

# The Determinants of Treatment Duration for Congenital Muscular Torticollis

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**Background and Purpose.** Although the success of conservative management of congenital muscular torticollis has been well documented, relatively little is known about the determinants of response to treatment, such as treatment duration. The purpose of this study was to determine how factors such as severity of restriction of range of motion, age at initiation of treatment, and presence of a palpable intramuscular fibrotic sternocleidomastoid muscle mass affect treatment duration. **Subjects.** One hundred one children (mean age=4 months, SD=2.87, range=0.5–15.5) who were diagnosed with congenital muscular torticollis and referred to physical therapy at British Columbia's Children's Hospital (Vancouver, British Columbia, Canada) prior to 2 years of age were included in the study. **Methods.** Following a standardized initial assessment, parents were taught the home treatment program, which included passive stretches of the affected sternocleidomastoid muscle and strengthening exercises for the contralateral side, and positioning and handling skills. Evaluation at 2-week intervals included measurement of passive neck rotation and lateral flexion using an adapted standard goniometer. Treatment duration was defined as the time between initiation of treatment and achievement of full passive neck range of motion. **Results.** Complete recovery (full passive range of motion) was achieved in all but one of the children in this sample. The mean treatment duration was 4.7 months (SD=5.06, range=1–36). Correlations were noted between severity of restriction and treatment duration ( $r=.31$ ) as well as between presence of a mass and treatment duration ( $r=.26$ ). Multiple regression analysis revealed that severity of restriction was the strongest predictor of treatment duration. **Conclusion and Discussion.** The results of this study will make it possible for therapists to better predict treatment duration at the time of the initial assessment. By providing parents with more precise information about the length of treatment, parents may be more willing to adhere to the exercise program. [Emery C. The determinants of treatment duration for congenital muscular torticollis. *Phys Ther.* 1994;74:921–929.]

**Key Words:** Congenital muscular torticollis; Muscle performance, general; Neck and trunk, general; Pediatrics, treatment; Physical therapy.

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Congenital muscular torticollis (CMT) is a musculoskeletal anomaly with a reported incidence in newborn infants of 0.3%<sup>1</sup> to 1.9%.<sup>2</sup> An infant with CMT has a restricted neck range of motion (ROM) secondary to a shortened sternocleidomastoid (SCM) muscle. The two current approaches to the treatment of CMT are surgical lengthening of the muscle and, more

conservatively, a stretching program to lengthen the muscle. Because conservative management has been so successful, surgery is typically done only in severe cases. Although the success of the conservative approach has been well documented,<sup>3-6</sup> little has been reported to characterize the determinants of a child's responsiveness to treatment (eg, treatment duration needed for a desired clinical effect). There are presumably interactive effects of determinants such as restriction of ROM, age at onset of treatment, presence of a fibrotic mass, and side of involvement.

The clinical features of CMT include a head tilt toward the side of the shortened muscle and head rotation toward the contralateral side. Facial asymmetries and plagiocephaly are also frequently observed. A palpable intramuscular fibrotic mass in the belly of the affected SCM muscles occurs in 20%<sup>7</sup> to 83%<sup>6</sup> of the muscles and usually consists of fibrous tissue.<sup>1,8</sup>

The two most frequently cited causes of CMT are intrauterine malposition and birth trauma. These causes, however, may not be mutually exclusive. Support for the birth trauma hypothesis arises from the high incidence of complicated labor and deliveries (22%<sup>3</sup>-42%<sup>5</sup> of CMT cases) compared with that for the general population (3%<sup>9</sup>-15%<sup>10</sup>). Support for intrauterine malpositioning as a cause comes from the high incidence of breech presentation at birth (17%<sup>3</sup>-40%<sup>11</sup> of CMT cases) compared with that reported for the general population (1.5%<sup>12</sup>-7%<sup>13</sup>). Support also comes from the incidence of congenital hip dysplasias (10%<sup>3</sup>-20%<sup>14</sup> of CMT cases) compared with that reported for the general population (1.2%<sup>15</sup>-1.9%<sup>16</sup>).

The cause of the fibrous mass observed in many infants with CMT is unknown. Experiments with animals indicate that venous occlusion results in fibrotic changes in muscle tissue.<sup>17</sup> Some researchers believe that the mass may therefore be a result of intrauterine malposition or from trauma during delivery.<sup>18</sup> The mass

appears within the first 3 weeks after birth and attains its maximum size by 1 month.<sup>19</sup> Without treatment, the mass gradually disappears by 2 to 6 months, leaving a shortened muscle.<sup>20</sup> Some authors<sup>3,19</sup> argue that all cases of CMT are due to fibrosis of the SCM muscle, representing a continuum from no palpable mass to a discrete mass.

If CMT is untreated, the soft tissues may not grow relative to the child's skeletal growth.<sup>21</sup> Deep cervical fascia becomes thickened, and as a result the carotid sheath and vessels also tighten.<sup>21</sup> A resultant cervical and compensatory thoracic scoliosis may develop.<sup>21</sup> Coventry and Harris,<sup>11</sup> however, reported spontaneous recovery in six infants with an SCM muscle mass with no intervention.

The success of passive stretching exercises in the management of CMT is well documented. Morrison and MacEwen<sup>6</sup> reported good to excellent results in all children treated with conservative measures before 1 year of age. Binder et al<sup>3</sup> reported resolution of CMT with conservative treatment by age 1 year in 70% of their patients, regardless of severity of restriction of neck ROM or presence of focal fibrosis.

Although little has been published on the relationship between initial restriction of ROM and treatment duration until clinical success is achieved, Canale et al<sup>5</sup> reported that individuals with a pretreatment loss of greater than 30 degrees of rotation were more likely to require surgery. Binder et al<sup>3</sup> indicated that the proportion of children with resolution of torticollis at age 1 year was greater in those with initial mild to moderate involvement.

Children referred to physical therapy before 1 year of age have better outcomes than those referred later.<sup>5,6</sup> The age at which treatment is initiated has been reported as a key predictor of outcome following conservative management.<sup>3</sup> Cameron et al<sup>4</sup> reported excellent results (full rotation and no facial asymmetry) in 65%,

good results (full rotation and mild facial asymmetry, or mild limitation of rotation and no facial asymmetry) in 27%, and fair results (mild limitation of rotation and mild facial asymmetry) in 8% of patients in whom treatment was initiated prior to 3 months of age; none of these children required surgery. For children in whom treatment was initiated later than 3 months of age, 45% required surgery.

The purpose of this study was to describe how factors such as restriction of ROM, age of initiation of treatment, presence of a palpable SCM muscle mass, and use of a prescribed collar affected treatment duration.

## Method

### Subjects

Children who were diagnosed with CMT and treated at British Columbia's Children's Hospital (BCH) (Vancouver, British Columbia, Canada) between 1989 and 1992 were the subjects for this prospective study. Information was included in the data set if (1) the child was diagnosed with CMT and referred by a family physician, pediatrician, or orthopedic surgeon; (2) the initial assessment and physical therapy program were initiated prior to 2 years of age; (3) the child had restricted neck ROM in lateral flexion or rotation relative to the contralateral side; (4) the child's parents attended follow-up appointments about once every 2 weeks initially and once monthly following the child's attainment of full neck ROM; and (5) the follow-up assessment and treatment were conducted by the author.

Children were excluded from the study if (1) treatment was initiated at another facility prior to the initial assessment and initiation of treatment at BCH, (2) additional medical complications interfered with the standard stretching program, (3) there was previous surgical correction for torticollis, (4) a radiological examination indicated vertebral anomalies, (5) ocular imbalance caused the head tilt, (6) there was any other diagnosed or

**Table 1.** *Clinical Features of Children Who Completed Treatment and Whose Data Were Used for Statistical Analysis (n=100)*

Gender <sup>a</sup>	59% male	41% female
Side <sup>a</sup>	61% left	39% right
Mass	25% palpable mass	75% no mass
TOT <sup>b</sup>	30% TOT	70% no TOT

<sup>a</sup>In both the mass (n=25) and no-mass (n=75) groups, the proportions of male: female and left:right were not statistically different than for the total group.

<sup>b</sup>TOT=tubular orthosis for torticollis.

suspected syndrome (eg, Down syndrome, Klippel-Feil syndrome, multiple orthopedic deformities), or (7) there was a nerve injury at birth that may be associated with the CMT.

One hundred eighty-one children diagnosed with CMT satisfied all of the inclusion criteria. They were all referred to physical therapy at BCCH between September 1989 and September 1992. Of this group, 58 children who had complied with the follow-up appointments were excluded from the study because they had not completed treatment prior to October 1992, when the statistical analysis was completed. A further 22 children who were assessed initially but failed to comply with the follow-up appointments were excluded. One child who complied with the follow-up appointments was included in the study, but the child's data were excluded from the statistical analysis because surgery was required. The remaining 100 children (mean age=4 months, SD=2.87, range=0.5-15.5) successfully completed treatment prior to October 1992, and their data were included in the statistical analysis.

The birth history of the population of 181 children was consistent with that reported in the literature. The incidence of complicated labor and delivery (forceps, vacuum extraction) in this population was 29%. The incidence of breech presentation at birth was 16%. The incidence of congenital hip dysplasia was 9%. The clinical

features of the total group of children who successfully completed treatment and whose data were used for the statistical analysis (n=100) are summarized in Table 1.

### **Treatment Procedures**

Treatment was initiated at the first visit at the BCCH physical therapy department. The parents were provided with a brochure to educate them about CMT and the home treatment program. The parents were taught a stretching program to increase the infant's range of neck rotation to the affected side and neck lateral flexion to the contralateral side.

Two people were required to stretch the infant's neck. One person secured the infant's shoulders, stabilizing the clavicle, while the other person did the stretching. Particular attention was paid to hand placement. For a right-sided torticollis, the parent cupped the left side of the infant's face. The parent supported the skull under the occipital region with the right hand. The same hand placement was used for right rotation and left lateral flexion. Slight traction to gain relaxation was applied prior to initiating full rotation of the head to the right through the available ROM. At the end of the ROM, the stretch was held. The lateral flexion stretch was also initiated with the application of slight traction followed by slight forward flexion and approximately 10 degrees of right rotation. Finally, the head was moved laterally toward the left side so that the left ear approached the left shoulder<sup>18</sup> (Fig. 1). Both stretches were held for 10 seconds and repeated five times each, twice daily. When full passive range of motion (PROM) was obtained (ie, symmetrical rotation and lateral flexion with no resistance at the end of the ROM), the stretching program was discontinued. To ensure that ROM was not lost after the program was stopped, the child was again examined 1 month after the stretching program was discontinued.<sup>18</sup>

In addition to the stretches described, treatment included educating the parents about positioning and handling skills that promote active neck rotation toward the affected side and discourage the child from tilting his or her head toward the affected side. For example, having the child sleep in a side-lying position on the side of the tight SCM muscle provided a gentle stretch of the contracted muscle and promoted skull symmetry. Having the child play in a prone position with the neck extended encouraged bilateral SCM muscle elongation. When the child reached 4 months of age, if there was a significant head tilt toward the affected side, it was found that lateral head righting on the contralateral side was weak. Parents were taught to strengthen the opposite SCM muscle using the lateral righting response in upright, rolling, and side-lying activities. At 4.5 months of age, if the child had a head tilt of 6 degrees or greater, a tubular orthosis for torticollis (TOT) was provided by the occupational therapy department at BCCH. The TOT was essentially a collar made of soft tubing, which the child wore while awake as an active correcting device (Fig. 2).

### **Data Collection**

Data were collected prospectively. A standardized assessment form was completed at the initial visit to ensure inclusion of the essential data. During the patient's first visit, a history was taken and a physical examination was completed. A home treatment program was initiated following the initial visit. The examination included an ocular screening test to rule out ocular imbalance.<sup>18</sup> Skull and facial asymmetry were also subjectively assessed at this time. The information recorded for study purposes included the infant's age at the initial assessment, side of involvement, presence of a palpable mass in the SCM muscle, neck PROM (rotation and lateral flexion), extent of active neck movement, angle of head tilt, and degree of lateral head righting.

Restricted neck motion was indicated by the absence of PROM in rotation

## Home Stretching Program

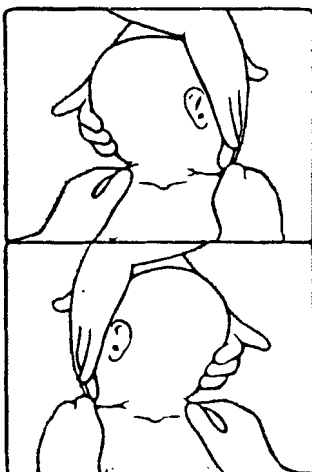
These stretches must be done \_\_\_\_\_ times daily, beginning with \_\_\_\_\_ stretches and increasing to \_\_\_\_\_ as your baby tolerates.

### First, position your baby:

- 1) The baby is placed on the back on a table, with the head free of the edge.
- 2) Person A secures the baby's shoulders to the table throughout the stretches.
- 3) Person B stands by the baby's head, placing one hand firmly at the base of the skull (stretching hand) and the other hand around the baby's chin (guiding hand).
- 4) The baby's head is then pulled slightly away from the shoulders.

### First Stretch:

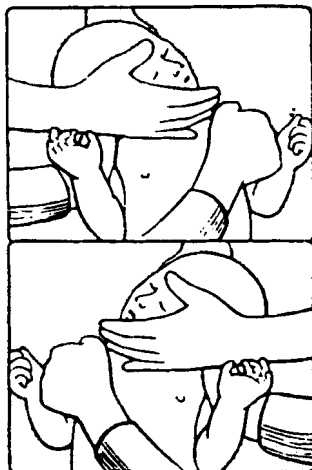
- 1) Person B pulls the baby's head slightly away from the shoulders.
- 2) Person B then rotates the baby's head toward the \_\_\_\_\_ side, so the baby's chin approaches the \_\_\_\_\_ shoulder. This position is held for about 10 seconds.
- 3) Repeat \_\_\_\_\_ times.



Allow the baby to rest momentarily before going on to the second stretch.

### Second Stretch:

- 1) Person B pulls the baby's head slightly away from the shoulders, bends it slightly forward, and rotates it slightly to the \_\_\_\_\_ side.
- 2) The baby's neck is bent sideways by Person B until the \_\_\_\_\_ ear is in contact with the \_\_\_\_\_ shoulder. The stretch is held for about 10 seconds.
- 3) Repeat \_\_\_\_\_ times.

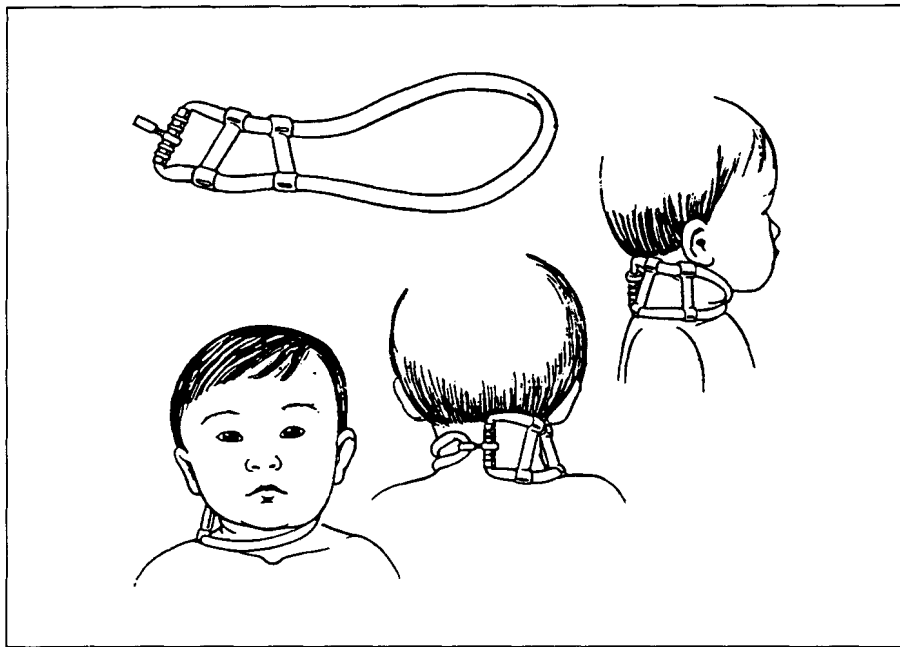


**Figure 1.** Home stretching program taught to parents at initial assessment. (Copyright, Physiotherapy Department, British Columbia's Children's Hospital.)

and lateral flexion compared with the contralateral side. An adapted standard goniometer was used to measure PROM in rotation and lateral flexion as well as the angle of head tilt. The goniometer had two carpenter's levels attached to its stationary arm. One level was located parallel to the stationary arm of the goniometer in midline. The other level was positioned perpendicular to the first level at the end of the goniometer's stationary arm. Two studies that examined interrater reliability of similar instruments for the measurement of cervical ROM yielded correlations of .86 to .96<sup>22</sup> and .58 to .89.<sup>23</sup> All measurements in this study were done by the author.

Neck rotation was the measured angle between the sagittal plane of the head when the child was positioned supine with the head centered (with the stationary arm of the goniometer maintained in this plane using the perpendicular carpenter's level) and the sagittal plane of the head at the end of the passive rotation (with the movable arm of the goniometer aligned with the infant's nose). If the child's chin reached his or her shoulder, the degree of neck rotation was 90 degrees. Infants typically have 100 to 120 degrees of neck rotation to either side.<sup>18</sup> The severity of restricted neck rotation was measured as the proportion of the ROM (in degrees) on the affected side to the ROM (in degrees) on the unaffected side.

The second component of the severity of CMT measure was the range of neck lateral flexion. The degree of lateral flexion was defined as the angle between the interorbital line when the infant's head was in a neutral position and the interorbital line when the infant's head was in a fully stretched position. This angle was measured between the interorbital line with the head laterally flexed and a line through the navel and sternum, parallel to the sagittal plane of the body. This angle was measured with the goniometer. Infants typically have 85 to 90 degrees of passive neck side flexion.<sup>18</sup> As with the rotation variable, severity of restricted lateral flexion



**Figure 2.** Tubular orthosis for torticollis provided to children with a head tilt of  $>6$  degrees at age 4.5 months or older.

was the ratio of the angle on the affected side to the angle on the unaffected side.

Head tilt was measured with the child in a supported sitting position. The goniometer was held 0.9 m (3 ft) in front of the child at eye level. The stationary arm was maintained horizontal by leveling the carpenter's bubble, and the movable arm was then aligned with the lateral corners of the child's eyes.

Follow-up visits were arranged for monitoring the home program and reassessment. Passive neck rotation, lateral flexion, and head-tilt measurements were recorded every 2 weeks. For the purposes of this study, the *TOT duration* was defined as the time from the initiation of TOT use to the discontinuation of TOT use, when a neutral head position had been achieved independently.

*Treatment duration* was defined by the time between the initial assessment and achievement of full and easy ROM of the neck, in both rotation and lateral flexion. This end point coincides with the discontinua-

tion of the stretching program but does not include the following month, during which the therapist continued to assess the child to ensure that there was no loss of ROM. The scope of this study was limited to a single course of treatment and the length of time to achieve full ROM. Because follow-up appointments took place every 2 weeks, recovery at a given date indicates that recovery occurred within the previous 2 weeks.

### Data Analysis

The Statistical Package for the Social Sciences<sup>24</sup> was used for all of the statistical analyses done in this research. Means, standard deviations, and ranges were calculated for age at initiation of treatment, treatment duration, angle of head tilt, age at initiation of TOT use, and TOT duration. Pearson Product-Moment Correlation Coefficients ( $r$ ) and multiple regression analysis were used to analyze the determinants of treatment duration. The level of significance for all statistical analyses was accepted at .01. The multiple regression analysis was done using data from the sample of children who achieved full recovery

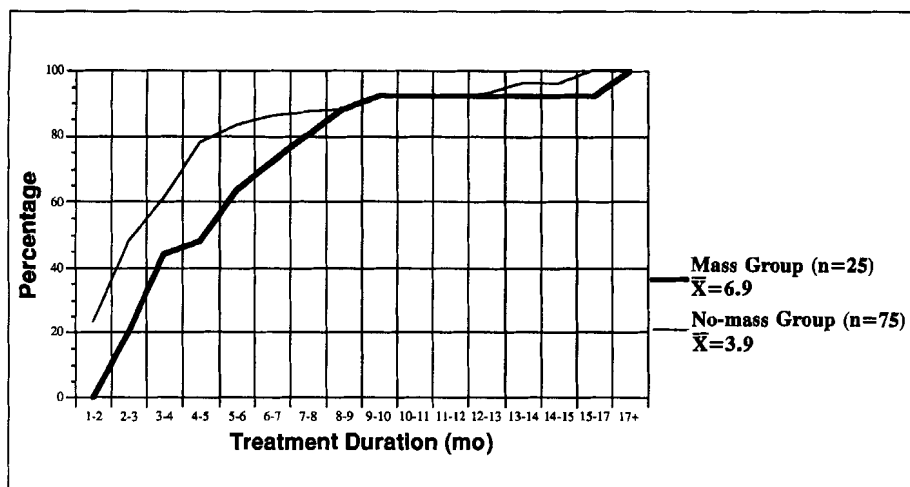
( $n=100$ ), with treatment duration as the dependent variable. The explanatory variables included were severity of restriction in rotation, severity of restriction in lateral flexion, presence of a mass, and age at initial assessment. Multiple regression analysis identifies the factor-specific contributions to treatment duration and allows for statistical testing of the significance of each variable, controlling for all other factors.

### Results

The mean age at initial assessment for the total group ( $n=100$ ) was 4.0 months ( $SD=2.87$ , range=0.5–15.5). The mean age at initial assessment was 1.9 months ( $SD=1.12$ , range=1–3.5) for the mass group ( $n=25$ ) and 4.7 months ( $SD=2.95$ , range=0.5–15.5) for the no-mass group ( $n=75$ ). The mean age at initial assessment was 5.1 months ( $SD=2.68$ , range=1–15.5) for the infants requiring a TOT ( $n=30$ ) and 3.5 months ( $SD=2.56$ , range=0.5–15) for the infants not requiring a TOT ( $n=70$ ). The child who required surgery was 2.5 months of age at the initial assessment and had a large palpable mass; the decision for surgery was made when the infant was 14 months of age.

The children with a mass typically presented a diagnosis of CMT at a younger age than did the children with no mass. The older the children were at the initial assessment, the more likely they were to have a significant head tilt ( $>6^\circ$ ) and to require a TOT.

In the total group, the mean treatment duration was 4.7 months ( $SD=5.06$ , range=1–36). The mean treatment duration was 6.9 months ( $SD=7.98$ , range=2–36) for the mass group and 3.9 months ( $SD=3.35$ , range=1–16) for the no-mass group. Children in the mass group were typically treated longer to achieve full recovery than children in the no-mass group (Fig. 3). The mean treatment duration was 7.2 months ( $SD=7.81$ , range=1–36) for the TOT group and 3.6 months ( $SD=2.81$ , range=1–12) for the no-TOT group (Fig. 4). Thus,



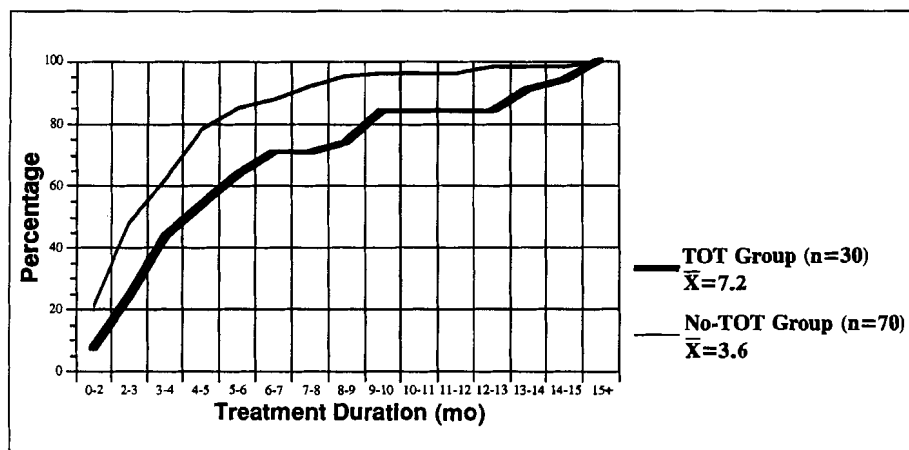
**Figure 3.** Probability of recovery by treatment duration (mass group versus no-mass group).

the children with a more significant head tilt also took longer to achieve full ROM.

For the TOT group, the mean initial head tilt was 13.5 degrees (SD=4.41, range=10-25). The mean age at which TOT use was initiated was 6.9 months (SD=2.66, range=4-15.5). The mean length of time the TOT was required (ie, neutral head position was achieved) was 5.2 months (SD=2.81, range=1-12.5). No children required the TOT after full neck PROM was achieved and the stretches were discontinued.

Correlations between the four determinants of treatment duration (mass, age at initiation of treatment, restriction in rotation, and restriction in lateral flexion) and duration of treatment are provided in Table 2.

Multiple regression analysis revealed severity of restriction of neck rotation as the only significant predictor of treatment duration ( $P=.0074$ ). When the data were divided into mass group and no-mass group, however, the severity of restriction of rotation was a significant predictor of treatment duration only in the no-mass



**Figure 4.** Probability of recovery by treatment duration (TOT group versus no-TOT group). (TOT=tubular orthosis for torticollis.)

group ( $P=.002$ ). Figures 5 and 6 clearly demonstrate these findings.

For the no-mass group, an equation was determined to predict treatment duration when severity of restriction had been identified:

$$y = -.012x + .824$$

where  $x$ =treatment duration (in months) and  $y$ =severity of restriction in rotation (affected side/unaffected side) ( $R^2=.1472$ ).

## Discussion

Full recovery was achieved in all except one of the children in the study. This result appears to exceed the results reported in other studies. Cameron et al<sup>4</sup> reported the necessity for surgical intervention in 45% of children who started a passive stretching program at age 3 months or older and no necessity for surgical intervention in children who started the program before age 3 months. Morrison and MacEwen<sup>6</sup> demonstrated good to excellent results (achievement of full neck ROM with or without mild persistence of head tilt and/or facial asymmetry) in children treated with passive stretching exercises before 1 year of age; however, 16% of the children in the study underwent surgery. Binder et al<sup>3</sup> reported full recovery by 12 months of age in 70% and surgical intervention in 6% of their sample (the remainder were unresolved at 1 year of age, failed to comply with follow-up, or refused surgery). It should be noted, however, that the stretching techniques used in other studies were not specifically described. In some of the studies, only one stretch in rotation was used in treatment.

My data suggest that the age at initiation of treatment does not affect treatment duration, provided treatment is initiated prior to 2 years of age. Although other investigators<sup>3,4</sup> suggested that age at initiation of treatment is a key predictor of outcome, they did not examine the relationship of age to treatment duration. In my sample, age at first treatment was

**Table 2.** Pearson Product-Moment Correlation Coefficients Between the Four Determinants of Treatment Duration (Mass, Age at Initiation of Treatment, Restriction in Neck Rotation, and Restriction in Lateral Neck Flexion) and Duration of Treatment

	Age	Rotation	Lateral Rotation	Treatment Duration
Mass	-.42 <sup>a</sup>	.46 <sup>a</sup>	.28 <sup>b</sup>	.26 <sup>b</sup>
Age		.35 <sup>a</sup>	.32 <sup>a</sup>	-.15
Restriction in rotation			.42 <sup>a</sup>	.31 <sup>a</sup>
Restriction in lateral flexion				-.17

<sup>a</sup>*P* < .001.

<sup>b</sup>*P* < .01.

related to severity of restriction in ROM and the presence of a mass. Typically, infants with a palpable mass or a severe restriction in neck movement are referred to physical therapy at an earlier age than those without a mass or with minimal restriction. It is my clinical experience that when a mass is not present, CMT may not be apparent until the child ages, when head control improves and the infant's head tilt becomes obvious.

The younger the children were at the initial assessment, the less likely they were to have a significant head tilt and to require a TOT. Perhaps early

strengthening exercises for the contralateral SCM muscle assisted the younger children with achievement of a neutral head position without the need for a TOT.

My data suggest that younger children had a greater restriction in both neck rotation and side flexion. The more severe the limitation in rotation, the longer the treatment duration necessary (*r* = .31). Even though there was a strong relationship between severity of restriction in rotation and severity of restriction in lateral flexion (*r* = .42), treatment duration was not related to severity of restriction in side flexion.

Binder et al<sup>3</sup> rated severity as mild, moderate, and severe and demonstrated better outcomes for the mildly restricted group; however, limitations in rotation and lateral flexion were not examined independently.

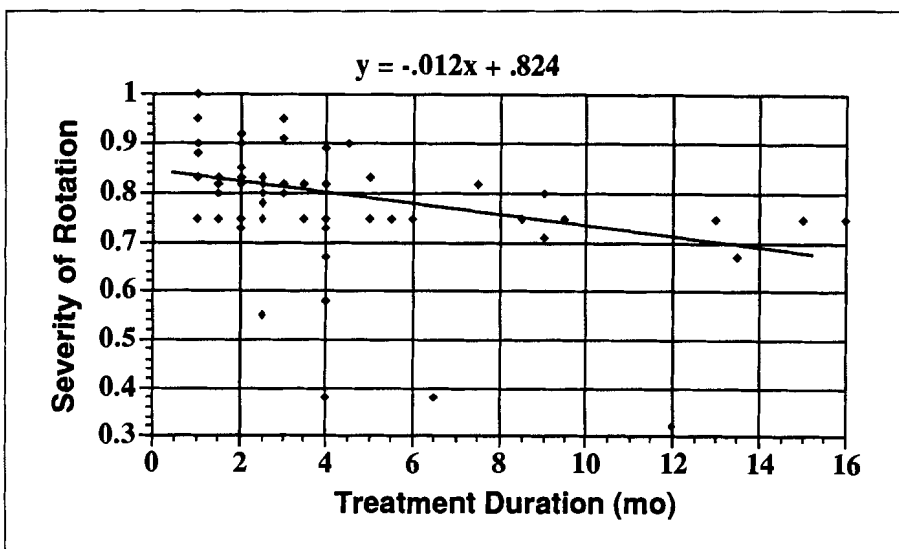
The presence of a mass was related to age at initial assessment (*r* = -.42) and severity of limitation in rotation (*r* = .46). Children with a mass tended to be younger at the initial assessment and had greater restrictions in neck rotation than children without a mass. These findings are consistent with those of Binder et al.<sup>3</sup> In my sample, the group of children with a mass were treated 3 months longer on average than the group with no mass. In their mildly and moderately restricted groups, Binder et al<sup>3</sup> reported better outcomes in the children with a mass than in those without a mass.

Severity of restriction in rotation was a strong predictor of treatment duration in the no-mass group but was not a significant predictor in the mass group. My data indicate that the children with a mass require longer treatment, irrespective of the severity of restriction in rotation.

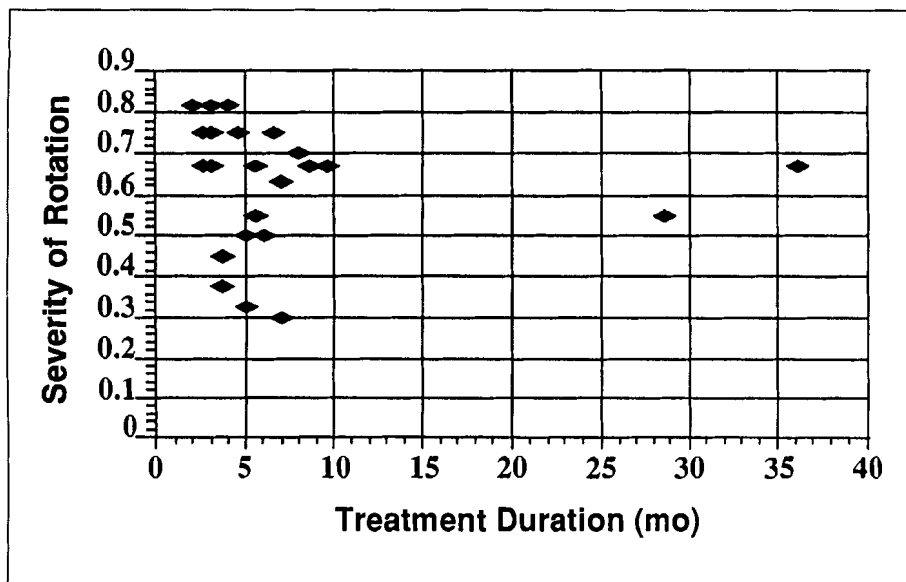
The reliability of measurements obtained with the adapted standard goniometer used in this study was not tested, and my results should be viewed with this limitation in mind. The measurements were also not taken in a blinded fashion, which may have affected my results. In addition, there was quite a large attrition rate. Finally, because there was no control group, some of the recovery could have been due to the natural history of CMT.

## Conclusions

Conservative management of children with CMT appears to be very successful if initiated prior to 2 years of age. Full recovery was achieved in all except one of the children in the sample. It is impossible, however, to determine the number of children who might have shown spontaneous recovery without any treatment. The severity of restriction of neck rotation



**Figure 5.** Severity of rotation versus treatment duration (no-mass group). Severity of rotation = passive range of motion to restricted side (in degrees) / passive range of motion to unrestricted side (in degrees).



**Figure 6.** Severity of rotation versus treatment duration (mass group). Severity of rotation = passive range of motion in rotation to restricted side (in degrees) / passive range of motion in rotation to unrestricted side (in degrees).

was a significant predictor of the treatment duration needed for full recovery in children who initially had no palpable mass. An equation has been provided to assist therapists in predicting treatment duration at the initial assessment if the child has no palpable mass. Children with masses, who were typically younger and had more severe restrictions in ROM, required longer durations of treatment than those without masses. Regardless of severity of restriction, a longer treatment duration (a mean of 6.9 months in this study) was needed for children with masses. Children requiring a TOT secondary to a significant head tilt ( $>6^\circ$  at age 4.5 months or older) also took longer to achieve full neck ROM. Age at initial assessment, side of involvement, and the child's gender were unrelated to treatment duration. In spite of my results, for practical reasons I believe that early initiation of treatment is important because parents typically have more difficulty with the stretches as the child becomes older and stronger.

The purpose of this study was to characterize the determinants of treatment duration when a specific conservative treatment program had been

carried out for children with CMT. The results of this study will allow physical therapists to better educate parents about the expected length of time they will be required to carry out home exercise programs. Not only will these results allow therapists to predict treatment duration in children without masses, but it will give therapists an estimate of the boundaries of treatment duration for all children with CMT.

Future study of children with CMT could include the determination of the rate of spontaneous recovery. In addition, it would be interesting to compare different frequencies or intensities of home treatment programming and the effect on speed of recovery.

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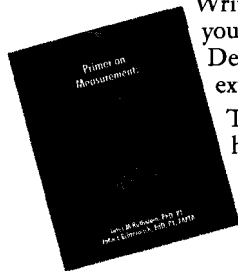
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