EFFECT OF ACTION OBSERVATION THERAPY VERSUS KINESIO TAPING ON UPPER EXTREMITY FUNCTION IN CHILDREN WITH ERB'S PALSY

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Abstract

Background: Erb's palsy is a condition affecting children's upper limb capabilities. One common therapeutic approach is Kinesio Taping (KT), which applies elastic tape to support muscles and improve joint mobility. Another method, Action Observation Therapy (AOT), helps patients recover motor skills by having them watch and mimic movements. This study compared how AOT and KT influence hand function and grip strength in children diagnosed with Erb's palsy.

Methods: Thirty-eight children aged 5 to 7 years with C5-C6 Erb's palsy participated in a randomized controlled trial. They were divided equally into two groups: one group performed AOT alongside a regular exercise program, and the other group received KT in addition to the same exercise plan. Hand function and grip strength were measured before and after a 12-week treatment period.

Results: After treatment, children in the AOT group showed a significantly greater improvement in grip strength compared to the KT group (P < 0.001). Their performance on fine motor tasks, such as writing, flipping cards, handling objects of various sizes, and stacking checkers, also improved more markedly (P < 0.001).

Conclusions: Overall, action observation therapy led to better outcomes than kinesiology taping in enhancing grip strength and fine motor skills in children with Erb's palsy.

The study was registered on ClinicalTrials.gov (NCT06930040)

Keywords: Action Observation Therapy, Kinesio Taping, Upper Extremity Function, Erb's Palsy

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Introduction

Erb's palsy involves injury to the brachial plexus, resulting in muscle weakness or paralysis in the shoulder and upper arm due to damage commonly to the fifth and sixth cervical nerve roots [1]. This injury can also affect sensation in the affected limb. Often called Erb-Duchenne palsy, it occurs in approximately 0.2% to 0.4% of live births worldwide. The World Health Organization estimates its global prevalence at around 1% to 2%, with higher rates in less developed regions [2]. Among children with brachial plexus injuries, the Duchenne-Erb type is most common, making up about 80–90% of cases and typically caused by a unilateral upper trunk lesion [3].

This disorder impacts the nerves emerging from the neck that direct arm movements. As a result, the arm muscles often turn inward, leading to noticeable movement disturbance [4]. Erb's palsy commonly develops during childbirth, especially when the infant's neck is excessively stretched as the head and shoulders progress through the birth canal.

Physical trauma during the early months of an infant's life may also contribute to the development of this palsy. Most children eventually regain normal function, though some may experience lingering nerve impairment [5]. Early involvement in physiotherapy, with exercises designed to maintain normal positioning and flexibility of the arm, is essential to increase the likelihood of full recovery and to prevent contractures.

Initial management strategies typically include physical and occupational therapy, daily passive range of motion exercises, and the use of splints to reduce abnormal muscle co-contraction. In certain cases, persistent deformities necessitate surgical intervention [6].

Timely physiotherapeutic intervention plays a critical role in preventing joint stiffness and muscle shortening, helping children retain natural movement patterns until recovery begins. Stimulating sensation in the affected arm is also a vital aspect of rehabilitation, supporting functional restoration, as infants rely on sensory feedback for effective limb movement [7].

The use of kinesiology tape has gained popularity in recent years as a supportive tool in therapeutic rehabilitation [8]. This tape is designed to be thin and stretchy, with an ability to elongate up to 120–140% of its original length, thereby imposing minimal restriction on natural movement. Kinesiology tape supports a wide range of motion by applying variable tension to the skin, which can either relax or facilitate muscle action depending on how it is applied. Regular use has been associated with improvements in joint proprioception, muscle strength, and overall range of motion [9].

The technique for applying kinesiology tape is determined by treatment objectives, the positioning of the area in question, and the amount of pre-stretch used. Custom strip shapes, such as "X," "Y," and "I", are applied to achieve targeted functional results. Research supports that kinesiology taping can decrease muscle spasticity, improve the performance of dynamic activities, and optimize extremity function and alignment [10].

Action observation therapy (AOT) uses the brain's inherent mirror neuron system; when one watches an action, the superior temporal sulcus interprets the movement, and this visual information is processed by the mirror neuron system, which then sends motor instructions back to the visual centers. This enables the observer to understand and imitate the observed action, facilitating motor learning and rehabilitation in children with neuromuscular conditions [11].

This study is grounded in the hypothesis that neither action observation therapy nor kinesiology taping have a significant effect on daily living activities for children with Erb's palsy, and that there is no difference between these two methods in terms of enhancing hand function or grip strength in these patients.

Patients and Methods

This randomized controlled study was conducted on a total of 38 children diagnosed with Erb's palsy affecting the C5 and C6 nerve roots, between 5 and 7 years of age, and including both boys and girls.

The research began after receiving approval from the Scientific and Research Ethics Committee at Kafr-Elsheikh University, Kafr-Elsheikh, Egypt. Informed written consent was obtained from the legal guardians of all participating children.

Exclusion Criteria

Children were excluded if they had shoulder subluxation or dislocation, congenital abnormalities, underlying serious medical conditions, those who had already undergone surgical intervention, or cases with complete sensory loss.

Randomization

An internet-based randomization tool (http://www.randomizer.org) was utilized to generate a random sequence list. Each participant's identification code was sealed in an opaque envelope to ensure allocation concealment. Participants were randomly distributed in equal numbers into one of two parallel groups following a 1:1 randomization scheme:

- Group A: Received action observation therapy (AOT) in addition to a conventional exercise program.
- Group B: Received kinesiology taping placed alongside the same conventional exercise routine provided to both groups.

Assessment Protocol

All participants underwent evaluations both before and after completion of the intervention protocols. Outcome measures included hand grip strength (using a hand-held dynamometer) and hand functionality (using the Jebsen Hand Function Test). The entire rehabilitation protocol lasted for 12 weeks.

Grip Strength Measurement (hand-held Dynamometer)

Children were instructed to sit upright on a chair without armrests. The dynamometer was positioned in the child's hand, keeping the forearm neutral and the elbow flexed at 90°. The child was asked to squeeze the dynamometer as firmly as possible and maintain this force until a reading was recorded. This procedure was repeated three times for each upper limb, allowing one-minute rest intervals between attempts [12]. The average of these three readings, expressed in kilogram-force, was taken as the recorded grip strength.

Hand Function Assessment (Jabsen Hand Function Test)

In line with [13], this standardized, objective test evaluates a range of daily hand functions. The assessment comprises seven items and requires approximately 15–45 minutes to complete. Tasks include writing, turning over 3-by-5-inch cards, grasping small common objects, simulated feeding, stacking checkers, and manipulating both large light and large heavy objects. The required time to complete each task is recorded. The same sequence of tests is administered in all participants, beginning with the non-dominant hand [14] .

Treatment procedures

Action observation therapy protocol

The intervention group participated in a 30-minute standard, carefully selected physical therapy program, supplemented by an additional 30 minutes of action observation therapy (AOT) targeting the upper extremity. This combined regime was conducted three times per week over a span of three consecutive months, resulting in a total therapy time of three hours weekly. During AOT sessions, the therapist provided guidance and supervised repeated task practice, each task was performed in three repetitions. The children observed 3-minute videos for each task, displayed on an adjustable monitor positioned approximately one meter in front of them, from several perspectives including front, side, and rear views. Following observation, each child was encouraged to replicate the task using the same tools, with verbal instructions and assistance from the therapist throughout the process [15]. The AOT comprised six unimanual tasks, such as pressing a rubber stamp, stacking cups, drinking from a cup, grasping a pen, flipping cards, and placing objects on a stick, and six bimanual tasks including opening bottle lids, punching holes in paper, folding towels, opening boxes, placing sweets into boxes, and buttoning/unbuttoning. For each session, children selected three tasks, consisting of two bimanual and one unimanual activity [16].

Kinesiology Taping

Shoulder taping was performed using two Kinesiotex tapes (each measuring 2.5 × 7 cm) applied in an "I" shape. The strips aligned with the natural pull lines of the anterior and posterior deltoid muscle fibers to aid deltoid muscle function. The application was carried out with the child seated, assisted by a caregiver, while the therapist supported the child's arm. The first tape commencement point was the upper border of the lateral third of the clavicle (origin of anterior deltoid fibers), extending to the deltoid prominence on the lateral midshaft of the humerus. This tape was applied while the arm was externally rotated and horizontally abducted. The second tape began at the lower margin of the posterior scapular spine (origin of posterior deltoid fibers) and extended toward the humeral deltoid prominence. It was applied with the arm internally rotated and horizontally adducted, mimicking a reaching movement toward the contralateral hip.

Forearm taping involved one Kinesiotex tape (2.5 × 20 cm), also shaped as an "I." With the elbow slightly flexed and the forearm pronated, the tape's starting point was the anterior surface of the humeral lateral epicondyle. The tape spiraled downward, passing over the anterior upper third of the ulna, continuing posteriorly around the mid-forearm, and finishing at the distal anterior border of the ulna. Minimal stretch was applied during the taping procedure [17].

Traditional Exercise Program

The baseline conventional exercise program involved several components designed to enhance upper extremity function. It began with weight-bearing activities lasting 10 minutes, which included shifting the child's body weight onto an arm that was fully extended and externally rotated while sitting, bearing weight on an outstretched arm from a quadruped position, and performing push-ups from a prone posture [18]. Joint approximation techniques were also implemented, involving the therapist applying rhythmic compressive forces manually to the wrist, elbow, and shoulder joints of the affected limb while the child sat comfortably [19]. To facilitate muscle activation, proprioceptive neuromuscular facilitation was used; this method recruited weakened muscles through neural overflow excitation from stronger muscles functioning in similar movement patterns [20]. The specific movement patterns targeted included combinations of flexion, adduction, and external rotation, as well as flexion, abduction, and external rotation. Additionally, scapulothoracic mobilization was carried out with the child lying on their side, positioning the affected side uppermost, and performing cephalocaudal and mediolateral glides of the scapula to improve joint mobility [21]. Strengthening exercises followed, consisting of progressive manual resistance focused on the shoulder abductors and external rotators. The program also incorporated stretching aimed at muscles prone to tightness, including the shoulder internal rotators (notably the subscapularis), forearm pronators, and the wrist and finger flexors. Each stretch was held for 20 seconds, then released for 20 seconds, repeated five times per session [22]. Except for weight-bearing and stretching exercises, all other activities were performed for roughly five minutes each, bringing the total duration of the conventional exercise session to approximately 45 minutes, conducted three times weekly [23].

Sample Size Calculation

The determination of the sample size was based on Cochran's formula, which calculates the necessary number of participants (n) by considering several parameters. The critical z-value was set at 1.96, corresponding to a confidence level of 95% (α = 0.05). The estimated proportion (p) of the attribute of interest in the population was assumed to be 0.14, while the acceptable margin of error (e) was specified as 0.11 [24]. Using these values, the calculated sample size amounted to 38 participants, with 19 children allocated to each group.

Statistical Analysis

All statistical computations were performed using SPSS software version 26 (IBM Corp., Chicago, IL, USA). Quantitative data were expressed as mean values with their respective standard deviations (SD) and comparisons between the two groups were carried out using the unpaired Student's t-test. For categorical variables, frequencies and percentages were calculated and analyzed using Chi-square tests or Fisher's exact test when conditions warranted. For all analyses, a two-tailed P value less than 0.05 was considered indicative of statistical significance.

Results

This study initially assessed 47 children for eligibility. Six patients did not meet the inclusion criteria, and three declined participations. Consequently, 38 children were randomly assigned in equal numbers to either Group A or Group B, with 19 participants in each group. All enrolled children completed the study and were included in the final analysis (Figure 1).

Demographic characteristics, including age, sex, weight, and height, showed no significant differences between the two groups (Table 1).

Grip strength significantly increased post-treatment compared to pre-treatment in both groups ($P < 0.001$) as shown in (Table 2).

Pre-treatment grip strength showed no significant difference between groups. However, after the intervention, Group A demonstrated significantly higher grip strength compared to Group B ($P < 0.001$), as detailed in (Table 3).

Regarding hand function measured by the Jebsen Hand Function Test (Table 4), both groups showed significant post-therapy improvements in writing speed and in picking up large light objects ($P < 0.05$). The time required to flip 3-by-5-inch cards decreased significantly after therapy in both groups ($P < 0.05$). In Group A, the duration to pick up small common objects, stack checkers, and lift large heavy objects significantly decreased post-therapy ($P < 0.05$), indicating improved performance. Conversely, Group B showed significant increases in

Table 1: Demographic data of the studied groups.

		Group A (n=19)	Group B (n=19)	P value
Age (years)		6.15 ± 0.61	5.96 ± 0.59	0.323
Sex	Male	11 (57.89%)	9 (47.37%)	0.516
	Female	8 (42.11%)	10 (52.63%)	
Weight (kg)		17.05 ± 2.15	15.95 ± 1.58	0.079
Height (m)		109.53 ± 6.35	107.21 ± 3.36	0.168

Data are presented as Mean ± SD, frequency (%).

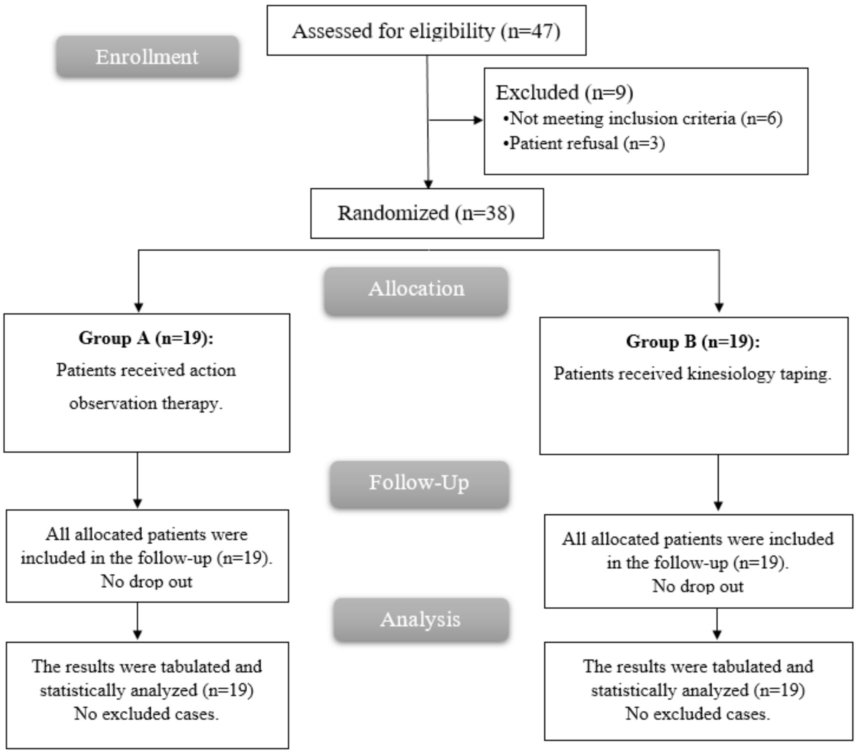

Figure 1. CONSORT flowchart of the enrolled patients.

Table 2: Inter group analysis of the grip strength by using Hand and Held Dynamometer of group A and group B.

	Pre therapy	**Post therapy**	**P value**
		Group A	
Grip strength (kg)	2.3 ± 0.18	5.5 ± 0.34	**<0.001***
		Group B	
Grip strength (kg)	2.3 ± 0.19	3.3 ± 0.19	**<0.001***

Data are presented as Mean ± SD, *Significantly different as P value ≤0.05.

Table 3: Between group analysis of the grip strength using Hand and Held Dynamometer of the studied groups.

		Group A (n=19)	**Group B (n=19)**	**P value**
Grip strength (kg)	**Pre therapy**	2.25±0.18	2.31±0.19	0.391
	Post therapy	5.46±0.34	3.28±0.19	**<0.001***

Data are presented as Mean ± SD, *Significantly different as P value ≤0.05.

Table 4: Inter group analysis of hand function using Jebsen hand function test of group A and group B.

	Pre therapy	**Post therapy**	**P value**
Writing (s)	12.2 ± 0.86	6.9 ± 0.47	**<0.001***
Turning over 3-by-5 inch cards (s)	9.9 ± 0.33	8.5 ± 0.39	**<0.001***
Picking up small common objects (s)	23.2 ± 0.66	9 ± 0.33	**<0.001***
Stacking checkers (s)	9.9 ± 0.59	5.1 ± 1.11	**<0.001***
Picking up large light objects (s)	8.5 ± 0.12	4 ± 0.55	**<0.001***
Picking up large heavy objects (s)	11.8 ± 0.43	6.7 ± 0.49	**<0.001***
Group B			
Writing (s)	76.9 ± 2.39	66.9 ± 1.47	**<0.001***
Turning over 3-by-5 inch cards (s)	11.5 ± 0.74	7.6 ± 0.21	**<0.001***
Picking up small common objects (s)	9.3 ± 0.25	8.9 ± 0.25	**<0.001***
Stacking checkers (s)	9 ± 0.25	6.7 ± 0.37	**<0.001***
Picking up large light objects (s)	8.8 ± 0.45	6.5 ± 0.31	**<0.001***
Picking up large heavy objects (s)	11.1 ± 0.17	8.4 ± 0.16	**<0.001***

Data are presented as Mean ± SD, *Significantly different as P value ≤0.05.

the time taken for these tasks post-therapy ($P < 0.05$).

Between-group comparisons (Table 5) revealed that writing speed was similar pre-treatment but significantly better in Group A post-treatment ($P < 0.001$). Times for turning over cards were initially better in Group A and remained significantly faster than Group B after therapy ($P < 0.001$). While Group A exhibited faster pre-treatment performance for picking up small objects,

Table 5: Between group analysis of hand function using Jebsen hand function test of the studied groups.

		Group A (n=19)	Group B (n=19)	P value
Writing (s)	**Pre therapy**	2.25±0.18	2.31±0.19	0.391
	Post therapy	5.46±0.34	3.28±0.19	**<0.001***
Turning over 3-by-5 inch cards (s)	**Pre therapy**	9.87±0.33	11.48±0.74	**<0.001***
	Post therapy	8.52±0.39	7.6±0.21	**<0.001***
Picking up small common objects (s)	**Pre therapy**	23.22±0.66	9.03±0.33	**<0.001***
	Post therapy	9.29±0.25	8.88±0.25	0.125
Stacking checkers (s)	**Pre therapy**	9.92±0.59	5.09±1.11	**<0.001***
	Post therapy	9.01±0.25	6.72±0.37	**<0.001***
Picking up large light objects (s)	**Pre therapy**	8.48±0.12	3.95±0.55	**0.003***
	Post therapy	8.82±0.45	6.52±0.31	**<0.001***
Picking up large heavy objects (s)	**Pre therapy**	11.84±0.43	6.74±0.49	**<0.001***
	Post therapy	11.06±0.17	8.38±0.16	**<0.001***

Data are presented as Mean ± SD, *Significantly different as P value ≤0.05.

post-treatment differences between groups were not statistically significant. Stacking checkers and handling large light and heavy objects consistently favored Group A both before and after therapy ($P < 0.05$).

Discussion

Duchenne–Erb palsy represents the predominant subtype of brachial plexus injuries in the pediatric population, constituting roughly 80 to 90% of cases. This condition arises due to an injury to the upper trunk of the brachial plexus, typically involving overstretching of the fifth and sixth cervical nerve roots during delivery or early life trauma [25]. The hallmark clinical presentation, commonly known as "waiter's tip" posture, is characterized by the arm being held in extension and internal rotation, coupled with wrist flexion. These motor deficits are often accompanied by sensory disturbances affecting the upper limb. Clinicians often suspect Erb's palsy when the Moro reflex is absent on the affected side while the hand grasp reflex remains intact, indicating selective nerve root involvement [1].

Our study demonstrated that both AOT and KT groups experienced meaningful improvements in grip strength following the 12-week therapy; however, the gains were significantly more pronounced in the AOT group. This supports emerging evidence that AOT actively engages motor circuits through the mirror neuron system, facilitating motor learning and stimulating voluntary muscle control.

The greater improvements in grip strength within the AOT group can be attributed to the therapy's active cognitive and motor involvement. Unlike passive modalities, AOT requires children to observe specific movements attentively, then consciously replicate these actions, which may promote neuroplastic changes within sensorimotor brain regions. Such adaptations strengthen neural pathways, leading to enhanced coordination and muscle recruitment, which aligns with core principles of motor skill acquisition involving repeated practice and feedback.

Complementing the strength gains, the AOT group also exhibited superior improvements in fine motor skills and hand function tasks. Specifically, times for completing activities such as flipping 3-by-5-inch cards, picking up small common objects, stacking checkers, and grasping large heavy and light objects were significantly reduced after therapy compared with the KT group. These improvements suggest that AOT not only enhances gross motor strength but also positively influences dexterity and coordination, which are essential for executing daily living activities. The decreased timing in performing these tasks likely reflects enhanced neuromuscular control and improved motor planning.

In contrast, the KT group showed less pronounced improvements, and in some fine motor tasks such as picking up small common objects and stacking checkers, there was an increase in task completion time post-therapy, indicating limited or no functional progress. Although kinesiology taping can provide mechanical support and potentially improve muscle activation by stimulating skin receptors and enhancing proprioceptive feedback, its effects appear insufficient alone to drive meaningful improvements in complex motor tasks that require active engagement and cognitive input [26].

The kinesiology taping technique applied in this study involved strategically placing two 2.5 × 7 cm strips in an "I" shape over the anterior and posterior deltoid muscle fibers to augment deltoid function, accompanied by one 2.5 × 20 cm tape spirally applied to the forearm to support wrist and finger muscles. This approach seeks to improve muscle activation and stabilize joints by mechanically easing tension in the tissues and gently lifting the skin. These effects may enhance blood flow and help alleviate discomfort [27]. The gentle stretch applied during the taping process preserves flexibility while delivering sensory feedback that can promote better movement coordination.

However, despite these advantages, kinesiology taping alone may have limitations that reduce its overall effectiveness for functional rehabilitation in children with Erb's palsy. Similar observations in other pediatric neuromuscular disorders suggest that, although KT can support muscle performance, it does not sufficiently stimulate the central nervous system pathways needed for effective motor relearning [28].

Backing these observations, Kamal-Eldeen and colleagues found that combining kinesiology taping with conventional physical therapy improved wrist extension and functional abilities in children with Erb's palsy, underscoring the value of early therapeutic intervention [29]. Likewise, research by ElKhatib demonstrated that integrating kinesiotherapy with additional rehabilitation techniques promotes faster and smoother recovery in this population [30].

Together, these findings emphasize the necessity of a comprehensive treatment strategy that blends passive support methods with therapies that actively engage motor function. Further supporting our results, Li and coauthors highlighted the superior role of active rehabilitation—where patients actively participate in motor exercises and functional tasks—in driving meaningful recovery [31]. Such active approaches encourage brain reorganization and strengthen motor circuits essential for lasting functional improvements. Occupational therapy typically plays a complementary role by targeting task-specific skills and fine motor control, both crucial for achieving greater independence and enhancing quality of life.

Our controlled, randomized study contributes uniquely to the literature by directly comparing AOT and KT in the context of upper extremity rehabilitation in children with Erb's palsy, an area with previously limited comparative research. The results underline the superiority of AOT in enhancing grip strength and fine motor functions necessary for daily living activities.

Nevertheless, the study has several limitations to consider. The sample size of 38 children, although adequate for preliminary findings, limits the statistical power and potentially the generalizability of the results. Additionally, being a single-center study, the findings may reflect institutional-specific factors and may not be broadly applicable across different clinical settings or populations. A further limitation is the absence of a non-intervention control group, which precludes definitive conclusions on the absolute efficacy of either therapy compared to natural recovery trajectories. Future research should address these gaps by conducting multicenter, large-scale randomized controlled trials with long-term follow-up assessments to better define optimal intervention strategies.

In conclusion, our findings confirm that action observation therapy leads to greater improvements in grip strength, writing speed, and essential hand functions such as turning cards, object manipulation of various sizes and weights, and stacking checkers compared with kinesiology taping in children with Erb's palsy. These results underscore the significance of therapies that actively engage neural motor systems and encourage cognitive-motor integration for effective rehabilitation in pediatric brachial plexus injuries.

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