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Case Study

Effect of Pediatric Integrative Manual Therapy, a Novel Mobilization with Facilitation Movement Technique, on Congenital Muscular Torticollis after Cervical Rotation and Head angle: A Case Report

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선천성 근성 사경에 대한 새로운 촉진 기법을 이용한 소아 통합 도수치료적용 후 경추각도의 변화와 머리각도 변화: 단일사례연구

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ABSTRACT

Background: Congenital muscular torticollis results in reduced head mobility, such as cervical rotation, due to the abnormal size and contraction of the sternocleidomastoid muscle. Korea Pediatric integrative manual therapy and stretching are recommended to improve head rotation upper cervical spine mobility. Therefore, in this study, the effect of the new PIMT was investigated.

Methods: The patient is a 3.5 month-old diagnosed with congenital muscular torticollis (CMT). Due to the limitation of head rotation and cervical spine rotation and flexion mobility, the child visited a rehabilitation center and after diagnosis, Pediatric integrative manual therapy (PIMT) treatment was performed five times a week for a total of 15 weeks. The child's head rotation and flexion limitation and plagiocephaly were evaluated.

Results: In conclusion, this study shows that compared to other treatments, PIMT approach is a more effective treatment for improving head rotation and cervical limitation for range of motion in CMT infants.

Conclusion: PIMT approach was effective in improving cervical rotation and Head lateral flexion mobility and plagiocephaly in CMT patients.

Key Words:

Congenital Muscular Torticollis, Manual Therapy, Pediatric

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I. Introduction

Congenital muscular torticollis (CMT) is a musculoskeletal disease caused by shortening of the sternocleidomastoid (SCM) muscle and resulting in ipsilateral flexion of the head and contralateral rotation of the chin (Song et al, 2021).

SCM muscle tumor may be also present (Cheng et al, 2001). The proposed etiology of CMT includes fetal malpostion and delayed normal development and plagiocephaly (Stellwagen et al, 2004), SCM injury during birth, ischemic injury to the muscle, and infection. Unfortunately, the exact etiology of CMT condition remains unknown. CMT is common managed conservatively. With only 8% to 16% of patients younger than on year of age requiring surgical intervention (Staheli, 1971).

Common physical therapy intervention strategies for CMT include passive stretching of the shortened SCM muscle strengthening of the contralateral SCM muscle (Cheng et al, 2001). Active range of motion exercises and handling and positioning to improve the infant's postural alignment (Emery, 1994).

However, infants who receive passive stretching often cry during the physical therapy and refuse the treatment and treatment that trigger active participation of an infant has recently been applied on the basis of the dynamic theories of motor control (Rahlin, 2005).

Cervical rotation limt and soft tissue manipulative physical therapy and active or active assist range of motion in pediatric with CMT can eliminate resistance. Crying, pain, and the risk of muscle damage. Few studies of manipulative approaches in patients with CMT have been performed (Yim et al, 2009).

The effectiveness of treatments in young children has not been well studied and evidence is lacking. The aim of this study was to analyze the effects of a novel intervention on cervical spine rotation angle and head rotation or counter flexion in a sample of children with CMT.

An integrated approach based on pediatric integrative manual therapy (PIMT) and dynamic theory was used. We aimed to investigate the effect of a new pediatric hand-eye-physical therapy intervention on head tilt and rotation angles and cervical spine rotation angles in children with CMT.

Ⅱ. Methods

1. Case Description

The patient, a 3.5-month-old boy, visited a pediatric rehabilitation hospital located in Yongin, Gyeonggi-do, Korea for CMT evaluation and treatment, and was referred for physical therapy. This child was selected for the case report because he showed good results including PIMT approach as physical therapy to treat his condition.

The patient was born by caesarean section at 1 week due to breech delivery at 39 weeks of gestation. From birth to 2 months, parents were concerned about the posture of looking only to the left rotation and tilt the head to the right. It was confirmed that the child turns to the left while looking at the toy. After requesting treatment to a specialist in rehabilitation medicine for the above problems, SCM mass was confirmed.

Later, patient was diagnosed with CMT. For evaluation of head angle and cervical rotation angle, photo still method Cervical rotation and flexion testing showed the patient to have an asymmetrical head alignment with left rotation, right in all positions and right lateral flexion in all positions.

In addition, he showed mild craniofacial asymmetry with a slightly flattened left frontal skull and right occipital. There was no cyanosis, reverse breathing, or subcostal contraction

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during respiration. The patient smiled and was cooperative throughout the examination.

2. Test and Measures

For the treatment of the patient, the following tests were performed. Developmental test reflex and postural response, cervical spine angle test, head angle test, ultrasound test, plagiocephaly test, and X-ray (Sig-40-525R500mA, Medi114 Medical System Co, Ltd, Korea) analysis for hip dislocation test were performed.

In order to confirm the right-left SCM thickness ratio in children with torticollis, the left and right side thicknesses were confirmed by ultrasonography (E-CUBE 11, Alpinion Medical Systems Co, Ltd, Korea) by a specialist in the Department of Rehabilitation Medicine.

1) Still photography method

Since the patient was able to actively rotate the head in the supine position, we measured the range of motion of passive cervical spine rotation up to 180 degrees in both directions in the supine position. In order to confirm and quantify the amount of the patient's habitual lateral flexion and rotation angle also cervical rotation angle (Pastor et al, 2021).

A total of 5 measurements were taken and averaged. Measured using the still photo method. This method involves providing visual stimuli to the infant after the infant is placed in a supine position. It is to place the head in a midline position without taking any additional action.

Then take a still picture. Before starting this procedure, the physical therapist explained the procedure of the experiment and evaluation to the patient's parents after obtaining parental consent to proceed with the experiment and evaluation. After taking the picture, Physical therapist made a copy and made it further (Figure 1, Figure 2).

2) Reflex. and postural reaction state

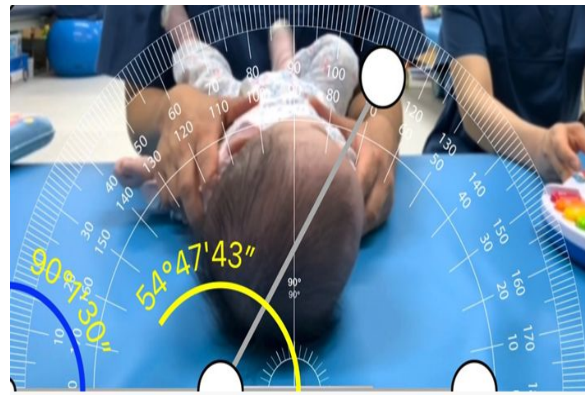

Figure 1. Cervical rotation angle to the right in the supine position at the initial physical therapy evaluation

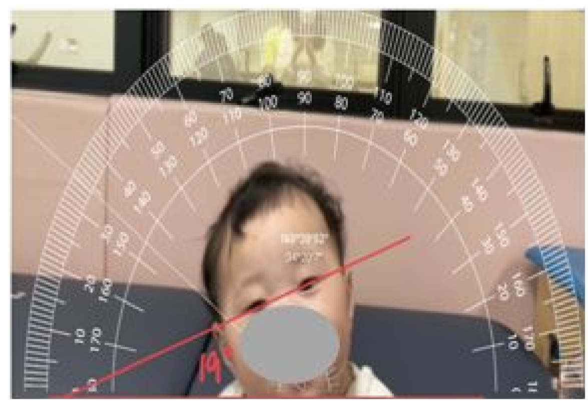

Figure 2. Lateral head tilt to the left in the sitting position at the initial physical therapy evaluation

Since the patient was able to actively rotate the head The SCM muscle was shown to right tilt the head to the left rotation. In the supine position, visual tracking of the toy up to 180 degrees horizontally was observed. But very short range moves.

Right lateral flexion and left rotation were observed. In the prone position, the patient raised his head to 90 degrees and actively tucked his chin in while supporting his weight with his forearms, and the patient was unable to extend his arms and push upwards.

Attempts to reach the arm and hold the toy against gravity failed. Tried to grab a toy against gravity with one upper arm but this performing also failed. The patient observed asymmetric tonic neck reflex (ATNR). To the right, it was evident

Table 1.
Initial examination results: reflex and potural reactions

Reflex/Postural Reaction	Absent	Emerging	Present
Plantar grasp			X
Moro			X
Landau	X		
forward protective extension		X	
Lateral protective reaction to the left	X		
Lateral protective reaction to the right		X	
Downward parachute response	X		

in both the upper and lower limbs(Piper and Darrah, 1994).

Additional tests for additional reflexes and postural responses are summarized in table 1.

3) Hip dislocation examination

The Migration Percentage (MP) index was confirmed through x-ray equipment (Sig-40-525R500mA, Medi114 Medical System Co, Ltd, Korea), and the abduction test which is a hip dislocation test(Figure 3). The pediatric physical therapists notified normal findings of hip dislocation (Hägglund et al, 2007).

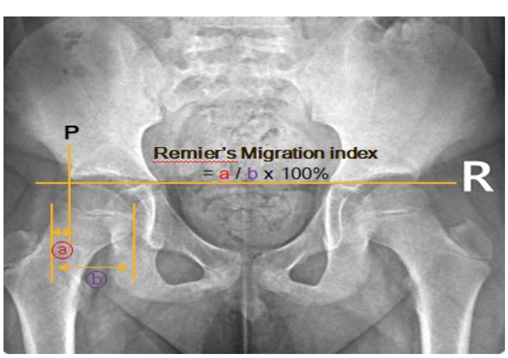

Figure 3. Measurement of Migration Percentage (MP). MP= A/B ×100. On the right hip with a "Gothic arch" formation of thelateral margin, the midpoint of the arch is used as reference point.

4) Plagiocephaly examination

As described by Loveday and de Chalain(2001), the circumference of the head is measured using a flexicurve (Figure 4). They slightly modified their technique to improve the accuracy of this clinical measurement.

Figure 4. Top view of flexible curve placement

For each measurement, two markers were placed vertically connecting the nasion and inion as described below. The nagion is the central point of the frontonasal suture, located in the middle of the nose and extending vertically, marked with an "N" on the forehead.

This label should be visible when the flexible curve is placed (Figure 5). The inion is the most prominent point of the external process of the larynx.

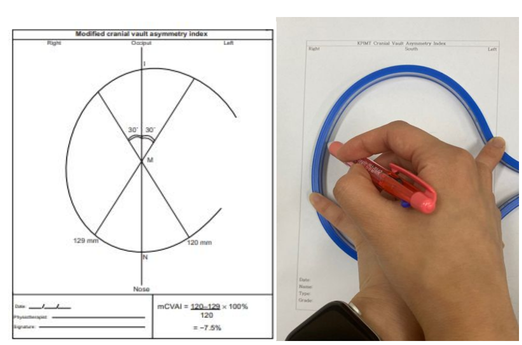

Figure 5. Tracing of head shape on the CVAI form. Tracing the head shape at the inner rim of the flexible curve with a sharp pencil

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The measure can slide the tip of the thumb from the cervical process to the larynx to locate the external occipital process first and identify the inion.

The measurer continues to extend the tip of the thumb vertically upward, and marks the mark (I) over the inion. This sign should be visible when the flexure is positioned on the child's head . Where north (N) will be located relative to the soft curve, a base marker for the soft curve is created.

The N marked on the forehead aligns with the N marked on the soft curve, which wraps tightly around the baby's head. The position of the inion can be read from the scale of the flexible curve. The lower edge of the smooth curve is aligned horizontally (auriculo-orbital plane. fruit) and is located at the maximum occipital-forehead circumference (Figure 6).

The auriculo-orbital plane is the line connecting the lower edge of the bony orbit with the upper edge of the ear canal. It is formed by the lines of the auriculo-orbital plane. It represents the anatomical horizontal plane of the head.

$$CVAI = \frac{shortdiagona - longdiagonal}{shortdiagonal} \times 100$$

A perfectly symmetrical head should have a Cranial Value Asymmetric Index (CVAI) score of 0%, and a head with a CVAI of -3.5% is considered to have significant asymmetry (Chang et al, 2001). However, the original paper did not clearly state how this value was determined. Other studies have reported different thresholds and severity classifications for plagiocephaly measures based on clinical experience, parental concerns (Van et al, 2006), and clinical perception (Hutchison et al, 2006).

Wilbrand (2012) measured 401 infants to obtain baseline values of cranial cavernous growth at the first birthday. Anthropological measurements of infants with a noncongenital isomorphic ideal head shape were compared to these reference values.

The authors suggested that the classification and severity of positional head deformity should be assessed based on baseline values according to age, sex and country. When using standardized measurements, this normalized data collection approach should be adopted.

Figure 6. Upper cervical treatment technique from sitting postion

3. Case prognosis

The patient problems identified through the physical therapy examination include;

19 degree head tilt to the left as measured by still photography; Asymmetric head posture with Right flexion and left rotation in all positions Restriction of cervical rotation, left SCM weakness and right SCM stiffness, reduced and absent left head upright response we hypothesized the following.

The patient has sensory processing error of hand, so the maturation of the hand reflex is still delayed, so it is difficult to use support surface contact. In the supine position to generate sustained adequate force, it was assumed that there would be difficulty in flexion to the left while turning the head to the right.

Due to this problem, the range of motion of the cervical vertebrae is limited, and as a result, the size and excessive contraction of the right SCM mass leading to right torticollis are limiting the cervical vertebrae. noted difficulties in achieving adequate shoulder girdle and torso control to free the head using support surface contact while prone(in a "gravity-depleted" position), supported sitting, or supported standing. patient noted that head rotation was difficult.

According to the American Physio Therapy Association clinical practice guideline, the typical duration of conservative treatment for CMT in infants less than 1 year of age varies from 3 to 12 months (Song et al, 2021).

Previous reports have found that the duration of treatment for a disease correlates with the severity of the condition. A child with a palpable intramuscular fibrous mass with limited range of motion and the following symptoms showed complete active rotation of the head to the left, and since there was a mass at the time of initial evaluation at the time of initial diagnosis, I would like to have him within 15 weeks of his outpatient diagnosis. It was determined that the expected treatment goals and expected outcomes could be achieved.

3. Intervention

Based on the patient's evaluation, diagnosis and prognosis, my clinical experience, and the published literature (Celayir, 2000), I selected the following physical therapy intervention techniques: (1) PIMT Press Release Therapy and Mobilization with Facilitation therapy (Emery, 1994). (2) active range-of-motion exercise (Song et al, 2021), exercise consistent with PIMT principles(Emery. 1994), (3) soft tissue mobilization for cervical muscles (Karmel-Ross and Leppy, 1997), and (4) parents in home programs Education (Celayir, 2000).

1) PIMT theory

According to the dynamic theory, motor control is not organized and controlled only by the central nervous system, but is a process in which the neuro-network binds and activates the movement of the body only when there is an interaction between the organism and the environment. In order to adapt to the new situation provided by the environment, the neural network is based on the interaction of several subsystems, including the level of arousal, nerves, muscular system, skeletal system, gravity and other external forces acting on the human body.

It is a product expressed by the organization of The human body is based on a very complex biological system, and even in very similar situations, it is not possible to predict the behavior of each subsystem because the environmental conditions are different between two times.

For example, a nail was stuck in the head, but after living for over 10 years without knowing it, the fact that the nail was stuck in the head after visiting the hospital due to an accidental headache is a representative example of pain perception information being processed but not congnition.

In another case, a patient complained of great pain due to an accident in which a nail was stuck in his foot, and when he removed the nail and looked at it, the case of a study in which the nail was actually placed between the toes resulted in only going directly to the cognition situation without perception information. It remains as a representative case study of the process.

Latash(1996) believes that the human body's systems are very complex and one of its characteristics is plasticity. In the process of learning a new skill, the human brain is a complex process that explores multiple neural networks to "record" new information and later multiple "memories".

It also increases the variability of movement required to adapt to external and internal influences acting on the system. Lack of variability limits movement patterns or posture. In other words, if you suddenly have to run in a walking situation, you cannot succeed because

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you cannot adapt to the environment.

The principle of PIMT approach based on the dynamic theory concept is that the child actively adapts motor behavior to various situations, actively selects task information and procedure learning for center pattern generation theory, develops the ability to synchronize one's own behavior with perceived information, and provides correct location information of the musculoskeletal system.

It aims to develop the ability of the nervous system to synchronize facilitation and body sensation and proprioception with their motor system.

For example, a child with cerebral palsy must touch the lamp to turn on the lamp and recover balance while not making contact with the surface. In this posterior tilted position, it tries to balance on the sacrum, and due to the secondary muscular and skeletal system damage, the order of muscle participation is also changed, resulting in many compensatory movements.

In order to solve this problem, the therapist first correctly inputs the information of the muscular system into the body sensation and proprioceptive sense, and uses the two concepts of PIMT muscular skeletal factor Kaltenbone segment movement and Mulligun concept where there is an arbitrary restriction of movement of the incorrect musculoskeletal system (McDowell et al, 2014; Kaltenborn, 1993).

With the coordinative control of the use of the arms and hands mixed with the spine, through the handling input of the therapist, with the distribution of various contacts, sufficient proprioceptive and somatosensory input, and through the guiding and assisting of the hand, the sensor light is sufficiently turned on.

Mobilization with facilitation technique and stretching release technique and press release technique are applied to each joint junction for inputting somatosensory and proprioceptive sensory information of the muscle when providing sufficient support for the ability to recover balance from touch to come. Provides joint stability.

These patterns of quantitative musculoskeletal system and qualitative neuro-system changes lead to the parameters of the motor Therapy. Although the basis for motor control and motor learning theories have existed for a long time (9~13), PIMT approach is relatively new. Treatment of the musculoskeletal system and the sensory and nervous system parameters of the PIMT musculoskeletal system and nervous system palpation therapy. The purpose of this case report is to describe the use of PIMT approach as a major component of a physical therapy intervention for infants with CMT.

The PIMT approach was used as a major component in a physical therapy intervention for this patient. After placing the patient in a supine position, the head is rotated to the right through visual tracking through visual feedback for the right SCM muscle extension.

At the same time, the therapist's right hand is supported on the temporal region from the top of the head, the index finger and thumb are placed in front of the patient's SCM muscle belly, and the third and fourth fingers are placed on the SCM muscle at the back of the submastoid process.

To minimize the pressure due to plagiocephaly of the patient's head, the therapist's hand slightly floating on the surface of the treatment table, the therapist's left hand fixes the patient's shoulder, and the index finger is placed on the inside of the clavicle. The SCM is statically stretched. (3 sets like EBP)

The direction (not positive) of the second vector is applied to the left frontal lobe one by one so that the left cervical mastoid muscle can be contracted, while pressing the right SCM during the PIMT approach and removing the pressure film again The therapist's right hand SCM muscle performs a release technique to maximize relaxation and release of this muscle.

Second, for the relaxation of the patient's SCM muscle, for PIMT mobilization with facilitation, the therapist manually bends the patient's head about 10 degrees with the right hand supporting the patient's head at the position of the therapist's hand and the patient's right-facing position as above.

At the same time, the left hand supporting the shoulder and clavicle lower point fixes the shoulder and clavicle as it is, then bends the head at the same time, and when it returns to the original position, the therapist the throgh press-release technique tigh band of the mass part of the SCM muscle with the third and fourth fingers of the SCM muscle. Release and perform 3 sets of 15 PIMT mobilization with facilitation techniques.

The patient received the same educational approach as the control group and a specific protocol based on manual therapy tailored for pediatrics, an intergrative concept of treatment that will be identified in the manuscript as Korea PIMT. The manual therapy protocol was applied by several pediatric physical therapists with specialized training and 10 years of experience and it included manual therapy techniques for the upper cervical spine and for remodeling the cranial deformation.

The objective of the manual therapy protocol for the upper cervical spine was to mobilize the occiput, atlas and axis to restore ROM. The technique applied consists in letting the baby's head rest on the hands of the practitioner. Both fourth and fifth fingers were placed on the condylar area of the occipital bone, the middle finger on the articular processes of the axis, the index fingers on the articular processes of the cervical vertebrae below C2.

The thumbs were placed on the anterior side of the transverse processes of the atlas to cause a very gentle dorsal positioning of the atlas.

The practitioner applied a myofascial induction aiming to relax the cervical myofascial structures with a gentle traction while gently assisting head movements of flexion and extension, side bending and rotation following the active and spontaneous movements of the baby (Giammatteo, 2003)(Figure 9). In all cases end-range positioning into cervical extension and rotation were avoided, following the recommendations of the International Federation of Orthopedic Manual Physical Therapists (Rushton et al, 2014). The subjects from the PIMT group were treated during 20-min sessions once a week for 15 week.

2) Active range exercise

Using Song et al.(2021) active assistance, the creation of active movements to strengthen weak cervical spine muscles in CMT patients is accomplished by placing toys, giving some childhood, and talking. Provide isometric, isotonic movements to rotate the head to the right to promote midline position. In order to cooperate with this facilitation, the right SCM muscle can be stretched by proceeding the right upper or lower starting pursuit, and the left muscle can be strengthened through the righting reflex.

It also aims to relax the posterior fibers of the right SCM muscle through strengthening and stretching. The child's mother participated in the therapy sessions and was continually explained this approach for active range of motion (Figure 7).

Figure 7. Handling an infant through head active rotation in the sitting position on the ball or mat.

3) Soft tissue mobilization

Several authors recommend using massage (Karmel and Leppy, 1997; Porter and Blount,

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1995), and other soft tissue mobilization techniques for CMT. According to Karmel and Leppy(1997), this type of intervention is helpful in relieving pain and discomfort that may result from a possible compartment syndrome, and in reducing irritable behaviors during therapy in infants with this condition. Benjamin(2010) list muscle relaxation as one of the potential general effects of massage.

Based on my clinical experience in treatment of torticollis, soft tissue mobilization techniques appear to promote relaxation of the tight cervical musculature leading to a more effortless use of the weakened SCM muscle on the opposite side. Soft tissue mobilization to the right SCM, scalene and suboccipital muscles (armel-Ross and Leppy, 1997), was used for patient. when he reverted to habitual asymmetrical head position.

This possibly occurred because of fatigue after practicing head rotation to the right with lateral flexion to the right in play situations set up for him. This intervention was usually provided in the supine position, unless the infant actively rolled into prone and preferred staying in that position. I applied the following techniques to the cervical musculature to achieve the relaxation effect: superficial and deep effleurage, and deep vibration alternating and finishing with superficial effleurage (Benjamin, 2010)(Figure 8).

Figure 8. Cervical and SCM part treatment soft tissue mobilization from supine position

4) Parent instruction

The patient mother actively participated in physical therapy, demonstrated an appropriate situation, and provided training to induce the patient's head rotation posture to the right.

A specific strategy for shifting the head to the right was discussed with the patient's mother to improve the patient's ability to rotate the head. The strategy refers to always placing a toy on the patient's right side in daily life, and repeating tummy time frequently while looking at the center in a raised posture, and encouraging her to move her head to the right and to the right in a raised posture.

A strategy was described that included active head movements, such as actively turning the head to the right, voluntarily pulling the chin, shifting weight to the left, and rotating the head to the right with the right upper extremity.

Other activities included teaching parents to hold the child in a vertically suspended position with the child's head turned to the right over the mother's heart and supported on her chest.

According to Tscharnuter(2002) postural support should be provided to children so that they can explore new movement opportunities beyond the bare minimum, especially when muscle tension is involved and placed on a large supporting surface to allow orientation.

Therefore, the therapist instructed the mother in a side-lying position program to stretch the right SCM. It was suggested and modified by movements to avoid the stress of stretching. The child is placed on the right side, a folded blanket is placed on the carpet, and the rest of the body is placed with the shoulders down. While lying on his right side, the patient's mother instructed him to place a tall blanket on top of him to support his head.

Ⅲ. Outcome

During the 4-week physical therapy sessions, the patient began to actively rotate his head to the right in both prone and upright positions with elbow support. He also showed lateral protective responses to the left and right in a seated position after his head was supported and directed to the right. The frequency of the 5~8 week sessions of physical therapy was reduced to 3 days per week.

This was due to the infant's steady progress toward treatment goals and the patient's parents becoming quite independent in the patient's home program. The table below shows the patient's average test results for the five measures at the end of full treatment with each type of lateral hearing glove (Table 2).

Table 2.
Case Patient outcomes for each assessment at the end of treatment

variables	Pre	Post
Cervical Rotation Angle (˚)	36.47	84.57
Lateral Head Tilt Angle (˚)	19.94	.50
Hip Dislocation Index (%)	13.20	9.30
CVAI Index	4.81	3.31
Affected side-SCM (mm)	1.67	1.66

A-SCM: sternocleidomastoid muscle thickness on the affected side, CVAI: cranial value asymmetric index

In the ultrasound end evaluation of the patient, the right SCM of 1.8㎝ to 1.7 and the left SCM of .4 to 1.6 were marked as mass before treatment (Figure 9). At the time of discharge after 15 weeks, mass retention and weakness of the right SCM muscle were not observed.

During the 9~15 week sessions of physical therapy, the patient achieved all short-term goals specified at the time of initial evaluation (Table 3). patient exhibited a midline head position (0 degree lateral tilt in the supine position as measured by still photographs(Figure 10) and Head tilt in the cross-section of the upright position was also within the normal range(Figure 11). an angle drop of less than 5 degrees in the sitting position(Figure 12).

The patient was able to maintain midline head alignment in prone and sitting positions while performing motor development skills. Patient also demonstrated active head right rotation from prone to the right when reaching for a toy against gravity with his left upper arm. When a posterior trunk support was provided, the patient was able to maintain a midline head position both in a sitting position and in a sitting position.

The same problem was observed when the infant was placed in a quadrupedal position and when reaching for a toy while rotating his torso in an independent ring sitting position. patient worked with patient mother to set new short-term goals for patients(Table 3).

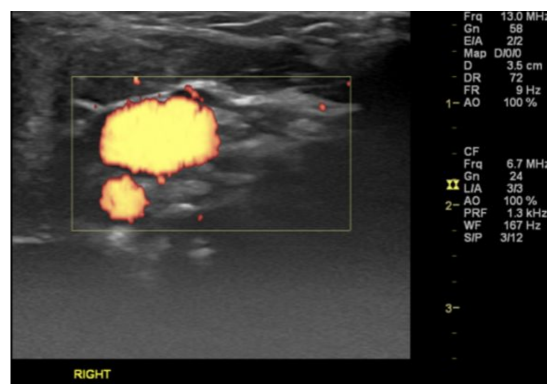

Figure 9. SCM on the right side. Type 2 ultrasonographic findings of CMT.

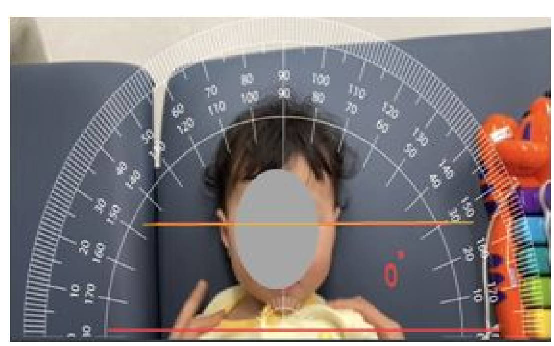

Figure 10. Midline head tilt angle in sitting position(intervention end session).

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Figure 11. Midline cervical rotation angle in supine position(intervention final session).

Figure 12. Midline head tilt angle in supine postion (intervention final session).

Table 3.
Short-term goals stated at initial evaluation and at session

Goal (15 weeks)	Initial Evaluation	Physical Therapy Session
Decrease amount of lateral head tilt, Increase cervical rotation	by 50% (from 10 to 5 degree) as measured by still photography	N/A
Assume and maintain midline head position	in the prone position, for 10~15s, at least 1/5 trials in supported right reaction, for 2~3sec, at least 1/5 tials	Consistently, in independent rolling
Symmetrical head righting to both sides	During reaching for toys in prone with either upper extremity, at least 3/5 trials	During reaching on prone position fo toys above shoulder, assume belly creeping on the table

Ⅳ. Discussion

Although passive stretching of the SCM muscles associated with CMT has been widely accepted as an effective intervention, this technique has not been included in infants' treatment plans. We choose PIMT approach as the primary intervention method for treatment for two reasons.

First, we wanted to avoid patient discomfort, resistance to handling, and crying. During PIMT approach, the therapist did not restrict or resist the patient's movements, but instead applied therapies and techniques to the environment. In parent last visit, she remained in satisfactory condition for most of the physical therapy sessions.

As my parent suggested, I was getting more and more irritable because patient was hungry. The second reason for choosing PIMT approach over passive stretching was a hypothesis derived from my clinical experience. We hypothesized that applying an organizing approach to this intervention would enable patients to achieve their short-term and long-term goals.

Intervention results within the time period specified in the Guide to Physical Therapist Practice (Tatli et al., 2006; Cheng et al., 2001), and reported in other literature (Petronic et al, 2009). As mentioned above, the duration of physical therapy intervention for CMT in infants under 1 year of age is 12 months.

According to the guide Demirbilek and Atayurt (1999) diagnosis of torticollis 80% of patients classified as Pattern 4B, which included, reported that they were expected to "achieve expected goals and expected outcomes within 6 to 20 visits during a single consecutive treatment episode."

Patients at week 15 had all treatment visits (including initial assessments) with no total absences, were treated, and were discharged when all targets were successfully achieved. So my hypothesis was confirmed. The issue of selecting the still photography to track the patient's progress needs to be discussed. As stated in the examination section of this case report, I have successfully used this method of measurement in my clinical practice.

However, no reliability data on its use for children with torticollis are currently available. This warrants a reliability study of the method of still photography for measurement of head tilt in infants with CMT.

It is important to note that when the intervention was initiated, the patient demonstrated rapid progress after the first two or three therapy sessions, first, in active range of motion in a reduced gravity position, and then in antigravity positions. Besides the benefits of PIMT mobilization with facilitation approach that are discussed below, this may be attributed to the fact that patient demonstrated full active head rotation to the right and did not have an SCM muscle mass that would have required a longer course of treatment(Emery, 1994).

Further research is needed to investigate the efficacy of PIMT approach method of intervention for CMT for infants with varying severity of restriction in range of motion and with the presence or absence of a palpable intramuscular fibrotic mass.

To examine a possible mechanism of action of PIMT approach on normal-development motor input, as described in this case report, it may be helpful to equate the patient to a development system (Liebovitch, 1998).

As suggested in the introduction, Liebovich(1998) compares the amount of change in the input required to control the output of linear and chaotic systems. He states that for linea systems, the bigger the target change in the output, the bigger input is required. On the contrary, for chaotic systems, “a delicate adjustment in the input can make a dramatic change in the output.” This notion may be illustrated by comparing passive stretching of the involved SCM muscle and PIMT approach as interventions for a patient with CMT.

If the human body is considered to be a development system, then a tight SCM muscle can be looked at as a force preventing the child from rotating the head to the side of torticollis and side bending it to the opposite side. A relatively significant amount of force is required to passively overcome this problem through passive stretching.

In comparison, looking at a human body as a biological system sensitive to small changes in control parameters would explain how a very gentle input in the amount of force applied to the head of an infant with CMT during PIMT loading could lead to a rapid change in the patient’s ability to assume and maintain the midline head position. Responding to the gradual change in a control parameter,

Such as the direction of the gentle loading force applied to the occiput, an active, dynamic change in the support surface contact occurs. The area and location of the support surface contact, in turn, serves as a control parameter to change the amount of force in the uninvolved SCM muscle the infant is able to generate working from the supporting surface. Further spontaneous exploration of the acquired ability to produce new antigravity movement patterns increases movement variability and leads to generalization of this ability to a variety of similar situations (Tscharnuter, 2002).

Thus, a “big input” in the form of a passive stretching force may not be required to produce a qualitative change in the motor development of a child with torticollis (Liebovitch, 1998).

This study had several limitations. On the one hand, the literature has not yet studied the relationship between cervical rotation AROM and PROM, which limits the comparison of these results.

Control groups may also include muscle stretching or manual mobilization protocols, but our aim was to focus on the effects of following recommendations in the field of physical therapy regarding posture and stimulation. Finally, it would be useful to have follow-up data to analyze long-term outcomes.

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In addition, symmetry of active and passive posture is important for infants with CMT. It is necessary to induce symmetry by using the infant's active movement through positioning or play intervention. Therefore, parental education is very important, and it is reported that continuous implementation of home programs for necessary.

However, in this study, to exclude instructions on passive stretching, each group was given the same home parent handling and hand position training and program (Persing et al., 2003). Therefore, biases that could affect the results were removed in advance. Other limitations of this study are the lack of statistical power due to the small sample size and the lack of long-term treatment effects due to the lack of continuous follow-up.

As the study variables were limited to muscle thickness and head rotation, changes in other functions were not studied. Future studies should include large sample sizes, and further studies confirming the persistence of treatment effects over time are needed.

Despite the limitations described, PIMT approach can be considered an efficient treatment alternative for the treatment of cervical mobility limitation and head angle limitation in infants with plagiocephaly in CMT. In this particular population, involvement of the upper cervical spine in limiting cervical rotation should be considered.

This manual approach would be appropriate if treatment was based on accurate physiotherapist evaluation procedures in studies using samples likely to share biomechanical conditions with our study samples, and more precise treatment protocols could be used.

Ⅴ. Conclusion

In conclusion, this study shows that compared to other treatments, PIMT approach is a more effective treatment for improving head rotation and cervical limitation for range of motion in CMT infants.

References

Celayir AC. Congenital muscular torticollis: Early and intensive treatment is critical. A prospective study. Pediatrics international. 2000;42(5):504-507. https://doi.org/10.1046/j.1442-200x.2000.01276.x

Chang PY, Chien YW, Huang FY, et al. Computer-aided measurement and grading of cranial asymmetry in children with and without torticollis. Clinical Orthodontics and Research. 2001;4(4):200-205. https://doi.org/10.1034/j.1600-0544.2001.40404.x

Cheng JCY, Chen TMK, Tang SP, et al. Snapping during manual stretching in congenital muscular torticollis. Clinical Orthopaedics and Related Research®. 2001;384:237-244. https://doi.org/10.1097/00003086-200103000-00028

Cheng JCY, Wong MWN, Tang SP, et al. Clinical determinants of the outcome of manual stretching in the treatment of congenital muscular torticollis in infants: A prospective study of eight hundred and twenty-one cases. The Journal of Bone & Joint Surgery. 2001;83(5):679-687. https://doi.org/10.2106/00004623-200105000-00006

Demirbilek S, Atayurt HF. Congenital muscular torticollis and sternomastoid tumor: Results of nonoperative treatment. J Pediatr Surg. 1999;34(4):549-551. https://doi.org/10.1016/s0022-3468(99)90070-2

Emery C. The determinants of treatment duration for congenital muscular torticollis. Phys Ther. 1994;74(10):921-929. https://doi.org/10.1093/ptj/74.10.921

Giammatteo S. Integrative Manual Therapy for Biomechanics: Application of Muscle Energy and "Beyond" Technique. North Atlantic Books. California. 2003.

Hägglund G, Lauge-Pedersen H, Wagner P. Characteristics of children with hip displacement in cerebral palsy. BMC Musculoskeletal Disorders. 2007;8:1-6. https://doi.org/10.1186/1471-2474-8-101

Hutchison BL, Mitchell EA, Thompson MD. Non-synostotic plagiocephaly and brachycephaly: An overview. Current Pediatric Reviews. 2006;2(1):33-39. https://doi.org/10.2174/157339606775518278

Kaltenborn FM. Orthopedic manual therapy for physical therapists Nordic system: OMT Kaltenborn-Evjenth concept. Journal of Manual & Manipulative Therapy. 1993;1(2): 47-51. https://doi.org/10.1179/jmt.1993.1.2.47

Karmel RK, Leppy M. Assessment and treatment of children with congenital muscular torticollis. Phys Occup Ther Pedi. 1997;17(2):21-67. https://doi.org/10.1080/j006v17n02_03

Latash ML. The Bernstein problem: How does the central nervous system make its choices. Dexterity and its development. 1996;277-303. https://doi.org/10.4324/9781410603357-18

Liebovitch LS. Fractals And Chaos Simplified For The Life Sciences. Oxford University Press. Wellington. 1998.

Loveday BP, de-Chalain TB. Active counter-positioning or orthotic device to treat positional plagiocephaly?. J Craniofac Surg. 2001;12(4):308-313. https://doi.org/10.1097/00001665-200107000-00003

McDowell JM, Johnson GM, Hetherington BH. Mulligan concept manual therapy: Standardizing annotation. Manual Ther. 2014; 19(5):499-503. https://doi.org/10.1016/j.math.2013.12.006

Pastor-Pons I, Hidalgo-García C, Lucha-López MO, et al. Effectiveness of pediatric integrative manual therapy in cervical movement limitation in infants with positional plagiocephaly: A randomized controlled trial. Ital J Pediatr. 2021;47(1):1-12. https://doi.org/10.21203/rs.3.rs-122219/v1

Persing J, James H, Swanson J, et al. Prevention and management of positional skull deformities in infants. Pediatrics. 2003;112 (1):199-202. https://doi.org/10.1542/peds.112. 1.199

Petronic I, Brdar R, Cirovic D, et al. Congenital muscular torticollis in children: Distribution, treatment duration and out come. Eur J Phys Rehab Med. 2009;46(2):153-157. https://doi.org/10.1016/j.rehab.2018.05.700

Piper MC, Darrah J. Motor Assessment Of The Developing Infant. Elsevier Saunders. London. 1994.

Porter SB, Blount BW. Pseudotumor of infancy and congenital muscular torticollis. Am FaM Physician. 1995;52(6):1731-1736. https://doi.org/10.1097/00005537-200104000-00023

Rahlin M. TAMO therapy as a major component of physical therapy intervention for an infant with congenital muscular torticollis: A case report. Pediatr Phys Ther. 2005;17(3): 209-218. https://doi.org/10.1097/01.pep.0000179176.20035.f0

Rushton A, Rivett D, Carlesso L, et al. International framework for examination of the cervical region for potential of cervical arterial dysfunction prior to orthopaedic manual therapy intervention. Manual ther. 2014;19(3):222-228. https://doi.org/10.1016/j.math.2013.11.005

Song S, Hwang W, Lee S. Effect of physical therapy intervention on thickness and ratio of the sternocleidomastoid muscle and head rotation angle in infants with congenital muscular torticollis: A randomized clinical trial. Medicine, 2021;100(33):e26998. https://doi.org/10.1097/md.0000000000026998

Song S, Hwang W, Lee S. Factors related to the treatment duration of infants with congenital muscular torticollis. Physical Therapy Rehabilitation Science. 2020;9(3):191-196. https://doi.org/10.14474/ptrs.2020.9.3.191

Staheli LT. Muscular torticollis: Late results of

ISSN 1226-3680 (Print)
ISSN 2508-7282 (Online)

operative treatment. Surgery. 1971;69(3):469-473. https://doi.org/10.1016/s0022-3468(71)80027-1

Stellwagen LM, Hubbard E, Vaux K. Look for the'stuck baby'to identify congenital torticollis. Contemporary Pediatrics. 2004;21(5):55-65.

Tatli B, Aydinli N, Çalıskan M, et al. Congenital muscular tortıcollis: Evaluation and classification. Pediatr Neurol. 2006;34(1):41-44. https://doi.org/10.1016/j.pediatrneurol.2005.06.010

Tscharnuter I. Clinical application of dynamic theory concepts according to tscharnuter akademie for movement organization (TAMO) therapy. Pediatr Phys Ther. 2002;14(1):29-37. https://doi.org/10.1097/00001577-200214010-00005

Van Vlimmeren LA, Takken T, Van Adrichem LN, et al. Plagiocephalometry: A non-invasive method to quantify asymmetry of the skull; A reliability study. Eur J Pediatr. 2006;165:149-157. https://doi.org/10.1007/s00431-005-0011-1

Wilbrand JF, Schmidtberg K, Bierther U, et al. Clinical classification of infant nonsynostotic cranial deformity. The Journal of pediatrics. 2012;161(6):1120-1125. https://doi.org/10.1016/j.jpeds.2012.05.023

Yim SY, Lee IY, Park MC, et al. Differential diagnosis and management of abnormal posture of the head and neck. Journal of the Korean Medical Association. 2009;52(7): 705-718. https://doi.org/10.5124/jkma.2009. 52.7.705.

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