

### Description of Outcome Measurement Methods

Active range of motion was measured by an occupational therapist using a goniometer and recorded in a standard fashion. Grip strength was measured by a Jamar dynamometer on the second position. Pinch strength was measured in the keypinch position. Both grip strength and pinch strength were recorded in kilograms.

For stereognosis testing, the child was asked to manipulate and identify, with each hand, twelve common objects hidden from view. One point was given for each correctly identified object; a higher score indicates better stereognosis<sup>19</sup>.

The VAS (visual analog scale) satisfaction score<sup>30</sup> for the child and parent ranged from 1 (least happy) to 5 (happiest) on the basis of the response to the question, how happy are you with the way your (your child's) arm looks?

The Shriners Hospital Upper Extremity Evaluation (SHUEE) is a videotaped test in which task completion is measured in terms of dynamic positional analysis (DPA) and spontaneous functional assessment (SFA). DPA measures the alignment of the elbow, forearm, wrist, thumb, and fingers during the completion of sixteen tasks. Higher scores are based on the ability to abduct the thumb, extend the wrist, and supinate the forearm<sup>31</sup>. DPA is a compilation of the individual elbow, forearm, and wrist DPA scores and is expressed as a percentage of the maximum attainable score. SFA rates nine selected tasks using a 0-to-5 scale, assessing the spontaneous use and incorporation of the hemiplegic hand into bimanual activities. It utilizes a modified House scale<sup>17</sup> (AVH-House), which describes how the hand is used (i.e., does not use, poor passive assist, poor active assist, active assist, and spontaneous use). The activities included require elbow (two), wrist (three), and finger and thumb (four) movements. The nine tasks are scored separately and are combined for a total score ranging from 0 to 45, expressed as a percentage of the maximum attainable score.

Box and Blocks is a timed test requiring a child to transfer as many blocks as possible over a barrier in one minute. The score is the number of blocks transferred<sup>32</sup>.

The Assisting Hand Assessment (AHA) is a videotaped test in which interaction with each of the twenty-two test items is graded on a 4-point scale<sup>23</sup>. A score of 4 points requires demonstration of effective and spontaneous use, and a score of 1 point indicates ineffective and nonspontaneous use. The scores achieved for all twenty-two test items are added to create a composite score, for a total possible score of 88<sup>33</sup>. All videotaped assessments were scored by a single occupational therapist who was blinded to the patient's identity and treatment group. (Children wore a stockinette sleeve during testing to cover any surgical scars.)

The Pediatric Outcomes Data Collection Instrument (PODCI) parent questionnaire includes six scales: upper-extremity function, mobility/transfers, sports/physical function, pain/comfort, happiness, and global function. Each scale is scored as a percentage of function, with possible scores from 1% to 100%; a score of <80% indicates abnormal function in that scale<sup>34</sup>.

The Pediatric Quality of Life Inventory (PedsQL) includes the standard parent version and the cerebral palsy (CP) module. The standard version includes four domains: physical, emotional, social, and school functioning. The CP module includes five domains: school, movement, fatigue, eating, and speech. All are scored as a percentage, with possible scores of 0% to 100%.

The Children's Assessment of Participation and Enjoyment (CAPE) includes three scores: the diversity score is 0 to 55 points, based on whether a child does each activity; the intensity score is 0 to 7 points, based on how often the child does the activity; and the enjoyment score is 1 to 5 points, based on how much the child enjoys the activity.

The Canadian Occupational Performance Measure (COPM) questionnaire includes two scores for activities selected by the subject with the help of the occupational therapist: the performance score and the satisfaction score, which are both assessed on a 5 to 50-point scale during interviews with an occupational therapist before and after treatment. ■

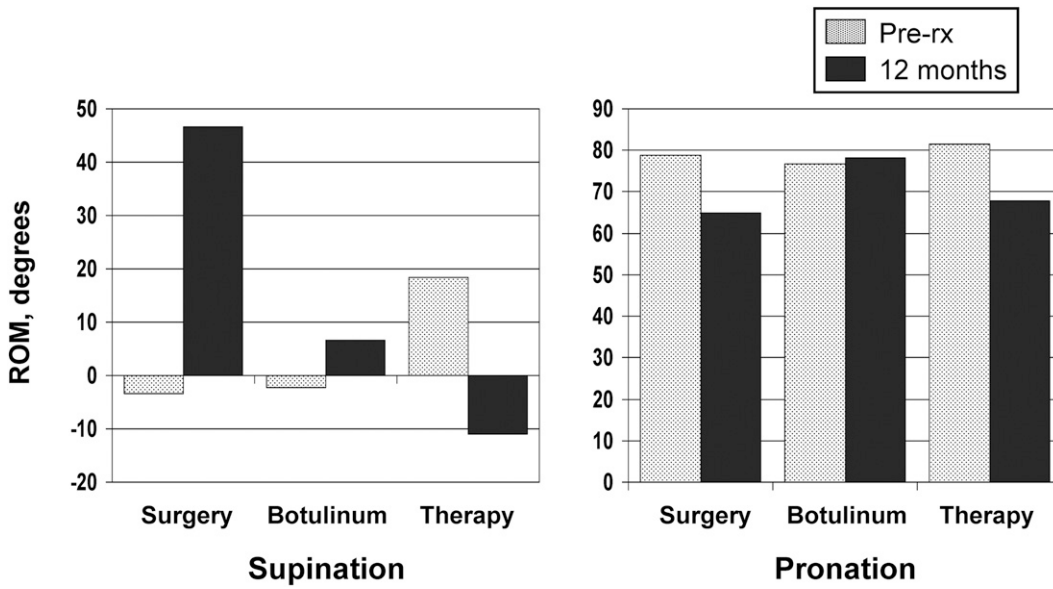


Fig. E-1A

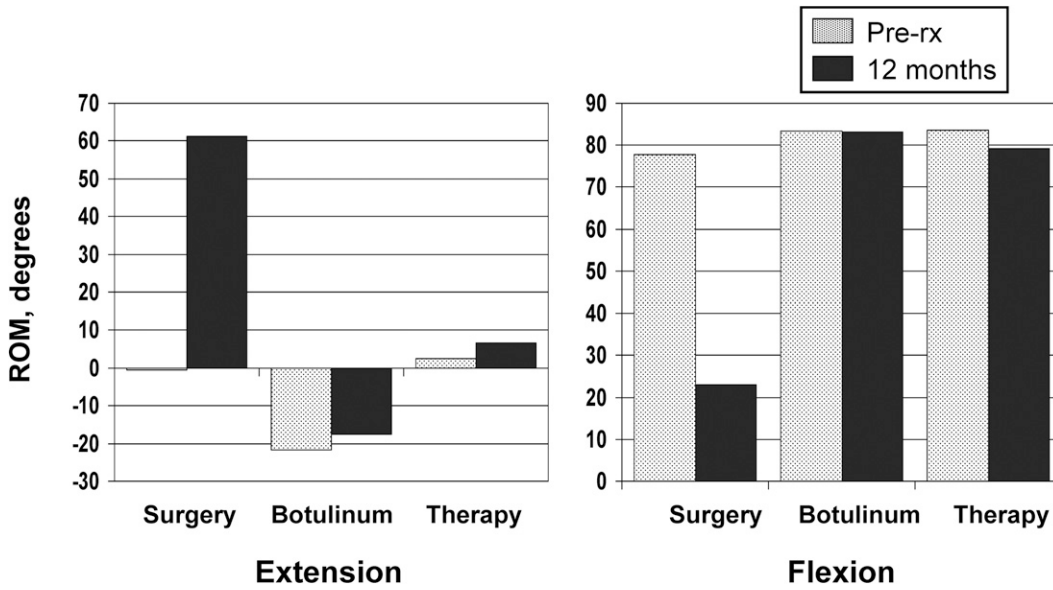


Fig. E-1B

**Figs. E-1A through E-1D** Comparison of the three treatment groups before treatment (pre-rx) and twelve months post-treatment for active range of motion (ROM) in forearm supination and pronation (**Fig. E-1A**) and in wrist extension and flexion (**Fig. E-1B**), grip strength (**Fig. E-1C**), and pinch strength (**Fig. E-1D**).

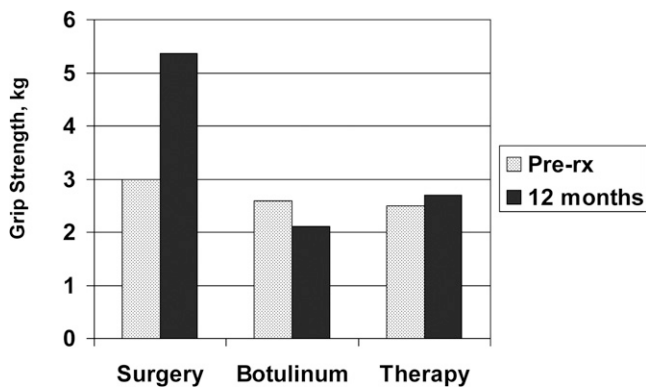


Fig. E-1C

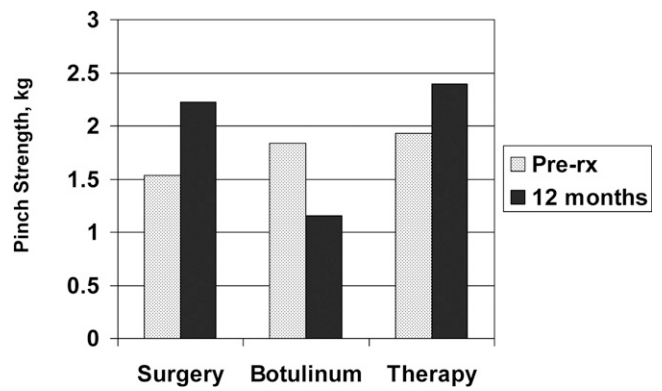


Fig. E-1D

TABLE E-1 Comparison within Each Treatment Group for All Outcome Measures							
	Normative Range	Surgical Group		Botulinum Toxin Group		Therapy Group	
		Initial Mean (Range)	12-Month Mean (Range)	Initial Mean (Range)	12-Month Mean (Range)	Initial Mean (Range)	12-Month Mean (Range)
<b>Bodily impairment measures</b>							
Stereognosis (no. of objects)	12 objects	6.4 (1 to 12)	6.9 (2 to 12)	4.8 (1 to 12)	5.4 (1 to 12)	6.9 (2 to 12)	6.1 (2 to 12)
Grip strength (kg)	3-43 kg, ages 4-17	3.0 (0 to 12.7)	5.4 (0 to 16.0)	2.5 (0 to 12.3)	2.1 (0 to 6.3)	2.5 (0 to 8.5)	2.7 (0 to 8.3)
Lateral pinch strength (kg)	2-11 kg, ages 4-17	1.5 (0 to 3.7)	2.2 (0.5 to 6.0)	1.8 (0 to 5.2)	1.2 (0 to 3.3)	1.9 (1.0 to 3.5)	2.4 (0.7 to 5.3)
Child satisfaction with appearance	Likert scale 1-5	3.6 (1 to 5)	4.0 (1 to 5)	2.6 (1 to 5)	3.2 (1 to 5)	3.0 (1 to 5)	3.4 (1 to 5)
Parent satisfaction with appearance	Likert scale 1-5	2.9 (1 to 5)	4.1 (3 to 5)	2.9 (1 to 5)	2.8 (1 to 5)	3.0 (2 to 5)	3.4 (1 to 5)
<b>Active range of motion* (deg)</b>							
Forearm supination	0-90	-3 (-90 to 55)	47 (-10 to 95)	-2 (-62 to 45)	7 (-30 to 80)	18 (-50 to 75)	-11 (-80 to 80)
Forearm pronation	0-90	79 (45 to 90)	65 (-55 to 80)	77 (60 to 90)	78 (65 to 90)	81 (80 to 90)	68 (10 to 90)
Wrist flexion	0-90	78 (54 to 90)	23 (-30 to 90)	83 (60 to 110)	83 (60 to 95)	84 (60 to 105)	79 (60 to 105)
Wrist extension	0-90	-1 (-90 to 50)	61 (30 to 85)	-22 (-85 to 50)	-18 (-90 to 50)	2 (-80 to 52)	7 (-50 to 70)
Thumb CMC palmar abduction		19 (0 to 50)	24 (0 to 60)	23 (0 to 50)	38 (0 to 60)	33 (0 to 50)	20 (0 to 50)
Thumb CMC radial abduction		17 (0 to 45)	29 (0 to 60)	20 (0 to 45)	30 (0 to 45)	29 (0 to 45)	24 (0 to 65)
Thumb MCP flexion		23 (0 to 90)	28 (0 to 50)	22 (0 to 60)	24 (0 to 45)	22 (0 to 50)	22 (0 to 45)
Thumb MCP extension		4 (0 to 50)	-5 (-50 to 25)	3 (0 to 25)	0 (0)	5 (0 to 30)	0 (0 to 2)
Thumb IP flexion		42 (0 to 90)	47 (0 to 90)	39 (0 to 90)	41 (0 to 90)	41 (0 to 90)	49 (-45 to 90)
Thumb IP extension		2 (-40 to 30)	1 (-58 to 22)	17 (0 to 70)	8 (0 to 60)	19 (0 to 65)	7 (0 to 45)
<b>Activity limitation measures</b>							
SHUEE DPA (%)	Percentage score for grade 0-72	65.9 (53 to 84)	87.5 (64 to 100)	60.9 (51 to 78)	66.1 (47 to 88)	63.7 (45 to 83)	62.7 (46 to 83)
SHUEE SFA (%)	Percentage score for grade 0-45	47.6 (13 to 71)	53.6 (18 to 80)	42.1 (3 to 71)	43.1 (7 to 69)	43.1 (22 to 62)	48.8 (18 to 76)
Box and Blocks (no. of blocks)	11-101, ages 4-17	11.0 (2 to 27)	13.0 (6 to 25)	10.8 (2 to 26)	10.3 (0 to 31)	10.6 (2 to 22)	11.4 (0 to 24)
AHA (points)	22-88 (score of 1-4 on 22 scales)	55.5 (38 to 71)	58.6 (42 to 69)	48.6 (34 to 64)	49.6 (36 to 63)	54.2 (37 to 67)	55.6 (42 to 63)
<b>Participation restriction measures</b>							
PODCI-parent (%)							
Upper extremity		65.8 (12 to 96)	85.4 (54 to 100)	63.3 (29 to 88)	68.9 (46 to 88)	67.0 (42 to 83)	66.2 (25 to 92)
Transfers		87.4 (61 to 100)	95.1 (85 to 100)	85.6 (67 to 100)	85.3 (61 to 100)	83.7 (52 to 100)	86.0 (58 to 97)
Sports		61.6 (37 to 92)	73.6 (53 to 94)	57.7 (36 to 89)	62.7 (30 to 92)	57.5 (17 to 85)	62.6 (24 to 83)
Pain		85.4 (50 to 100)	94.1 (58 to 100)	73.7 (33 to 100)	80.7 (25 to 100)	91.7 (67 to 100)	92.6 (50 to 100)

continued

<b>TABLE E-1 (continued)</b>							
	Normative Range	Surgical Group		Botulinum Toxin Group		Therapy Group	
		Initial Mean (Range)	12-Month Mean (Range)	Initial Mean (Range)	12-Month Mean (Range)	Initial Mean (Range)	12-Month Mean (Range)
Happiness		75.6 (45 to 100)	86.1 (55 to 100)	73.0 (40 to 95)	71.3 (35 to 100)	81.5 (65 to 100)	81.1 (50 to 95)
Global		75.2 (45 to 97)	87.1 (78 to 96)	70.0 (57 to 92)	74.4 (40 to 94)	75.1 (53 to 90)	76.8 (52 to 92)
PedsQL-parent (%)							
Physical		54.9 (15 to 91)	70.3 (22 to 94)	58.8 (34 to 84)	56.0 (9 to 91)	58.4 (16 to 81)	61.3 (13 to 88)
Emotional		67.8 (45 to 100)	78.7 (50 to 100)	62.5 (20 to 85)	73.3 (25 to 100)	74.4 (60 to 100)	72.2 (55 to 100)
Social		60.6 (25 to 95)	64.3 (25 to 100)	58.0 (10 to 80)	59.4 (0 to 85)	56.7 (25 to 85)	55.6 (25 to 75)
School		59.4 (20 to 100)	64.7 (38 to 100)	60.5 (15 to 90)	72.2 (35 to 95)	61.7 (40 to 95)	63.3 (50 to 100)
PedsQL CP-parent (%)							
School		56.5 (31 to 88)	77.4 (38 to 100)	65.7 (44 to 100)	71.6 (25 to 100)	62.7 (19 to 100)	61.9 (38 to 100)
Movement		49.7 (20 to 85)	78.9 (60 to 100)	55.5 (35 to 95)	56.1 (30 to 90)	64.0 (40 to 90)	62.2 (25 to 100)
Fatigue		68.1 (25 to 100)	79.3 (31 to 100)	60.4 (31 to 100)	71.0 (31 to 100)	80.7 (13 to 100)	74.3 (50 to 100)
Eating		70.6 (25 to 90)	90.0 (75 to 100)	72.7 (45 to 90)	82.2 (70 to 90)	73.5 (35 to 90)	72.8 (40 to 100)
Speech		68.5 (25 to 100)	85.9 (50 to 100)	68.4 (38 to 100)	75.2 (38 to 100)	79.4 (25 to 100)	81.3 (38 to 100)
CAPE (points)							
Diversity	0-55	29.8 (16 to 43)	27.5 (6 to 39)	31.5 (24 to 41)	32.2 (29 to 35)	27.9 (20 to 40)	26.7 (16 to 36)
Intensity	0-7	2.7 (1.6 to 3.7)	2.5 (0.7 to 3.3)	2.9 (2.3 to 4.1)	2.9 (2.2 to 3.4)	2.4 (1.8 to 3.1)	2.4 (1.4 to 3.1)
Enjoyment	1-5	3.9 (3.1 to 4.8)	4.1 (2.9 to 5.0)	4.0 (3.8 to 4.5)	4.0 (3.1 to 4.8)	4.2 (3.4 to 4.9)	4.2 (3.4 to 5.0)
COPM (points)							
Performance	0-10	3.4 (1.0 to 7.0)	6.8 (3.2 to 10.0)	3.5 (0 to 6.5)	5.0 (2.0 to 8.2)	4.2 (1.8 to 9.2)	5.4 (2.8 to 7.0)
Satisfaction	0-10	3.1 (1.0 to 6.2)	7.5 (3.0 to 10.8)	3.2 (0 to 7.0)	5.5 (1.3 to 8.8)	4.3 (1.4 to 8.8)	5.5 (2.8 to 7.4)

\*CMC = carpometacarpal, and IP = interphalangeal.

**TABLE E-2 Mean Change in Secondary Outcome Measures: Differences Among Groups from Baseline to Twelve Months**

	Surgery			Botulinum Toxin			Therapy			P Value
	N	Mean (Std. Dev.)	95% Confidence Interval	N	Mean (Std. Dev.)	95% Confidence Interval	N	Mean (Std. Dev.)	95% Confidence Interval	
<b>Bodily impairment measures</b>										
Grip, affected (kg)	15	2.5 (2.5)*	1.14 to 3.89	9	-0.80 (2.6)	-2.76 to 1.16	9	0.87 (1.6)	-0.38 to 2.12	0.007
Pinch, affected (kg)	15	0.69 (0.89)*†	0.20 to 1.19	9	-0.72 (0.73)	-1.28 to -0.16	9	0.44 (1.2)†§	-0.46 to 1.35	0.004†
Parent satisfaction with appearance	14	1.3 (1.4)*	0.49 to 2.08	9	-0.44 (1.1)	-1.31 to 0.42	9	0.33 (1.6)	-0.88 to 1.55	0.02
Child satisfaction with appearance	14	0.29 (1.5)	-0.60 to 1.18	9	0.33 (1.5)	-0.82 to 1.49	9	0.44 (1.7)	-0.84 to 1.73	0.97
<b>Participation restriction measures (%)</b>										
PODCI global	14	12.9 (8.9)*†	7.8 to 18.1	9	2.1 (11.1)	-6.4 to 10.6	9	1.3 (10.1)	-6.4 to 9.1	0.01
PedsQL physical	15	12.7 (20.3)	1.51 to 23.95	8	1.4 (16.9)	-12.71 to 15.46	8	-1.0 (14.2)	-12.91 to 10.91	0.17
PedsQL psychosocial	15	0.06 (0.13)	-0.02 to 0.13	8	0.06 (0.07)	0.00 to 0.12	7	0.00 (0.08)	-0.08 to 0.07	0.43
PedsQL CP school	14	19.1 (24.4)	5.1 to 33.2	9	-1.3 (32.2)	-24.3 to 21.7	9	-0.78 (18.5)	-15.0 to 13.4	0.10
PedsQL CP movement	14	26.4 (19.6)*††	15.1 to 37.7	9	-3.3 (24.4)	-22.1 to 15.4	9	-3.3 (19.0)	-18.0 to 11.3	0.002†
PedsQL CP fatigue	15	11.2 (19.3)	0.5 to 21.9	9	5.6 (18.5)	-8.6 to 19.8	9	-4.2 (28.6)	-26.2 to 17.8	0.27
PedsQL CP eating	15	16.3 (12.9)†	9.2 to 23.5	9	8.3 (9.7)	0.9 to 15.8	9	0.0 (12.5)	-9.6 to 9.6	0.01
PedsQL CP speech	15	16.1 (18.5)	5.9 to 26.4	9	4.2 (11.6)	-4.7 to 13.1	9	4.2 (34.0)	-21.9 to 30.4	0.33
COPM performance	15	3.4 (2.2)†	2.15 to 4.58	9	1.5 (1.9)	0.20 to 2.91	9	1.2 (2.2)	-0.53 to 2.89	0.03
COPM satisfaction	15	4.4 (2.3)*††	3.10 to 5.69	9	2.0 (1.8)	0.63 to 3.33	9	0.91 (2.2)	-0.79 to 2.61	0.002†

\*Surgery versus botulinum toxin. †Significant after Bonferroni correction ( $p \leq 0.004$  [0.05/14]). ††Surgery versus therapy. §Therapy versus botulinum toxin.