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Original Article

Recovery of Left-Hand Mobility After Erb-Duchenne Infantile Paralysis Through Specific Manual Therapy of the Neck: A Case Study

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Authors' Contribution: A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion

ABSTRACT

Study aim(s): This study describes a relatively new strategy involving manual therapy adjustment to treat a child diagnosed with OBPP. Our primary goal was to undertake treatment actions addressing the root cause of the pathology. Considering that the main problem of OBPP lies in the cervical region, our treatment focused on the neck instead of the arm, as is common with other therapeutic methods.
Methods: The treatment protocol involved the adjustment of C5, C6, and C7 vertebrae, along with massage and stretching of relevant muscles. Manual therapy sessions were conducted three times a week for two months, focusing on the cervical vertebrae (C5, C6, and C7) and incorporating neck and shoulder muscle stretching exercises taught to the parents.
Results: Significant improvements were observed in the child's arm movement within weeks, progressing to functional use and increased range of motion. By the end of the intensive treatment period, the child demonstrated substantial motor recovery, aligning with the British Medical Council classification.
Conclusion: This case study highlights the effectiveness of targeted manual manipulation in treating OBP by addressing cervical region dysfunctions. The outcomes suggest potential benefits of this approach over traditional arm-focused therapies, warranting further research and consideration in clinical practice.

Keywords: OBPP, Manual therapy, Treatment, Cervical, Vertebrae, Dysfunctions

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INTRODUCTION

Neonatal brachial palsy, also called Erb-Duchenne palsy, is a total or partial peripheral nerve injury that may affect C5-T1 cervical and thoracic nerve roots, and occurs during birth [1]. Brachial nerve injury has an incidence of between 0.4-2 per 1000 deliveries [2]. The brachial plexus consists of the C5, C6, C7, C8, and T1 nerves, and clinical features will depend on the nerve roots that have been injured and the severity of the injury. Factors that increase the risk of a brachial nerve injury include macrosomia [3], prolonged labor, shoulder dystocia, breech delivery, and assisted delivery [4]. The injury occurs secondary to forceful traction of the infant's neck [5, 6].

A baby with Erb's palsy holds the affected shoulder in internal rotation, with the elbow extended, and the wrist in flexion [7]. The deformity is described as 'Waiter's tip' and is synonymous with Erb's palsy. The child hangs the affected arm limply by their side and is unable to abduct or externally rotate the shoulder; flex, and actively supinate or pronate the elbow [8]. There is paralysis of the biceps, deltoid, supraspinatus, and brachioradialis muscle [9].

The incidence is believed to be somewhere between 0.5-4.4 per 1000 live births [8, 10]. There are varied recovery rates reported in the literature, ranging from a few percent to 96% achieving spontaneous resolution [8]. It has been reported that the natural history of the injury is difficult to predict due to insufficient available data. Studies with the highest methodological quality report that residual deformities remain in 20-33% of cases.

Physical therapy treatment of this pathology should begin as early as possible. Key physical therapy treatments include strength training, tactile stimulation, electrical stimulation, functional electrical stimulation, soft tissue manipulation, and functional splinting [11]. However, external rotation remains a problem in achieving full recovery. Surgical intervention or surgical nerve techniques become very important if physical therapy interventions are ineffective [12]. In late cases, tendon transfers are used to increase the functional status of these children [13]; however, the evidence is not conclusive to suggest it consistently leads to successful outcomes. Often, a second surgery is required to treat an internal shoulder contracture and associated weakness of abduction and external rotation [8]. The criteria used to determine the need for surgery are also inconclusive, with opinions varied between authors [14].

Treatment recommendations are not yet validated. However, the general medical protocol involves physiotherapy along with the early implementation of passive joint range of motion and, in some cases, splinting or taping of the involved limb [15]. Numerous authors suggest that if there is some active range of motion beginning by 3 months of age, full recovery is unlikely to be achieved [10, 16, 17]. Some innovative methods are being explored; studies have shown the effectiveness of using strategies such as Armeo robotic therapy, virtual reality, and plyometric training in the rehabilitation of children with Erb's palsy. These methods can complement conventional therapy [18, 19, 20].

Manual therapy is a group of procedures in which the hands directly contact the body to treat the articulations or soft tissues [21]. Joint manipulation therapy, broadly defined, includes all procedures in which the hands are used to mobilize, adjust, manipulate, apply traction, stimulate, or otherwise influence the joints of the body to affect the patient's health [22]. A manual procedure that involves a directed thrust to move a joint beyond the physiologic ROM without exceeding the anatomic limit [21, 23].

Several authors state that the pillars of the treatment of Erb-Duchenne palsy include postural correction of the affected limb, passive mobilizations, muscle percussion, massage, and active mobilizations, taking into account the neurodevelopment of the child [24, 25]. In this case, manual therapy adjustments were

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very effective, resolving this issue and achieving a fast full range of motion by week 8 of treatment.

Other treatments, such as thermoplastic splints used at night to prevent contractures that could limit function, must be held for a long period and are complementary to physical therapy treatment [25, 26]. Electrical stimulation should be used as a complement to training to accelerate nerve regeneration, improve muscle strength, and prevent muscle contractures [27, 28]. Kinesiotaping offers a better alignment of bone structures, facilitating muscle and bone function [29].

Botulinum toxin is used to paralyze the subscapularis muscle teres minor, and pronator teres, allowing the muscle affected by injury to be worked to gain strength and functionality [30].

All these complementary treatments require treatment for a long period, yet their effectiveness is often limited to these injuries. They can cause significant emotional, financial, and physical stress to both the child and their family.

METHODS

Model of the study

This is a case study conducted at our 'Fiziomed' clinic in Istog, Kosovo, demonstrating our experience in managing children with Erb-Duchenne palsy. The case study describes a relatively new treatment strategy involving a manual method (adjustment-manipulation) for a 7-week-old child diagnosed with the pathology of Erb-Duchenne paralysis (OBPP). Our primary objective has been to undertake such treatment actions aimed at eliminating the "origin of the problem" or treating the root cause of this pathology. Considering that the main issue in Erb-Duchenne paralysis pathology lies in the region of the cervical rings, our treatment approach in this study has been practically focused on the neck region, rather than treating the arm as typically done in other therapeutic methods. Throughout the treatment process, we continuously evaluated motor recovery score using the British Medical Council classification.

The study was conducted in accordance with the principles outlined in the Helsinki Declaration and received approval from the Ethics Committee of the University for Business and Technology (UBT). The ethics approval number for this study is 3116/45.

Patient Profile

On September 25, 2023, the parents brought their 7-week-old baby to our clinic. Their child was born on August 4, 2023, at 38 weeks of pregnancy, with a normal delivery and a birth weight of 4750 gr. He is the second child since he has a 6-year-old brother. The parents also reported that their child has not moved his left arm since birth. The parents mentioned that they were not informed by the medical staff immediately that the child might have been injured during the birth. For this reason, they took the child to the Hospital on August 26, 2023, when he was 3 weeks old, where he was examined by an orthopedic specialist. The doctor diagnosed the child with "P 14.0 Paresis obstetrica superior (Erb-Duchenne) pl. brachialis lat. sin. Fractura obstetrica claviculae lat. Sin. The orthopedic specialist who diagnosed recommended physiotherapeutic treatment for the child.

Diagnosis

Upon the child's presentation to our clinic, his parents provided us with a documented diagnosis: “P 14.0 Paresis obstetrica superior (Erb-Duchenne) pl. brachialis lat. sin. Fractura obstetrica claviculae lat. sin.”, established by the orthopedic specialist during the visit to the American Clinic. This diagnosis has been the basis for the child’s continuation of the treatment. Recovery of function and the effectiveness of treatment were monitored over time primarily through physical examinations (observations) at key

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moments, which predicted the evolution and prognosis of Erb's palsy.

During the observations of his left arm, it was noted that the arm hangs loosely by his side, and he was unable to move it (flex, extend, abduct, or rotate). The child's hand was slightly swollen due to muscle dysfunction and denervation. His arm was internally rotated with the elbow extended, the wrist was in ulnar deviation, and the fingers flexed. He had only slight movements in his fingers. Physical examination of his neck: decreased lateral flexion bilaterally, decreased neck extension and rotation on the right side. Primitive reflexes asymmetric "moro reflex" and absent asymmetric cervical tonic reflex were noted, along with no tactile response in his left arm. The test of pull to sit showed weak strength, with his head falling back due to muscle weakness. There was no Lendau present at this stage. Passive movements of the left shoulder were painful on flexion and adduction (photo 1).

Static palpation of the neck revealed prominent and painful palpation of the C5, C6, and C7 transverse processes on the right side, as well as bumpy and tenderness in the middle part of the clavicle of the left side.

Treatment Plan

The treatment objective aimed to give the child an intensive early rehabilitation process using manual therapy based on neurodevelopment techniques (neurological, sensory, and motor development). The primary intervention was made in the neck region without incorporating electrical stimulation, massage, passive exercises splints, or bandages on his arm.

Interventions for Erb's palsy recovery were incorporated into manual therapy sessions conducted three days a week, maintaining this intensive manner for 2 months. Initially, sessions lasted 15 minutes for 3 sessions and then 20-25 minutes depending on the child's tolerance. Importantly, many intervention strategies like stretching the muscles of the neck and shoulder were taught to parents for home practice at various times throughout the day. I explained my findings to the child's parents and suggested the adjustment of the C5, C6, and C7 vertebras to see the arm's response. I asked them to allow me 3-5 visits to assess some responses.

Treatment Implementation

First session: Conducted on September 25, 2023, the initial focus was on the treatment of the child's neck on his right side, specifically in the C5 vertebra. Massaging and stretching of the sternocleidomastoideus (SCM) muscle were applied on both sides, but 2 times more on the left side. A slight cervical traction was applied at the end of the session. (photo 2)

Second session: Held on September 27, 2023. The child's parents reported a change in the arm's positioning; some movements were in place, but he wasn't able to move the arm from the bed. The patient in supination was rechecked to see if there was any asymmetry or tenderness in his neck. It was noticed that there is less tension on C5 transverse processes on the right, while C6 and C7 were very tender in palpation. Adjustments were made to C6 and C7, followed by the usual massaging of the SCM, scaleni, and pectoralis of the left shoulder. A slight traction was incorporated three times, held for 15 to 30 seconds each.

The third session: Conducted on September 29, 2023, following the same assessment and treatment protocol. On this day, the adjustments were made to 3 vertebras: C5, C6, and C7. The swelling subsided immediately after three treatments, and now his arm feels lighter. He had started to adjust to this treatment, and his parents were very glad that he started to move his arm on flexion and abduction 10 to 15 degrees, elbow rotation, and finger movements. (photo 3)

The fourth, fifth, and sixth sessions were conducted on October 2, 2023, following the same protocol for rechecks and treatment. Adjusting the C7

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on this day, along with massage and stretching of the neck muscles. The active range of motion was increasing daily. Now the whole arm is moving, not against gravity, but with gravity eliminated. (photo 4)

Other ongoing treatments have also gone well, based on the preliminary treatment plan, which involved sessions 3 times a week using the same treatment protocol, and continuing until the final treatment on November 29, 2023.

Parents were involved in the treatment process based on the recommendations that we had given them, which focused on maintaining the proper position of the hand while the child was sitting or asleep. It was important to keep the hand in external rotation because paralysis tends to keep the hand in internal rotation.

RESULTS

Short-Term Results

After one month of treatment, he showed great progress. He was able to touch objects and move his left arm, bringing the thumb toward his mouth, and flexing the shoulder, elbow, and wrist. The shoulder abduction was 90 degrees with gravity eliminated. The elbow flexion of 140 degrees, finger movement, and grasping reflex appeared at this stage of treatment.

By six weeks of intensive treatment, he achieved shoulder and elbow flexion against gravity, as well as functional movements such as bringing his thumb to mouth and bringing both arms together. He played with small balls actively, but supination was not yet observed. The elbow flexion and wrist flexion were good, but the forearm was still in pronation - Waiter's tip. During this time, he began to use his left arm to roll and turn his body, transition from a sitting to lying position, from sitting to a four-legged position, and crawl (photo 5).

Long-Term Results

On the last intensive treatment of the left shoulder with Erb's palsy (November 27, 2023), the child showed increased integration of his left arm. He demonstrated improved manual motoric skills and autonomy in activities such as rolling, crawling, and hand manipulation, incorporating the left arm (the injured arm). Most of the activities at this time were bimanual, but the left arm was slightly slower. The active range of motion continued to increase and reached 90% of normal active ROM (photo 6).

Photo 1. Initial status of the patient (before the treatment)

Photo 2. 1st week of movement

Photo 3. 3rd week of movement

Photo 4. 6th week of movement

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Photo 5. 8th week of movement

Photo 6. After three months

Objective Measures

The progress in the condition of children with Erb's palsy was followed regularly during each treatment session. We have evaluated the range of movement using the standardized evaluation of the British Medical Council classification [17, 18], which is suitable for assessing motor recovery, a vital parameter for monitoring neurological recovery at this age. The British Medical Council (BMCC) classification scores range up to 5:

1. no contraction;
2. contraction without movement or with slight movement;
3. active movement with gravity eliminated, perceptible intrinsic contraction;
4. active movement against gravity;
5. active movement against resistance, some intrinsic weakness;
6. contraction with normal power.

Table 1. Modified Malet scale

Pre-intervention	One week	Six weeks	Eight weeks	Development diff.
Arm at rest	1	3	4+	4+
Global abduction	1	3+	4	4
Global ext. rotation	1	3	4	4
Hand to neck	1	3	4+	4+
Hand to spine	1	3	4	5
Hand to mouth	0	3+	4	5
Supination	1	3	4	4

The findings of the patient's improvements in active ROM from the first week, continuing through the sixth and eighth weeks of treatment, are presented in Table No. 2.

Table 2. Active Range of Motion's Goniometry

Pre-intervention	First week	Six weeks	Eight weeks	Development diff.
Shoulder Abduction	100	900	1600	1600
Shoulder Flexion	150	1400	1800	1800
Shoulder Extension	50	200	300	300

Finally, on November 29, 2023, an electromyogram (EMG) was conducted in Prishtina, at the Diagnostical Clinic 'Neuropsikiatria' to detect the conduction velocity of the nerves in the left arm. The EMG

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report revealed very good results, showing normal velocity conduction. However, the Axillaris and Musculocutaneous nerves displayed a wide M potential.

A follow-up EMG conducted on May 13, 2024, reported improvements in both velocity and nerve conduction in all nerves of the left arm, as well as improvement in the potentials of the nerve. The results of EMG are represented below in Table No. 3.

Table 3. The results of Electromyography (EMG)

Nerves	29 November 2023 (vel), (pot)	13 May 2024 (vel), (pot)
N. Axillaris	40 m/sec, M wide potential	48 m/sec, 2,4 and 6
N. Musculocutaneus	43 m/sec, M wide potential	48 m/sec, 2.2 and 6.1
N. Radialis	42 m/sec, normal	50 m/sec, 2.4 and 3.2
N. Ulnaris	45 m/sec, normal	52 m/sec, 3.8 and 6.2
N. Medianus	40 m/sec, normal	52 m/sec, 2 and 5.2

DISCUSSION

The results of this case study indicate that the manual manipulation method, focusing on the cervical region rather than the affected arm, can be an effective treatment strategy for Erb-Duchenne palsy (OBPP). Unlike traditional treatments that primarily target the arm, our method addressed the cervical spine, specifically the C5, C6, and C7 vertebrae. This approach is based on the premise that the origin of OBPP lies in cervical nerve root injuries. By focusing on the cervical region, we aimed to mitigate the root cause of the pathology. The rapid improvement in the child's motor functions supports the hypothesis that cervical spine alignment plays a crucial role in OBPP recovery. This hypothesis is substantiated by the data on the improvements observed in the treated child in our case study. The early and significant improvements observed in his arm movements and overall motor function were noteworthy. Within two weeks, the child exhibited increased shoulder abduction and flexion, elbow flexion, and finger movements. By the end of the two-month intensive treatment period, the child could perform more complex tasks such as bringing the thumb to the mouth and playing with small objects. Most of the activities at this time were bimanual, and the active range of motion continued to increase, reaching 90% of normal active ROM. To support the hypothesis that the manual method of treating this pathology is effective, we can reference the works of other authors. For instance, a study done in 1993 by Harris and Wood [31], demonstrated very good results in treating an infant, 5 weeks old, suffering from Erb's palsy. To align with the hypothesis that the manual method of treating this pathology is effective, we can reference other authors' work. In a study done in 1993 by Harris and Wood [31], they achieved very good results treating a 5-week-old infant suffering from Erb's palsy. The child undertook chiropractic treatment combined with electrical stimulation and an upper extremity exercise program, and the palsy resolved within 2 months with only a slight deformity; Waiter's tip. Another study by Cooper and Alcantara [32] reported on a 14-day-old male suffering from Erb's palsy. He experienced pain and limitations in both active and passive movements. Chiropractic adjustments were applied to C1 vertebra, and in 4 days full functional range of motion was returned in his right arm. A study by. Jeyanthi, S. [33] concludes that, as a complement to conventional therapies, electrical stimulation of nervous branches helps solve functional limb impairment and promotes active movement gains, especially in the biceps, wrist, and finger extensors. The early and significant improvements observed child's arm movements and overall motor function were noteworthy. Within two weeks, the child exhibited increased shoulder abduction and flexion, elbow flexion, and finger movements. By the end of the two-month intensive treatment period, the child could perform more complex tasks such as bringing the thumb to the mouth and playing with small objects. This rapid recovery contrasts with the slower progress typically seen in arm-centric therapies, suggesting that our method may accelerate neural and muscular adaptation. Additionally, Smith, B. [34], highlighted that the old indication of immobilizing the arm after diagnosis of the lesion is completely outdated. Currently, after an early diagnosis of the lesion, the child is recommended to undergo conservative treatment with physiotherapy and occupational therapy as soon as possible.

During the treatment of this pathology, the parents of the child-patients play a crucial role. Educating parents on stretching and exercise techniques ensured that therapeutic activities continued at home, reinforcing clinical sessions. This holistic approach involving the family likely played a significant role in the child's recovery, as consistent and repetitive exercises strengthen neural pathways and muscle coordination. In Otto, HC [35], it is emphasized that in conventional treatment, physiotherapy and occupational therapy are of great importance, while involving parents in the rehabilitation program so that professionals and family members work jointly. Passive range of motion exercises are fundamental for preventing muscle contractions and should be performed several times a day. It is important to integrate them in daily routines such as during diaper changes and meals (bottle/breastfeeding). As the child grows, develops, and gains intentional voluntary control and body awareness, it is important to promote activities that stimulate the affected limb to prevent apraxia.

At the end, we can emphasize that the success of this treatment has significant implications for clinical practice. It suggests that healthcare professionals should consider the potential benefits of cervical spine manipulation of OBPP treatment. This approach could be integrated into standard therapeutic protocols, offering a complementary method to existing treatments.

CONCLUSION

The positive outcomes observed in this case study underscore the potential of manual therapy adjustment focusing on the cervical spine for treating OBPP.

By addressing the root cause of the pathology, this method provides a promising alternative to conventional arm-focused therapies, contributing to more effective and faster recovery for children with OBPP. Additionally, we believe that this treatment method enables rapid recovery at a patient against low financial, material, psychological, and emotional cost, making it a more suitable method compared to other methods, whether conservative or surgical. Further research is warranted to establish this approach as a standard treatment option in pediatric neuromuscular rehabilitation.

CONFLICT OF INTERESTS

The authors reported no potential conflict of interest.

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