

Original Article

Assessing Congenital Muscular Torticollis Using Myotonometry: A Novel Approach

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Abstract

Objective: This study aimed to evaluate sternocleidomastoid (SCM) muscle properties in infants with Congenital Muscular Torticollis (CMT) using myotonometry and determine its sensitivity to changes following physiotherapy. **Methods:** Twenty-five infants (0-12 months) diagnosed with CMT participated in this study from May 2023 to February 2024. They underwent an 8-week physiotherapy program. Muscle tone, elasticity, and stiffness were measured using myotonometry, muscle strength by the Muscle Function Scale (MFS), and neck range of motion by an arthrodiagonal protractor before and after treatment. **Results:** The mean age was 4 ± 1.56 months. Significant differences in SCM tone and stiffness between affected and intact sides were observed pre-treatment ($p < 0.05$) but were not significant post-treatment ($p > 0.05$). Intra-group improvements were significant for muscle tone ($p = 0.005$), elasticity ($p = 0.009$), stiffness ($p = 0.009$), strength ($p = 0.006$), and neck range of motion ($p = 0.021$). Muscle tone decreased by 19.65%, muscle stiffness by 24.99%, and muscle elasticity improved by 9.42%. Passive lateral flexion increased by 59.09% and passive rotation by 25.40%. **Conclusions:** SCM muscle properties differ between sides in individuals with CMT; however, myotonometry effectively detects improvements following physiotherapy, making it a valuable clinical evaluation tool. Nevertheless, the relatively small sample size should be taken into account when interpreting the findings.

Keywords: Congenital Muscular Torticollis, Muscle Elasticity, Muscle Stiffness, Muscle Tone, Physiotherapy

Introduction

Congenital muscular torticollis (CMT) is a musculoskeletal disorder characterized by a neck deformity that appears in newborns or during the first months of life¹. CMT is the third most common musculoskeletal abnormality in infants next to hip dysplasia and clubfoot². Research indicates that CMT affects between 3.9% and 16% of infants³. This deformity is caused by the unilateral shortening of the sternocleidomastoid muscle, which can occur due to the

intrauterine position of the head, intrauterine vascular changes in the muscle, or obstetric trauma⁴. Since there is an imbalance in the muscles around the neck in torticollis, infants with CMT tend to prefer unilateral use, leading to disruptions in normal developmental movements such as head control, rolling, reaching, sitting, crawling, and bilateral coordination skills. Additionally, CMT can cause facial asymmetry⁵.

In torticollis, structural and functional changes occur in the sternocleidomastoid (SCM) muscle, leading to loss of normal function. The most common pathological change is fibrosis, which reduces flexibility as normal muscle cells are replaced by connective tissue. Fibrosis also causes muscle shortening and limits range of motion. Additionally, muscle atrophy may develop due to prolonged abnormal positioning, disuse, or excessive tension, resulting in decreased muscle volume and strength⁶. Myofibril damage is another significant change observed in the SCM muscle. Continuous contraction and abnormal tension cause microscopic damage to muscle fibers, leading to

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inflammation. Prolonged inflammation can result in the hardening of muscle tissue and the development of pain⁷. Evaluation of muscle structural features is important for prognosis and treatment planning.

The myotonometer has been proven to be reliable and useful in assessing the biomechanical properties of myofascial tissues^{8,9}. These devices apply a constant pre-load to the soft tissue via a movable indentation probe, which is then rapidly released, and the tissue response (damping oscillation) is measured¹⁰. Although it has been used as an objective assessment tool in various pediatric diseases in the literature^{11,12}, no studies have been found where it was used as an assessment tool in infants with CMT. However, a myotonometer, which evaluates the biomechanical properties of muscles such as muscle tone, can be an objective method for demonstrating the effectiveness of physiotherapy and rehabilitation interventions¹³. Objective measurements provided by the myotonometer may support clinical decision-making and contribute to more individualized physiotherapy planning in infants with CMT.

Physiotherapy treatments in CMT can play a fundamental role in restoring functionality in children and promoting motor development^{4,14}. It has been reported that early initiation of physiotherapy is effective in treating CMT¹⁵. The general treatment goals are to address restrictions in neck movements and muscle imbalances, as well as to prevent facial and cranial deformities. Studies have reported that with physiotherapy and rehabilitation, muscle tension in the SCM significantly decreases, head tilt is reduced, and asymmetries in neck movements and plagiocephaly are improved¹⁶. Although there are various studies on the effectiveness of therapeutic methods for the treatment of CMT, focusing on passive neck movements, head tilt, and ultrasound of the SCM muscle¹⁷, there are no studies examining muscle properties, such as muscle tone, elasticity, and stiffness. Therefore, this study aimed to evaluate the biomechanical properties of the SCM muscle in infants with CMT using the myotonometer, and to determine whether the device can objectively detect changes following physiotherapy intervention.

Materials and Methods

The study was completed between May 2023 and February 2024 with 25 patients aged 0-12 months who were diagnosed with congenital muscular torticollis by a specialist physician and deemed suitable for physiotherapy and rehabilitation. The study was conducted in a private Physiotherapy and Rehabilitation Clinic in Istanbul.

The primary outcome measure, muscle tone assessment, was used to calculate the sample size. The effect size was determined as 1.577958 through post hoc analysis using group means and standard deviations. The power of the study was calculated using the GPower 3.0.10 analysis program, and with 25 participants, the power was found to be greater than 90%, with an alpha level of 0.05. One possible reason

for the large effect size observed in this study could be the pre-post design conducted within a single group. In such designs, participants serve as their own controls, which eliminates between-group variability and can lead to a higher effect size. Additionally, the intervention might have been genuinely effective, the measurement tool may have been sensitive enough to detect meaningful changes, and the homogeneity of the participant group could have also contributed to the large effect size. Infants aged between 4 and 12 months who were clinically diagnosed with congenital muscular torticollis (CMT) and did not present with palpable fibrotic masses in the sternocleidomastoid (SCM) muscle were included in the study. Participants were required to have normal neurodevelopmental status for their age, with no history of prematurity (i.e., born after 37 weeks of gestation), and to be free of any musculoskeletal deformities other than torticollis. Additionally, infants with parental consent to participate in a physiotherapy-based intervention program and the related assessments were included in the study sample. Babies were excluded from the study if they had other health problems such as vertebral anomalies or neurological deficits.

Cases meeting the inclusion criteria were subjected to an initial evaluation. Following the initial assessment, the patients were enrolled in an 8-week treatment program, and after the completion of the program, a second evaluation was conducted.

Data Collection Tools

In this study, data were collected using Demographic Information Form, myotonometry, Muscle Function Scale (MFS), arthrodiagonal protractor.

Myotonometer: A myotonometer (MyotonPRO, Myoton AS, Estonia) was used to evaluate the tone, stiffness, and elasticity of the SCM muscle¹⁸. Three measurements were taken for each evaluation, and the averages were recorded.

Muscle Function Scale (MFS): The MFS is a diagnostic tool used to evaluate the response of the sternocleidomastoid (SCM) muscle during upward head movements to the side. This tool utilizes a visual ordinal scale with five categories, ranging from 0 to 4, designed to measure muscle strength and the orienting response of cervical lateral flexion muscles. During the assessment, the infant is initially held vertically and then shifted to a horizontal position in front of a mirror. The MFS score is determined by the infant's head position in relation to a horizontal line; 0 (head below the line) indicates no muscle function, while 4 (head well above the line) indicates strong muscle function. This scale is particularly useful for assessing the function of cervical lateral flexion muscles in infants with conditions like torticollis and is known for its high inter-rater reliability¹⁹. The MFS demonstrates high inter-rater and intra-rater reliability, with kappa statistics and intraclass correlation coefficients (ICC) both exceeding 0.9¹⁹.

Range of Motion: Passive range of motion was assessed using an arthrodiagonal protractor. The infant lies in a supine

position while the caregiver stabilizes the shoulders to prevent compensatory movements. For lateral flexion, the therapist bends the neck to the side opposite the affected sternocleidomastoid (SCM) muscle. For neck rotation, the therapist rotates the neck toward the affected SCM and measures the movement with an arthroial protractor. Studies have shown that evaluating passive range of motion with an arthroial protractor is reliable and can effectively be used to assess the effects of treatment in infants with congenital muscular torticollis²⁰.

Intervention

The treatment program was implemented once a week for a total of 8 weeks and included the following interventions:

Manual Stretching Techniques: Gentle passive stretching techniques were applied to alleviate the shortening and tension in the SCM muscle. Parents were advised to perform 15 stretching movements 4-5 times a day as part of a home program. Each stretch lasted 10-15 seconds. Practical training on how to perform these stretches carefully and gently, ensuring the baby does not experience discomfort, was provided by an experienced physiotherapist. Parents were also monitored weekly via phone and WhatsApp to ensure they encountered no issues while performing these exercises.

Positioning: Proper positioning methods were used to support head and neck alignment, especially during sleep, daily care, and in infant carriers and car seats. Parents received practical training on positioning the baby in supine, side-lying, and prone positions, with recommendations to reduce plagiocephaly caused by head asymmetry. This training was given in a hands-on manner to ensure understanding.

As part of daily routine carrying activities, it was recommended that during outward-facing carrying, the baby's neck be gently stretched into lateral flexion to the opposite side of the tort

Active Movement and Play-Based Exercises: Parents were encouraged to engage in symmetrical, play-based exercises to improve the baby's head control and muscle balance. These movements were guided by toys that captured the baby's attention and were integrated into the daily routine with the support of the parents.

Soft Tissue Mobilization: Gentle movements were applied in a comfortable position for the baby to reduce tension in the SCM muscle and enhance circulation.

Family Education: Parents were allowed to record the entire program while the physiotherapist conducted the session. Simple stretching and positioning techniques to be performed at home were taught in person, and during the sessions, the physiotherapist ensured parents performed the movements correctly by asking them to demonstrate and correcting any mistakes. The physiotherapist aimed to boost the parents' confidence by assuring them they could contact the therapist anytime for support. Additionally, information was provided on key points to be mindful of

Table 1. Demographic and Disease Related Characteristics of the Cases.

	n (%)	Mean ± SD
Age (months)	25	4 ±1.56
		n (%)
Sex	Female	10 (40%)
	Male	15 (60%)
Affected Side	Right	15 (60%)
	Left	10 (40%)

during daily care routines. The caregiver's adherence to home exercises was checked via telephone message.

Statistical Analysis

The data were analyzed using the SPSS 25 statistical software package (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Descriptive statistics (standard deviation, mean, percentile, and count) were provided for categorical and continuous variables, and the assumption of normality was assessed using the "Shapiro-Wilk" test. The Wilcoxon test was used to compare pre- and post-treatment evaluations. To reduce the risk of Type I error due to multiple comparisons, the Bonferroni correction was applied. A p-value of less than 0.05 was considered statistically significant.

Results

The average age of the infants in the study was 4 ± 1.56 months. In terms of sex distribution, 40% of the participants were female infants and 60% were male infants. No mass presence was detected in any of the infants. Of the infants, 60% had right-sided involvement and 40% had left-sided involvement (Table 1).

Table 2 presents the comparison of SCM muscle properties between the affected and intact sides before to treatment. The muscle tone and stiffness of the affected side were significantly higher than those of the intact side ($p < 0.05$). Conversely, no statistically significant difference was observed in muscle elasticity between the affected and intact sides ($p > 0.05$).

Table 3 presents the comparison of SCM muscle properties between the affected and intact sides after to treatment. After treatment, there was no significant difference in SCM muscle tone, stiffness, or elasticity between the affected and intact sides ($p > 0.05$).

Table 4 presents the comparison of SCM muscle properties, muscle strength, and passive range of motion before and after treatment. After treatment, significant improvements were observed in the affected side SCM

Table 2. Comparison of affected and intact side sternocleidomastoid (SCM) muscle properties before treatment (n=25) (*p<0.05).

	Mean ± SD	p value
Affected side tonus	18.63± 2.47	0.001*
Intact side tonus	16.28± 1.72	
Affected side stiffness	318.27± 82.88	0.025*
Intact side stiffness	292.54± 67.17	
Affected side elasticity	1.38±0.22	0.68
Intact side elasticity	1.35± 0.36	

Table 3. Comparison of affected and intact side sternocleidomastoid (SCM) muscle properties after treatment (n=25).

	Mean ± SD	p value
Affected side tonus	14.97± 1.87	0.067
Intact side tonus	15.17± 1.04	
Affected side stiffness	238.72±54.75	0.095
Intact side stiffness	245.93± 68.19	
Affected side elasticity	1.25±0.16	0.68
Intact side elasticity	1.31± 0.47	

Table 4. Evaluation of muscle properties, muscle strength and range of motion of the affected side before and after treatment (*p<0.05).

Parameter	Pre-Treatment Mean ±SD	Post-Treatment Mean ±SD	p-value	Cohen's d	η ²
Affected side Muscle Tone	18.63± 2.47	14.97± 1.87	0.005*	1.67	0.218
Affected side Muscle Stiffness	318.27±82.88	238.72±54.75	0.009*	1.13	0.114
Affected side Muscle Elasticity	1.38±0.22	1.25±0.16	0.009*	0.68	0.044
Muscle Function Scale (MFS)	2.40±0.69	3.90±0.31	0.006*	-2.80	0.440
Passive Lateral Flexion	44.00±21.18	70.00±11.54	0.021*	-1.52	0.189
Passive Rotation	63.00±10.59	79.00±5.67	0.011*	-1.86	0.257

muscle properties and functional outcomes (p<0.05). Muscle tone and stiffness decreased, while elasticity improved. Furthermore, the MFS score increased, along with enhancements in passive lateral flexion and rotation.

Discussion

In this study, the properties of the SCM muscle were evaluated using the myotonometer on the affected and intact sides before and after physiotherapy intervention. The selection of methods used in the evaluation of CMT plays a critical role in understanding the condition and monitoring treatment progress. Evaluation in infants presents unique challenges due to limited cooperation and rapid developmental changes, which highlights the importance of accurate, reliable, and objective measurement tools. While traditional evaluation methods are often based on observational assessments, the integration of objective tools such as myotonometry provides measurable and reproducible data on muscle properties. These quantitative approaches complement other assessments, enhancing the precision of treatment monitoring and offering valuable insights into the effectiveness of physiotherapy interventions in infants with CMT. Therefore, the use of objective tools alongside clinical observations is of great

importance for advancing research and clinical outcomes in pediatric populations.

Prior to treatment, the tone and stiffness of the affected SCM muscle were significantly higher compared to the intact side. Following the physiotherapy intervention, improvements were observed in muscle tone, stiffness, muscle strength, and neck range of motion. After treatment, no differences were observed between the SCM muscle properties of the affected and intact sides. These findings indicate that SCM muscle properties differ between the affected and intact sides in congenital torticollis. However, no differences were observed after the physiotherapy intervention. In the literature, ultrasound has been used to evaluate the effectiveness of treatments such as physiotherapy and microcurrent therapy by measuring changes in muscle thickness and range of motion^{21,22}. The innovative aspect of our study is that the improvements obtained with physiotherapy were evaluated using myotonometry and myotonometry reflects the improvements observed after physiotherapy intervention. Myotonometry can be considered in clinical practice as a non-invasive alternative.

Current evidence reflects that CMT is a significant musculoskeletal alteration that can limit an infant's functionality and condition their development²³. The origin of

this postural disorder appears to be the sternocleidomastoid muscle; therefore, the aim of treatments is to impact this muscle and correct the position^{24,25}. The reduction in SCM muscle tone and stiffness observed in this study after treatment provides substantial evidence supporting the muscle-relaxing effects of physiotherapy and rehabilitation interventions. However, the lack of directly comparable findings in the existing literature suggests that the impact of physiotherapy on CMT may not have been sufficiently explored, indicating a gap in current research. While some studies have reported the use of botulinum toxin to reduce muscle tone in torticollis²⁶⁻²⁸, highlighting the relevance of alternative treatment modalities, the rationale for comparing these approaches remains underdeveloped. A clearer justification—such as differences in mechanism of action, duration of therapeutic effect, or patient suitability—would strengthen this line of inquiry. Alternatively, this comparison may be more appropriately framed as a direction for future research. In this context, further comprehensive studies comparing the effectiveness and long-term outcomes of physiotherapy versus botulinum toxin injections, or investigating the potential benefits of their combined use, would be valuable for informing clinical decision-making in the treatment of CMT.

Muscle elasticity is one of the mechanical properties of the muscle and determines how much the muscle can stretch under tension²⁹. In our study, an improvement in SCM muscle elasticity was recorded after treatment. In this context, the results of our study indicate that the exercises performed contributed to enhancing muscle tissue elasticity and making the muscle more flexible. The improvements in muscle elasticity recorded after treatment are an important indicator highlighting the effectiveness of the rehabilitation process. Our results show that physiotherapy programs applied in congenital muscular torticollis are effective in improving the properties of the muscle and contribute to the treatment process of the baby, and that these improvements shown by other measurement parameters can also be shown by the myotonometer. In our study, a significant improvement in the MFS was also observed after treatment. This result aligns with findings in the literature, where functional exercises and motor control strategies have been reported to improve muscle function in torticollis treatment, enabling children to participate more effectively in daily activities³⁰.

Significant increases in passive lateral flexion and rotation movements were detected after treatment. These results are consistent with existing studies in the literature. Movement restrictions are commonly observed in infants with torticollis due to the shortening of the SCM muscle, and physiotherapy interventions play an effective role in alleviating these restrictions³¹. Specifically, stretching and mobilization techniques help restore joint range of motion by increasing muscle length³². The increased joint mobility observed after treatment can improve the infant's symmetrical head control and postural control, helping motor development to become more sequential

and symmetrical. This, in turn, can enhance the infant's participation in daily life and play activities.

Although the authors reported that no fibrotic masses were observed in the study participants, it is important to consider how this absence may have influenced the sensitivity and generalizability of the findings. Fibromatosis colli, characterized by fibrotic tissue formation within the SCM muscle, can significantly alter muscle elasticity and reduce responsiveness to physiotherapy. The lack of fibrotic involvement in the study group suggests that the observed improvements may be more representative of milder cases of CMT with a more favorable prognosis. Consequently, these results may not be fully generalizable to all CMT cases, particularly those with fibrotic masses, where muscle properties may be less adaptable and treatment outcomes more variable. Additionally, the greater modifiability of muscle properties in non-fibrotic cases may have contributed to the pronounced improvements detected through myotonometric evaluation.

A limitation of our study is the relatively small sample size, which may affect the generalizability of the findings. Additionally, the study lacked a long-term follow-up to assess the sustained effects of the physiotherapy interventions on muscle biomechanics and functional outcomes. Future studies with larger sample sizes and extended follow-up periods are necessary to validate these results and explore the long-term benefits of physiotherapy in congenital muscular torticollis. The strength of our study is that it is the first to evaluate the effect of physiotherapy intervention on the biomechanical properties of the SCM muscle in congenital muscular torticollis.

Conclusion

This study demonstrates that physiotherapy and rehabilitation programs positively influence the properties of the SCM muscle in infants with torticollis by reducing muscle tone and stiffness, increasing elasticity, and improving neck joint range of motion. Beyond highlighting these outcomes, the findings suggest important implications for clinical practice. The ability of the myotonometer to detect changes in muscle biomechanics supports its potential use as an objective tool for monitoring treatment response, particularly in early intervention settings where accurate and quantifiable assessment methods are essential. Moreover, as this is the first study to apply the myotonometer to evaluate muscle elasticity in torticollis, it provides preliminary evidence for the device's clinical utility and warrants further validation. Given its portability, ease of use, and cost-effectiveness, myotonometry represents a non-invasive and accessible alternative to imaging-based modalities for assessing muscle properties in both clinical and research settings. Future research should focus on the device's role in guiding individualized therapy, compare muscle properties in infants with and without fibromatosis colli, and include

larger sample sizes to strengthen generalizability and clinical relevance.

Ethics Approval

This study was approved by the Ethics Committee for Non-Interventional Research at Istanbul Okan University (Date: 10.05.2023, Decision No: 2023/168). All study procedures were conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Informed Consent

Informed consent was obtained from the parents or legal guardians of all infants included in the study.

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Authors' contributions

DA, GA, EA, and TD contributed to the study's conceptualization, design, data collection, and analysis, as well as to writing and critically revising the manuscript. All authors read and approved the final version of the manuscript.

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