Pilot Study: Investigating the Effects of Kinesio Taping® in an Acute Pediatric Rehabilitation Setting

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OBJECTIVES. The purpose of this pilot study is to describe the use of the Kinesio Taping® method for the upper extremity in enhancing functional motor skills in children admitted into an acute rehabilitation program.

METHOD. Fifteen children (10 females and 5 males; 4 to 16 years of age), who were receiving rehabilitation services at the Rehabilitation Institute of Chicago participated in this study. For 13 of the inpatients, this was the initial rehabilitation following an acquired disability, which included encephalitis, brain tumor, cerebral vascular accident, traumatic brain injury, and spinal cord injury. The Melbourne Assessment of Unilateral Upper Limb Function (Melbourne Assessment) was used to measure upper-limb functional change prior to use of Kinesio Tape(r), immediately after application of the tape, and 3 days after wearing tape. Children's upper-limb function was compared over the three assessments using analysis of variance.

RESULTS. The improvement from pre- to posttaping was statistically significant, $F(1, 14) = 18.9$; $p < .02$.

CONCLUSION. These results suggest that Kinesio Tape may be associated with improvement in upper-extremity control and function in the acute pediatric rehabilitation setting. The use of Kinesio Tape as an adjunct to treatment may assist with the goal-focused occupational therapy treatment during the child's inpatient stay. Further study is recommended to test the effectiveness of this method and to determine the lasting effects on motor skills and functional performance once the tape is removed.

Yasukawa, A., Patel, P., & Sisung, C. (2006). Pilot study: Investigating the effects of Kinesio Taping® in an acute pediatric rehabilitation setting. *American Journal of Occupational Therapy, 60,* 104–110.

Introduction

Kinesio Tape® is a relatively new technique used in rehabilitation programs to treat upper-arm or hand pain. Although it has been used in the orthopedic and sports settings, it is gaining acceptance as an adjunct in the treatment of other impairments. The use of Kinesio Taping® in conjunction with the child's regular therapy program may favorably influence the cutaneous receptors of the sensorimotor system resulting in subsequent improvement of voluntary control and coordination of the upper limb. Children admitted into an acute rehabilitation program receive intensive daily therapies during their inpatient stay. Important intervention objectives are to strengthen weakened muscles, to improve the quality and active range of motion, and to improve the child's level of independence with activities of daily living.

Kinesio Taping®, when applied properly, can theoretically improve the following: strengthen weakened muscles, control joint instability, assist with postural alignment, and relax an over-used muscle. Kinesio Tex™ is the brand name of the tape. The Kinesio Tex tape is more elastic compared to conventional rigid tape. The nonstretch rigid tape is used to limit unwanted joint movement or to protect and support a joint structure (Grelsamer & McConnell, 1998; Macdonald, 1994). However, data suggest that regular athletic tape does not restrict joint movement. Bragg et al. (2002) found that athletic tape loses its ability to restrict joint motion after 15–20 minutes of exercise. Therefore, the effects of taping may be due to the cutaneous stimulation of the sensorimotor and proprioceptive systems (Simoneau, Degner, Kramper, & Kittleson, 1997). Taping provides immediate sensorimotor feedback regarding functional abilities. With the Kinesio Tape applied, patients

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often report symptom relief, improved comfort level, or stability of the involved joint. The elasticity of Kinesio Tape conforms to the body, allowing for movement. The tape is latex-free, very thin, and stretches in the longitudinal plane. Kinesio Tape has been suggested to provide proprioceptive input in the acute phase of the injury process for lateral ankle sprain (Murray & Husk, 2001). Healthy subjects with good proprioception did not benefit from patellar taping on the knee joint. However, patellar taping for those healthy subjects with poor proprioception appeared to enhance proprioception (Callaghan, Selfe, Bagley, & Oldham, 2002). The elastic quality and proprioceptive input as well as subtle biomechanical factors may account for the functional changes observed.

When the application procedure is followed correctly, the taped area can be used to facilitate a weakened muscle or to relax an overused muscle. The method for applying the tape varies depending on the specific goals: improve active range of motion, relieve pain, adjust misalignment, or improve lymphatic circulation (Kase, Wallis, & Kase, 2003). Theoretically Kinesio Tex is applied based on treatment goals. The variables in tape application include the amount of prestretch applied to the tape, position of the area to be taped, treatment goals (pain reduction, subcutaneous blood flow, improved muscle function). Unpublished data (Kase & Hashimoto, 1997) suggest that applying Kinesio Tex to areas most likely to affect blood circulation, superficial blood flow was increased in all cases where underlying neuromusculoskeletal pathology (pain, tingling, swelling in upper extremity, patella tendonitis, osteoarthritis, hypertension) was present but demonstrated no effect on blood flow in subjects who did not display any pathology. This limited case report suggests that Kinesio Taping may affect superficial blood flow in cases where pathology is present and have no effect on superficial blood flow measures on normal, healthy subjects.

Various taping approaches have been adapted to be used clinically in rehabilitation centers for patients who present with shoulder subluxation or shoulder pain. Taping can be used as an adjunct during the rehabilitation program to enhance functional recovery. For the treatment of anterior shoulder impingement, taping was applied to provide proximal scapular stability. The application of the scapular taping used in conjunction with a home exercise program provided relief of shoulder pain and improved overhead reach (Host, 1995; Schmitt & Snyder-Mackler, 1999).

We started using Kinesio Taping at the Rehabilitation Institute of Chicago as an adjunct to therapy in 1998. Typically children who are admitted into an acute pediatric rehabilitation program at the Rehabilitation Institute of Chicago receive 3 hours or more of therapy throughout their inpatient stays. Prior to the intensive rehabilitation program, the Functional Independent Measure (FIM™) is used initially to measure functional outcomes during the length of the inpatient stay (Hamilton et al., 1987). The age range is from from 8 years of age to adult and six domains are assessed: self-care, mobility, locomotion, sphincter control, communication, and social cognition. The WeeFIM® measures independent rating and the developmental level of the age of the child from 6 months to 7 years of age (*Guide to the Uniform Data Set for Medical Rehabilitation for Children*). The WeeFIM and the FIM present uniform data describing the severity of disability and the need for assistance. Both instruments are used as an initial evaluation to measure the basic functional abilities in the six domains prior to the initiation of the therapy program. By considering the child's developmental level and physical ability, intervention can be targeted at the essential skills component necessary for improved independence in self-care function (Shepherd, Procter, & Coley, 2001). The therapy program may consist of a daily morning self care program, strengthening exercises through functional activities for the involved upper extremity, improvement of fine motor control, and coordination.

The secondary musculoskeletal effects of a neurological assault include muscle weakness or imbalance, pain, limited active and passive range of motion, and poor functional use (Hertling & Kessler, 1996). The treatment approach of taping is difficult to objectively measure as a viable tool to use to assist with promoting function of the upper extremity. Limited data exist to support the effectiveness of Kinesio Taping as an adjunct to treatment to facilitate attainment of functional motor skills. Therapists often use qualitative assessment tools to measure their results, including subjective clinical observation, anecdotal reporting, or descriptive terminology to assess upper-extremity movement quality. If evidence supports the use of taping this could ultimately justify the rationale for taping children with upper-extremity weakness.

The primary objective of this pilot study was to describe functional hand and arm skills in children admitted into a rehabilitation program subsequent to use of Kinesio Taping.

Method

Subjects

Fifteen children (5 males, 10 females, 4–16 years of age) admitted to the pediatric inpatient program at the Rehabilitation Institute of Chicago participated in this study. Informed consent was obtained from the guardians in accordance with the Institutional Review Board, which

approved the study. Study criteria included: decreased muscle strength of the upper extremity as measured by manual muscle testing (poor to fair range) and/or abnormal muscle tone interfering with functional movement as measured by the Modified Ashworth Scale (MAS) (Bohannon & Smith, 1986). This study enrolled children admitted into the pediatric rehabilitation program with varied diagnoses (Table 1). However, all children demonstrated the inclusion criteria of muscle weakness and/or abnormal tone that interfered with upper-extremity functional use. Criteria for selection included children with enough motivation and cognition to follow direction to the Melbourne Assessment of Unilateral Upper Limb Function (Melbourne Assessment) (Randall, Johnson, & Reddihough, 1999), and had no significant behavioral problems. The primary treating therapists recommended those children who were able to follow directions to task, appeared alert and oriented to their surroundings.

Children with dense sensory and motor loss (muscle grade at zero to trace) in the area to be taped were not eligible for the study. Children with significant spasticity on the MAS of 3 or 4 (3 representing considerable increase in tone, passive movement difficult and 4 representing affected parts rigid in flexion or extension) were also not eligible for inclusion as a study participant.

Assessing clinical change in the upper extremity in children admitted into a rehabilitation program is a complex measurement task. The results of this study demonstrate that, despite the heterogeneity of the diagnoses in this study, the subjects presented with similar presenting causes for functional losses (muscle weakness and imbalance). The inclusion criteria were established to target children with decreased muscle strength; except for those who presented a muscle grade at zero to trace. The subjects were all evaluated by the same therapist to eliminate the variability found in manual muscle testing. Although this assessment was designed for children with neurological conditions, it was also used in this study for children with muscle weakness from orthopedic condition and/or spinal cord injury (SCI). The subjects in this study were listed by neurological impairments 1–9, and orthopedic and SCI 10–15 (Table 1).

The test items of the Melbourne Assessment were task-specific, which represented the most important components of arm and hand function (Table 2).

Measures

The Melbourne Assessment scores quality of upper-limb function based on 16 criterion-referenced items with 37 subscores, and consisting of 3-, 4-, and 5-point scales to record results. The Melbourne Assessment is an objective standardized measure evaluating the quality of upper-extremity function of reach, grasp, release, and manipulation. Each subject's performance is recorded on a videotape for scoring. Each movement test item is subdivided into specific descriptive criteria and assigned a point scale. The raw scores are recorded on the score sheet and later converted to a percentage score (range 0% to 100%). A higher percentage score indicates better quality of arm and hand movements based on the specific test items.

The Melbourne Assessment was developed to measure function in children with cerebral palsy (Bach, Reddihough, Burgess, Johnson, & Byrt, 1994, Reddihough, Bach, Burgess, Oke, & Hudson, 1990). The test–retest reliability of the Melbourne Assessment consisted of a study population of 20 children with cerebral palsy of varying types and severity and indicated that the Melbourne Assessment was highly reliable with the sample population. An initial reliability study resulted in the final 16 items. The development of the clinical test battery quantifies the quality of upper-limb function and demonstrates

Table 1. Physical Characteristic and Taped Areas of the Subjects

Subject Impairments	Sex	Age	Area Taped
1. R hemiplegia/encephalitis	F	4 yrs	forearm supination, triceps, finger extension, thumb extension, palmar stability
2. L hemiplegia/CVA	F	7 yrs	supination, wrist extension, thumb extension
3. L hemiplegia/ seizure	F	7 yrs	scapula stability, supination, encephalomyelitis, palmar stability
4. R hemiplegia/CVA, brain tumor	F	10 yrs	wrist extensor, palmar stability, thumb extension, scapular stability
5. R hemiplegia/brain tumor	F	12 yrs	scapular stability, supination, palmar stability
6. Traumatic brain injury	M	12 yrs	scapular stability, wrist extension, deltoid
7. R hemiplegia/Traumatic brain injury	M	16 yrs	scapula stability, deltoid, supination, palmar stability
8. R hemiplegia/brain stem CVA	M	12 yrs	back extensor, palmar stability thumb extension, postural correction
9. Generalized muscle weakness, cerebral palsy	M	14 yrs	wrist extension, palmar stability, deltoid, thumb extension
10. C2-C6 SCI lesion/brain tumor	F	8 yrs	wrist extension, thumb extension, palmar stability, scapular stability
11. Left shoulder arthritis/sickle cell disease, multifocal osteomyelitis,	F	11 yrs	scapula stability, deltoid
12. SCI C5-6 incomplete/tetraplegia	F	14 yrs	finger extensor, wrist stability
13. SCI C5-6 incomplete/tetraplegia	F	15 yrs	finger flexors, wrist extensors, scapula, deltoid
14. SCI C5-6 incomplete/tetraplegia	F	15 yrs	wrist extension, palmar stability, deltoid
15. SCI C6-7 incomplete/tetraplegia	M	16 yrs	finger flexor, thumb opposition, palmar stability

Note. C2–7 cervical spinal levels 2–7; CVA = cerebral vascular accident; L = left; R = right; SCI = spinal cord injury.

Table 2. Melbourne Assessment Test Items (Randall et al., 1999)

Items	Task
1	Reach forward
2	Reach forward to an elevated position
3	Reach sideways to an elevated position
4	Grasp of crayon
5	Drawing grasp
6	Release of crayon
7	Grasp of pellet
8	Release of pellet
9	Manipulation
10	Pointing
11	Reach to brush from forehead to back of neck
12	Palm to bottom
13	Pronation/supination
14	Hand to hand transfer
15	Reach to opposite shoulder
16	Hand to mouth and down

a strong relationship between the Melbourne Assessment and subjective judgment of the clinicians (Johnson et al., 1994). Interrater, intrarater, and test–retest reliability were at a high level, indicating the Melbourne Assessment performs very reliably when used for the population it was intended (Randall et al., 1999).

Johnson et al. (1999) describes the evaluation of 11 children with cerebral palsy and found agreement with the clinical experts' and the children's score on the objective assessment. By using statistical correlation analysis, the subjective judgment of the clinical experts established the concurrent validity in strong agreement.

The evaluation validity of the Melbourne Assessment was used to determine sensitivity to change in the children's upper-limb function. The manual describes the study in detail and concludes that the instrument is significantly sensitive to measure change in function (Randall et al., 1999).

Bourke-Taylor (2003) investigated the performance on the Melbourne Assessment as it related to the child's ability to perform functional skills using the Pediatric Evaluation Disability Index (PEDI). The Melbourne Assessment is a criterion-referenced assessment with items that relate to a child's ability to perform daily living skills. A correlation study comparing the Melbourne Assessment and the PEDI demonstrated concurrent validity between the activities of daily living/self-care domain, the mobility domain, and overall performance on the PEDI. The results confirmed a strong correlation between the Melbourne Assessment as a measure for upper-limb function and functional living skills.

Procedure

Children identified as having upper-extremity movement problems interfering with function were evaluated with the Melbourne Assessment. To prevent bias and to examine inter-tester reliability in administering and scoring the Melbourne Assessment each child's performance was administered and scored by a qualified and experienced occupational therapist familiar with the requirements of each test item and the components of movements scored for each test. A certified occupational therapy assistant was trained to videotape the assessment, which was administered following the guidelines and specific instructions of the assessment.

The Melbourne Assessment was given prior to taping and immediately after application of the Kinesio Tex during the same session to prevent the subject from practicing the skills used in the assessment. The Melbourne Assessment was again administered after the child had worn the tape constantly for three days. The adhesive qualities and elasticity of the Kinesio Tex normally last 3–5 days. Because some children washed their hands frequently, subjecting the tape to excessive wear, the palmar stability tape application was reapplied daily.

An occupational therapist certified in the Kinesio Taping method evaluated the child's ability to use his or her upper extremity for performing functional task. The Kinesio Taping method was applied to assist with a weakened muscle and to improve joint stability and alignment as a means to assist the arm and hand in performing functional task (Kase, 2000; Kase et al., 2003). This therapist was involved only in the taping intervention phase and not the measurement phase of this pilot study.

Case Methodology. To illustrate the use of the Melbourne Assessment as a tool to evaluate upper-limb function and the qualitative decision making and processes underlying the application of Kinesio Tex, one subject's clinical case will be described.

A 12-year-old boy in previously good health was admitted to the acute-care hospital with pneumonia. A magnetic resonance image showed extensive areas of acute infarct involving the brain stem, basal ganglia, cerebellum, thalamus, and frontal lobe cortex. A percutaneous gastric tube was placed 1 month after the acute onset of symptoms and he was transferred to the Rehabilitation Institute of Chicago pediatric program. On initial evaluation he presented with spasticity right-sided involvement (lower extremity greater than upper extremity), and dysphagia. He was able to comprehend simple instructions and answered yes or no by a head nod. He was able to use a language board for communication and preferred to use his right hand for pointing.

The boy's right-arm function was evaluated with the Melbourne Assessment. He demonstrated full passive range of motion of both upper extremities. He exhibited mild spasticity of the right upper extremity with a Modified Ashworth Score of 1+ in the biceps and finger flexors

(slightly increased tone) and 2 in thumb flexors (more marked increase in tone, but affected parts are easily moved). He exhibited flexion of the thoracic-lumbar spine with a posterior pelvic tilt in sitting. He postured his head forward and down with his shoulders protracted. His active range of motion for overhead activities was limited due to decreased trunk stability and poor postural alignment.

During the testing session, he was seen in his wheelchair with the lateral trunk supports removed. He exhibited dystonic movement and overshooting when attempting to reach for items in front and to the side of him. Upon grasping, he was able to maintain the wrist in a neutral position, but he lacked fine finger prehension and used an immature mass grasp and release pattern (Figure 1). Prior to Kinesio Tape application he obtained a 57 out of a maximum possible score of 122 points (47%) on the Melbourne Assessment. The child's greatest difficulties appeared to be: poor trunk control and stability, poor alignment of the shoulder, decreased palmar stability for facilitating finger movements, and decreased thumb stability for thumb-finger prehension. This resulted in difficulty with maintaining a stable base of control for performing functional task such as writing, feeding portions of his meals, moderate assistance for oral and facial hygiene, and dressing.

Intervention: Kinesio Tex was applied from distal to proximal attachments of the erector spinae from L5 to T2 spinal level using 2-inch tape on both sides of the trunk to facilitate a functional upright position of the trunk while sitting in the wheelchair. A mechanical correction technique (tape is applied with downward pressure and pulling the elasticity out of portions of the tape as it is applied), was applied to the right protracted shoulder to assist with positioning the shoulder in neutral alignment. Tape was also applied to his right hand from the palm through his web space to provide palmar stability, support the arch, and to facilitate prehension. His thumb was taped to assist with thumb extension (Figure 2). During the initial session, the Melbourne Assessment was repeated immediately after the tape application, with a raw score of 61 (50%). Three days after wearing the Kinesio Tex, a third Melbourne Assessment was completed, resulting in a raw score of 61 out of 122 (50%). His inpatient program consisted of a daily self-care regimen, mat activities to improve trunk control and arm placement, and tabletop activities to improve fine motor skills.

Results

Means and standard deviations for the Melbourne Assessment before taping, immediately after taping, and 3 days of wearing the tape are presented in Table 3. Analysis of variance was used to compare the Melbourne Assessment scores across the 3 time periods. Overall, the Melbourne Scores improved over time, $F(2, 14) = 17.7$, $p < .001$. Further, the improvement from pre- to posttaping was statistically significant, $F(1, 14) = 18.9$, $p < .02$.

Discussion

The primary finding in this study was that the functional status of the upper limb as measured by the Melbourne Assessment improved following the application of Kinesio Tex.

The Melbourne Assessment evaluates the ability of unilateral arm and hand function and provides detailed information regarding the child's ability and disability. Through measuring change, it appeared to be adequately sensitive to document the acute change associated with wearing the tape. The items in the Melbourne Assessment were applicable to the population for whom it was developed, but it also appears to be an applicable measurement tool in children

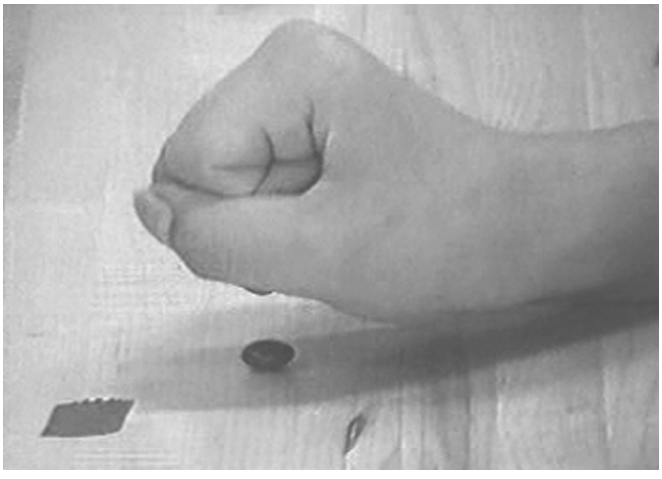

Figure 1. Grasp of pellet-item 7 of Melbourne Assessment.

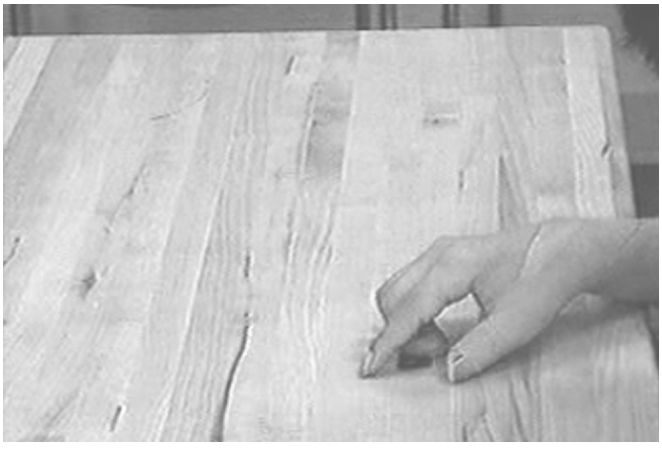

Figure 2. After taping—grasp of pellet-item 7 of Melbourne Assessment.

Table 3. Means and Standard Deviations for the Melbourne Assessment Before, Immediately After Taping, and 3 Days of Wearing the Tape

	Mean	Standard Deviation
Pretape	60.5	23.6
Posttape (immediate)	65.5	23.1
Follow-up (3 days' follow-up)	70.1	23.3

with muscle weakness from an orthopedic condition or SCI. Thus, the Melbourne Assessment may have a wider application than to the population with neurological impairment, a hypothesis that will require empirical testing. Potentially it could be used with children with muscle weakness and joint involvement or inflammation regardless of the medical diagnosis. This assessment appears to provide the sensitivity to measure change over time, particularly for children with joint involvement or inflammation and muscle weakness where changes and improvements may be very subtle.

The Melbourne Assessment was able to detect subtle changes in upper-extremity control and movement quality in children that the parents and attending occupational therapist judged to have changed. Other studies have examined the effect of Kinesio Taping in normal subjects and found no difference in maximum leg press (Cabri, Olivera, & Coelho, 2002) or in pain and function following maximal exercise and delayed onset muscle soreness in the taped and untaped conditions (Shoger, Nishi, Merrick, Ingersoll, & Edwards, 2000). The effects of Kinesio Taping may be so subtle as to be observed only in cases where movement disorders are present. Studies examining effects of the tape on normal subjects may not detect the subtle improvements in movement observed with the Melbourne Assessment. The use of the Kinesio Taping method appeared to have improved purposeful movement, provided needed stability of the shoulder and/or hand, and alignment to perform the task for reach, grasp, release, and manipulation.

Although this pilot study demonstrated an association between use of Kinesio Taping and treatment outcome, a number of additional studies are required (1) to determine the sensitivity of using the Melbourne Assessment in detecting small but clinically significant changes for children with SCI or orthopedic conditions, (2) to evaluate the responsiveness to giving the Melbourne Assessment over time to a controlled group, (3) to examine other assessment tools and to determine correlation with results obtained using the Melbourne Assessment, (4) to compare the use of Kinesio Taping application with a control group design to investigate the effectiveness of Kinesio Taping, and (5) to determine the lasting effects on motor skill performance once the tape has been removed.

Limitations

This study was a quasi-experimental design with pre- and postmeasure but no control group. Subject selection was a challenge in the clinical setting as well as the time frame in completing this pilot study. Clinically, this study demonstrated that the Kinesio Taping application may be associated with improvements in upper-extremity function. These improvements were noted as long as the tape was applied; further studies should examine the duration of the effects once the tape has been removed. The Melbourne Assessment detected a gradient of performance change with Kinesio Taping. After performing the initial assessment the child was then immediately taped and reassessed to prevent any motor learning effects on task familiarization. This eliminates practice of the motor skill as a factor in for the probable change in the quality of arm movement. The natural recovery of children who present with different diagnoses such as SCI posttrauma and a child with brain-based diagnoses may be very different. The immediate change in both diagnostic groups seen after the application of the tape may potentially be attributed to the sensory input provided by the Kinesio Tape, although without a control group no definitive conclusion can be drawn. However, these children are receiving multiple interventions during their inpatient stay, many also likely receiving medications, and one cannot rule out maturation and normal recovery from central nervous system and orthopedic conditions. The continued improvement in upper-limb functional skills observed on day 3 may be the combination of the sensorimotor input of the tape, the continued therapy program, or the natural recovery that is likely occurring at the same time spontaneously.

Conclusion

This change associated with use of Kinesio Taping emerged after 3 days' post-intervention, and is not a long enough assessment of the outcome to support the widespread use of this intervention. However, this pilot study investigated the initial outcome of taping that could ultimately provide the basis for a controlled study to support and document changes in relation to using the Kinesio Taping technique over longer periods. As clinicians we have an obligation to evaluate new treatment techniques with objective measures for assessing change in function. Taping a child's upper extremity can be crucial for participation in activities of daily living, and thus a primary concern to practioners working with children to optimize areas of self-care. ▲

Acknowledgments

The research was supported by the Buchanan Family Fellowship in Occupational Therapy. We would also like to thank Dr. Allen Heinemann and Dr. Sue Mukherjee for their statistical assistance, and Dr. Kristinn Heinrichs, PhD, PT, for her editorial assistance.

At the time of the study the investigator, Audrey Yasukawa, was working at the Rehabilitation Institute of Chicago.

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