Quantifying Real-World Upper Limb Activity Via Patient-Initiated Spontaneous Movement in Neonatal Brachial Plexus Palsy

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RUNNING HEAD: Quantifying Arm Use in Children with NBPP

ABSTRACT

Introduction: Neonatal brachial plexus palsy (NBPP) results in muscle weakness and impaired somatosensory function of the arm. Current functional assessment is primarily based on clinician-elicited measurements including muscle strength and range of motion. To what extent these measures are representative of real-world arm movement is unclear. However, advances in wearable technology have made it possible to monitor real-world upper limb movement.

Objective: To determine the feasibility of using body-worn accelerometers to remotely assess arm movements in children with NBPP.

Design: Criterion standard.

Setting: Academic medical center.

Participants: Nine adolescents with NBPP and nine age- and gender-matched control adolescents participated in the study. All were enrolled in school and participated in community activities.

Interventions: Not applicable.

Methods: Standard clinician-elicited measurements were collected. For assessing spontaneous arm movements, participants wore activity monitors during all waking hours for 7 days. Results were expressed as ratios of affected to unaffected arm motion for duration and magnitude and correlated with traditional clinic-based assessments. Spearman correlations were used to determine relationships between accelerometry results and traditional assessments. *P*-value <.05 was considered statistically significant.

Main Outcome Measurements: Accelerometry measurements of arm motion and traditional clinical assessments.

Results: Compared to control ratios, duration of arm movement and magnitude ratios were reduced in the NBPP group, particularly for arm magnitude due to reduced affected arm movement and an increase in unaffected arm movement. Ratios were highly correlated with shoulder function and, to a lesser extent, with elbow function.

Conclusions: Real-world arm use is an appropriate outcome measure that reflects functional recovery. We demonstrate the feasibility of wearable technology to quantify duration and intensity of spontaneous arm movement in children with NBPP. Accelerometry also allows for the association between traditional clinician-elicited assessment measures and spontaneous arm movements, demonstrating the importance of the shoulder as a focus of treatment in NBPP.

Key Words: pediatric, brachial plexus, functional outcome, accelerometry, arm movements

INTRODUCTION

Neonatal brachial plexus palsy (NBPP) can be a devastating disablement that affects approximately 0.9-1.5 per 1000 live births in the U.S.,[1-3] with higher rates reported elsewhere.[2] Injury to the nerves of the brachial plexus occurs during the perinatal period as a result of nerve compression or traction,[4,5] leading to sensorimotor dysfunction of the upper limb. In many cases, spontaneous recovery occurs within several months following delivery, although persistent muscle weakness can occur in 20-30 percent of patients.[6-9] Notably, the Narakas classification of the extent of injury (number of nerve roots) not only describes the NBPP pathophysiology but also provides a guideline for persistence of motor dysfunction for each Narakas group.[10] Similarly, impaired somatosensation as evidenced by poor hand tactile[11,12] and proprioceptive acuity[13] may also persist through childhood and adolescence.

Current clinical evaluation of function in NBPP patients primarily addresses motor function via standard clinician-dependent methods, including passive and active range of motion, muscle strength, and various ordinal rating instruments that quantify movement at the shoulder,[14,15] elbow,[16] and hand.[10] While these motor assessments are useful for the clinician to observe movement of the arm, they remain within the WHO-ICF Body Function and Structure domain, are subject to both patient and clinician bias, and may not reflect daily use of the arm.[17] To address the WHO-ICF Activity and Participation domains, clinicians have used patient-reported quality of life surveys, but these patient/parent survey assessments may be prone to recall biases related to recall time frame, socio-demographics, and intervening medical conditions.[18] The ideal assessment provides information regarding actual motion of the arm in everyday settings that rely upon adequate joint range of motion[19]: spontaneous, patient-initiated arm movements thus avoids the limitations associated with patient-reported outcomes.

Advances in wearable technology have made it possible to reliably monitor real-world upper limb movements in a variety of central nervous system conditions, including stroke,[20,21] amyotrophic lateral sclerosis,[22] Parkinson's disease,[23] and hemiplegic cerebral palsy.[24] Despite the growing use of activity monitors to measure self-initiated motion, few studies have been conducted in peripheral nerve injury conditions. A recent study has demonstrated the value of using body-worn accelerometry to quantify patient-initiated arm movements in adults following nerve reconstruction to repair traumatic injury to the brachial plexus.[25] To what extent remote monitoring technology is suitable for use in younger patients with peripheral nerve injury and/or late spontaneous recovery has not been examined. Thus, the aim of this study was to determine the clinical utility of using accelerometry to remotely assess arm motion in older children with

NBPP.

METHODS

Participants

Nine adolescents with NBPP (5 female, 10.5 ± 2.2 y) who were serially recruited from the Brachial Plexus and Peripheral Nerve Program at Michigan Medicine participated in the study. In addition, 9 typically developing participants (5 female, 10.4 ± 2.0 y; 8 right hand dominant) were included as a control group for comparison with accelerometry data. Standard demographic data were collected and are reported in Table 1 for both groups. To reflect the extent of nerve root involvement, the Narakas grade is reported, with 4 participants having nerve roots C5–6 involved (Narakas I and II) and 5 having nerve roots C5-T1 involved (Narakas III and IV).[26] Inclusion criteria comprised age (8-17 years), a diagnosis of NBPP at birth, and having no history of pre-existing nerve or musculoskeletal surgery. The affected arm was the non-dominant arm in seven of the participants. The study was approved by the University of Michigan's Institutional Review Board (HUM00103135), and participants were reimbursed for their time and involvement in the study. One of two certified therapists with more than 10 years of experience collected standard clinician-elicited measurements in an outpatient setting.

Shoulder active range of motion (AROM) included measurements of flexion, abduction, extension, external rotation in adduction, and internal rotation in adduction. Elbow flexion and forearm supination AROM were also included. The Mallet scale, comprised of 5 different shoulder movements (abduction, external rotation, hand behind neck, hand to mouth, and hand to back), provides a quantifiable measure of shoulder and elbow function in patients with NBPP.[14,27,28] Scores range from 1 (no motion) to 5 (normal motion) with a maximum score of 25. Individual movement subscores of 4 or above indicate good shoulder function.[29,30]

Muscle strength was assessed using the Medical Research Council (MRC) scale, where 0 indicates no detectable muscle contraction and 5 is indicative of normal strength. The Gilbert and Raimondi elbow recovery score, ranging from 0 to 5, quantifies elbow flexion and extension as well as flexion contractures (extension deficit) in patients with NBPP, where low scores reflect reduced elbow function.[31] Hand function was assessed using the Raimondi hand function scale (0-5), where scores of 0-2 indicate poor hand use and scores of 3-5 indicate moderate to good hand function.[31]

Accelerometry

Accelerometry-based activity monitors (GT9X Link ActiGraph; ActiGraph, LLC., Pensacola, FL, USA) were worn on both wrists during all waking hours for 7 consecutive days and were only removed for showering/bathing, swimming, and sleeping. Accelerometers were calibrated prior to use and attached at the wrist using adjustable medical-grade rubber or Velcro watchbands. Raw acceleration was recorded in 3 planes of motion at 30 Hz. Accelerometers were returned using prepaid mailing boxes. Data were downloaded and filtered using commercially available ActiLife© software (ActiGraph, Pensacola, FL, USA) to remove the effect of gravity and combine data samples into 1-second activity counts.[20,32] The intensity of arm movement (vector magnitude VM) was calculated for each arm using the formula, $\sqrt{(x^2 + y^2 + z^2)}$. The amount of time (duration) when arm motion was recorded was calculated by summing all the seconds of activity counts greater than zero and converting values into hours of use for each arm (vector time VT). Magnitude and time ratios were then calculated for each participant by dividing affected arm values by unaffected arm values and correlated with clinic-based assessments. ActiLife© software was also used to visually inspect the data for compliance across the 7 days of recording. Identical procedures were used to acquire and analyze VM and VT data from control participants. Ratios were calculated by dividing nondominant arm values by dominant arm values. Density plots to show accelerometry data obtained from both limbs were constructed using methods described by Lang and colleagues.[20] Such visualization techniques provide a means of interpreting bilateral arm movement in everyday activities, as demonstrated in unilateral central nervous system insult.[20,24,33]

Statistical Analysis

Commercially available statistical software (SPSS Statistics version 24; IBM Corp., Armonk, NY, USA) was used to calculate descriptive statistics for demographic, clinical evaluation, and ActiGraph data. Unpaired two-sample t-tests were used to compare group mean differences. Spearman correlations were calculated to determine relationships between magnitude and time ratios with AROM, MRC, and functional assessments. A p-value $<.05$ was considered statistically significant.

RESULTS

Range of motion, muscle strength, and functional scores for the affected arm of NBPP participants are reported in Table 2. Mean AROM was reduced by approximately 25% for shoulder flexion, abduction, and internal rotation and 50% for shoulder extension and external rotation. Median MRC grading scores indicated variable muscle strength across participants with muscle weakness the greatest for the posterior deltoid. The median aggregate Mallet score was 18/25 with the lowest scores reported for abduction, exorotation, and hand to back movements. Elbow function, based on Gilbert and Raimondi scores, was variable across participants. Raimondi hand scores ranged 3-5, indicative of moderate to good hand function.

Mean vector magnitude (VM) and vector time (VT) accelerometry scores, expressed as a ratio of affected (nondominant) to unaffected (dominant) arm values were significantly different between groups. Compared to controls in whom the ratios reflected nearly equivalent movement magnitude and duration of motion of both arms (VM ratio: 1.01 ± 0.05, VT ratio: 0.99 ± 0.04), a 33% reduction in VM (ratio: 0.67 ± 0.18) of the affected arm in the NBPP group was observed ($p<0.01$). Lower VM ratios were due to a 20% reduction in affected arm movement compared to that of the non-dominant arm in controls and a 25% increase in unaffected arm movements compared to controls. Arm movement time was reduced to a smaller extent (ratio = 0.86 ± 0.08) compared to control values ($p<.05$), driven by a 15% increase in unaffected arm VT compared to control dominant arm VT. Box plots were used to depict individual VT and VM ratios (Fig 1). Correlations between accelerometry ratios and AROM and muscle strength based on MRC scores are shown in Tables 3 and 4. VM and VT ratios were strongly correlated with shoulder flexion and abduction AROM but not as much with shoulder extension or external rotation. Both elbow flexion and consequently forearm supination demonstrated weaker correlations with VM. VT and VM were strongly correlated with muscle strength for all three heads of the deltoid, biceps brachii, and triceps brachii muscles. No correlations were found with wrist and hand muscle strength.

Correlations between functional disability scales and accelerometry measures are shown in Table 5. Mallet scores were strongly correlated with both VM and VT indicating that greater shoulder function was predictive of greater self-initiated movement of the arm. Functional scores, such as the Gilbert Raimondi elbow recovery score, which relates to the elbow and hand did not correlate as strongly with acceleration ratios. Examples of the strong correlations between measures of shoulder function and patient-initiated arm movement (VT, VM) are shown as scatter plots in Fig. 2 for shoulder flexion (A), middle deltoid muscle strength (B) and Mallet scores (C).

Visualization of acceleration data obtained over 7 days on a second-by-second basis (approximately 90 hours of self-initiated arm movement) revealed consistent differences in bilateral arm movements between control and NBPP participants. Representative density plots are shown in Figure 3, where bilateral magnitude (y axis) reflects the intensity of movement recorded from both limbs, whereas the contribution of the two arms is shown on the x axis and is described as a ratio of acceleration magnitude data from the two arms using a natural logarithm transformation.[20,34] Data plotted in the center of each image (dashed vertical lines) indicate activities involving bilateral limb movement, whereas data plotted further to the right or left represent activity increasingly dominated by one or the other limb. The vertical bars at either end of the x axis indicate the amount of unilateral movement of each arm. The frequency of arm movement (bilateral and unilateral) is indicated by the color scale.

In the control participant (Figure 3A), a symmetric distribution of data reflects the typical pattern of weekly bilateral arm motion, indicating that movement involving both arms occurred during a significant percentage of daily activities. Further, the frequency of unilateral arm movements was similar in both arms. In contrast, skewed distribution of acceleration data shown for the NBPP participant (Figure 3B) indicates greater motion of the unaffected arm with a reduction in the frequency of movements involving simultaneous movement of both arms—a pattern typical of all NBPP participants in this study.

DISCUSSION

This study demonstrated the clinical usefulness of accelerometry to monitor real-world arm movements in older children with NBPP and extends previous work using such technology to remotely quantify arm movements in adults following surgical reconstruction to repair damage to the brachial plexus.[25] NBPP is a devastating event for the pediatric patient and parents/caregivers, resulting in decreased function of the upper extremity.[28,35] With increasing interest by physiatrists into this condition and advances in surgical techniques,[36,37] the treatment of NBPP has improved significantly over the past 25 years. Increased recognition of the importance of maintaining or improving joint passive range of motion in conservatively treated NBPP throughout childhood and into adolescence is paramount to optimizing outcomes. Standard therapy includes range of motion and muscle strengthening exercises to maintain muscle balance and prevent joint contractures that, otherwise, can lead to joint deformities, particularly about the shoulder.[38,39] Passive range of motion exercises are typically started early after diagnosis,[40] and are effective in improving shoulder function[41,42] without leading to shoulder complications such as posterior shoulder subluxation.[43]

Although traditional rehabilitation may lead to increased movement in the outpatient setting in response to clinician-driven therapy and/or assessments, it may not lead to increased movements of the arm in real-world settings. In other pediatric onset disorders such as cerebral palsy, children may stop using the affected limb because of muscle weakness and the effort required to move, and instead develop compensatory strategies using the unaffected limb. This discrepancy between capacity to move and actual arm use, referred to as developmental disregard[44,45] or developmental apraxia,[46] likely results from central nervous system changes following withdrawal of movement-related sensory feedback. For example, abnormal cortical activation patterns associated with motor imagery tasks have been described in young adults with NBPP, suggestive of motor planning deficits.[47] Further evidence of central alterations in NBPP include reduced corpus callosal volume in motor association areas coupled with decreased activation of sensorimotor networks in both the contra- and ipsilateral hemispheres.[48]

Therefore, treatment strategies for NBPP in the context of central alterations require evaluation of clinical presentation supplemented with ancillary studies (e.g., electro-diagnostic, imaging, etc.)—in addition to serial evaluations of not only WHO-ICF Body Function and Structure domains (e.g., ROM and muscle power) but more importantly Activity and Participation domains (e.g., functional arm use at home and school). Although clinical tests such as imaging or electrodiagnostic assessment of the nerve lesion site, extent, and severity may lead to identification of remediable lesions and/or prognostication, they have demonstrated variable sensitivity and specificity[49]—but understanding functional movements of the arm once the patient leaves clinic remains elusive. As such, initial attempts to understand the real-world use of the arm have been limited to patient/parent recall and various surveys[50,51] but these are rife with subjective bias.[17]

In this study, we captured patient-initiated movement, and we were able to quantify the duration and intensity of the movement of both upper extremities via bilateral upper extremity accelerometers. These devices successfully captured and quantified the timing and magnitude of arm movements over the course of 7 days. With rehabilitation management alone, we showed that patients' time and magnitude of movement of the affected arm were up to 86% and 67%, respectively, compared to the unaffected arm. We believe that these data ideally describe the duration and magnitude of patient-initiated movements that are critical for subsequent treatment decision-making.

As we captured patient-initiated movement with accelerometers, we evaluated our NBPP patients via multiple traditional NBPP-specific assessments. Although these assessments have been widely used, their relationships with one another have rarely been explored.[52] The paucity of correlations between objective clinical outcomes (e.g., MRC grading)/ subjective outcomes collected by clinicians in the outpatient arena versus real-life patient movements at home raises concerns that traditional evaluations remain inadequate for treatment decision-making. Together, these issues can explain the discrepancy between spontaneous movements and clinician-elicited outcome measures. Accelerometry measurements circumscribe these issues by gathering objective data on patient-initiated, multi-joint movements throughout the patient's normal day.

Additionally, we discovered a strong correlation between shoulder movement and patient-initiated arm movements. Similar to adults with brachial plexus injury[24], weaker or no correlations were found between acceleration-based arm movement and elbow, wrist, and hand joint motion. Gilbert reported 30 years ago that the importance of the shoulder should remain the focus of treatment[53]; however, we are not aware of any published data until now that substantiates this concept that good shoulder function directly correlates with overall spontaneous arm motion. Since the brachial plexus mediates all movement and sensation in the arm, NBPP often results in a reduced ability or inability to externally rotate and abduct the shoulder. By improving shoulder ROM, compensatory patterns may be reduced, and overall arm function may be improved. Given that the shoulder is the joint that primarily positions the hand in space, our preliminary data may demonstrate that the shoulder could be the limiting factor in meaningful movements of the arm. Since adequate surgical reanimation of the shoulder remains elusive in NBPP, objective rehabilitation techniques such as accelerometry that capture real-world limb motion provide valuable and accurate information for optimizing arm function for daily activities and/or adaptation of movement in order to achieve patient goals. Such methods can overcome potential biases associated with observer-related changes in motor behavior in clinical settings (Hawthorne effect) and/or self or care-giver reporting of perceived upper limb function.[54] Lastly, further studies with larger patient numbers will be necessary to more clearly define the relationships between accelerometry measures obtained in every day settings and current clinical methods of assessment.

Limitations

While our findings regarding differences in movements of the two arms and correlations between accelerometry and shoulder AROM were statistically significant, our sample size is relatively small. Further, these results were obtained from children who had not received surgical reconstruction to repair brachial plexus damage. To what extent shoulder function is predictive of real-world, spontaneous arm movements in children having received surgery is currently under investigation. Commercially available accelerometry software provides information in the form of global activity counts and, as such, information regarding motion around specific joints is limited, particularly when only one device per limb is utilized. Thus, it is not possible to determine if larger amplitude movements about, for example, the shoulder, may disproportionally influence the correlations reported here. It should be also noted that walking and other whole-body movements were included as part of our analysis which may have led to overestimations of arm movement activity. However, using an arm movement ratio is one method to overcome this possibility as shown recently in hemiparetic stroke patients.[55] Despite these limitations, accelerometry can provide clinicians with an objective and unbiased method to determine self-initiated arm motion in everyday settings—a significant advancement in determining “true” function in clinical conditions characterized by impaired motor performance.

CONCLUSION

Determining treatment strategies for NBPP remains difficult as many assessment methods exist, but few regard WHO-ICF Activity and Participation domains and/or spontaneous movement of the arms. Wearable technology permits quantification of the duration and magnitude of patient-initiated arm movements outside of the clinic environment. Additionally, accelerometry assessments facilitate the comparison of traditional clinic-based assessment methods with spontaneous arm movements, resulting in the demonstration of the shoulder joint as a critical treatment focus for rehabilitation and therapy.

FIGURE LEGENDS

Figure 1. Box and whisker plots for vector time (VT) and vector magnitude (VM) for the NBPP and control groups. Each box shows the median (horizontal line) and the first and third quartiles. Whiskers show the minimum and maximum values. Overplotted data points represent individual participant ratios.

Figure 2. Scatter plots showing the correlation between VT and VM ratios and shoulder flexion AROM (A), middle deltoid strength based on MRC scores (B), and total Mallet score (C) for NBPP participants. Simple regression (dashed) and Loess lines (solid) are depicted for each scatter plot.

Figure 3. Exemplar density plots for a control (A) and a NBPP participant (B) using 7 days of bilateral accelerometry activity count data plotted on a second-by-second basis. X axis: Magnitude ratio transformed using a natural logarithm showing contribution of each arm to the activity. Dashed vertical line at 0 magnitude ratio indicates equal contributions from both arms to overall activity. Small vertical bars at -7 and 7 indicate unilateral arm activity. Y axis: Bilateral magnitude (intensity of movement). Color bar on right represents duration of activity.

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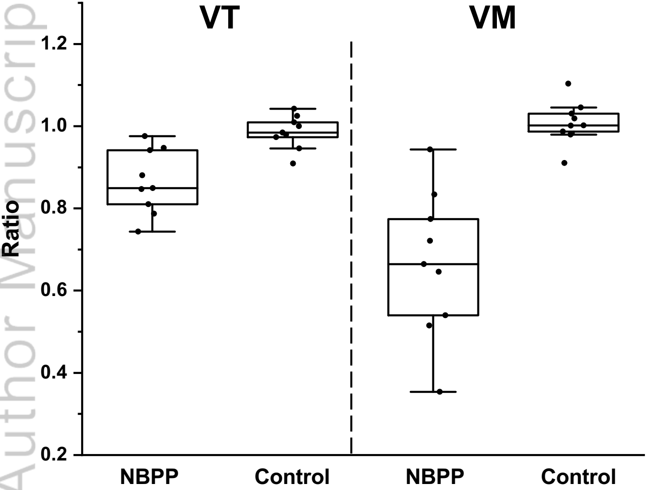
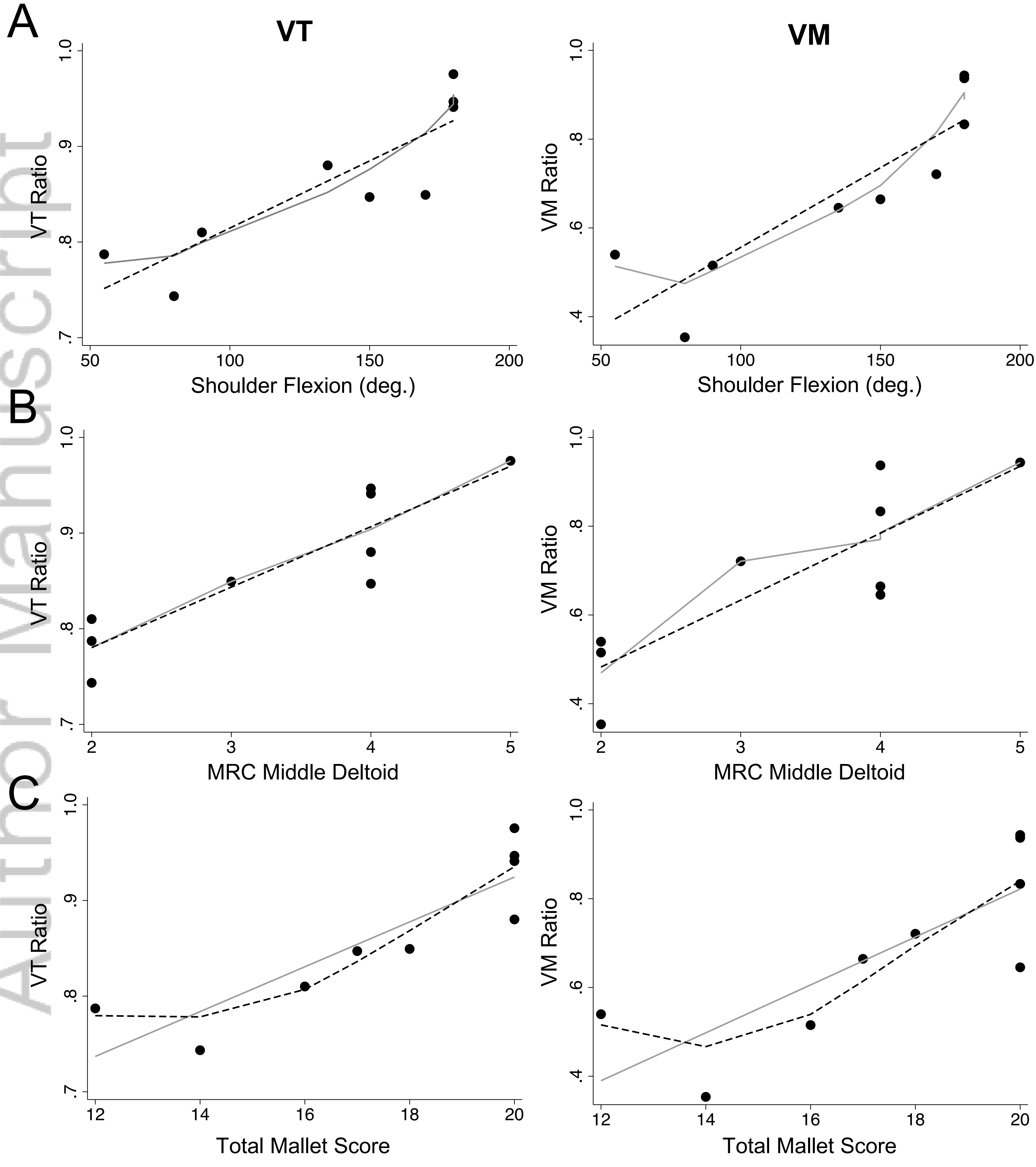
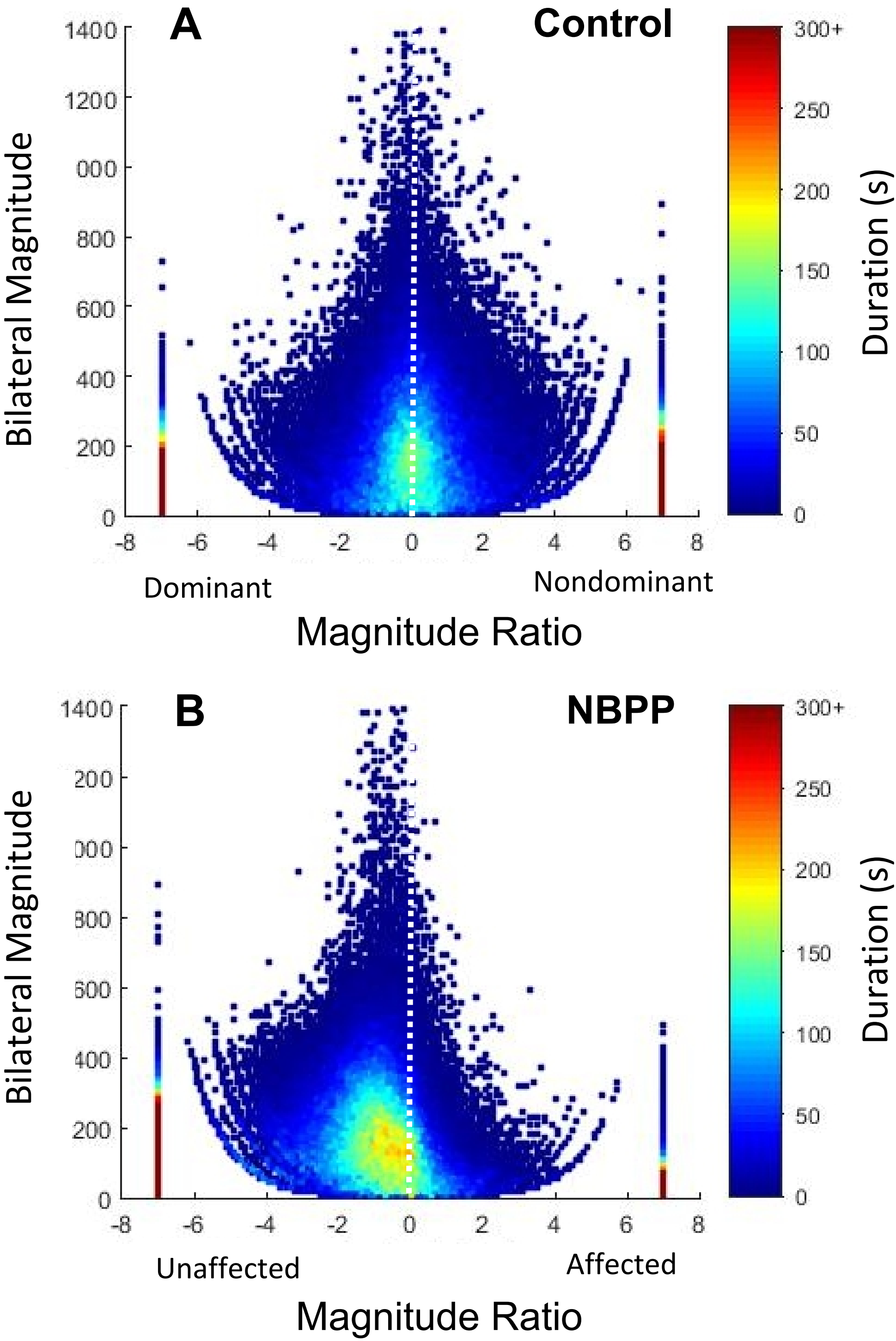

VT
VM
Ratio
1.2
1.0
0.8
0.6
0.4
0.2
NBPP
Control
NBPP
Control


A
VT
VM
VT Ratio
VM Ratio
Shoulder Flexion (deg.)
B
MRC Middle Deltoid
C
Total Mallet Score



A
Control
Bilateral Magnitude
Magnitude Ratio
Dominant
Nondominant
Duration (s)
B
NBPP
Bilateral Magnitude
Magnitude Ratio
Unaffected
Affected
Duration (s)

Table 1. Study Participant Characteristics

Characteristics	NBPP	Control
Mean age (y) ± 1 SD	10.5 ± 2.2	10.4 ± 2.0
Gender		
Male	4 (44%)	4 (44%)
Female	5 (56%)	5 (56%)
Race		
Caucasian	3 (33%)	9 (100%)
African American	3 (33%)	
Asian	2 (22%)	
Other	1 (11%)	
Involved Side		
Left	5 (56%)	
Right	4 (44%)	
Dominant Side		
Left	2 (22%)	1 (11%)
Right	7 (78%)	8 (89%)
Narakas Score		
Level I/II	4 (44%)	
Level III/IV	5 (56%)	

SD = standard deviation

Table 2. NBPP Affected Arm Clinical Measurements

Active Range of Motion (mean ± 1SD, degrees)	
Shoulder flexion (0-180°)	136 ± 49
Shoulder abduction (0-180°)	130 ± 54
Shoulder extension (0-50°)	25 ± 20
Shoulder external rotation adduction (0-90°)	46 ± 39
Shoulder internal rotation adduction (0-90°)	68 ± 9
Elbow flexion in adduction (0-150°)	143 ± 13
Forearm supination (0-90°)	61 ± 37
Muscle Strength (MRC scale) (median, range)	
Anterior deltoid (0-5)	4 (2-5)
Posterior deltoid (0-5)	2 (1-5)
Biceps (0-5)	4 (3-5)
Triceps (0-5)	3 (3-5)
Wrist Flexors (0-5)	4 (2-5)
Wrist Extensors (0-5)	4 (2-5)
Hand superficial/deep flexors (0-5)	4 (2-5)
Finger extensors (0-5)	4 (2-5)
Thumb extensors (0-5)	4 (2-5)
Mallet Grade (median, range)	
Abduction (1-5)	4 (2-4)
Exorotation (1-5)	3 (2-4)
Hand to head (1-5)	4 (2-4)
Hand to back (1-5)	3 (2-4)
Hand to mouth (1-5)	4 (3-4)
Total (5-25)	18 (12-20)
Gilbert and Raimondi Elbow Recovery Score (median, range 0-5)	3 (2-5)
Raimondi Hand Score (median, range 0-5)	5 (3-5)

Table 3. Spearman correlations of vector time and vector magnitude with active range of motion (AROM)

	Vector Time Ratio (VT)		Vector Magnitude Ratio (VM)	
	R Value	***P* Value**	**R Value**	***P* Value**
Shoulder flexion	0.90	0.00*	0.92	0.00*
Shoulder abduction	0.90	0.00*	0.92	0.00*
Shoulder extension	0.72	0.03*	0.73	0.03*
Shoulder external rotation adduction	0.70	0.03*	0.57	0.11
Shoulder internal rotation adduction	0.35	0.33	0.11	0.76
Elbow flexion in adduction	0.59	0.09	0.71	0.03*
Forearm supination	0.74	0.02*	0.75	0.02*

*P value <0.05

Table 4. Spearman correlations of vector time and use and vector magnitude with muscle strength (MRC)

	Vector Time Ratio (VT)		Vector Magnitude Ratio (VM)	
	R Value	***P* Value**	**R Value**	***P* Value**
Middle Deltoid	0.94	0.00*	0.90	0.00*
Anterior Deltoid	0.94	0.00*	0.90	0.00*
Posterior Deltoid	0.80	0.00*	0.81	0.01*
Biceps	0.78	0.01*	0.83	0.01*
Triceps	0.90	0.00*	0.73	0.03*
Wrist Flexors	0.48	0.18	0.47	0.20
Wrist Extensors	0.58	0.10	0.69	0.04*
Hand Superficial/Deep Flexors	0.55	0.13	0.64	0.06
Finger Extensors	0.55	0.13	0.64	0.06
Thumb Extensors	0.55	0.13	0.64	0.06

*P value <.05

MRC = Medical Research Council scale.

Table 5. Spearman correlations with Mallet scores, Gilbert and Raimondi elbow recovery score, and Raimondi hand score

	Vector Time Ratio (VT)		**Vector Magnitude Ratio (VM)**	
	R Value	***P* Value**	**R Value**	***P* Value**
Mallet aggregate score	0.94	0.00*	0.93	0.00*
Gilbert and Raimondi elbow recovery score	0.78	0.01*	0.58	0.10
Raimondi hand score	0.38	0.32	0.57	0.11

*P<0.05

Quantifying Real-World Upper Limb Activity Via Patient-Initiated Spontaneous Movement in Neonatal Brachial Plexus Palsy

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CONFLICTS OF INTEREST/DISCLOSURES: none

RUNNING HEAD: Quantifying Arm Use in Children with NBPP