CASE REPORT

Treatment of a brachial plexus injury using kinesiotape and exercise

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ABSTRACT

Purpose: This describes a child whose neonatal brachial plexus injury was treated with kinesiotape and exercise. Description: The subject was a two-year-old female whose X-rays demonstrated severe inferior subluxation of the humeral head and winging of the scapula on the left. She was fitted with a shoulder brace with surgery scheduled in six months. The initial PT exam noted 80 degrees of shoulder abduction (trumpet sign), significant asymmetry, and nonuse. Mallet score was 15/25. Treatment consisted of d/c of the brace and E-stimulation, parent education on exercise and taping, and kinesiotape to facilitate rotator cuff and scapular stabilizers. Typical wear time was 2–3 days on, 1–2 days off. Outcomes: After 2 weeks, there was prominent deltoid definition. The shoulder was in 20 degrees of abduction, shoulders level with less scapular winging. Scapular stabilizers were then taped. At 4 weeks, her arm was held to her side displaying a stable symmetrical scapula. The arm displayed increased fine motor use and initiation of activities. At 10 weeks there was a forced d/c, and a decline toward baseline levels. After 2 weeks of reinstatement, function returned to prior level. At 20 weeks (12 total visits) she displayed full ROM, symmetrical shoulders, Mallet score of 20/25, rare trumpet sign, and was hanging by arms during play. X-rays displayed significant improvement in humeral head position, rib cage rotation, angle of scapula and clavicle, and size and mineralization of humerus. Reconstructive surgery was cancelled. Discussion: Kinesiotape and parent education made a significant difference in this child’s function.

INTRODUCTION

Neonatal brachial plexus injuries are frequently seen in the physical therapy department with treatment most often beginning soon after birth (Basciani and Intiso, 2006; Malessy and Pondaag, 2009). Treatment ranges from periodic monitoring to neurosurgical repair dependent upon the severity of the injury, the speed of spontaneous recovery, boney changes, and the age of the child (Yam, Fullilove, Sinis, and Fox, 2009). Neonatal brachial plexus injuries are noted in approximately 2 per 1,000 live births (Malessy and Pondaag, 2009). The injury occurs at some point during late pregnancy or the birth process due to a pressure or a traction injury on any of the brachial plexus components (Dunham, 2003). Full recovery rates are thought to be as high as 95% with conservative treatment (Malessy and Pondaag, 2009; Pollack, Buckman, Yaffe, and Divon, 2000). However, if later monitoring of residual deficits are included, full recovery rates drop to 70%–80% (Malessy and Pondaag, 2009).

Recovery is very dependent on the severity of the neural injury. A generally followed treatment strategy is neurosurgical repair if antigravity deltoid and bicep movement is not available by 2 months of age (Malessy and Pondaag, 2009). Early surgery most often involves reconstruction of neural tissues, whereas secondary reconstruction often not done until 3 years of age or older may involve muscle or tendon transfers or boney osteotomies (Bain, Dematteo, Gjertsen, and Hallenberg, 2009; Dodds and Wolfe, 2000). Historically, muscles associated with good long-term progression include deltoid, triceps, biceps, and wrist extensors (Bain, Dematteo, Gjertsen, and Hallenberg, 2009; Noetzel, Park, Robinson, and Kaufman, 2001).
The last muscles to show sign of recovery are typically the external rotators and supinators (Malessy and Pondaag, 2009). Without these active muscles children often experience shoulder subluxation, adduction and internal rotation contractures, and resultant boney deformities. This greatly impacts function as the typical daily demands on the upper extremities increases as the child matures. Thus, some research has suggested that the external rotators and supinators have the highest correlation with ultimate long-term functional outcome (Hoeksma et al., 2004). Unfortunately, surgical reconstruction when these secondary complications arise has its own difficulties. Surgical reconstruction typically entails a 2- or 3-day hospital stay and a shoulder spica/body brace for 6–8 weeks (Bain, Gematteo, Gjertsen, and Hollenberg, 2009; Dunham, 2003). Besides the pain of boney surgery and extensive medical costs, there is difficulty with compliance in a young child and physical therapy is still needed for 6 months after the brace is removed (Dunham, 2003).

There is very little research examining conservative treatment of obstetrical brachial plexus sequelae. Baschian and Intiso (2006) studied 22 children treated with botulinum toxin and plaster casting. As a result, active elbow range and upper extremity function was significantly improved. In a case study, Gum (2003) was able to display significant functional improvement when a 27-month-old child was treated in physical therapy with manual therapy, neuromuscular reeducation, and therapeutic exercise. There has also been some preliminary research indicating that threshold electrical stimulation may show some promise (Kerr et al, 2006).

The Mallet system is a scale developed to objectively evaluate the shoulder function of children after brachial plexus injury (Bae, Waters, and Zurakowski, 2003; Gilbert, Razaboni, and Amar-Khodja, 1988). It uses a scale of 1 to 5 with 5 being normal and 1 being no movement. It was later modified to include internal rotation (Gilbert, 1993) (Figure 1). Both interrater and intrarater reliability has been demonstrated in children with brachial plexus birth injury (Bae, Waters, and Zurakowski, 2003). One of the components of the Mallet system is the trumpet sign (Figure 1). When a shoulder is subluxing, the individual will often seek a position of comfort that holds the humerus in the socket. This position is shoulder abduction when the hands are in front of the body. This effectively shortens the deltoid and gives it a better chance to work appropriately. It is commonly a position used when an individual plays the trumpet, thus its name, trumpet sign (Bae, Waters, and Zurakowski, 2003; Gilbert, 1993; Gilbert, Razaboni, and Amar-Khodja, 1988).

Another treatment that has possibilities for positive treatment of neonatal brachial plexus injuries is the use of flexible tape. Kinesio Tape® was selected for use in this patient (KinesioTex Tape, Kinesio USA, LLC, Albuquerque, NM). Kinesio Tape® was developed in Japan by Dr. Kenzo Kase (Kase, Martin, and Yasukawa, 2006). It can be used for both muscle relaxation and to facilitate muscle contraction depending on application. The theory is that by applying the flexible taping from a muscle’s origin to insertion that it will facilitate the muscle contraction. Because most of the evidence is anecdotal with very low levels of evidence, it is difficult to determine the mechanism of action or its efficacy in different populations. However, as clinicians are beginning to see more and more clinical evidence of its use in varying patient populations, research as to its effectiveness and use is increasing in the literature (Jaraczewska and Long, 2006; Thelen, Dauber, and Stoneman, 2008; Yasukawa, Patel, and Sinsung, 2006; Yoshida and Kahanov, 2007).

The purpose of the current case report is to describe the treatment and subsequent progress of a 2-year-old child whose brachial plexus injury was treated successfully with Kinesio Tape® and exercise.

![FIGURE 1 Mallet classification.](image)
Prior to the use of this case information, the patient’s mother received and signed an Informed Consent. IRB approval was received by both the treating outpatient clinic and the local university where the treating therapist was a full-time employee. There was no relationship between the author and the manufacturer of Kinesio Tape® at any time before, during, or after this report.

**CASE DESCRIPTION**

The patient was a 2-year-old female with a diagnosis of brachial plexus birth injury. She presented at her local outpatient rehabilitation facility with her mother. Referral from the physician stated, “Physical therapy evaluation and treat, electrical stimulation, range of motion, and exercise, return for surgical reconstruction in 6 months.”

**History**

The child had been followed periodically at a large regional hospital and also received physical therapy from an outpatient center closer to her home, until 1½ years of age. She had been discontinued from the local physical therapy when she had reached her functional goals and her progress plateaued for a period of time. A follow-up at the regional hospital at age 2, was considered successful until late in the examination when x-rays demonstrated severe inferior subluxation of the humeral head and severe winging of the scapula. As a result, the child was fitted with a nighttime brace to stretch shoulder internal rotators and referred to physical therapy at her prior outpatient center close to her home. Boney and soft tissue reconstructive surgery was scheduled in 6 months.

**Evaluation/examination**

At the initial physical therapy examination the child was observed to hold the involved shoulder in approximately 80° of abduction (significant trumpet sign), displayed significant asymmetry between sides, severe winging of the involved scapula, used the arm only as an assist, and always transferred objects to the noninvolved hand for manipulation (Figure 2). She was unable to catch a playground ball with both hands, avoided weight bearing on the involved upper extremity, and could not engage in playground activities that required climbing and support of her body weight through the involved upper extremity. Her range of motion was limited to 10° of external rotation from neutral and supination to 45° from neutral. Her Mallet score was 15/25.

**Diagnosis/prognosis**

The patient displayed signs and symptoms consistent with a diagnosis of 5F impaired peripheral nerve integrity and muscle performance associated with peripheral nerve injury. The associated ICD-9-CM code was 767.6 birth trauma, injury to brachial plexus. 5F displays a prognosis of 4–8 months for optimal outcomes and a range of 12–56 patient visits. However, this patient at 2 years of age was well beyond these parameters. The therapist determined the prognosis to be fair for increasing function due to the strong support of the family, the engagement the child had with her surroundings, and her high level of communication skills. Limiting factors to her progression included the fear the child displayed for manipulation of her involved upper extremity, her wariness of strangers, and the severity of her muscle weakness.

**Intervention**

Treatment at the local outpatient clinic consisted of discontinuing use of the night resting brace because...
the child was not sleeping, and her family could no longer deal with her crying throughout the night. Electrical stimulation was also discontinued because the child refused to comply with any handling or external devices. The primary therapist then began active treatment with parent education. The patient underwent a short, 3- to 4-day trial of a very small piece of tape to ensure no allergic reaction would occur and to assess patient compliance. The parent was taught how to apply the tape, the position of the tape, and instructed in play activities that would facilitate shoulder external rotation, weight bearing through the involved shoulder, and two-handed activities. The parent was instructed to encourage the exercise as part of play and avoid mandatory forcing of any activity. The tape was placed in such a way to facilitate rotator cuff function. This was accomplished by placing one piece of tape from the origin to the insertion of the deltoid and stretching the tape slightly before application. Primary placement was over the middle, anterior, and posterior segment of the involved deltoid muscle. After the parent became proficient in positioning and applying the tape, the parent was responsible for tape rest days and reaplication of the tape throughout the week. The tape was typically left on for 2–3 days with a 1-2-day break before reapPLYing. The average weekly wear time was 4–5 days/week.

At 2 weeks, taping was modified to include the scapular stabilizers. A second piece of tape was added from the medial border of the scapula, just distal to the spinous process, to the insertion of the deltoid (Figure 3). At 10 weeks of treatment (9 total patient visits) there was a forced 3-week discontinuation of taping due to the patient’s illness. Taping began again and continued through 20 total weeks of taping prior to her return for evaluation by the surgical staff.

OUTCOMES

After 2 weeks of taping (4 visits), there was significant progress. The deltoid muscle definition was prominent. The child typically held her shoulder in approximately 20° of abduction during play. Her shoulders were level and her scapula was displaying less winging.

At this point the tape was then added for scapular stabilizers. At the end of 4 weeks of taping (6 visits), the involved arm was held to her side similar to her uninvolved arm during play. She used the involved arm to initiate activities, no longer routinely transferred objects to the uninvolved arm, and displayed increased fine motor use with the involved hand such as picking up and using markers on an easel, turning pages in a book, and putting large pegs in a board. The child’s involved arm also displayed a very stable scapula on the thoracic spine with negligible asymmetry (Figure 4). At week 10 when taping needed to be discontinued due to the child’s illness she began to decline to baseline levels, losing approximately 30% of her progress by the time she returned to therapy 3 weeks later. After 2 weeks of therapy reinstatement, her function returned to the prior noted level. Also, at this time due to skin irritation, a thin coat of Milk of Magnesia was placed on the skin and allowed to dry prior to every tape application. After 20 weeks of taping (12 total patient visits) the child displayed full range of motion, a Mallet score of 20/25, and an extremely rare trumpet sign. She was able to support her body weight through her bilateral upper extremities during play both in weight bearing and hanging by playground equipment, catch a
playground ball when thrown to her with two hands, and asymmetry was almost impossible to detect (Figures 5 and 6).

The patient returned to the regional hospital for evaluation and preparation for surgery. X-rays as compared to those taken just prior to the initial examination, displayed significant improvement in humeral head position, rib cage rotation, angle of scapula and clavicle, and size and mineralization of the humerus (Figures 7, 8, and 9). Note that Figures 7 and 8 were taken in supine, whereas Figure 9 was taken in standing. As a result of the significant change in x-rays and the large change in functional skills, reconstructive surgery was cancelled.

Physical therapy continued, while efforts were made to determine how long the patient needed to wear the tape, how long breaks from the tape could last prior to losing the gained skills, and when the changes to the patient’s functional skills were permanent. The parent and family were elated as to the improvement in their child’s function and the avoidance of surgical intervention.

Taping continued to be applied by the parent with a decreasing number of days per week for the next 4 months. The child only came into therapy 1x/month during this time for a quick recheck. A total of 40 weeks of taping had occurred by this point. The last month of taping, tape was only applied 1 day per week and was then discontinued. A phone interview to the parent 6 months after the tape was discontinued confirmed the improvements had maintained over that time. The child’s activity levels and use of the involved upper extremity continued with no decrease in use or skills.
Discussion

This child displayed significant functional change with conservative physical therapy over 5 months. Significant bony improvements were also made during this time. Treatment costs were minimal, consisting of the cost of tape and 12 physical therapy visits of 30–45 minutes each. Follow up visits 1x/month over the next 4 months were approximately 15–20 minutes each.

There are many issues involved in this case but one of primary importance is patient compliance. When treating children the whole family is the patient and must be considered when treatment decisions are made. In this case, the severe bracing to stretch shoulder internal rotators was an unwise choice for this young child and her family. It is difficult to stretch shoulder internal rotators when the humerus is subluxed. Subluxation in this child’s case limited the amount of available external rotation range. Because of the child’s fear and discomfort she was very upset and was unable to move within the brace. Within a few minutes of donning the brace, the humeral head subluxed, preventing any positive impact of the brace. The family made considerable effort to comply with its use, but after 4 weeks the child still had to be restrained to apply the brace and cried throughout the night for hours. This was very disruptive for the family and led to the decision to discontinue its use.

The child also refused several trials of electrical stimulation and was very resistant to any passive handling by individuals other than her family. The use of kinesiotape appeared to give the child some control. She was a very bright and verbal child. As a result, an explanation of what was being done and why, was shared with her in an age-appropriate manner. The tape appeared to facilitate muscular seating of the humeral head in an appropriate position. This coupled with play activities to facilitate range and use of the involved arm led to a successful outcome.

Also of note was that not only the rotator cuff musculature was taped. After initial changes to the deltoid and rotator cuff muscles were apparent, taping to facilitate stabilization of the scapula on the thoracic spine was initiated. Scapular stabilization is imperative for appropriate shoulder biomechanics (Buchler et al, 2002).

The significant bony changes seen in this case were a result that was unexpected during the short time frame. The author can only theorize that the increased use and weight-bearing activities that frequently occurred contributed to these very positive changes on x-ray.

The savings in health care costs was also a significant issue. The cost of this treatment including the cost of tape was under $2,500. This is only a fraction of the cost that could be anticipated with a reconstructive surgery, 2- to 3-day hospital stay, physician follow-up, casting/bracing, and 6 months of physical therapy that is common for this type of reconstructive surgery (Dunham, 2003).

There was no doubt that parent compliance was a very positive component that contributed to the success of this program. After the traumatic trial of
bracing, the parent was very willing to be an active participant and decision maker. In this case, the therapist acted primarily as an educator and facilitator. Decisions were made as a team consisting of the therapist, parent, and child. In addition, after it became easier for the child to use the involved arm, her very active play and exploration of her environment provided all the exercise necessary. It is possible that the child could have shown improvement with exercise alone. However, the child had plateaued in progress for approximately 1 year prior to the start of this detailed episode of care. The taping appeared to be just the assist she needed to allow normal play to facilitate muscular and boney change.

Because every child with neonatal brachial plexus injury is different both in the degree and manner of injury, it is difficult to generalize these results to the entire population of children with neonatal brachial plexus injuries. Therefore, further study with larger sample sizes and standardized protocols would be extremely beneficial. In addition, exploration of when taping is most helpful in the course of the diagnosis and determining how long taping must continue before change is permanent, would also add important information regarding this treatment.

The use of Kinesio Tape® and exercise in the treatment of this case appeared to facilitate significant functional, muscular, and boney changes. It did so with little trauma to the family and minimal cost. This treatment shows considerable promise in the habilitation of children with neonatal brachial plexus injuries.

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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