculectomy. Four subjects in each group had only AA. Although not all patients undergoing AA require physical therapy (PT), we included it so patients in the placebo group would receive an attractive benefit from participating in the study. This was also a means to maintain homogeneity of subjects, since patients who are slow to recover are often referred to PT. Prior to participation in the study, all subjects completed a patient history form containing questions about medical and orthopaedic history, perceived quality of life/health, and prior acupuncture treatment. Subjects also gave written informed consent as approved by the Merle West Medical Center Institutional Review Board.

Inclusion criteria consisted of diagnosis with impingement syndrome [31] and a minimum of six months failure of conservative management (extensive physical therapy for stretching, strengthening, and conditioning; NSAIDS; activity modification and; in most cases, subacromial injections of corticosteroids). Diagnosis with impingement syndrome included marked impingement findings, often with tenderness at the acromioclavicular (AC) joint and at the supraspinatus insertion, and marked pain upon isolation of the supraspinitus. Arthrograms and X-rays were also employed for verification. Average length of symptoms was 3.7 years. All patients were scheduled to undergo AA with or without concomitant distal claviculectomy. (Decision to perform distal claviculectomy was based on symptoms referable to the AC joint, significant tenderness at the AC joint, and/or the presence of inferior ostoephytes.) Exclusion criteria included complete rotator cuff tears or additional shoulder pathology apart from impingement.

All surgical procedures were performed with the patient in the lateral decubitus position using standard arthroscopic equipment and techniques well described in orthopaedic literature [35]. After adequate anesthesia, patients were placed in the lateral decubitus position. The symptomatic arm was elevated overhead with 7–10 pound weights, and saline was injected into the shoulder posteriorly. The arthroscope was inserted and the joint inspected before corrective procedures were performed. The AA portion of the procedure was conducted as described by Altchek et al. [2]. PT began within one week and consisted of three visits per week for two weeks, starting with passive range of motion (ROM) and graduating to active ROM and strengthening of the rotator cuff muscle using therabands. Heat packs were applied to the shoulder prior to exercises, and cold packs were applied afterwards. All PT was facilitated by the same therapist.

Acupuncture

Acupuncture treatment commenced 3–8 days after surgery and continued three times per week for one month (total = 12). Randomization was accomplished by placing a small piece of paper with the typed letter "A" ($n = 20$) or "B" ($n = 20$) into 40 identical, sealed envelopes. Prior to acupuncture treatment, subjects were asked to draw an envelope from a large container and hand it to the principal investigator (BG). Subjects who drew an "A" were randomized to the SA group, and subjects who drew a "B" to the RA group. All acupuncture treatments were performed by the primary investigator, a physician-acupuncturist. Thin, sterile, stainless steel acupuncture needles were utilized and left in place for a standard 20–30 min.

The 20 RA subjects were given acupuncture treatments as described by Helms [23], and were slightly individualized. Although the Eastern medical concept of individualized treatment is difficult to reconcile with contemporary Western biomedical information, it continues to be invaluable in the evaluation of patients and the formulation of acupuncture treatments [32]. We chose not to dilute acupuncture effects by artificially confining point options and thereby performing acupuncture incorrectly. Having a single skilled acupuncturist design and deliver the appropriate intervention stands up to rigorous scrutiny better than using a standardized—and likely inadequate—treatment. Points were located by anatomic palpation, then verified by ohmmeter point detection, which measures decreased skin electrical resistance at true acupuncture points [5,8]. RA subjects received needles in one or both upper extremities, one or both lower extremities, trunk, and/or ears. Points were chosen with the primary expectation of localized benefit to the operated shoulder. According to results of pre-treatment exams, some needles were stimulated electrically utilizing frequencies between 2.5 and 150 Hz [23].

The 20 SA subjects were given sham treatments in which acupuncture needles were inserted at points that definitely did *not* have electrical characteristics similar to true acupuncture points. SA subjects received two needles in the upper extremity that had undergone surgery, and one needle in each lower extremity. Needles in the upper extremity were connected to a stimulator with disabled leads but a functioning, blinking red light. Subjects, orthopaedic surgeons, the physical therapist and the certified medical assistant were blinded and instructed not to discuss acupuncture with anyone.

Table 1
Age ranges of patients

Chipchase et al. study [9]			Gilbertson et al. (this study)					
Age groups	*n*	%	Total *n*	% Total	*n*(RA)	% RA	*n*(SA)	% SA
15–24	1	1	1	2.5	0	0	1	5
25–34	4	5	4	10.0	3	15	0	0
35–44	5	6	16	40.0	8	40	8	40
45–54	15	19	12	30.0	5	25	8	40
55–64	18	22	7	17.5	4	20	3	15
65–74	22	27	0	0	0	0	0	0
75–84	16	20	0	0	0	0	0	0

Reprinted with permission from Chipchase et al. [9].
Comparison: This study had a more narrow age distribution than the Chipchase et al. study, with larger percentages of patients aged 35–54.

UCLA shoulder scale

The UCLA shoulder rating scale [14] was recorded weekly [42], corresponding to the fourth, seventh, tenth and twelfth visits before acupuncture, and again at the four-month follow-up. This brief and simple scale has components for pain level, function in daily living, range of motion, strength, and patient satisfaction. The scale is well recognized in orthopaedic research literature, and has been used at three and six month intervals following AA [14]. We chose to measure more frequently, like the weekly shoulder pain scale measurements made by Winters et al. [42].

Measures made at each visit

Prior to each acupuncture treatment, and again at a four-month follow-up, subjects self reported their pain level by marking a 10 cm visual analog pain intensity scale (VAS) [12]. Range of motion was measured by goniometer. Analgesic use was scored from 0 to 3. Zero indicated no pain medication was needed; "1" indicated occasional use of NSAIDS; "2" indicated daily use of NSAIDS; and "3" indicated need for prescription analgesics such as hydrocodone.

HSQ 2.0

Prior to surgery, each subject completed a modification of the SF-36 quality of life questionnaire known as "HSQ 2.0" (1994, National Computer Systems, Inc.). This measure was repeated at the final acupuncture visit and again at the four-month follow-up.

Opinion of acupuncture

Prior to the first acupuncture treatment, and again after the twelfth and final treatment, subjects were asked to rate their opinion of acupuncture as a valid treatment modality on a scale of 0–4. Zero indicated that acupuncture definitely does not work, "1" indicated that acupuncture probably does not work, "2" indicated that acupuncture may possibly work, "3" indicated that acupuncture probably works, and "4" indicated that acupuncture definitely works.

Statistical analyses

Power calculations were used to determine sample size. For the primary outcome, we anticipated a minimal difference of interest of six points on the UCLA shoulder scale, with an anticipated standard deviation of six. For two groups, assuming a Type 1 error = 0.05, and power = 80%, 17 subjects per group would be needed. After preliminary analyses using student's *t*-test, the data were analyzed with the general linear model (GLM) ANOVA for repeated measures. The latter test assumes measurements are related to one another and is therefore a preferable test for measuring post-surgical recovery.

Results

Preliminary student's *t*-tests revealed that between the two groups there were no significant differences in age, sex, duration of symptoms, presence of partial rotator cuff tears, amount of bone removed, release of the coracoacromial ligament, or opinion about acupuncture (Table 2). Of the 40 subjects who entered the study, 35 (22 women and 13 men) completed acupuncture treatments and follow-up, four dropped out within the first week, and one dropped out after 10 acupuncture treatments, becoming lost to follow-up. All dropouts had been given SA and cited "not enough time for the study" as the reason for discontinuing. Four dropouts who left after having only 1–3 acupuncture treatments were excluded from the study because no post-acupuncture UCLA shoulder scale evaluations could be performed. Data were analyzed without them. Intention to treat analysis was performed for the single subject who received 10 acupuncture treatments, i.e., data were generated under the assumption that the subject completely recovered, scoring the highest scores in all test instruments.

All subjects who completed the study believed they had received RA. Although student's *t*-tests showed no difference between the two groups in their opinions about acupuncture either before or after 12 treatments, paired *t*-tests revealed that, overall, the opinions of acupuncture significantly improved, regardless of treatment group ($t = 2.584$, df = 35, $p < 0.014$).

UCLA shoulder scale

Subjects given RA scored significantly better on the UCLA shoulder scale than subjects given SA ($p < 0.000$).

Table 2
Age, gender and treatment history at randomization

	Real acupuncture (RA)		Sham acupuncture (SA)		$p <$
	Mean	SD	Mean	SD	
Age	43.00	9.195	47.81	6.765	0.92
Gender	1.40	0.503	1.38	0.500	0.883
Symptoms duration (yrs)	3.500	5.3064	3.938	5.1961	0.806
Prior PT	1.00	0.000	1.10	0.308	0.154
Cortisone injections	1.10	0.308	1.35	0.489	0.061
NSAIDS	1.15	0.366	1.15	0.366	1.00
Partial rotator cuff tear	1.60	0.503	1.75	0.447	0.357
Bone removed (cm)	1.07	0.9271	1.031	0.9391	0.883
CA ligament released	1.75	0.444	1.69	0.479	0.688
Opinion	2.85	0.875	3.00	0.966	0.629

Baseline data revealed no significant differences between RA and SA subjects in: age, gender, duration of symptoms, prior physical therapy history, prior cortisone injections in the affected shoulder, non-steroidal anti-inflammatory drugs (NSAIDS) use, presence of partial rotator cuff tears, centimeters of bone removed, release of the coracoacromial (CA) ligament, or opinion about acupuncture. Note that non-parametric values (1 = yes; 2 = no) were assigned for analyses of gender, prior physical therapy (PT), cortisone injections, use of NSAIDS, presence or absence of partial rotator cuff tears, and release of the CA ligament.

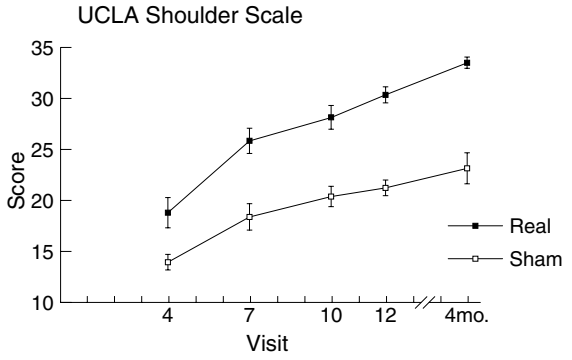

Fig. 1. Average UCLA shoulder scale scores were significantly higher ($p < 0.000$) in real acupuncture subjects than in sham acupuncture subjects. ■ represent real acupuncture; □ represent sham acupuncture.

Their average scores, with margin of error bars, are shown in Fig. 1.

Visual analog pain scale

At the first acupuncture treatment, there was no significant difference in pain levels between groups. However, RA subjects reported less pain than SA subjects from the second visit through the four-month follow-up. Fig. 2 shows that self-reported pain levels in subjects given RA were significantly lower than subjects given SA ($p < 0.022$).

Self-reported medication use

Medication use proved identical prior to the initial treatment only. By the second visit, RA subjects reported use of fewer analgesics. While all subjects decreased pain medication use over the course of the study ($p < 0.000$), Fig. 3 illustrates that self-reported medication use was significantly lower in RA than in SA subjects ($p < 0.008$).

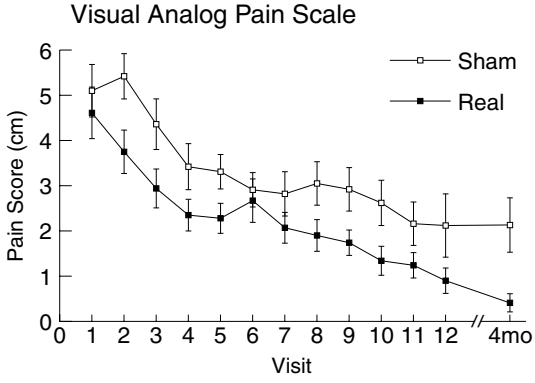

Fig. 2. Average scores on a visual pain scale were significantly lower ($p < 0.022$) in subjects who received real acupuncture than in subjects who received sham acupuncture. ■ represent real acupuncture; □ represent sham acupuncture groups, respectively.

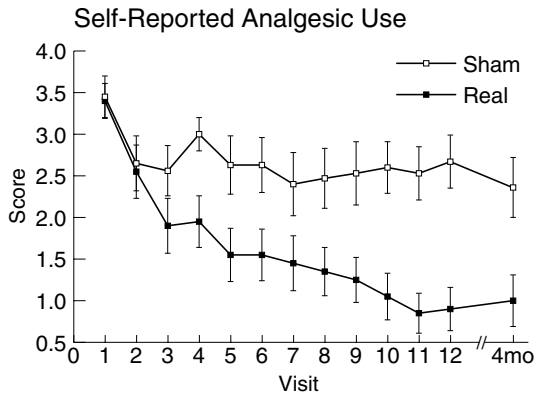

Fig. 3. Average use of analgesic medication was significantly lower ($p < 0.008$) in real acupuncture than in sham acupuncture subjects. ■ represent real acupuncture; □ represent sham acupuncture groups.

Range of motion

GLM measures indicate all subjects experienced improved range of motion over the course of the study. RA subjects experienced significantly greater angles of abduction than SA subjects ($p < 0.046$). RA subjects also averaged slightly better scores in flexion, internal rotation, and external rotation, though these measures did not reach significance.

Health status questionnaire

GLM analysis of the health status questionnaire indicated subjects given RA scored significantly higher than subjects given SA in the following components: health perception ($p < 0.003$); physical function ($p < 0.000$); physical health ($p < 0.000$); social function ($p < 0.000$); bodily pain ($p < 0.000$); and energy/fatigue ($p < 0.01$). There were no significant differences found in the emotional problem or mental health categories of the questionnaire. One unexpected result occurred in pre-surgical questionnaire data: Subjects who eventually were randomized to RA scored significantly higher in the health perception component than subjects randomized to SA. However, including health perception as an additional factor in GLM analysis did not wash out the significance of the results described above.

Observed power

Although we anticipated a need for 17 subjects per group to display a significant change in primary outcome, when final measurement of the UCLA shoulder scale had a difference in means = 6.12 and a common standard deviation = 6, only 16 subjects per group were needed for a power of 80% and a Type 1 error = 0.05. Furthermore, GLM is more robust for repeated measures in the same subjects because it assumes measuring

events are related. GLM observed power for the UCLA shoulder scale was 98%. Secondary tests, for visual pain rating and pain medication use, revealed GLM observed powers of 64.4% and 79%, respectively.

Discussion

Most critically, we now see that overall short-term shoulder recovery, as measured by UCLA shoulder scale, significantly improves with RA. UCLA score data were strengthened by additional findings of lower pain levels and lower analgesic use in RA subjects. Improved recovery is no surprise, as a growing body of literature supports use of acupuncture to diminish pain [18,30,32,42] and need for analgesics [10,22,25,41,43]. Furthermore, sustained improvement after initial acupuncture is not uncommon when pain is the primary symptom. Pain often diminishes within minutes, with activation of spinal gating mechanisms, increased concentration of endogenous opioids, and other pain modulating mechanisms [7,15–17,19,20,27,28,38,39].

Given that RA subjects enjoyed enhanced recovery compared to SA subjects, it is reasonable that RA patient satisfaction reflected in the health status questionnaire was significantly better in most categories. No differences were observed in categories describing mental/emotional health, which were beyond the scope of this study. However, it is reassuring that mental health status was evenly attributed to both groups, as one can speculate that none of our results, therefore, can be credited to an innate difference in emotional health between groups.

The results of this study support Batra et al. [4] and Kleinhenz et al. [24] in that a series of eight or more acupuncture treatments proved useful in alleviating pain and stiffness in the shoulder. Our findings further demonstrate acupuncture efficacy through an extended post-surgical period.

Our results differed from those in an early pilot with 12 subjects per group, where placebo injection or no treatment appeared to improve pain and stiffness more than acupuncture, physiotherapy, or steroid injection [6]. Our results also contrasted with data from 42 subjects who were randomized to receive three treatments of RA, or SA consisting of repeated tapping on RA sites. The investigators [29] reported that RA caused no improvement that could not be attributed to placebo effect. However, tapping a needle on a true acupuncture point more than one minute, is performing real acupressure, which could easily confound results.

As is often the case with projects using a low number of subjects, risk of bias was increased in this study, particularly in terms of self-selection to join an "alternative medicine" study, and randomization. This bias was obviated as our subjects were blinded and, in fact, all believed they had received RA. None were capable of "self-selecting" sham treatment. This underscores contemporary Western thought regarding the necessity of an adequate control group.

Table 3
SF-36 health status for patients with shoulder impingement syndrome

Chipchase et al. study [9]		Gilbertson et al. (this study)
SF-36 health dimension	Mean (SD)	Mean (SD)
Physical functioning	52 (23)	66 (22)
Role-physical (physical health)	20 (32)	17 (31)
Bodily pain	33 (17)	33 (17)
General health (health perception)	62 (20)	65 (20)
Vitality (energy/fatigue)	51 (16)	41 (20)
Social functioning	60 (27)	55 (31)
Role-emotional (emotional problems)	42 (44)	55 (44)
Mental health	65 (19)	65 (20)

Reprinted with permission from Chipchase et al. [9].
Baseline data for SF-36 (with corresponding health status questionnaire 2.0 categories in parentheses) in 40 pre-operative subjects in this study were similar to SF-36 scores in 81 patients with chronic shoulder pain tested by Chipchase et al. [9].

It is also important to this study's findings that subjects' pre-operative SF-36 scores, and age distribution, were similar to those of 81 patients with shoulder impingement syndrome who were not expecting to be randomized for treatment (Tables 1 and 3, Chipchase et al. [9]). Still, randomization of a small number of subjects in this study proved difficult to accomplish. As mentioned, prior to surgery, student's *t*-tests revealed that RA subjects had significantly higher health perception scores than SA subjects. However, at the first acupuncture clinic visit, no differences between groups were found in pain level or analgesic medication use. The HSQ was not repeated until all acupuncture treatments had been completed. At that time, health perception score averages were reversed, but not to the level of significance.

The use of non-piercing needles introduced by Kleinhenz et al. [24] in 1999 addresses an important challenge. SA involves piercing of the skin, a source of concern among researchers [40,44], including the present authors. Acupuncture practitioners contend that needling anywhere has an effect [36]. Furthermore, Western neuroscientists have demonstrated that needling activates at least four pain modulating mechanisms [7,15–17,19,20,27,28], including diffuse noxious inhibitory control [26]. Those findings imply that actual differences between SA and RA groups may be dampened by the physiological effects of *any* skin piercing whatsoever.

The new non-piercing placebo needle was not available when work began on this study. Consequently, our non-specific needling used in this study may well have produced data biased against RA. Thus, finding significantly less pain in RA than SA subjects is remarkable,

because non-specific needling did not overshadow the helpfulness of RA.

For our project, we chose to employ the standard of care in all therapies, including acupuncture. This is in keeping with the 1997 NIH Consensus Statement [32] recognition of the need to use oriental medical theory for prescribing Eastern treatments, while seeking to interpret their physiological mechanisms. For this project, real and sham acupuncture treatments were designed to differ from one another using anatomical acupuncture guidelines, aided by testing skin resistance with an ohmmeter. Until acupuncture's physiological mechanisms are completely understood, treatment design will have to rely upon traditional methodology.

Finally, it is imperative to reiterate that individualized acupuncture treatment, given in a series of sufficient length and frequency, supported recovery following a standard and common orthopaedic surgical procedure. Continued exploration of acupuncture's potential helpfulness to the field of orthopaedic surgery surely will prove worthwhile, especially for patients who do not tolerate or desire analgesic medications.

Conclusions

Following arthroscopic acromioplasty for impingement syndrome, subjects who received a series of RA treatments exhibited significantly greater improvement than subjects given a series of SA treatments in the following categories: (1) overall recovery as measured by the UCLA shoulder scale; (2) lower pain levels; (3) less analgesic use; (4) improved range of motion; and (5) better patient satisfaction (as reflected in perceived quality of life).

Acknowledgements

This work was supported by a grant from the Merle West Center for Medical Research. The authors are indebted to Gary Sexton, Ph.D., for consultation on biostatistics, Diane N. Solomon, M.S.N., R.N., for editing, Susan White and Jennifer Botens.

References

[1] Altchek DW, Carson EW. Arthroscopic acromioplasty: current status. Orthop Clin North Am 1997;28(2):157–68.
[2] Altchek DW, Warren RF, Wickiewicz TL, et al. Arthroscopic acromioplasty. J Bone Joint Surg 1990;72-A:1198.
[3] Andersson S, Lundeberg T. Acupuncture—from empiricism to science: functional background to acupuncture effects in pain and disease. Med Hypotheses 1995;45:271–81.
[4] Batra YK, Chari P, Negi ON. Comparison of acupuncture and placebo in treatment of chronic shoulder pain. Am J Acupunct 1985;13:69–71.
[5] Becker RO, Reichmanis M, et al. Electrophysiological correlates of acupuncture points and meridians. Psychoenerg Syst 1976; 1:195–212.
[6] Berry H, Fernandes L, Bloom B, Clark RJ, Hamilton EB. Clinical study comparing acupuncture, physiotherapy, injection and oral anti-inflammatory therapy in shoulder-cuff lesions. Curr Med Res Opin 1980;7:121–6.
[7] Bing Z, Villaneuva L, LeBar D. Acupuncture and diffuse noxious inhibitory controls: naloxone-reversible depression of activities of trigeminal convergent neurons. Neuroscience 1990;37(3):809–18.
[8] Chan SHH. What is being stimulated in acupuncture: evaluation of existence of a specific substrate. Neurosci Biobehav Rev 1984; 8:24–33.
[9] Chipchase LS, O'Connor DA, Costi JJ, Krishnan J. Shoulder impingement syndrome: preoperative health status. J Shoulder Elbow Surg 2000;9:12–5.
[10] Christensen PA, Noreng M, Andersen PE, Nielsen JW. Electroacupuncture and postoperative pain. Br J Anaesth 1989;62(3): 258–62.
[11] Curtis AS, Wilson P. Shoulder pain in the work place. Orthop Clin North Am 1996;27:763–81.
[12] DeLoach LJ, Higgins MS, Caplan AB, Stiff JL. The visual analog scale in the immediate postoperative period: intrasubject variability and correlation with a numeric scale. Anesth Analg 1998; 86:102–6.
[13] Diehl DL, Kaplan G, Coulter I, Glik D, Hurwitz EL. Use of acupuncture by American physicians. J Altern Complem Med 1997;3:119–26.
[14] Ellman H. Arthroscopic subacromial decompression: analysis of one- to three-year results. Arthroscopy 1987;3:173–81.
[15] Ernst M, Lee MH. Sympathetic vasomotor changes induced by manual and electrical acupuncture of the Hoku point visualized by thermography. Pain 1985;21(1):25–33.
[16] Ernst M, Lee MH. Sympathetic effects of manual and electrical acupuncture of the Tsusanli knee point: comparison with the Hoku hand point sympathetic effects. Exp Neurol 1986;94(1):1–10.
[17] Ernst M, Lee MH. Influence of naloxone on electro-acupuncture analgesia using an experimental dental pain test. Review of possible mechanisms of action. Acupunct Electrother Res 1987;12(1):5–22.
[18] Felhender D, Lisander B. Pressure on acupoints decreases postoperative pain. Clin J Pain 1996;12(4):326–9.
[19] Ghia JN, Mao W, Toomey TC, Gregg JM. Acupuncture and chronic pain mechanisms. Pain 1976;2:285–99.
[20] Gunn CC. Transcutaneous neural stimulation, acupuncture and the current of injury. Am J Acupunct 1978;3:191–5.
[21] Hanson PG. Athletic shoulder injury. Am Acad Med Acupunct Rev 1994;6(1):39.
[22] He JP, Friedrich M, Ertan AK, Muller K, Schmidt W. Pain-relief and movement improvement by acupuncture after ablation and axillary lymphadenectomy in patients with mammary cancer. Clin Exp Obstet Gynecol 1999;26(2):81–4.
[23] Helms JM. Acupuncture energetics: a clinical approach for physicians. Redwing Book Co.; 1996.
[24] Kleinhenz J, Streitberger K, Windeler J, Gussbacher A, Mavridis G, Martin E. Randomised clinical trial comparing the effects of acupuncture and a newly designed placebo needle in rotator cuff tendinitis. Pain 1999;83:235–41.
[25] Lao L, Bergman S, Langenberg P, Wong RH, Berman B. Efficacy of Chinese acupuncture on postoperative oral surgery pain. Oral Surg Med Oral Path 1995;79(4):423–8.
[26] LeBars D, Willer JC, DeBroucker T, Villaneuva L. Neurophysiological mechanisms involved in the pain relieving effects of counterirritation and related techniques including acupuncture. In: Stux G, Pomeranz B, editors. Scientific bases of acupuncture. Heidelberg, Berling: Springer; 1989. p. 79–112.
[27] Lewit K. The needle effect in the relief of myofascial pain. Pain 1979;6(1):83–90.

[28] Martelete M, Fiori AM. Comparative study of the analgesic effect of transcutaneous nerve stimulation (TNS); electroacupuncture (EA) and meperidine in the treatment of postoperative pain. Acupunct Electrother Res 1985;10(3):183–93.
[29] Moore ME, Berk SN. Acupuncture for chronic shoulder pain. An experimental study with attention to the role of placebo and hypnotic susceptibility. Ann Intern Med 1976;84:381–4.
[30] Murray JB. Evidence for acupuncture's analgesic effectiveness and proposals for the physiological mechanisms involved. J Psychol 1995;129(4):443–61.
[31] Neer II CS. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. J Bone Joint Surg Am 1972;54(1):41–50.
[32] NIH Consensus, 1997, November 3–5, vol. 15(5), p. 1–34 JAMA 1998;280(17):1518–24.
[33] Patel VR, Singh D, Calvert PT, Bayley JI. Arthroscopic subacromial decompression: results and factors affecting outcome. J Shoulder Elbow Surg 1999;8(3):231–7.
[34] Peng AT, Behar S, Yue SJ. Long-term therapeutic effects of electro-acupuncture for chronic neck and shoulder pain—a double blind study. Acupunct Electrother Res 1987;12(1):37–44.
[35] Rockwood CA, Matsen FA. The shoulder. WB Saunders Co.; 1990.
[36] Ryan D. Toward improving the reliability of clinical acupuncture trials: arguments against the validity of sham acupuncture as controls. Am J Acupunct 1999;27:105–9.
[37] Sommerich CM, McGlothlin JD, Marras WS. Occupational risk factors associated with soft tissue disorders of the shoulder: a review of recent investigations in the literature. Ergonomics 1993;36:697.
[38] Ulett GA, Han S, Han J. Electroacupuncture: mechanisms and clinical application. Biol Psychiatry 1998;44:129–38.
[39] Ulett GA, Han J, Han S. Traditional and evidence-based acupuncture: history, mechanisms, and present status. South Med J 1998;91:1115–20.
[40] Vincent C, Lewith G. Placebo controls for acupuncture studies. J R Soc Med 1995;88:199–202.
[41] Wang B, Tang J, White PF, Naruse R, Sloninsky A, Kariger R, et al. Effect of the intensity of transcutaneous acupoint electrical stimulation on the postoperative analgesic requirement. Anesth Analg 1997;85(2):406–13.
[42] Winters JC, Sobel JS, Groenier KH, Arendzen JH, Meyboom-De-Jong B. A shoulder pain score: a comprehensive questionnaire for assessing pain in patients with shoulder complaints. Scand J Rehab Med 1996;28:163–7.
[43] Wong JY, Rapson LM. Acupuncture in the management of pain of musculoskeletal and neurologic origin. Phys Med Rehab Clin North Am 1999;10:531–45.
[44] Zaslawski C, Rogers C, Garvey M, Ryan D, Yang CX, Zhang SP. Strategies to maintain the credibility of sham acupuncture used as a control treatment in clinical trials. J Altern Complem Med 1997;3:257–66.