

**Ultrasonographic Correlation between  
SCM Muscle and Prognosis in Congenital  
Muscular Torticollis**

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**Ultrasonographic Correlation between  
SCM Muscle and Prognosis in Congenital  
Muscular Torticollis**

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This certifies that the master's thesis  
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## **Abstract**

**PURPOSE:** To correlate between sternocleidomastoid muscle (SCM muscle) and the prognosis of congenital muscular torticollis (CMT) using ultrasonography.

**MATERIALS AND METHODS:** Ultrasonography was performed on 24 patients from June 2004 to March 2007. We measured the thickness and the cross sectional circumference of both sides of SCM muscle at the 3 levels; below the mastoid process, below the carotid artery bifurcation, and above the clavicle, respectively sternal part and clavicular part. The ratio of the affected side to the normal side (the A/N ratio) of the SCM muscle was calculated. We followed up ultrasonography at each two months intervals until the final assessment was done and evaluated the ultrasonographic echopatterns of the affected SCM muscle. Wilcoxon signed-rank test was used to correlate the A/N ratio before and after the treatment. Spearman's rank test was used to correlate the A/N ratio and the total treatment duration. Paired T-test was used to correlate with the ultrasonographic echopatterns of SCM muscle and the treatment duration divided by 12 months.

**RESULTS:** Under measuring thickness of SCM muscle, the A/N ratio after treatment (1.36) has decreased compared with the initial A/N ratio (2.31) (statistically significant,  $p < 0.05$ ). The correlation between the A/N ratio of the thickness with the total treatment duration was statistically significant

( $p < 0.05$ ). The ultrasonographic echopatterns of the affected SCM muscle did not correlate with the treatment duration.

**CONCLUSION:** The A/N ratio of the thickness of SCM muscle is useful to predict the prognosis of CMT.

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Key words : Congenital muscular torticollis, Prognosis, Ultrasonography, sternocleidomastoid muscle

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**I. Introduction**

Congenital muscular torticollis (CMT) consists of fibrous contracture of unilateral sternocleidomastoid muscle (SCM muscle). The incidence of CMT varies from 0.4% to 1.3 % and the third most common congenital anomaly after the hip and club foot [1–3]. Contracted muscle fibers of the affected SCM muscle may forces the infants to hold the head tilted toward the affected side and may result in limitation of neck rotation. Persistent head tilting and limitation of neck rotation may result in asymmetric pressure in the growing cranium may affect growth and development of the spine,

causing progressive deformity of the skull (plagiocephaly) and facial hemihypoplasia [1,2,4]. When clinically palpating firm mass within the SCM muscle or presence of head tilting to affected side and the chin to point to the opposite side, the diagnosis of CMT is made [1]. Ultrasonography has been used to evaluation and differentiation of mass within SCM muscle in CMT patients. Real-time high resolution ultrasonography has many advantages of relatively low cost, need short study time, provide patient comfort, does not require anesthetics, and does not exposure radiation. In spite of these advantages, ultrasonography has been a little role in evaluating of prognosis of CMT [2-4].

Although several studies have been used ultrasonography for evaluation of CMT, they used simple cross sectional or longitudinal information or ultrasonographic features [1-7]. To our knowledge, there is no study about prediction of prognosis in CMT using ultrasonography [1, 4].

The aim of our study is to predict prognosis of CMT using ultrasonography by new method, the A/N ratio and to correlate of ultrasonographic echopattern of the affected SCM muscle and prognosis.

## II. Materials and Methods

Twenty four patients who were clinically diagnosed CMT were followed up from June 2004 to March 2007. Presenting clinical features, including head tilt in the upright position, facial asymmetry, and passive range of motion of neck, were evaluated before ultrasonographic evaluation. All patients underwent regular follow-up in the clinic during the treatment at regular intervals of two months until the final assessment. They were all received physiotherapy, including range of motion exercise, postural training, and gentle stretching, continuously during follow up.

Serial ultrasonographic examination of bilateral SCM muscle was done by experienced radiologist. A 6~11 MHz linear-array transducer attached ultrasound machine (LOGIQ 700, General Electric Company, Milwaukee, WI) was used. The patients were examined in the supine position with head slightly rotated to the opposite side with sedation. We measured the thickness and the cross sectional circumference of both sides SCM muscle at the 3 levels; below the mastoid process, below the carotid artery bifurcation, and above the clavicle, respectively sternal part and clavicular part. All parameters were measured on ultrasound machine.

Ultrasonography of the affected muscle were compared with those of the contralateral normal side gained and the ratio of the affected side to the normal side (the A/N ratio) was calculated (Fig. 1). We followed up ultrasonography from the beginning of physiotherapy at each two months

intervals until the final assessment was done. When the clinical symptoms disappeared, the study was ended. We classified ultrasonographic echopatterns of the affected SCM muscle into heterogeneous or homogenous by comparing with those of the contralateral side.

Data were analyzed with the SPSS 12.0KO for Windows software program (SPSS Inc., Chicago, Illinois, USA). Wilcoxon signed-rank test was used to correlate the A/N ratio before and after the treatment. Spearman's rank test was used to correlate the A/N ratio and the total treatment duration. Using the paired T-test, we tried to correlate the A/N ratio with the treatment duration divided by twelve months. And also by the paired T-test, we tried to correlate the ultrasonographic echopatterns of SCM muscle and the treatment duration divided by twelve months. Values  $p < 0.05$  was regarded as statically significant.

### **III. Results**

Unilaterally affected 24 CMT patients (15 male and 9 female) were analyzed. Among the total 53 lesions, the side of lesion was higher in the right SCM muscle (15 lesions) than the left SCM muscle (9 lesions). The patients belonged to our study had no other congenital musculoskeletal anomalies.

The significant change in the A/N ratio was found in both the thickness and the cross sectional circumference after the treatment. When treatment is finished, the mean A/N ratio of the thickness was decreased. The initial A/N ratio was 2.31 and the final A/N ratio was 1.36, the mean A/N ratio of the cross sectional circumference was decreased, the initial A/N ratio was 1.28 and final A/N ratio was 1.12 with statistical significance ( $p < 0.05$ ) (Fig. 2).

The A/N ratio was proportional to the total treatment duration, and the correlation between the A/N ratio of the thickness and the total treatment duration was statistically significant ( $p < 0.05$ ). This implies that if the treatment duration is longer than 10 months, the A/N ratio of thickness was calculated to be greater than 3.37, but for the treatment duration less than 6 months the A/N ratio of thickness was calculated to be less than 2.71. But it was not significant correlation between the A/N ratio of the cross sectional circumference and the total treatment duration (Fig. 3). If the treatment duration is greater than 12 months, surgical treatment is considered [4]. For the treatment duration greater than 12 months, the A/N ratio of the

thickness was calculated to be 3.38 and when the duration is less than 12 months the value was calculated to be 2.04. This shows that as the A/N ratio is increased, the treatment duration is also significantly prolonged ( $p < 0.05$ ).

If the A/N ratio of the thickness is greater than 3.38, the treatment duration was longer than twelve months. But the A/N ratio of the cross sectional circumference was not correlate the treatment duration (Table 1).

It was not significant correlation between the ultrasonographic echopattern of the affected SCM muscle with the treatment duration divided by twelve months (Table 2).

#### **IV. Discussion**

Although CMT has been described in the literature for many years, and despite of many hypotheses, the etiology of CMT is remains unknown [5,7]. Many cases of CMT have been detected at birth or shortly after birth and related to history of trauma, difficult delivery, or breech delivery.

Light and electromicroscopy have consistently shown replacement of the SCM muscle by dense fibrous tissue. This has led to the hypothesis that this condition represented the sequelae of an intrauterine or perinatal compartment syndrome of injury through the birth canal [5].

About 80% of CMT resolved spontaneously without treatment, but Canale et al found that persistent of CMT beyond age of twelve months, it did not resolve spontaneously [4]. The treatment of CMT consists of physiotherapy, including range of motion exercise, postural training, and gentle stretching. Craniofacial asymmetry may persist and scoliosis can develop in children with severe torticollis who have been treated inadequately or in whom surgery has been delayed. For these patients, early surgical correction is crucial for improvement of not only head tilt, neck bands, and loss of neck contour, but also prevention of craniofacial asymmetry. Surgery is considered when symptoms persistent for twelve months in despite of physiotherapy or severe complication [4]. Thus, prediction of treatment duration is clinically important for determining of surgical consideration or continuing of physiotherapy [1-5].

One of hypothesis suggests that CMT results from the replacement of SCM muscle by dense fibrous tissue producing either fibrous mass or a tumor that leads to shortening the affected muscle [5–6]. Replacement of fibrous tissue in SCM muscle may result in change of morphological feature and ultrasonographic echopattern of the affected SCM muscle. But morphologically changed SCM muscle is not uniformed out line. Thus, for this indeterminate form of the affected SCM muscle, we tried to use new methods; The A/N ratio of the thickness and of the cross sectional circumference.

Significant decreased the A/N ratio of the thickness and the cross sectional circumference after the treatment imply that the A/N ratio can use in assessment of treatment effect (Fig. 2). The A/N ratio was proportional to the total treatment period, therefore the A/N ratio can help us predicting of the total treatment period and determining of surgical consideration (Fig. 3, Table 1). Particularly, the A/N ratios greater than the mean value in group of longer than twelve months treatment duration (greater than 3.38 in the thickness) mean the possibility of long term treatment duration and necessity of surgical treatment.

Ultrasonographic imaging of SCM muscle provides information about arrangement of muscle fibers. Skeletal muscle fibers are grouped in fascicles separated from one another by connective tissue called perimysium and whole muscle is covered by the epimysium. On axial scans of normal SCM muscle, the perimysium appears in cross- section as fine dotted echoes and

short lines scattered that determines ultrasonographic echopattern [4]. Combination of the perimysium and the fibrous component determine ultrasonographic echopattern, heterogeneous or homogenous. Microscopically there is replacement of the muscle fiber, which in various stages of degeneration results in various ultrasonographic echopattern. Because of the affected SCM muscles in CMT have various stages of fibrotic components; it may result in various ultrasonographic echopattern [4–5].

Bias can be made from indeterminate morphologic outline of the affected SCM muscle and morphologic changes in concordance with variable degree of muscle stretching. Between assessment of the A/N ratio of the thickness and the cross sectional circumference of the affected SCM muscle, evaluating the thickness seems to be useful for predicting treatment effect and the treatment duration in determining surgical considerations. It is on account of the measuring of the A/N ratio of the thickness is easy and simple with minimal operator variation, lesser alteration in proportion to degree of muscle stretching. In contrast, it is difficult to measuring of the cross sectional circumference in constant value. The cross sectional circumference is largely affected by this bias, thus the A/N ratio of the cross sectional circumference has limited role in predict prognosis.

Our study has some limitations. First, the sample size was small to define accurate threshold value for surgical determination. There is no follow up studies was done after complete treatment. Second, there was no severe complicated CMT case needed surgery. Although six CMT patients have

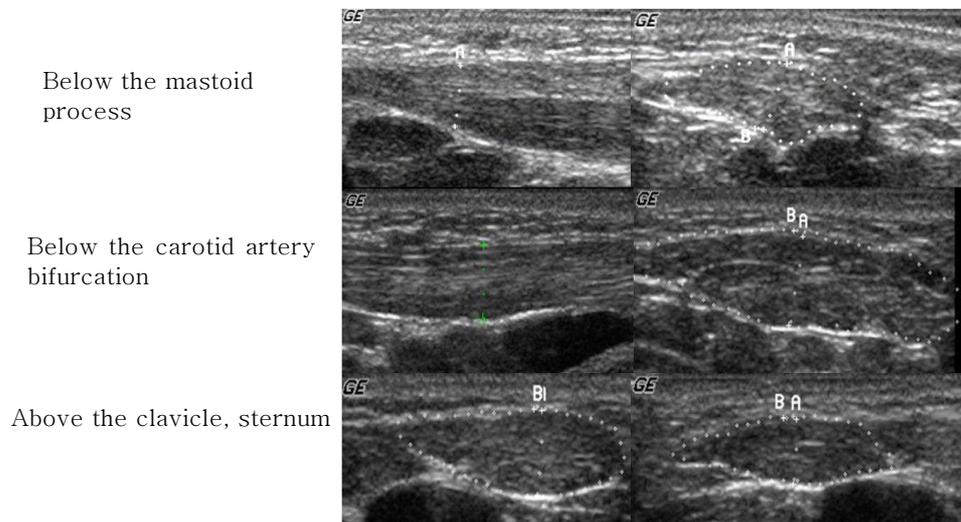
more than twelve month treatment durations, all of them had full recovery without surgical correction. Therefore, we could not evaluation of ultrasonographic pattern and the A/N ratios in surgery need patients. In the future, larger study group including severe complicated cases, it will make more accurate determining prognostic factors and values in CMT.

In conclusion, the A/N ratio of the thickness of SCM muscle is useful to predict the prognosis of CMT.

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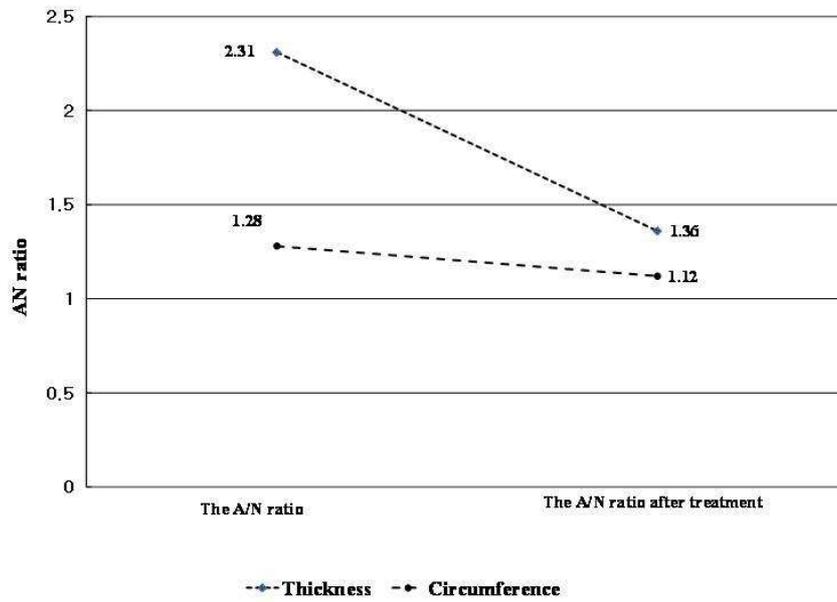
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**Figure. 1 Measuring the A/N ratio**

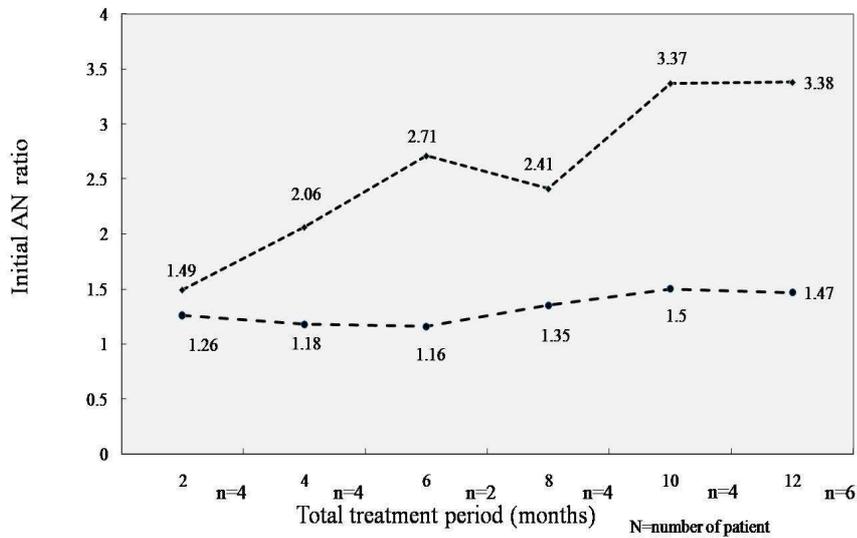
Below the mastoid process, below the carotid bifurcation, and above the clavicle, sternum

$$\text{The A/N ratio} = \frac{\text{Affected side SCM muscle (The thickness, circumference)}}{\text{Normal side SCM muscle (The thickness, circumference)}}$$



**Figure. 2 The Change of the A/N ratio after Treatment**

The significant change in the A/N ratio was found in both the thickness and the cross sectional circumference after the treatment



--♦--Thickness --♦-- Circumference

**Figure. 3 The A/N ratio and the total treatment duration**

The correlation between the A/N ratio and the total treatment duration was statistically significant in the thickness ( $p < 0.05$ )

Duration of treatment	The A/N ratio of the thickness	The A/N ratio of the Cross sectional Circumference
Longer than 12 months	3.38±0.93	1.47±0.28
Shorter than 12 months	2.04±0.9	1.40±0.32
	$p < 0.05$	$p = 0.064$

**Table 1 The A/N Ratio and the Treatment Duration Divided By 12 Months**

If the A/N ratio of the thickness is greater than 3.38, the treatment duration was longer than twelve months

Duration of treatment	US pattern of SCMM* (Heterogeneous)	US pattern of SCMM* (homogenous)
More than 12 months	4	2
Less than 12 months	7	11
	<i>p</i> = 0.27	<i>p</i> = 0.56

**Table 2 Ultrasonographic Echopattern of the Affected SCM Muscle and the Treatment Duration**

It was not significant correlation between ultrasonographic echopattern of the affected SCM muscle with the treatment duration divided by twelve months

\*SCMM= SCM muscle

## Abstract in Korean

### 선천성 사경환자에서

### 흉쇄유돌근의 초음파 소견과 예후와의 연관성

**목적:** 선천성 사경 환자의 예후를 초음파를 이용하여 예측한다.

**대상 및 방법:** 2004년6월부터 2007년 3월까지 24명의 선천성 사경 환자를 대상으로 하였다. 초음파를 사용하여 흉쇄유돌근의 유양돌기 아래부위, 경동맥 분지 아래부위, 흉골 부위와 쇄골 부위에서 근육의 두께, 둘레를 각각 양측에서 측정하였다. 병변의 이환부에 대한 정상부의 비율(A/N ratio)을 구하였다. 2개월마다 정기적으로 추적 관찰하였으며, 병변이 이환된 흉쇄유돌근의 메아리 양상을 평가하였다. Wilcoxon signed-rank test로 치료 전, 후 A/N ratio의 변화를 분석하였으며, Spearman's rank test로 A/N ratio와 총 치료 기간과의 관계를 평가하였다. Paired T-test를 사용하여 12개월의 치료기간을 기준으로 나눈 두 그룹간의 흉쇄유돌근의 메아리 양상을 비교하였다.

**결과:** 치료 전 두께의 A/N ratio (2.31)는 치료 후 의미 있게 감소하였으며 (1.36), 통계적으로 유의하였다( $p < 0.05$ ). 두께의 A/N ratio와 총 치료기간은 의

미 있는 상관 관계를 보였다 ( $p < 0.05$ ). 흉쇄유돌근의 메아리 양상은 치료기간과 상관관계가 없었다.

**결론:** 두께의 A/N ratio는 선천성 사경 환자의 예후 예측에 도움을 줄 수 있다.

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핵심되는 말: 선천성 사경, 예후, 초음파, 흉쇄유돌근