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Cerebral palsy symptoms in children decreased following massage therapy

Maria Hernandez-Reif*[a], Tiffany Field[a], Shay Largie[a], Miguel Diego[a], Natasha Manigat[a], Jacqueline Seoanes[a] and Joan Bornstein[b]

[a]*University of Miami School of Medicine, USA*; [b]*Easter Seal Society, USA*

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Twenty young children (mean age = 32 months) with cerebral palsy (CP) recruited from early intervention programs received 30 minutes of massage or reading twice weekly for 12 weeks. The children receiving massage therapy showed fewer physical symptoms including reduced spasticity, less rigid muscle tone overall and in the arms, and improved fine and gross motor functioning. In addition, the massage group had improved cognition, social and dressing scores on the Developmental Profile, and they showed more positive facial expressions and less limb activity during face-to-face play interactions. These findings suggest that massage therapy attenuates physical symptoms associated with CP, enhances development and should be considered as an early intervention for children with CP.

Keywords: *Cerebral palsy; Massage therapy; Spasticity; Muscle tone; Development*

Introduction

The symptoms of cerebral palsy (CP) in children are often severe and wide ranged, including spasticity (rigidity of muscles) and impaired motor organization and functioning, including deficits in sitting, standing, locomotion and daily living skills (Davis, 1997; Wiley & Damiano, 1998). In addition, children with CP may be cognitively, socially and emotionally impaired (Davis, 1997; Petersen *et al.*, 1998). As a result of the complexity of the disorder, multidisciplinary treatments are often prescribed.

*Corresponding author. Touch Research Institute, Department of Pediatrics, University of Miami School of Medicine, PO Box 016820 (D-820), Miami, FL 33101, USA.

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Current interventions for CP include: (1) physical therapy to prevent the weakening or deterioration of muscles and for motor development; (2) braces or orthotic devices to stretch spastic muscles, which can disrupt balance and normal motor development; (3) occupational therapy to help develop daily living skills, such as feeding, dressing or using the bathroom; (4) speech therapy to help develop communication and language skills; (5) behavioral therapy to promote socially appropriate behaviors; and (6) surgery to treat severe cases of contractures of muscles that cause movement problems, or to place a feeding tube in severe cases of swallowing problems and malnutrition.

Surprisingly, a review of the literature revealed that the effectiveness of these therapeutic interventions is not well established. Hur's (1995) MEDLINE review of articles published in English from 1966 to 1994 on therapeutic interventions (e.g. physical and occupational therapy, biofeedback, behavior modification) for children with CP yielded 88 articles. Of these, only seven employed control or comparison groups and/or random assignment, and of these only four provided information on statistical analyses.

Our more current MEDLINE search for articles published in English between 1995 and 2000 on interventions for cerebral palsy yielded 93 papers, but again only a few that were controlled studies. These suggested improvements following physical activity, movement and swimming therapy, therapeutic electrical stimulation, physiotherapy and occupational therapy. Administering treatments that have not passed rigorous evaluation can be detrimental. For example, chronic use of biomechanical devices and immobility to treat musculoskeletal problems has been associated with excessive physical stress and strain, over-use syndrome and early degeneration of joints in adults with CP (Murphy *et al.*, 1995). The paucity of controlled studies on interventions for CP in children and the need to find innovative treatments with fewer adverse effects is critical for achieving maximum rehabilitation status.

Massage therapy has been effective for several of the problems related to CP but in other conditions. For example, fine motor functioning, dressing and arm and leg muscle tones improve following massage therapy in preschool children with Down Syndrome (Hernandez-Reif *et al.*, 2003), and stiffness was reduced in joints of children with chronic juvenile rheumatoid arthritis (Field *et al.*, 1997). Massage therapy might also be expected to reduce spasticity, to improve muscle tone and to improve the range of motion or enhance motor functioning in children with CP. The current study evaluated massage therapy (versus reading as an attention control group) for children with moderate to severe CP for (1) reducing spasticity, (2) improving range of motion, (3) facilitating motor functioning and (4) enhancing social interactions and development.

Methods

Participants

The study was approved by the Institutional Review Board of the university and was conducted at the Easter Seal Society and the United Cerebral Palsy Foundation in Miami, Florida. The children were participating in Early Intervention programs and

were in their centers from 8:00 a.m. to 2:00 p.m. The two centers provided information about the massage study to parents of children with CP, and the first 20 children whose parents consented to being in the study were recruited (mean age = 31 months, standard deviation = 9.6). Using a random stratification procedure based on age, type of CP (spastic, athetoid and ataxic) and mobility level (ambulatory, no independent steps, no weight bearing, no sitting), the children were randomly assigned to a massage therapy or a reading attention control group. Spastic cerebral palsy was the most common form of CP, affecting 80% of the participants with the major problems being stiffness and permanently contracted muscles. Children with this form of CP typically have additional symptoms, including hemiparetic tremors (uncontrolled shaking affecting the limbs on one side of the body) and dyskinesia (slow, uncontrolled, writhing movement affecting one or more extremity and, in some cases, the muscles of the face and tongue). Dyskinesia may increase during periods of emotional stress and tends to disappear during sleep. Ten percent of the children displayed athetoid disorders (characterized by uncontrolled, slow writhing movements of the limbs, face and tongue) and the remaining 10% displayed ataxic disorder (characterized by a loss of balance and depth perception). The stratification procedure proved successful as the groups did not differ on age, CP type and mobility level. The groups were also similar on demographic variables (see Table 1). The ethnic make-up of the sample was 40% Caucasian, 35% Hispanic and 25% African-American, the children came from lower-middle socioeconomic families (mean = 3.5 on the Hollingshead Two Factor Index) and the groups were evenly distributed on gender.

Procedure

The children received regular preschool activities (finger painting, story time, play time) in addition to special interventions, including 1–1.5 hours per week of physical

Table 1. Demographic background on the participants: means (standard deviations) for the massage therapy and reading control group

Variables	Massage therapy (n = 10)	Reading group (n = 10)	t-Test p value	X^2 p value
Age (months)	29 (8)	33 (10)	.26	
CP type				.33
Spastic	90%	70%		
Athetoid	10%	10%		
Ataxic		20%		
Mobility level				.49
I. Ambulatory	30%	20%		
II. No independent steps		20%		
III. No weight bearing	30%	20%		
IV. No sitting	40%	40%		

therapy, one hour per week of occupational therapy and one hour per week of speech therapy. The children also received music therapy and one hour of naptime every day. The children's interventions were conducted individually by licensed therapists (PTs, OTs, speech therapists) and occurred between 9:00 and 11:30 a.m. or between 12:30 and 2:00 p.m. The 30-minute sessions of massage therapy or reading (control group) two times per week for 12 weeks were integrated within the children's intervention program. The one-on-one study sessions were conducted by massage therapists in a quiet, matted area outside the children's classroom. At the time of the individual session, the children were simply told that they would be receiving a massage or a reading session at that moment.

The therapists and teachers were told that the effects of massage therapy and reading sessions were being studied for improving the children's development. They were not informed of the specific tests being conducted or measures being collected on the children. At the end of the study, an inservice was presented to the therapists and teachers to reveal the purpose and results of the study.

Massage therapy

The massage therapy sessions were conducted by volunteer licensed massage therapists who were trained on the massage protocol. The therapists were kept blind as to the hypothesis of the study and were asked to keep talking to a minimum during the massage, except to inform the child that he/she would be receiving a massage or to ask the child if everything was OK. The massages were conducted without music and by different therapists as therapists typically volunteered only one day per week. In a supine position on a mat, the child's shoes, socks, braces and orthotic devices and clothing were removed, except for the underwear or diaper. The child was draped with a small towel for warmth and security.

The therapist started each session by cradling the child's head and making small circular strokes on the scalp while making eye contact to orient the child to being touched. Subsequently, the therapist applied non-scented oil to his/her hands and massaged the child in the following sequence:

Head/face/scalp: (a) using flats of fingers, stroking forehead and temple area; (b) stroking cheekbones outwards toward temple; (c) massaging, using circular movements, under the chin, cheeks, jawline around the ears, back of neck and base of skull.

Shoulders/arms/hands: applying oil to the hands, (a) kneading shoulders, including scapula area, deltoids and pectoral muscles; (b) making hands like the letter 'C' and milking the arms from the shoulder to the wrist; (c) with hands turning opposite each other, twisting and wringing from the shoulder to the wrist and off the hand; (d) using thumb over thumb motion to massage the palm of the hand; (e) massaging and gently pulling each finger; (f) massaging the top of hand, including the wrist and areas in between fingers; (g) flexing and extending wrist and fingers; (h) rolling the arm from shoulder to wrist; and finishing by (h) using long

milking strokes and smooth strokes from wrist to the shoulder.
Chest: (a) making small finger circles down and then up both sides of sternum; (b) making small lateral movements with fingertips under clavicles from sternum to shoulder, working both sides of chest simultaneously; (c) with one hand on each shoulder, squeezing whole deltoid area with entire hand, then lightly moving both shoulders back and forth to open up chest area (relaxing and repeating three times).
Hips: (a) without forcing joints since knees may not bend, holding the lower legs and moving both knees toward chest (relaxing and repeating three times); (b) repeating same step but alternating lower leg towards opposite shoulder (relaxing and repeating three times).
Legs and feet: applying oil to the hands, following procedure for arms and hands to one, then the other, leg and foot.
Back: (a) holding chest with fingers and thumbs on child's back, applying small thumb circles down sides of spine from the neck to the tailbone and back up to the neck; (b) making soothing circular strokes around the tops of the shoulders; (c) using heel of hand, making circles around entire back, including shoulder blade and lower back areas; (d) making large full palm circles across entire back.

Reading attention, control

The reading sessions were conducted on the same time schedule as the massage sessions. Children in this group were seen twice a week for 12 weeks for individual 30-minute sessions. The sessions were held in the same matted area as the massage. The reading teacher held the child in her lap while reading and showing the child books from the Dr Seuss series. The purpose of this group was to control for potential attention effects that might result from the individual attention therapists were giving the children in the massage therapy group.

The children in both groups were provided with two warm-up sessions. If the child cried during a session, the therapist stopped and simply held the child to reassure him/her. All of the children appeared to like their sessions and all tolerated their sessions. No child was dropped from the study because of intolerance or an adverse event.

Assessments

On the first and last day of the 12-week study, the children were assessed prior to massage or reading by a team of interventionists that included the child's teacher and trained therapist/researchers. (Shoes, socks and braces or orthotic devices were removed for these assessments.)

Physical measures and symptoms

Spasticity scale/modified Ashworth scale. This scale ranges from 0 (no increase in muscle tone) to 4 (affected part(s) rigid in flexion or extension). Testing was

conducted with the child in a supine position on a padded mat. Using this scale, a therapist unaware of the child's group assignment assessed tone by extending each arm at the shoulder, elbow and wrist separately, over a duration of one second, and then moving each part to a position of maximal possible flexion for one second. The same procedure as conducted for the arms were conducted for the right and left leg, except that extensions and flexions were at the hip, knee and the ankle. (Separate scores were recorded for the right and left arms and legs.) A high correlation on grading has been reported for this scale (Kendall's tau correlation = 0.847; Bohannon & Smith, 1987).

Arms, legs and trunk muscle tone scale (ALT muscle tone scale). The therapist/researchers also assessed muscle tone on a scale designed by the authors for a Down Syndrome massage therapy study (see Hernandez-Reif *et al.*, 2003a). The scale is rated on a Likert continuum, ranging from 'severe hypertonicity' (4), to 'moderate' (3), to 'mild' (2), to 'slight hypertonicity' (1), to 'normal' (0), to 'slight hypotonicity' (–1), to 'mild' (–2), to 'moderate' (–3), to 'severe hypotonicity' (–4). Separate muscle tone ratings were made for the right and left arms and legs. Inter-rater agreement was assessed for 25% of the sample using Cohen Kappas, which ranged between 0.82 and 0.94 (mean = 0.88).

Range of motion. Using a goniometer joint range of motion, the therapist/researcher assessed: (1) hip abduction, aligning the goniometer at the intersection of the hip and thigh joint, moving the thigh away from the hip joint to measure stiffness; and (2) hip extension, placing the child on the right hip and aligning the goniometer on the left hip bone, assessing straightening of the left hip and legs (and repeating on other hip). A second therapist/researcher conducted range of motion (ROM) measures for one-third of the children to assess reliability. Inter-observer reliability ranged between 0.80 and 0.91 (mean = 0.85).

Developmental measures

Developmental programming for infants and young children (DPIYC) (Rogers & D'Eugenio, 1977). This scale, designed to yield an early intervention developmental profile, includes six subscales: perceptual/fine motor, gross motor, self-care (feeding, toileting, dressing/hygiene skills), social/emotional, language and cognition. Each child's range of functioning is determined following brief observations with and without objects in open-ended activities. When criteria are met (e.g. repeatedly finding toy when hidden under multiple covers), the item receives a pass (P). The child's functioning level is determined by the age range containing the child's highest passed item. The DPIYC is correlated with the Bayley Mental and Motor Scales and the Vineland Social Maturity Scale and has an overall scoring agreement rating of 82%. Improvement was expected from the first to the last day of treatment for the fine and gross motor and for the social/emotional

subscales based on previous literature for physical activities (Dykens *et al.*, 1994; Fewell & Glick, 1996). The DPIYC was completed by the child's teacher and/or physical, occupation or speech therapist.

Videotaped interactions. The children were videotaped by a researcher during one-on-one structured play interactions with an experimenter. With the child sitting in a buckled cushioned seat, a female experimenter sat facing the child and invited the child to play with a small toy for one minute, and then to play a peek-a-boo game for one minute. The play sessions were preceded and followed by one-minute periods of still face posing by the experimenter. The same experimenter served for the first and last day's interaction session. The interactions were later coded by an observer who was blind to the child's treatment condition and one-third of the tapes were coded by a second observer for reliability purposes. Cohen's Kappa inter-observer reliability between the two observers was *0.87*. The videotapes were coded every three seconds for *facial expressions*—(a) positive, smile or raised eyebrows; (b) neutral, no curving of lips or eye or eyebrow movement; (c) negative, downward curving of lips, frown; or (d) crying—and *limb activity*—(a) no movement; (b) low activity, one limb or two < 30 degrees of the time; (c) moderate activity, two or more limbs moving < 30 degrees or one limb > 30 degrees; and (d) high activity, two or more limb movements of large range. The number of three-second time sample units during which the behaviors occurred was then converted to percent time.

Results

Physical measures and symptoms

Spasticity scale/modified Ashworth scale. Separate paired sample *t*-tests, alpha corrected for family pair-wise error, were conducted for the massage therapy and reading attention control groups. The paired *t*-tests compared the first and last day's scores on the spasticity scale and revealed reduced arm spasticity for the massage therapy group [t (9) = 3.54, $p < .01$] (see Table 2).

ALT muscle tone scale. Paired sample *t*-tests (one-tailed) revealed for the massage therapy group improved muscle tone for the overall body [t (9) = 1.98, $p < .05$] and arms [t (9) = 1.84 $p < .05$], and for the control group improved leg muscle tone [t (9) = 2.23, $p < .05$] (see Table 2).

Range of motion. Analyses revealed that the range of motion data were not normally distributed. Therefore, non-parametric statistics were applied. Wilcoxon Signed Ranks paired-sample *t*-tests revealed for the massage therapy group improved right hip ($Z = 1.86$, $p < .05$) and left hip extension ($Z = 1.85$, $p < .05$) (see Table 2).

Table 2. Means (standard deviations) for massage therapy and reading control group for first versus last day's physical measures

	Massage (n = 10)		Reading control (n = 10)	
Variables	First day	Last day	First day	Last day
Ashworth spasticity (lower is optimal)				
Arms	$2.7(.8)_a$	$1.8(.7)_b$[1]	$2.2(1.3)_a$	$2.0(1.2)_a$
Legs	$2.3(.8)_a$	$1.8(1.2)_a$	$2.0(1.1)_a$	$2.2(1.2)_a$
ALT muscle tone (4 = hypertonic, 0 = normal, –4 = hypotonic)				
Overall	$2.5(1.1)_a$	$2.0(1.3)_b$[1]	$2.6(0.9)_a$	$2.4(1.3)_a$
Arms	$2.7(1.1)_a$	$2.0(1.4)_b$[1]	$2.4(1.5)_a$	$2.3(1.4)_a$
Legs	$2.4(1.1)_a$	$2.1(1.2)_a$	$2.6(.7)_a$	$2.1(1.2)_b$[1]
Range of motion				
Hip abduction (higher is optimal)				
Right	$27\ (18)_a$	$28(21)_a$	$20(13)_a$	$18\ (16)_a$
Left	$28\ (19)_a$	$20\ (19)_a$	$18(15)_a$	$19(18)_a$
Hip extension (zero is optimal)				
Right	$31(20)_a$	$11(11)_b$[1]	$13(18)_a$	$17\ (26)_a$
Left	$25(19)_a$	$9\ (9)_b$[1]	$17\ (26)_a$	$13\ (14)_a$

Note: Different letter subscripts reflect significant difference between adjacent means within each group. Superscripts denote significance levels: [1]p <.05.

Developmental measures

DPIYC. Analyses on the DPIYC revealed that the data were not normally distributed. Thus, separate Wilcoxon Signed Ranks related t-tests were conducted for each group. Analyses on first versus last day's scores for the massage therapy group showed improved: (a) cognition (Z = 1.60, p < .05); (b) fine motor (Z = 1.84, p < .05); (c) gross motor (Z = 1.61, p < .05); (d) dressing (Z = 1.84, p < .05); and (e) social functioning (Z = 2.37, p < .01). The reading control group revealed improved language (Z = 2.06, p < .05) and feeding (Z = 2.23, p < .05) (see Table 3).

Videotaped interactions

The data for the interaction ratings were not normally distributed and were therefore subjected to non-parametric Wilcoxon Signed Ranks t-tests. The analyses for facial expressions revealed that the massaged children by the end of the study were spending less time displaying neutral expressions (Z = 2.00, p < .05) and more time displaying positive expressions during play (Z = 2.20, p < .05). This pattern was again evident during the peek-a-boo game where the massaged children spent less time showing neutral expressions (Z = 2.02, p < .05) and more time showing positive facial expressions (Z = 1.80, p < .05). The massage therapy group also showed a reduction

Table 3. Means (standard deviations) for massage therapy and reading control group for first versus last day for development measures: Developmental profile (DPIYC) (months) (higher is optimal)

	Massage		Reading control	
Variables	First day	Last day	First day	Last day
Cognition	$7.1(10.5)_a$	$8.0(10.6)_b$[1]	$10.2(8.8)_a$	$10.8(9.4)_a$
Language	$9.0(8.4)_a$	$10.1(8.4)_a$	$10.7(7.9)_a$	$11.7(8.0)_b$[1]
Fine motor	$4.9(8.1)_a$	$6.4(8.9)_b$[1]	$9.7(8.9)_a$	$10.4(9.3)_a$
Gross motor	$5.8(11.8)_a$	$6.8(10.9)_b$[1]	$6.0(4.4)_a$	$6.2(5.5)_a$
Feed	$8.6(8.6)_a$	$10.2(10.2)_a$	$8.1(7.2)_a$	$10.4(10.8)_b$[1]
Toilet	$9.9(13.9)_a$	$9.0(13.3)_a$	$6.0(8.2)_a$	$7.3(9.9)_a$
Dress	$8.3(10.9)_a$	$9.5(11.5)_b$[1]	$8.8(8.9)_a$	$8.8(8.9)_a$
Social	$11.4(10.9)_a$	$15.4(13.6)_b$[1]	$13.9(10.8)_a$	$13.4(11.2)_a$

Note: Different letter subscripts reflect significant difference between adjacent means.
Superscript denote significance levels: [1] $p < .05$.

in time showing lower limb activity during play ($Z = 2.20$, $p < .05$) and during the peek-a-boo game ($Z = 1.90$, $p < .05$). The reading control group, in contrast, showed an increase in time spent in moderate limb activity during play ($Z = 2.02$, $p < .05$) by the last day of the study.

Discussion

Following 12 weeks of twice weekly massage therapy sessions (added to standard care), very young children with CP showed reduced spasticity and less overall and arm hypertonic (rigid) muscle tone. A reduction in spasticity is optimal, as spastic tone disorder leads to increased muscle tone or rigidity, decreased range of motion and the formation of contractures and limited movement patterns (Harris, 1997). In addition, range of motion scores for hip extension improved for the CP children receiving massage therapy, further supporting the finding of overall reduction in hypertonicity. Perhaps the reduced spasticity led to the improved muscle tone, or vice versa, and these improvements led to more optimal range of motion. Future studies might examine *EMG* responses to massage therapy to examine the effects on underlying muscle groups and massage therapy effects for reducing hand and feet contractures. That massage therapy might attenuate muscular symptoms associated with CP is compelling and should promote further study, as early interventions for reducing spasticity may reduce the development of atypical movement patterns and abnormal tone. Improved muscle tone findings have also been reported for young children with Down syndrome receiving massage therapy (Hernandez-Reif *et al.*, 2003a). The standard care/reading control group showed reduced leg hypertonicity, suggesting the benefits of early standard care interventions; that is, the physical therapy, occupational therapy and standard care the children were routinely receiving. Although no 'true' control

Table 4. Means (standard deviations) for massage therapy and reading control group for first versus last day for videotaped interactions

	Massage		Reading control	
Variables	First day	Last day	First day	Last day
% facial expressions				
During play				
Positive	1.8 (4.7)$_a$	44.1 (34.1)$_b$^{2}	15.5 (23.7)$_a$	25.3 (31.3)$_a$
Neutral	89.9 (21.8)$_a$	54.1 (34.4)$_b$^{2}	79.2 (23.1)$_a$	50.3 (33.3)$_b$^{1}
Negative	8.3 (17.2)$_a$	1.6 (4.2)$_a$	5.3 (13.1)$_a$	2.7 (6.5)$_a$
During peek-a-boo				
Positive	2.2 (5.7)$_a$	30.0 (36.7)$_b$^{2}	16.8 (16.2)$_a$	47.8 (33.3)$_b$^{1}
Neutral	92.3 (20.3)$_a$	55.7 (42.3)$_b$^{2}	66.5(35.4)$_a$	52.2(33.3)$_a$
Negative	5.5(14.5)$_a$	0.0 (0.00)$_a$	16.7 (40.8)$_a$	0.0 (0.0)$_a$
% limb activity				
During Play				
None	31.6(31.7)$_a$	21.3(26.7)$_a$	30.8(40.4)$_a$	22.3(40.4)$_a$
Low	52.5(29.1)$_a$	28.0(26.1)$_b$^{2}	49.3(31.5)$_a$	38.8(30.3)$_a$
Moderate	15.1(20.2)$_a$	15.4(16.3)$_a$	16.8(18.9)$_a$	36.5(23.2)$_b$^{2}
High	1.0 (1.8)$_a$	6.7(17.7)$_a$	3.0(7.3)$_a$	2.3(4.4)$_a$
During Peek-a-boo				
None	30.9(29.6)$_a$	44.7(41.8)$_a$	51.8(48.8)$_a$	41.5(46.9)$_a$
Low	63.9(35.2)$_a$	16.1(25.2)$_b$^{2}	16.2(21.1)$_a$	22.3(29.3)$_a$
Moderate	5.3(11.2)$_a$	8.6(16.5)$_a$	28.7(36.3)$_a$	14.0(26.8)$_a$
High	0.0(0.0)$_a$	2.0(5.3)$_a$	3.3(8.2)$_a$	5.5(13.5)$_a$

Note: Different letter subscripts reflect significant difference between adjacent means. Superscripts denote significance levels: $^1p < .10$, $^2p < .05$.

group was available for study (e.g. waiting-list of children with CP not receiving services), we would expect that the standard care group would fall between a waiting-list control group and a standard care/massage therapy group. Future studies might examine this and might also include longer treatment sessions and longer-term follow-up evaluations.

Surprisingly, few developmental measures improved for the reading control/standard care group over the 12 weeks. Only improved language and feeding scores were observed, suggesting the severe impact of CP on development. The additional reading sessions might have contributed to the improved language scores and might be encouraging news for parents who have children with CP who may want to add reading to their daily or nightly routine. In contrast, the children in the standard care/massage therapy group showed improved scores in cognition, fine and gross motor functioning, dressing and social skills. Several studies have reported that massage leads to enhanced alertness as measured by *EEG* (see Field [1998] for a review) and

increases cognitive scores in preschool children (Hart *et al.*, 1998) and children with Down syndrome (Hernandez-Reif *et al.*, 2003a). Anecdotally, one teacher stated that the children in her classroom seemed to be sick less and miss fewer days of preschool since enrollment in the study.

Future studies might also examine massage therapy effects on school absenteeism in this population. Improved immune function has been noted in at least three massage studies (Ironson *et al.*, 1996; Diego *et al.*, 2001; Hernandez-Reif *et al.*, 2003b), showing increased numbers and activity of natural killer cells, which are noted to destroy viral cells (Brittenden *et al.*, 1996). Perhaps if the massage students were attending more classes, this might also explain their improved cognition scores. The improved muscle tone and reduced spasticity in the massage therapy group might have led to the improved fine and gross motor functioning scores, as measured on the DPIYC, and as previously reported for Down syndrome children receiving massage therapy (Hernandez-Reif *et al.*, 2003a). Indirectly, the improved motor functioning might have also contributed to the massage children's improved score on dressing, although this was only at the nine-month functioning level.

Children in the massage therapy also had better social development scores on the DPIYC for the last day of the study. This finding and the finding of more time spent showing positive facial expressions during play and peek-a-boo game interactions suggest that massage therapy benefits extend beyond the physical gains. Massage therapy has been shown to decrease stress hormones (cortisol) levels (see Field *et al.*, 1992). That limb activity was also lower for the massage therapy group during interactions suggests that perhaps the children were more calm or relaxed and this enhanced their being more sociable. Future studies might examine stress hormone levels in children with CP. Unlike the massage therapy group, the reading group showed an increase in moderate limb activity during play interaction. It is unclear why the children in the reading group showed this increase in limb activity as an inspection of the data revealed that the limb activity scores for the children in that group with ataxia and uncontrolled movements were not any higher than the scores for the other children in the reading group.

In summary, massage therapy attenuated spasticity and rigid muscle tone characteristic of CP and improved the hip range of motion and fine and gross motor functioning. In addition to the physical benefits, children with CP who received massage therapy showed better cognitive performance and more positive social behavior, including more positive facial expressions during play and less limb activity. These encouraging findings highlight the effectiveness of massage therapy for use in early intervention programs.

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