

Early Conservative Physical Therapy Management of Babies With Obstetric Brachial Plexus Injury to Facilitate Spontaneous Recovery

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Objective: To evaluate the effect of early immobilization and proper handling techniques in infants with Obstetric Brachial Plexus Injury (OBPI) in the first 2 weeks of life.

Method: Six 1-day-old infants (2 males and 4 females) with OBPI were included. The assessments were done at baseline, post-intervention, and 3-month follow-up, which involved a physical exam, Narakas classification, Active Movement Scale, and gross and fine motor skills evaluation.

Result: All infants had upper Erb's palsy. They had statistically significant improvement in the Active Movement Scale scores post-intervention with a large effect size. These improvements were maintained at follow-up. All infants achieved age-appropriate gross and fine motor skills with the affected upper limb at 3 months of age.

Conclusion: Early conservative physical therapy management had a statistically significant effect on enhancing spontaneous recovery and preventing further nerve injury in OBPI infants. (Pediatr Phys Ther 2025;37:100–108)

Key words: conservative management, neonatal brachial plexus injury, obstetric brachial plexus injury, physical therapy, rehabilitation

INTRODUCTION

Obstetric brachial plexus injury (OBPI) refers to damage to some or all of the nerve roots that conduct signals from the spinal cord (C5-T1) to the upper extremities and can be associated with ocular impairment, known as Horner's syndrome.¹ It is the most common injury in newborn infants, with an incidence of 0.5 to 2 per 1000 live births.^{2,3} Moreover, OBPI is a peripheral nerve injury that possibly leads to physical disability and long-term financial and psychological consequences.⁴

Diagnosing OBPI starts with obtaining an obstetrical history to identify risk factors such as macrosomia (birth weight exceeding

4 kg), a diabetic mother, breech delivery, shoulder dystocia, a mother's small pelvis, or a prolonged expulsion phase. These factors are unpredictable and multifactorial, making prevention difficult.^{1,5,6}

To ensure an accurate diagnosis, a comprehensive examination helps rule out conditions mimicking brachial plexus palsy, including upper limb injuries and infections, spinal cord issues, tumors, and congenital deformities such as arthrogryposis.⁷ Diagnosing OBPI relies primarily on clinical examination, which involves observing posture and spontaneous movements, evaluating primitive reflexes, measuring active and passive upper extremity range of motion and strength, and stimulating the cutaneous area corresponding to the affected muscle. Evaluating sensation in infants poses challenges due to age. However, inspection is one method of identifying sensation as infants tend to ignore the affected side and keep their heads turned away from it, which suggests that they have a lack of sensations.^{8,9} Radiological examinations eliminate the possibility of associated fractures in the humerus or clavicle. The contralateral upper limb is examined for signs of bilateral involvement.¹

Several valid, objective tools exist to assess upper limb function in infants and children with OBPI, targeting different age groups and providing valuable insights into a child's progress. The Toronto Test Score, used at 3 months, is a 7-point scale that quantifies 5 key movements and predicts long-term recovery to aid surgical decision-making. For children over 3 years old who can follow instructions, the Mallet Scale assesses their ability to perform specific tasks on a 5-point scale. The Active Movement Scale (AMS), an 8-point grading

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WHAT THIS EVIDENCE ADDS

Current Evidence: The evidence of rehabilitation of infants with Obstetric Brachial Plexus Injury (OBPI) supports the importance of early referral to a multidisciplinary management model to initiate the intervention by specialized therapists as soon as possible to optimize outcomes.^{4,22-24} The conservative intervention includes passive movements, sensory stimuli, and guidance for the child's caregivers.^{17,18}

Gap in the Evidence: Although early management of infants with OBPI was recommended by multiple previous studies, the effects of early management at the 2 weeks after birth have not been established.

How did this study fill this evidence gap? We studied the effect of early immobilization and proper handling techniques as early conservative physical therapy management in the first 2 weeks in infants with OBPI. We found that early management supported large favorable effects in infants with OBPI as it helped protect against nerve stretching and other provoking factors.

Implication of all the evidence to clinicians: Early immobilization and proper handling techniques appear to be beneficial in enhancing spontaneous recovery and preventing further nerve injury. Incorporating physical therapy into early management could improve the outcomes of those infants.

system, objectively measures upper limb strength for newborns through adolescence.^{8,10}

The Narakas classification is a tool used to categorize the severity of the condition. It is an ordinal scale consisting of 4 categories: Narakas I (C5–C6, upper Erb's), Narakas II (C5–C7, extended Erb's), Narakas III (C5–T1, total paralysis), and Narakas IV (total paralysis with Horner's syndrome, indicating root avulsion). As one progresses from Group I to Group IV, the overall prognosis for spontaneous recovery reduces, leading to a higher probability of considering primary surgery.¹¹ Isolated lower plexus injuries (C8–T1, Klumpke palsy) are not a part of the Narakas classification and are rare.¹²

The outcomes of OBPI vary and can be temporary or permanent motor and sensory deficits depending on the extent and severity of the injury, which ranges from stretching neuropraxic, axonotmesis, neurotmesis, and avulsion, which is considered the most severe injury.¹³⁻¹⁶

Management of infants with OBPI involves both conservative and surgical intervention. The conservative intervention started initially includes passive movements, sensory stimuli, and guidance for the child's caregivers. Primary surgical nerve repair is carried out for those with the most serious damage who have minimally improved and is optimally performed between the ages of 3 and 12 months.^{17,18} Subsequently, when a child has residual dysfunction after primary surgery or has experienced partial spontaneous improvement with persistent deficiencies, secondary surgical interventions, such as tendon transfer, arthrodesis, or osteotomies, are undertaken to improve movement and enhance function.¹⁹

The total spontaneous recovery rate is reduced to 66%, with residual deficits present in 20% to 30% of affected individuals and significantly reduced function in 10% to 15% of cases.^{20,21} Consequently, the fundamental goal of early intervention should be promoting nerve regeneration and spontaneous recovery while preventing aggravating factors, such as nerve stretching.

Previous studies reported the importance of early referral to a multidisciplinary management model to initiate the intervention by specialized therapists as soon as possible to optimize outcomes.^{4,22-24} However, the effects of early management at the 2 weeks after birth have not been established. Therefore, the

purpose of the current study was to evaluate the effect of early immobilization and proper handling techniques as early conservative physical therapy management in infants with OBPI in the first 2 weeks of their lives.

METHODS

Study Design and Procedures

This study was a case series and was approved by the institutional review board (IRB) of the King Abdullah International Medical Research Center, Jeddah, Saudi Arabia (approval no. IRB/1681/23; reference no. JED-22-427780-157790). It was carried out at the Physical Therapy Department of the National Guard Hospital, Jeddah, Saudi Arabia.

Participants were born between 2019 and 2023 and referred to physical therapy after being diagnosed with OBPI by neonatologists. All participants' caregivers received a detailed explanation of the intervention and provided written informed consent.

Early conservative physical therapy was implemented for infants for the first 2 weeks of life. Following that, they were followed at regular intervals until the age of 1 year. Their caregivers received education on a comprehensive home program to be implemented after the initial 2 weeks (including passive movements, sensory stimulation, facilitation of age-appropriate skills to enhance affected upper limb use, muscle strengthening, and proprioceptive input) to help their children achieve full recovery and prevent complications such as arm neglect, which can develop when the weaker arm is not used as much as the stronger arm. In this study, the focus was on the effect of early conservative physical therapy intervention, and the infants were assessed at 3 time points: T1 (baseline, pre-intervention on day 1 of life), T2 (post-intervention at 2 weeks old), and T3 (follow-up at 3 months old). The follow-up assessment was conducted at 3 months of age, as it is the optimal time for nerve repair surgery in infants who have not achieved full recovery.

Cases Description

Six 1-day-old infants (2 males and 4 females) had limited spontaneous movements of the upper limb and an absent Moro

reflex on the affected side. Four deliveries were normal spontaneous vaginal deliveries; 2 were assisted spontaneous vaginal deliveries. All infants were in vertex presentation during birth, with birth weights ranging from 3.18 to 4.20 kg. Four deliveries were complicated by shoulder dystocia, and 3 mothers had gestational diabetes mellitus. One of these mothers also had hypothyroidism, and another mother had hypothyroidism.

Two infants had left-sided involvement, and the remaining 4 had right-sided involvement. X-rays confirmed the absence of clavicle or humerus fractures in all infants. Table 1 provides a detailed overview of the participants' demographic and clinical characteristics.

Clinical Evaluation and Assessment

Assessments were conducted at pre-intervention, post-intervention, and follow-up at 3 months of age. At the initial assessment on day 1, all infants' demographic and clinical characteristics were collected from parents and medical records and were evaluated by inspection of the affected arm position, sensory assessment by observing the baby's head for signs of ignorance, which are indicative of sensory impairment, and evaluation of primitive reflexes (Moro and grasp reflexes). Thereafter, to classify the baseline severity of the injury, the Narakas classification was used, and to assess upper extremity function, the AMS was used.

At post-intervention and follow-up, reassessment of the affected arm position, sign of ignorance, primitive reflexes, and AMS was done. In addition, at follow-up, infants were assessed for their use of the affected upper limb in age-appropriate gross and fine motor skills.

Narakas Classification

At the time of the initial evaluation, the Narakas classification was used to determine the severity of the neurological

injury from I to IV. It focuses on body function and structure within the ICF framework, and it provides predictions for recovery. Its validity and reliability for OBPI have not been formally established. Despite this limitation, it remains the most commonly used classification tool among OBPI practitioners.^{11,25}

Active Movement Scale

The AMS is an ordinal 8-point scale ranging from 0 to 7. It objectively measures upper limb strength by observing spontaneous active movement both with gravity eliminated and against gravity; higher scores indicate stronger upper limb muscles.²⁶ The AMS can be used in adolescence.⁸ The AMS has robust psychometric properties, including fair to substantial intra-rater and inter-rater reliability, especially among experienced physical therapists.²⁷ It has content validity, indicating it accurately reflects the various injury patterns.²⁶ The AMS was used to evaluate shoulder abduction, elbow flexion, and wrist extension.

Gross and Fine Motor Skills

At the 3-month follow-up, infants were assessed for their use of the affected upper limb in age-appropriate gross and fine motor skills; the Denver Developmental Screening Test-II (DDST-II)²⁸ was used as a reference. It is an easy and simple developmental screening tool. Scoring relies on the examiner's observations and parental reports. The DDST-II demonstrates good inter-rater and test-retest reliability, and it exhibits validity with a strong correlation to established assessments like the Bayley Infant Scale and the Stanford-Binet Intelligence Scale.^{29,30}

The infants were assessed for skills outlined in the DDST-II. A 3-month-old baby should be able to weight-bear equally on

TABLE 1
Demographic and Clinical Characteristics of the Participants

N	Gender	Birth Weight	Affected Side	Narakas Classification	Mode of Delivery	Presentation of Baby	Maternal History	Delivery Complication	X-Ray
1	M	4.16 kg	Right	Upper Erb's palsy	ASVD	Vertex	Hypothyroidism GDM	Nil	No clavicle or humerus fractures
2	F	3.77 kg	Right	Upper Erb's palsy	NSVD	Vertex	Nil	Shoulder dystocia	No clavicle or humerus fractures
3	F	4.20 kg	Right	Upper Erb's palsy	NSVD	Vertex	Nil	Shoulder dystocia	No clavicle or humerus fractures
4	F	3.84 kg	Left	Upper Erb's palsy	NSVD	Vertex	GDM	Shoulder dystocia	No clavicle or humerus fractures
5	F	3.18 kg	Right	Upper Erb's palsy	NSVD	Vertex	Hypothyroidism	Nil	No clavicle or humerus fractures
6	M	3.99 kg	Left	Upper Erb's palsy	ASVD	Vertex	GDM	Shoulder dystocia	No clavicle or humerus fractures

Abbreviations: ASVD, Assisted Spontaneous Vaginal Delivery; F, Female; GDM, Gestational Diabetes Mellitus; M, Male; NSVD, Normal Spontaneous Vaginal Delivery.

Precautions for Obstetrical Brachial Plexus Injury

- Avoid wrapping the baby tightly with affected arm in adduction and internal rotation at shoulder, extension at elbow and flexion at wrist.
- Avoid pulling the affected arm while dressing/ undressing and bathing the baby.
- Avoid letting the arm dangle in space while carrying the baby.
- Avoid passive movement exercises.

Reason: To avoid applying further stretching to the injured brachial plexus and ensure good healing.

- Avoid positioning in alternate side lying.

Reason: It is difficult to position the affected arm appropriately (abduction and external rotation at shoulder, flexion at elbow, and extension at wrist). In addition, it is not recommended in the case of fractured clavicle or arm.

- Avoid doing massage particularly at site of injury.

Reason: It increases pain and decreases the possibility of good healing.

Fig. 1. Precautions for obstetrical brachial plexus injury and its reasoning.

forearms from a prone position and sit head up steadily as a gross motor skill. Furthermore, as part of their fine motor skills, infants should be able to bring their hands together and perform hand-to-mouth movements.

Intervention

The intervention started with explaining the nature of the injury and precautions to the participants' caregivers (Figure 1). Thereafter, caregivers received demonstrations and explanations for proper positioning, wrapping, and handling techniques on day 1 (Figure 2), followed by hands-on training during which the therapist demonstrated the positioning and handling techniques to the caregivers, then asked them to perform the same technique under the therapist's supervision to ensure the accuracy of their performance. On discharge day (day 2), caregivers were monitored to ensure they could effectively implement the techniques as a home program for the following 2 weeks.

Additionally, illustrations that were created by an artist and reviewed and approved by the therapist were provided to help the participants' caregivers carry out the home program properly (Figure 2).

Data Analysis

Data were entered and analyzed using SPSS (version 27), then presented via tables and graph. For descriptive analysis,

the median and interquartile range were used. Moreover, the nonparametric Wilcoxon signed-rank test was used to compare the differences between pre-intervention, post-intervention, and follow-up scores. The significance level was $P < .05$.

The Wilcoxon signed-rank test's Z value was used to calculate the effect sizes (r), and interpretation of the result was done according to Cohen's criteria of 0.1 = small effect, 0.3 = medium effect, and 0.5 = large effect.^{31,32}

RESULTS

Narakas Classification

All infants were categorized as Narakas I (upper Erb's palsy) according to the Narakas classification, which has a high likelihood of approximately 80% of spontaneous recovery.¹¹

Clinical Findings

At pre-intervention, upon inspection of upper limb posture, all infants exhibited an upper limb posture of upper Erb's palsy, characterized by shoulder adduction, elbow extension, and the wrist remaining in a neutral position. Additionally, all infants had a positive ignorance sign, and primitive reflex assessment showed an absent Moro reflex with a preserved grasp reflex in all infants.

At post-intervention, examination revealed normal upper limb spontaneous movements evidenced by shoulder abduction and external rotation, elbow flexion, and extended wrist positions except for 1 baby, whose wrist was in neutral position, and both upper limbs moved evenly throughout the full range of motion. The ignorance sign was negative in all except 1 baby. Primitive reflex assessment revealed the presence of both Moro and grasp reflexes in all infants.

In the follow-up, infants had normal spontaneous movement in their upper limbs. In addition, the ignorance sign was negative in all infants, and the primitive reflex assessment revealed the presence of both Moro and grasp reflexes in all infants (Table 2).

Active Movement Scale

Complete recovery was achieved for all participants except for 1 case, which exhibited residually limited wrist extension. The comparison of the AMS scores pre- and post-intervention had a statistically significant improvement with a large effect size in all movements: shoulder abduction (P value = .024, $r = 0.654$), elbow flexion (P value = .026, $r = 0.644$), and wrist extension (P value = .034, $r = 0.612$) (Table 3) (Figure 3).

At follow-up assessment, all participants retained the achieved recovery. Moreover, the baby who exhibited limited wrist extension at the post-intervention assessment achieved full recovery by the follow-up. The comparison of the AMS scores pre-intervention and 3-month follow-up showed a statistically significant improvement with a large effect size in all movements: shoulder abduction (P value = .024, $r = 0.654$), elbow flexion

Obstetrical Brachial Plexus Injury Rehabilitation Program

A PROPER POSITIONING



The affected arm should be positioned (using a roll) as following:

- Shoulder abduction (60 – 70 degrees).
- Shoulder external rotation.

While baby is unwrapped for changing diaper, hygiene, dressing/undressing to prevent further stretching of the injured brachial plexus.

B PROPER WRAPPING



Step 1



Step 2



Step 3



Step 4

C HANDLING TECHNIQUES



Bathing: Keep the affected arm supported.



Dressing: Start with affected arm.



Undressing: Start with the non-affected arm.



Carrying & Feeding: Always keep the affected arm supported while carrying and feeding; do not let it dangle.

Fig. 2. The rehabilitation program for obstetrical brachial plexus injury in the first 2 weeks.

(P value = .026, r = 0.644), and wrist extension (P value = .020, r = 0.674) (Table 3) (Figure 3).

Individual baby scores, descriptive and inferential statistics for the Active Movement Scale for shoulder abduction, elbow flexion, and wrist extension are shown in Table 3.

Gross and Fine Motor Skills

All infants were able to weight-bear equally on their forearms in a prone position and sit steadily with head up at 3 months. They were able to bring their hands together and perform hand-to-mouth movements.

DISCUSSION

One baby did not achieve full recovery post-intervention; this could be attributed to factors related to the caregiver's

application of the techniques. Thus, caregivers should be educated about the condition, and the program should be instructed properly for better outcomes. Furthermore, the home program should be reviewed and monitored frequently and continuously to confirm that the home program is delivered properly.

Simple, straightforward, and repeatable intervention was chosen to enable parents to carry out the home program several times throughout the day. Multiple previous studies highlighted the importance of early management with parental participation at home.^{4,33,34}

Infants had various risk factors, including birth weight exceeding 4 kg, maternal diabetes, shoulder dystocia, and complicated prolonged delivery. Moreover, 2 mothers were diagnosed with hypothyroidism; however, no research definitively links maternal hypothyroidism and OBPI. However, some studies suggest a potential association between hypothyroidism and an

TABLE 2
Clinical Findings of the Study Participants at Pre-Intervention (T1), Post-Intervention (T2), and Follow-up (T3)

Position of the Affected Arm			Moro Reflex		Grasp Reflex		Ignorance Sign	
N	Pre-Intervention (T1)	Post-Intervention (T2)	Follow-up (T3)	Pre-Intervention (T1)	Post-Intervention (T2) & Follow-up (T3)	Pre-Intervention (T1)	Post-Intervention (T2)	Follow-up (T3)
1	Shoulder adducted, elbow extended, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative
2	Shoulder adducted, elbow extended, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative
3	Shoulder adducted, elbow extended, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative
4	Shoulder adducted, elbow extended, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative
5	Shoulder adducted, elbow extended, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative
6	Shoulder adducted, elbow extended, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist in neutral position	Shoulder abducted, elbow flexed, and wrist extended	Absent	Present	Present	Positive	Negative

TABLE 3
Active Movement Scale

	Movement								
	Shoulder Abduction			Elbow Flexion			Wrist Extension		
	Pre- Intervention (T1)	Post- Intervention (T2)	Follow-up (T3)	Pre- Intervention (T1)	Post- intervention (T2)	Follow-up (T3)	Pre- Intervention (T1)	Post- Intervention (T2)	Follow-up (T3)
1	Grade 2	Grade 7	Grade 7	Grade 2	Grade 7	Grade 7	Grade 5	Grade 7	Grade 7
2	Grade 1	Grade 7	Grade 7	Grade 5	Grade 7	Grade 7	Grade 5	Grade 7	Grade 7
3	Grade 2	Grade 7	Grade 7	Grade 3	Grade 7	Grade 7	Grade 5	Grade 7	Grade 7
4	Grade 2	Grade 7	Grade 7	Grade 3	Grade 7	Grade 7	Grade 5	Grade 7	Grade 7
5	Grade 2	Grade 7	Grade 7	Grade 3	Grade 7	Grade 7	Grade 6	Grade 7	Grade 7
6	Grade 3	Grade 7	Grade 7	Grade 2	Grade 7	Grade 7	Grade 5	Grade 5	Grade 7
Median (IQR)	2.0 (2.0-2.0)	7.0 (7.0-7.0)	7.0 (7.0-7.0)	3.0 (2.0-3.0)	7.0 (7.0-7.0)	7.0 (7.0-7.0)	5.0 (5.0-5.0)	7.0 (7.0-7.0)	7.0 (7.0-7.0)
P value		T1-T2: .024 ^a T1-T3: .024 ^a			T1-T2: .026 ^a T1-T3: .026 ^a			T1-T2: .034 ^a T1-T3: .020 ^a	
Effect size, <i>r</i>		T1-T2: 0.654 T1-T3: 0.654			T1-T2: 0.644 T1-T3: 0.644			T1-T2: 0.612 T1-T3: 0.674	

Abbreviations: IQR, interquartile range; T, Assessment time points. *P* value is for the Wilcoxon signed-ranks test comparing pre-intervention, post-intervention, and follow-up scores.

^aSignificant difference, *P* < .05.

increased risk of prolonged difficult deliveries, which can increase the risk of OBPI.^{35,36}

Functional impairments frequently persist in approximately 20% of infants, although OBPI can resolve spontaneously. When spontaneous recovery does not take place, the upper limb suffers from deficits such as muscle atrophy, soft tissue contractures, a reduced range of motion, and a shortened forearm and hand, which may result in permanent impairment that causes limitations in activity and participation as defined by the International Classification of Functioning. Thus, enhancing spontaneous

recovery by protecting against nerve stretching and other provoking factors with early immobilization and proper handling techniques is important.^{4,37,38}

A previous study reported that children with OBPI may develop a preference for using their unaffected arm, which could result in a shift in their dominant arm.³⁹ Consequently, both infants who achieved full recovery and those who did not are engaged in a comprehensive physical therapy program designed to ensure complete recovery and prevent complications like arm neglect. This program incorporated passive

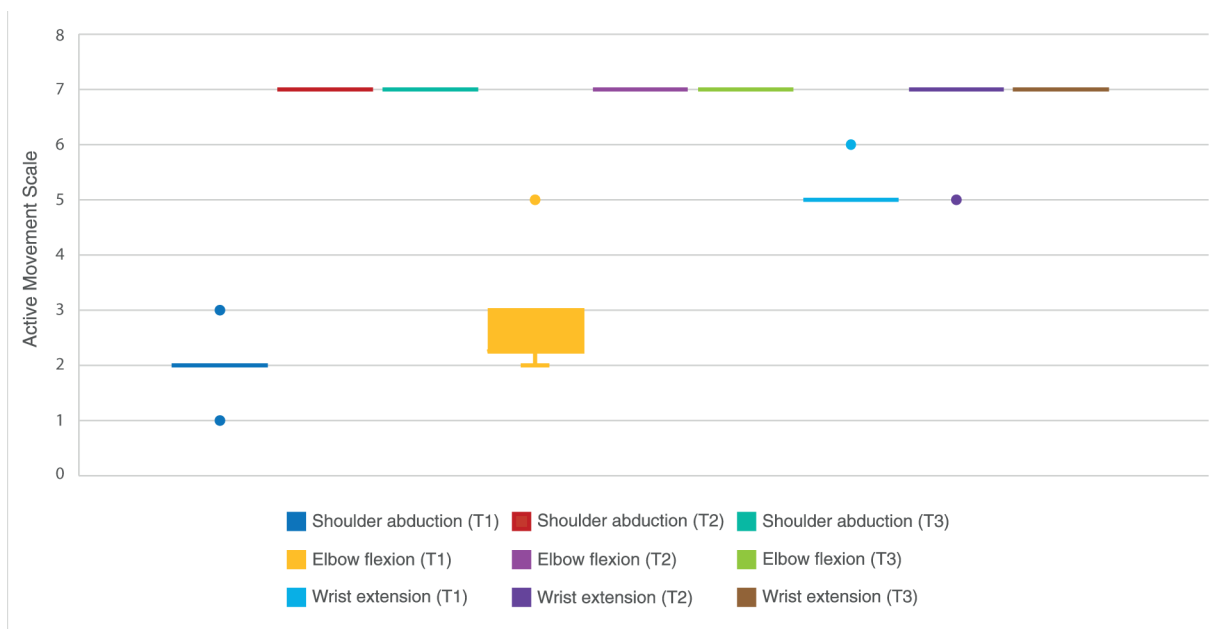


Fig. 3. Box and Whisker Plot Representing the Scores of the Active Movement Scale for Shoulder Abduction, Elbow Flexion, and Wrist Extension at T1 (Pre-Intervention), T2 (Post-Intervention), and T3 (Follow-up).

movements, sensory stimulation, facilitation of age-appropriate skills to enhance affected upper limb use, muscle strengthening, and proprioceptive input.

There is a lack of evidence investigating the effect of physical therapy intervention in the first 2 weeks; thus, the study's findings provide beneficial and useful information for this population. Moreover, the family rehabilitation model, which involves engaging the family in newborn rehabilitation, was considered when creating the intervention as it was recommended in many previous studies.^{4,33,34} Furthermore, the explanations and illustrations provided in Figures 1 and 2 will ease the practical application of immobilization and handling techniques.

This study has several limitations. The small sample size limits the generalizability of the results. A larger sample size is recommended in future studies. The absence of control cases makes it impossible to definitively confirm the effect of the early conservative intervention. All participants were classified as upper Erb's palsy using the Narakas classification. This limits the generalizability of the findings to other types of OBPI.

CONCLUSION

Early conservative physical therapy management had a significant and large effect on enhancing spontaneous recovery and preventing further nerve injury in infants with OBPI. However, further studies are needed to confirm these findings and incorporate physical therapy into early management to improve the outcomes of those infants.

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