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Quantitative Measurement of Neck Range of Motion in Spasmodic Torticollis Patients Treated with Botulinum A Toxin

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—국문초록—

Botulinum A Toxin으로 치료한 경련성 사경환자에서 경부운동범위의 정량적 측정

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이 명 종

경련성 사경환자를 botulinum A toxin으로 치료함에 있어 경부운동범위의 호전을 객관적으로 측정하는데는 어려움이 많았다. 최근, 일차 경부회전각과 이차 경부회전각의 측정으로 3차원적 경부운동범위를 평가하는 방법이 개발되었다. 이 방법은 electromagnetic tracking system으로서 personal computer로 자료분석과 그림을 보여주는 것이다. 본 연구결과, 이 방법은 botulinum toxin으로 치료한 경련성 사경환자에서 경부운동범위의 객관적 측정을 위하여 임상적으로 유용할 것으로 사료되었다.

Key Words: Spasmodic torticollis, Botulinum A toxin

Introduction

Botulinum A toxin has been used since 1985 to treat spasmodic torticollis[1-7]. In each of these studies subjective improvement in cervical range of motion has been noted in patients treated with botulinum A toxin. However, objective improvement in cervical range of motion has been difficult to confirm because measurement with available devices and methods are difficult to use and often not well standardized[1,8]. Recently, a three-dimensional cervical range of motion system (EMROM) using an electromagnetic tracking system for data collection and a personal computer for analysis and graphic representation of data has been developed[8].

This system provides users with objective measurements of the primary as well as the secondary cervical rotation angles along with the poles or centers of rotation. Secondary rotations occur commonly in patients with significant neck problems such as torticollis. Secondary rotations can cause errors in the primary angle measurement when using mechanical devices that assume the movement

occurs only in the primary plane.

Investigation into the sensitivity of the electromagnetic data collection device indicates that in most clinical settings (free of nearby metal) the system can be used with reasonable accuracy (less than 1.3 degrees of error).

The purpose of this study is to evaluate the use of the EMROM in measuring cervical range of motion in patients with torticollis by comparing these measures before and after treatment with botulinum A toxin injections.

Materials and Methods

Three patients with idiopathic spasmodic torticollis who are followed in our Movement Disorder Clinic were included in this study. Two patients were male and one female. Their average age was 39 years with a range of 32-51 years. The average duration of their torticollis was 5 years with a range of 3-5 years.

After a careful history and physical examination, each patient was injected with a total of 200 units of botulinum A toxin (supplied by Dr. Allan Scott, The Smith-Kettlewell Eye Research Foundation, 2232 Webster Street, San Francisco, California 94115) diluted in 2 cc of normal saline, The injections were performed with a 3.75 cm. 23 gauge motor point block needle connected to a TECA Model M electromyographic machine. Those neck muscles thought to be most active by clinical and electromyographic examination were selected for injection. These muscles included the right and left trapezius, sternocleidomastoid, splenius capitis and scalene. Usually two to fore muscles were injected at a session. The toxin was injected evenly in two to three sites per muscle. On average each muscle received 50-100 units of toxin depending on the number and severity of the muscles involved.

Initially and at a two week followup the patients had their cervical range of motion measured with the EMROM system. The details of this system have been described previously.[8]

The EMROM system utilized in this study was developed by the University of Minnesota Rehabilitation Engineering Center and was supported by NIDRR Grant number 6008300075. The basic three-dimensional data was obtained by using a commercially available electromagnetic tracking system, the 3 Space Isotrak (developed by Polhemus Navigation Sciences Division of McDonnell Douglas Electronics Company, Model 3SI002).

The Isotrak emits low-frequency (10 KHz) electromagnetic waves from three mutally perpendicular coils (source unit) and a small sensor with three mutually perpendicular coils receives the electromagnetic signals (Fig. 1). The magnitude of the received signal in each of the coils is determined by the coils position in the sensor with respect to the source. This phenomenon is similar to the change in volume observed when a small AM radio is rotated

Fig. 1. Subject with electromagnetic sensors in place. A) Sensor and B) Source unit.

in different positions. A microprocessor in the device calculates the X, Y and Z positions and the three angles describing the rotation of the sensor with prospect to the source. The six outputs from the device (three for position and three for rotational angles) are serial data streams that can be fed to a digital computer for processing and display.

An interactive computer program using Turbo Basic was developed to collect the range of motion data. The program also uses advanced graphic representations and wire frame models of the head to display the data (Fig. 2).

The procedure used to obtain the EMROM measurements started with removal of any metal that the patient might have on their person, such as jewelry and keys. Use of the electromagnetic data collection system requires a specialized environment free of nearby metal objects. The patient was then instructed to sit in a wooden chair with their back straight and their feet flat on the floor. A lumbar roll was placed in the area of the lumbar spine to encourage good sitting posture, thereby minimizing trunk substitution motions during the cervical range of motion measurements. The chest harness with the sensor in place was positioned on the patient.

The tester first collects the neutral position data. A set of reference axes in the head is determined from points located at the right and left ear canals and the top of the head. At the beginning of the test the tester uses the sensor to locate these points. As the sensor is placed at each location, a switch is activated that imprints the position data to the com-

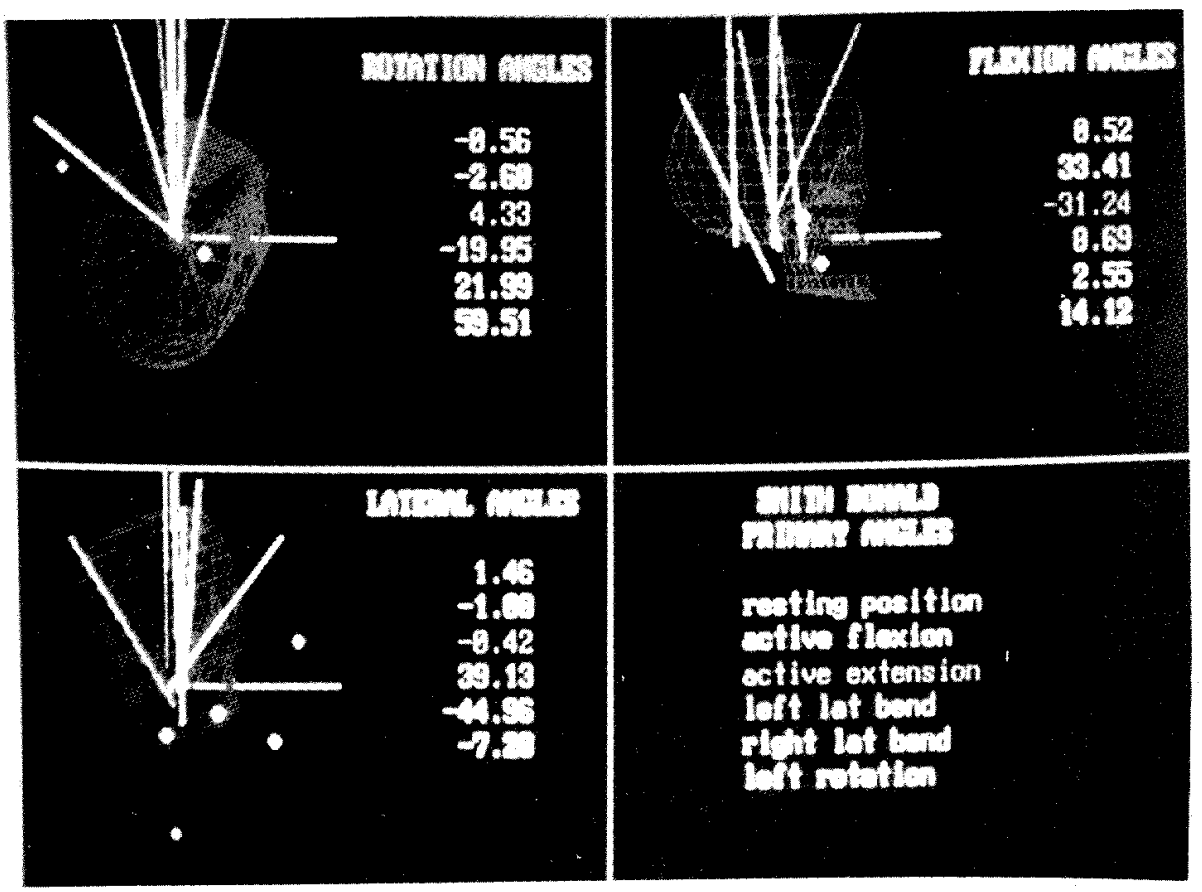

Fig. 2. Wire frame images of the head showing rotation, flexion/extension and lateral angles (right rotation was not measured in this patient). The angle numbers correspond to the patients resting and active cervical motions. On the computer screen the different angles of motion are color coded. The dots in the wire frame image represent poles or the center of rotation of the head.

puter. All rotation angle and pole (center of rotation) position data are determined from the neutral and displaced positions of the head coordinate system from the reference source on the chest.

Following the collection of neutral position data, the subject is instructed to move his or her head to the desired positon (full flexion, extension etc.). Using a hand held switch, the patient activates data collection when he or she can no longer move in the specified direction.

Postition analysis is performed and the three rotation angles and poles of motion from the neutral position to the displaced position are displayed. Rotations and translations occurring simultaneously have no effect on the accuracy of results. the rotation angles reported are the angular changes between the neutral and displaced head position referenced to a local head coordinate system established at the beginning of testing. The soft ware in this system computes the location of the pole for each measured movement. This is relevant to the description of head movements, since they are complex and virtually always involve rotation and translation (shift without turning).

In this system a "primary" angle is the angle of motion in the direction requested by the tester. A "secondary" angle is any other rotation that may accompany the desired rotation. If for example, flexion/extension is to be tested and during the movement the head also rotates the head rotation would be referred to as a secondary angle with flexion/extension as the primary angle. The display allows viewing of both primary and secondary angles during testing.

The angle information displayed gives the head position with respect to the chest. No information is given on where rotation occurs in the cervical spine, although pole data should reflect changes in the location of that axis.

Results

The results of the changes in cervical neck range of motion after the three patients were treated with botulinum A toxin as measured by EMROM are summarized in Table 1.

Discussion

The three patients in this study all subjectively improved after the toxin injections. However, the objective measurements made of these patients showed some cervical range of motions improved while others got worse. A number of reasons may help explain these findings :

1) In spasmodic torticollis usually there is stimulation of the synergists on one or either side of the midline and relaxation of the antagonists. In fact the relaxation of the antagonists may be so extreme that they may need to be retrained once the over active synergist is inhibited[9].

2) Poor technique in injecting the involved muscles and/or the amount of toxin used in these muscles may effect the patients outcome.

3) Since both primary and secondary muscles are involved in head postition and movement, which muscles are injected with toxin will have an effect on the final cervical range of motion.

4) Tissue contracture may cause position and movement changes that are difficult to change immediately with toxin injections.

From my limited experience with these three torticollis patients and the data obtained, I feel the EMROM can be used clinically to objectively measure cervical range of motion accurately in patients with torticollis who receive botulinum toxin injections. It is my hope that the use of this system will add to the understanding of spasmodic torticollis and its treatment.

Abstract

In patients treated with botulinum A toxin for spasmodic torticollis it has been difficult to objectively measure improvement in cervical range of motion. Recently, a three-dimensional cervical range of

Table 1.

1st visit (pre-toxin)			2nd visit (post-toxin)		
* Rest Pos 20.57 EXT, 17.95 RROT, 17.53 LLB			Rest Pos 18.61 EXT, 2.69 RROT, 1.48 LLB		
	Primary Measure	Secondary Measures		Primary Measure	Secondary Measures
ACT FLEX	57.71	1.97 LROT, 12.96 LLB	ACT FLEX	68.91	.09 RROT, 5.61 LLB
ACT EXT	51.27	2.41 LROT, 3.78 LLB	ACT EXT	55.56	1.21 LROT, 2.01 LLB
ACT LLB	51.04	14.76 RROT, 4.67 EXT	ACT LLB	49.03	10.05 RROT, 21.71 EXT
ACT RLB	54.23	19.68 LROT, 17.43 EXT	ACT RLB	39.69	6.82 RROT, 12.24 EXT
ACT L ROT	89.02	14.11 RLB, 1.13 FLEX	ACT L ROT	80.97	17.19 RLB, 6.15 FLEX
ACT R ROT	77.82	20.12 LLB , 8.68 EXT	ACT R ROT	64.82	10.65 LLB, 8.10 EXT

1st visit (pre-toxin)			2nd visit (post-toxin)		
*Rest Pos 3.95 EXT, 17.75 RROT, 19.27 LLB			Rest Pos 0.45 FLEX, 20.21 RROT, 14.00 LLB		
	Primary Measure	Secondary Measures		Primary Measure	Secondary Measures
ACT FLEX	6.24	2.99 RROT, 2.87 RLB	ACT FLEX	14.09	8.96 RROT, 2.84 LLB
ACT EXT	27.15	7.50 RROT, 22.11 LLB	ACT EXT	29.70	7.84 RROT, 17.79 LLB
ACT LLB	43.58	8.13 EXT, 3.51 LROT	ACT LLB	34.62	4.31 EXT , 5.89 LROT
ACT RLB	-17.82	2.96 FLEX, 7.61 RROT	ACT RLB	4.77	4.88 FLEX, 8.19 RROT
ACT L ROT	46.85	3.26 EXT, 4.12 LLB	ACT L ROT	47.75	3.39 FLEX, 0.22 LLB
ACT R ROT	47.44	3.99 FLEX, 17.33 LLB	ACT R ROT	45.39	3.00 FLEX, 8.36 LLB

1st visit (pre-toxin)			2nd visit (pre-toxin)		
*Rest Pos 0.56 EXT, 4.55 LROT, 12.40 RLB			Rest Pos 4.48 FXT, 8.01 LROT, 9.85 RLB		
	Primary Measure	Secondary Measures		Primary Measure	Secondary Measures
ACT FLEX	45.74	5.93 RROT, 13.26 RLB	ACT FLEX	42.72	2.80 LROT, 5.88 RLB
ACT EXT	46.44	14.64 LROT, 25.89 RLB	ACT EXT	44.62	21.38 LROT, 27.29 RLB
ACT LLB	25.50	10.68 FLEX, 4.05 RROT	ACT LLB	33.86	5.42 FLEX, 0.37 LROT
ACT RLB	34.67	2.74 EXT, 15.45 RROT	ACT RLB	39.41	2.89 FXT , 2.47 RROT
ACT L ROT	50.31	1.67 EXT, 16.08 RLB	ACT L ROT	64.78	2.19 EXT, 14.07 RLB
ACT R ROT	68.67	0.10 EXT, 8.07 LLB	ACT R ROT	61.01	4.96 EXT, 8.74 LLB

Rest Pos=resting position, ACT FLEX=active flexion, ACT EXT=active extension, ACT LLB=active left lateral bend, ACT RLB=active right lateral bend, ACT L ROT=active left rotation, ACT R ROT=active right rotation

*All measurements are in degrees

motion system has been developed that provides users with primary, as well as secondary cervical rotation angles. This system uses an electromagnetic tracking system for data collection and a personal computer for analysis and graphic display.

The results of this study suggest this system can be used clinically to objectively measure cervical range of motion accurately in patients with torticollis who receive botulinum toxin injections.

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