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An Electromyographic Study of the Shoulder Musculature during Codman's Exercises

Myndi L. Frey
University of North Dakota

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AN ELECTROMYOGRAPHIC STUDY OF THE SHOULDER MUSCULATURE
DURING CODMAN'S EXERCISES

by

Myndi Lea Frey
Bachelor of Science in Athletic Training
University of North Dakota, 1995
Bachelor of Science in Physical Therapy
University of North Dakota, 1997

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements


for the degree of

Master of Physical Therapy

Grand Forks, North Dakota

May
1998

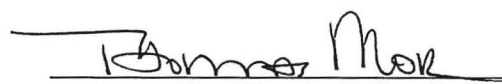
This Independent Study, submitted by Myndi Lea Frey in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



(Faculty Preceptor)



(Graduate School Advisor)



(Chairperson, Physical Therapy)

PERMISSION

Title An Electromyographic Study of the Shoulder Girdle Musculature
During Codman's Exercises.

Department Physical Therapy

Degree Master of Physical Therapy

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Signature Miyndi L. Frey
Date December 15, 1997

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A special thanks to my beloved husband, Mark, who has supported me and given me encouragement in my physical therapy and life endeavors. I Love You!

ABSTRACT

Codman's exercises are commonly used in physical therapy as a supposed passive shoulder activity to help increase range of motion without causing detrimental damage to the injured tissue or surgical graft. These mild shoulder exercises are often the first exercises used post-operatively. Some clinicians often add a weight to the hand or wrist with the assumption that the distraction will decrease the impingement between the acromion and the shoulder musculature while performing these exercises. The purpose of this study is to determine the level of muscle activity within the shoulder musculature during Codman's exercises with and without the addition of a weight. Ten healthy, male students from the University of North Dakota volunteered to participate in the study. The electromyographic (EMG) activity was collected during trials of Codman's exercise with and without a cuff weight from the following muscles: anterior deltoid, middle deltoid, posterior deltoid, triceps, biceps, and supraspinatus using surface electrodes. Performing Codman's exercises with and without a two pound weight showed minimal muscular activity. No significant differences were found between the activity without a weight and with a weight. Codman's exercise was shown to produce minimal muscular activity; however, it is important for therapists to know the correct technique and to know how to adequately explain and demonstrate Codman's exercise to their patients. Further research is needed in this area to compare the muscle activity during Codman's exercise with muscle activity during other passive activities.

CHAPTER I

INTRODUCTION

Introduction:

In the early 1930's, Dr. E. A. Codman began recommending swinging exercises for almost every patient he saw with an acute shoulder injury or post-surgical shoulder repair. During these exercises the patient is placed in a stooped-over position and instructed to move his/her body allowing the arm to swing freely. Codman's initial intention was to initiate early motion without muscular effort and to avoid injuring the supraspinatus tendon or causing pain due to impingement of the structures between the tuberosity and the acromion.

Today, these stooping exercises are widely known as Codman's exercises. Codman's exercises are commonly used in physical therapy as a supposed passive shoulder activity to help increase range of motion without causing detrimental damage to the injured tissue or surgical graft. These mild shoulder exercises are often the first exercises used post-operatively. Some clinicians often add a weight to the hand or wrist with the assumption that the distraction will decrease the impingement between the acromion and the shoulder musculature while performing these exercises. The main purpose of Codman's exercise is to initiate early motion within the joint, prevent adhesions, and relieve pain.

Problem Statement:

Codman's exercises are thought to be a passive activity used after surgery or immobilization to increase range of motion without putting strain on the injured or surgically repaired tissues. These exercises were initially performed using the weight of the arm as a distractive force; however, many clinicians began using an additional weight to reduce impingement. This was not documented in Codman's works. Despite the intentions of Codman's exercise being passive, many patients appear as though they are actively performing these exercise, and therefore, could possibly be endangering the healing structures.

Purpose of the Study:

The purpose of this study is to determine the level of muscle activity within the shoulder musculature during Codman's exercises with and without the addition of a weight.

Significance of Study:

This study may prove beneficial to medical professionals involved in the treatment of shoulder injuries. The outcomes may impact the treatment protocols used to rehabilitate patients who have undergone certain surgical procedures. Passive activities are initiated so as not to further irritate inflamed tissues or stress tissue repairs. Active motion not only imposes tension on the contractile structures, but when the rotator cuff and deltoid contract, already irritated tissues are compressed against the acromion causing increased pain. The goal in rehabilitation is to treat patients using the most efficient and effective techniques.

Research Questions:

What is the level of muscle activity during Codman's exercise? Will they help or hinder the healing of tissues after a surgical procedure? How does adding a cuff weight change the level of muscle activity?

Hypotheses:

Primary Null Hypothesis: There is no EMG activity during Codman's exercises.

Primary Alternate Hypothesis: There is an increase in EMG activity during Codman's exercises.

Secondary Null Hypothesis: There is no significant change in EMG activity between Codman's exercises with a weight versus without a weight. Secondary Alternate Hypothesis: There is an increase in EMG activity during Codman's exercises with the use of a cuff weight versus without a weight.

CHAPTER II

LITERATURE REVIEW

E. A. Codman¹ is well known for his extensive exploration and research of the shoulder joint. Codman studied many aspects of the shoulder including anatomy, pathology, surgical techniques, and treatment.

It was Codman who initially recommended “swinging exercises” for the postoperative treatment of a ruptured supraspinatus tendon repair. Codman and others¹⁻⁹ have also recommended swinging exercises as part of the rehabilitation treatment for other shoulder pathologies, such as manipulation of a frozen shoulder, removal of calcium deposits, operative and non-operative ruptured supraspinatus tendon, shoulder dislocations and instability repairs, humeral fractures, and total shoulder arthroplasties.

In his book, *The Shoulder*, Codman also refers to these swinging exercises as stooping exercises. Other sources identify them simply as pendulum or passive pendulum exercises.^{2-5, 8-10} Today these exercises are widely known as Codman’s exercises and are commonly used in physical therapy. Often Codman’s exercises are the first exercise used postoperatively because they are a mild and gentle shoulder exercise. Passive shoulder activities are initiated to help increase shoulder range of motion without causing detrimental damage to injured tissue or a surgical graft. Codman’s intention for these exercises was to provide movement within the synovial tissues of the joint and to prevent adhesions of inflamed tissues without great muscular effort.¹ Therefore, these

exercises are specifically used to regain range of motion in the shoulder and are not used to regain strength.

To perform these exercises, the patient must bend at the waist so that the body is parallel to the floor. The involved arm hangs freely downward at a 90-degree angle to the body. The uninvolved arm can be used for support from a table, chair, or wall. To begin the exercise the patient must move his/her body forward and backward, bending at the knees to prevent low back strain. For a shoulder flexion and extension exercise the relaxed arm should swing passively forward and backward in the same direction as the moving body. A pendulum action is generated due to the movement of the body and the force of gravity on the swinging arm. These exercises can also be done with the arm swinging in the direction of shoulder horizontal abduction and adduction or circumduction.

Some clinicians have experimented using a hand weight during Codman's exercises. The only reference to using weights during Codman's exercises is made by Cailliet.¹¹ Even though this technique using weights is frequently used, he states that "adding a weight to the hand to enhance effectiveness of the pendular exercise is counter productive." His assumption is that there is a cocontraction of the arm and shoulder muscles when grasping a weight. Muscular contraction of any kind should be avoided. It should also be noted that Cailliet makes no reference to using cuff weights which are applied around the wrist and eliminate manually grasping the hand weight.

The original principle behind Codman's exercises is that no fulcrum is needed for the muscles to act on the arm. Gravity is the main force acting on the arm with the assisting forces in the trunk. Gentle exercises like these help prevent adhesions following an acute

or subacute injury or surgery. While in the stooped over position, gravity alone acting on the arm will cause the joint surfaces to separate. The gentle motion will not only prevent joint adhesions but they will also help mobilize debris and blood within the joint, which will in turn increase healing.¹ Codman's¹ theory of healing involves "gentle postoperative exercises," and exercises that are too vigorous can cause scapulo-humeral spasm and inhibit recovery.

Much of the electromyographic research done on the shoulder joint is directly related to normal shoulder movements, mainly concentric and isometric.¹¹⁻¹⁷ Very little research has been done on passive exercise and specifically about Codman's exercises. Moseley and colleagues¹⁸ completed an EMG analysis on scapular muscles during strength exercises commonly used in rehabilitation; however, the exercises they studied were all active exercises designed to gain strength. EMG activity has also been studied during PNF patterns and other therapeutic active range of motion exercises.^{11-14, 19} The only study found with relevance to passive exercise was completed by McCann, et al.¹⁰ They recorded EMG activity during exercises in the following three phases of rehabilitation: phase I, passive; phase II, active; and phase III, resistive. The authors of this study used active shoulder exercise to normalize their data. The muscle activity was recorded while each subject abducted his/her arm with a 2.25-kg weight. This activity was considered the maximum level of EMG. The data for each rehabilitation exercise was then described as a percentage of the maximum level of EMG while performing the normalization exercise.

To describe the results, McCann and colleagues¹⁰ arbitrarily categorized the muscle activity into three categories: minimal, moderate, and marked. The exercise was

considered minimal if the normalized mean was less than 20%. Moderate was classified as muscle activity between 20-50%, and marked was any exercise displaying muscle activity greater than 50%. One of the passive activities was the pendulum exercise which was shown to elicit minimal muscular activity. However, passive pendulum exercises with the addition of a hand weight was not evaluated in this study.

CHAPTER II

METHODOLOGY

Subjects

Ten healthy, male students from the University of North Dakota volunteered to participate in the study. Subjects with previous history of orthopedic or neurological shoulder pathology were excluded. Descriptive anthropometric statistics of the subjects is summarized below (Table 1). Upon the approval of the University of North Dakota Institutional Review Board, informed consent was obtained from each subject prior to participating in this study (Appendix).

Instrumentation

The electromyographic (EMG) data was collected using a Noraxon Telemetry 8 telemetry unit (Noraxon USA, 13430 North Scottsdale Rd., Scottsdale, AZ, 85254). The telemetered information from the EMG electrodes was collected by a Noraxon Telemetry 8 receiver and then digitized by an analog to digital interface board installed in the computer. The digitized EMG signals were analyzed using the Myosoft software package. EMG data was collected using a sampling frequency of 100 Hz for a period of six seconds for collecting maximum voluntary contractions of each muscle and four sets of ten repetitions for the experimental trials.

Table 1. Anthropometric Statistics of Subjects (n=10 males)

	Range	Mean	Standard Deviation
Age (years)	22-32	24.6	2.84
Height (inches)	66-75	70.6	2.76
Weight (pounds)	142-225	178	23.031

Procedure

After giving consent, each subject's age, height, and weight was recorded. Each subject was then given a short training session to learn the proper procedure and technique to be used during the exercise trials. The subject's right upper extremity was used for data collection.

The electromyographic (EMG) activity was collected from the following muscles: anterior deltoid, middle deltoid, posterior deltoid, triceps, biceps, and supraspinatus (Table 2). These muscles were monitored via surface electrodes and are representative of the shoulder motions analyzed in this study.²⁰

To record the EMG activity, surface electrodes were placed over the belly of the above muscles by using standard measurements from bony landmarks as defined by Basmajian.²⁰ The skin over the electrode location was prepared by cleansing the area with alcohol before attachment of the EMG surface electrodes. The self-adhesive, pre-gelled electrodes (Multi Bio-Sensors, El Paso, TX, 79913), were then attached to the skin (Figure 1). An electrogoniometer (Penny and Giles M180, Penny and Giles Inc., 2716 Ocean Park Boulevard, Santa Monica, CA, 90405) was used to monitor the exercise cycles. Using two pieces of double-sides adhesive tape, the electrogoniometer was placed superior to the supraspinatus electrodes and posterior to the middle deltoid electrodes (Figure1).

Prior to beginning the experimental trial, the researcher's assistant applied manual resistance to the subject's upper extremity in order to elicit a maximal voluntary contraction (MVC) from each muscle being monitored in this study. Each individual

Table 2. Muscles monitored and their origin, insertion, and action.

Muscle	Origin	Insertion	Shoulder Action
Anterior Deltoid	lateral 1/3 clavicle	deltoid tuberosity	flexion internal rotation horizontal adduction
Middle Deltoid	lateral 1/3 clavicle acromion process spine of scapula	deltoid tuberosity	abduction
Posterior Deltoid	spine of scapula	deltoid tuberosity	extension external rotation horizontal abduction
Supraspinatus	supraspinous fossa	superior facet of greater tuberosity	abduction external rotation
Triceps	infraglenoid tubercle posterior humerus	olecranon process	extension horizontal abduction
Biceps	supraglenoid tubercle coracoid process	radial tuberosity	flexion horizontal adduction

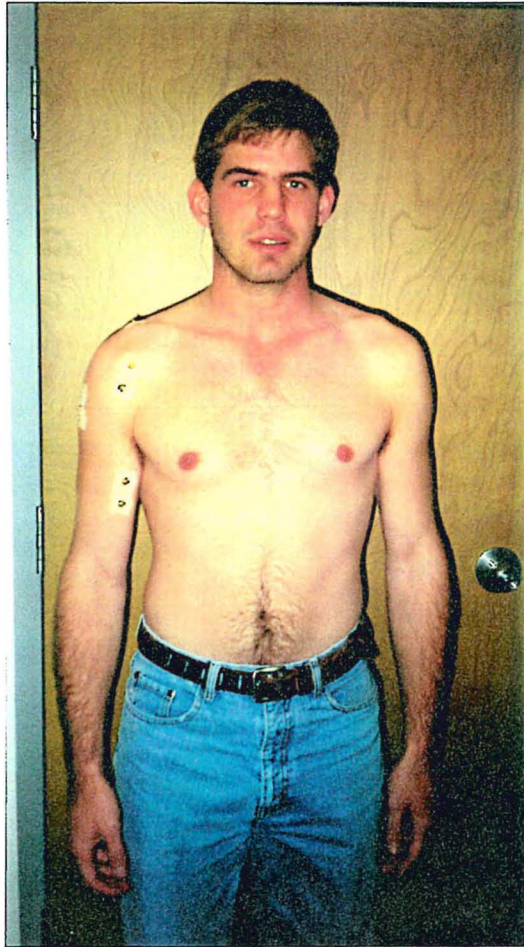


Figure 1. Anterior and posterior view of electrode placement.

muscle was isolated and resisted for six seconds using Cyriax's techniques for the subject's position and the investigator's hand placement.²¹ The muscle activity recorded during the maximal voluntary contraction was considered 100% EMG activity level to which the EMG activity during the experimental trials was compared. This procedure was done to normalize the EMG data.

The subjects were randomly assigned to an initial trial exercise, either performing Codman's exercises with a two-pound weight or without. The subject was then placed in the correct starting position with the body bent over so that the trunk was parallel to the floor and the dominant arm dangling perpendicular to the floor. The uninjured arm was placed on a table for support (Figure 2). With a cue from the investigator, the subject began the experimental trial by moving his body forward and backward with the arm freely swinging. The subject was instructed to perform two sets of ten repetitions of the initial trial, either with the cuff weight or without. A 30-second rest period was given in between sets. The procedure was repeated for the second trial, taking into consideration either removing or adding the two-pound cuff weight. The EMG equipment and electrodes were removed from the subject at the conclusion of the experiment.

The EMG signals were transmitted to the receiver unit and then into a computer for display and recording of the data. The EMG information for each subject was recorded and stored on the computer hard drive for future analysis.

Data Analysis

Statistical analysis of the mean activity of each monitored muscle has been performed on the EMG activity during the MVC trials and the experimental trials with and without the



Figure 2. Starting position for Codman's exercise.

use of a cuff weight. For each subject EMG activity was recorded using Myosoft software for six seconds during the initial maximum voluntary isometric contraction for each muscle. Two seconds of this six second trial were selected for analysis. The mean of the 50 highest peak amplitudes of this two second interval is considered the maximal voluntary contraction (MVC). Data from the experimental trials was analyzed by selecting two consecutive cycles of the exercise. One cycle was defined as the period starting at zero (with the arm perpendicular to the floor) extending through shoulder flexion all the way through shoulder extension and ending back at zero, the starting position. To determine the average EMG activity during exercise an average of the 50 highest peak amplitudes during the selected two cycles was calculated. These calculations were completed for both the trials with and without weight. To normalize the data, the EMG data collected on each muscle during the experimental trials is expressed as a percentage of the EMG activity recorded during the maximum voluntary contraction trials. The formula is as follows:

$$\% \text{ MVC} = \frac{\text{Average EMG Activity During Exercise}}{\text{Average EMG Activity During MVC}} \times 100$$

The independent variables of this study consist of Codman's exercise trials with and without weight and the dependent variable is muscle activity measured as a percent of MVC. T-tests for paired-samples were completed using the statistical package for social sciences (SPSS) software program to determine significant differences between the trials with weight and the trials without. Alpha level was set at .05 using a two-tailed test.

CHAPTER IV

RESULTS

Performing Codman's exercises with and without a two pound weight showed minimal muscular activity. Figure 3 shows the percent of maximum voluntary contraction that was recorded for each muscle. The percent of MVC ranged from .7% in the posterior deltoid to 7.4% in the anterior deltoid.

Figure 3 also graphically compares the differences between a cuff weight and without. Paired sample t-tests using the SPSS software program were performed on each muscle to identify significant difference between trials. No significant differences were found between the activity without a weight and with a weight.(Table 3)

Figures 4 and 5 display the integrated EMG activity in one subject during two cycles of Codman's exercise.

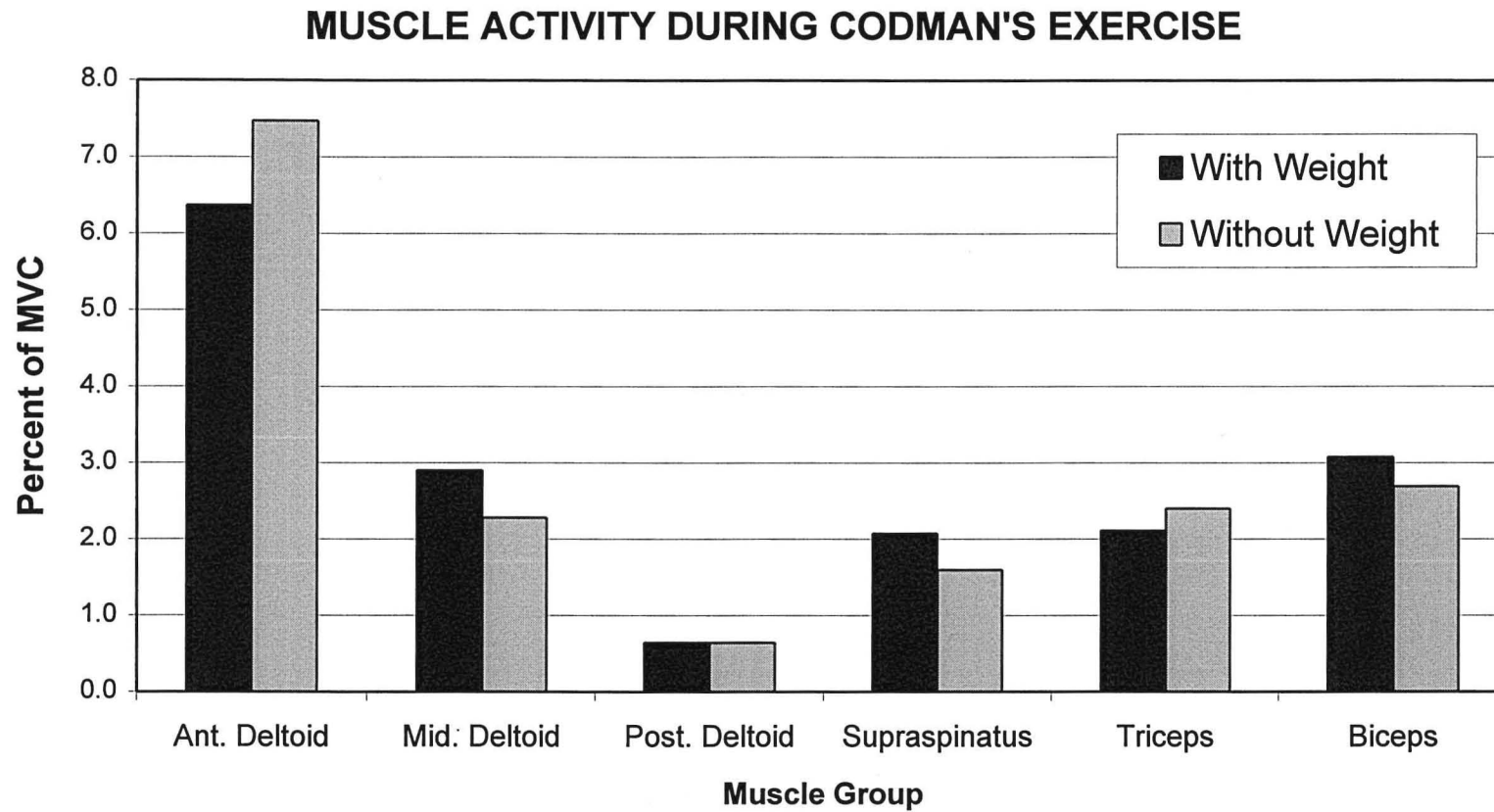


Figure 3. Percent of MVC per muscle during Codman's exercise with and without weight.

Table 3. Mean percent of MVC for each specific muscle during Codman's exercise with and without a weight.

Muscle	Mean % of MVC Without Weight	Mean % of MVC With Weight	Mean Difference	t-Value	p-Value
Anterior Deltoid	7.48 ±9.02	6.36 ±8.05	1.120	.81	.428
Middle Deltoid	2.29 ±.65	2.82 ±2.20	-.5250	-1.00	.329
Posterior Deltoid	.64 ±.89	.65 ±1.01	-.01	-.10	.925
Supraspinatus	1.59 ±4.12	2.07 ±3.81	-.4750	-.86	.401
Triceps Brachii	2.4 ±4.05	2.11 ±4.36	.2950	.83	.418
Biceps Brachii	2.7 ±3.52	3.09 ±4.05	-.3850	-1.37	.186

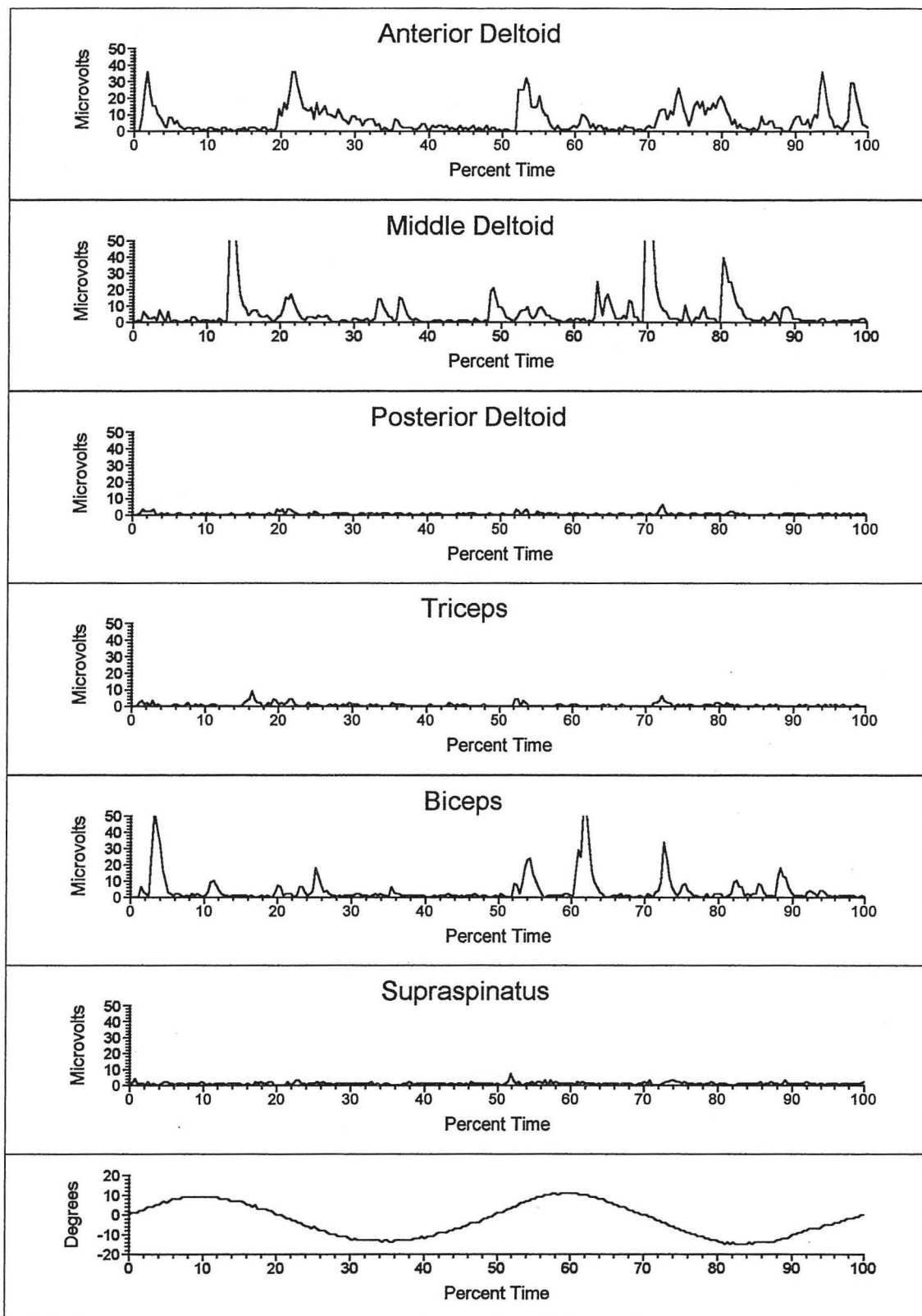


Figure 4. Subject 3 during two cycles of Codman's exercise without weights.

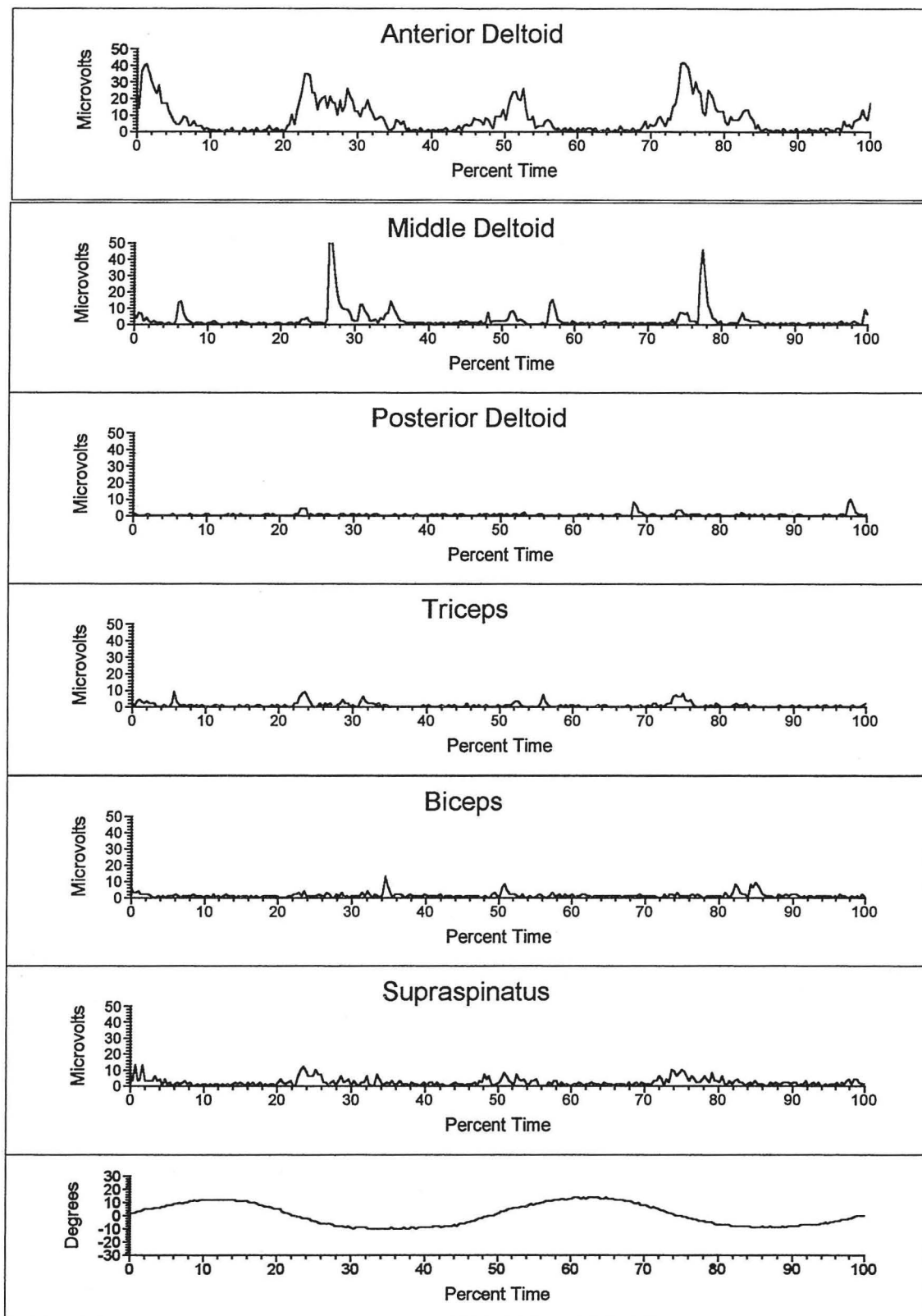


Figure 5. Subject 3 during two cycles of Codman's exercise with weights.

CHAPTER V

DISCUSSION

Discussion

The results of the study show that performing Codman's exercises elicit only minimal muscular activity when performed properly. It was Codman's intention for these exercises to be performed "without great muscular effort," and indeed this is what was demonstrated. EMG activity in all the muscles monitored was below 7.5% of MVC for each muscle. Applying a cuff weight did not appear to make a significant difference in muscle activity. In three of the six muscles studied, there was an increase in percent of MVC when the cuff weight was applied, however the increase was not significantly different from the trials without the cuff weight. These findings differ from the statements made by Cailliet,¹¹ who felt that adding a weight was counterproductive and caused a cocontraction of the shoulder musculature. The benefits of Codman's exercises appear to be somewhat dependent on proper technique. Based only on this researcher's observation, the subjects who were lacking in trunk movement displayed higher muscle activity than the other subjects. The results of this study generally correspond with McCann and colleagues¹⁰ who found minimal muscle activity with Codman's exercise in comparison to more vigorous exercise.

Limitations of Study

There were several limitations of this study. First, the sample was taken from a non-representative population and was limited in size. All the subjects were physical therapy

students without prior shoulder pathology. The majority of the subjects had been previously exposed to and instructed on how to correctly perform Codman's shoulder exercises. This sample does not best represent the assumed patient population who have experienced shoulder pathology undergoing rehabilitation. The sample size was limited to ten subjects, which does not guarantee that the distribution of sample means will follow a normal distribution curve.

The techniques used during the training session allowed room for error. Each subject was individually shown how to perform the exercises; however, they were not asked specifically to practice prior to performing the experimental trials. Therefore, throughout the experimental trials some subjects demonstrated a lack of trunk movement, which could have been minimized with a practice session. A practice session would have also eliminated the learning curve factor. Using video analysis one could have identified poor technique quantitatively by measuring the amount of movement the entire body moved or did not move to put the relaxed arm in motion. Without trunk motion the arm can only be moved by muscles around the joint, which is what Codman's exercise tries to avoid to prevent further injury to muscular structures or damage to a surgical graft. Another study incorporating video analysis may be warranted.

Another limitation involved the availability of electrode types specifically to isolate EMG activity of the supraspinatus. Disadvantages to surface electrodes include limited ability to monitor deep muscles and decreased specificity as compared to inserted electrodes.²¹ Because the supraspinatus muscle lies beneath the upper trapezius fibers there was a chance for cross-talk and possible inaccurate EMG readings for the supraspinatus. All the other muscles tested and recorded are located superficially.

The inability to standardize force and velocity may also have limited the study. Collecting and quantifying EMG activity is dependent on the force produced by the muscle, which is related to the velocity of the motion. There is a linear relationship between EMG activity and force. When there is an increase in force there is a corresponding increase in EMG activity. Standardization of the distance and speed for each repetition was unobtainable for this study. During a preliminary trial a metronome was attempted with to time the cycles. However, it was found that when performing a passive activity it was very difficult to remain relaxed when having to match a designated beat. It forced the subjects to use their muscles to either speed up or slow down to match the beat of the metronome. We were unable to devise appropriate stops for the arm to reach each repetition. Any measure of distance would likely have forced the subject to use muscular assistance to reach the designated stop and/or slow the arm so as not to overshoot the distance to the stop.

Conclusions

Codman's exercise does elicit muscle activity, however this activity is minimal at most. These exercises should continue to be used in early rehabilitation for patients with appropriate shoulder pathologies to facilitate early motion without great muscular effort. When performed properly Codman's exercise will initiate early motion, relieve pain, and prevent adhesions.

Clinical Implications

Codman's exercises are a gentle, passive activity that can and should continue to be used for rehabilitating acute shoulder injuries and/or post-surgical repairs to the shoulder.

This exercise has shown to produce minimal muscular activity; therefore, should be considered a safe activity when used with proper technique.

It is important for therapists to know the correct technique and to know how to adequately explain and demonstrate Codman's exercise to their patients with shoulder injuries or impairments. Trunk movement is essential during these exercises to allow the arm to swing freely. If the trunk is moving properly, the arm will follow in a passive manner. Therapists should realize that performing Codman's exercise in prone or kneeling positions prevents the trunk from exerting adequate motion, therefore requiring the shoulder musculature to move the arm and decreasing the passive component.

Also, it is important to identify patients who are performing Codman's incorrectly and either correct their technique or change the exercise to prevent damage or inhibit healing. Initially, it is a good idea to have patients demonstrate performing the exercises. If they do not demonstrate proper technique, passively move their arm through the range to show them how it should feel. It is imperative that the patient understands and performs Codman's exercises properly to reap the benefits of the exercise.

APPENDIX

REPORT OF ACTION: EXEMPT/EXPEDITED REVIEW
University of North Dakota Institutional Review Board

DATE: October 14, 1997 PROJECT NUMBER: IRB-9710-055

NAME: Thomas Mohr; Myndi Frey DEPARTMENT/COLLEGE: Physical Therapy

PROJECT TITLE: An Electromyographic Study of the Shoulder Musculature During
Codman Exercises (Protocol Change)

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on October 16, 1997 and the following action was taken:

- Project approved. **EXPEDITED REVIEW NO.** 7.
Next scheduled review is on October 1997.
- Project approved. **EXEMPT CATEGORY NO.** _____. No periodic review scheduled unless so stated in the Remarks Section.
- Project approved **PENDING** receipt of corrections/additions. These corrections/additions should be submitted to ORPD for review and approval. **This study may NOT be started UNTIL final IRB approval has been received.** (See Remarks Section for further information.)
- Project approval **deferred**. **This study may not be started until final IRB approval has been received.** (See Remarks Section for further information.)
- Project **denied**. (See Remarks Section for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairperson or ORPD.

cc: T. Mohr, Adviser
Dean, Medical School

Guida M. Laason 10/16/97
Signature of Designated IRB Member Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 310 Form may be required. Contact ORPD to obtain the required documents.

(3/96)

REPORT OF ACTION: EXEMPT/EXPEDITED REVIEW
University of North Dakota Institutional Review Board

DATE: September 23, 1997 PROJECT NUMBER: IRB-9710-055
NAME: Thomas Mohr; Myndi Frey DEPARTMENT/COLLEGE: Physical Therapy
PROJECT TITLE: An Electromyographic Study of the Shoulder Musculature During Codman Exercises

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on October 3, 1997 and the following action was taken:

- Project approved. **EXPEDITED REVIEW NO.** 7.
Next scheduled review is on October 1998.
- Project approved. **EXEMPT CATEGORY NO.** _____. No periodic review scheduled unless so stated in the Remarks Section.
- Project approved **PENDING** receipt of corrections/additions. These corrections/additions should be submitted to ORPD for review and approval. **This study may NOT be started UNTIL final IRB approval has been received.** (See Remarks Section for further information.)
- Project approval **deferred**. **This study may not be started until final IRB approval has been received.** (See Remarks Section for further information.)
- Project **denied**. (See Remarks Section for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairperson or ORPD.

cc: T. Mohr, Adviser
Dean, Medical School

Linda M. Laessle 10/3/97
Signature of Designated IRB Member Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 310 Form may be required. Contact ORPD to obtain the required documents.

(3/96)

EXPEDITED REVIEW REQUESTED UNDER ITEM 3 (NUMBER[S]) OF HHS REGULATIONS
 EXEMPT REVIEW REQUESTED UNDER ITEM _____ (NUMBER[S]) OF HHS REGULATIONS

**UNIVERSITY OF NORTH DAKOTA HUMAN SUBJECTS REVIEW FORM
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED
PROJECTS INVOLVING HUMAN SUBJECTS**

PRINCIPAL

INVESTIGATOR: Thomas Mohr and Myndi Frey TELEPHONE: 777-2831 DATE: September 15, 1997

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: University of ND, P.O. Box 9037,
Grand Forks, ND 58202

PROPOSED

SCHOOL/COLLEGE: School of Medicine DEPARTMENT: Physical Therapy PROJECT DATES: 9/15/97-6/1/98
(Month/Day/Year)

PROJECT TITLE: An Electromyographic Study of the Shoulder Musculature during Codman Exercises.

FUNDING AGENCIES (IF APPLICABLE): _____

TYPE OF PROJECT (Check ALL that apply):

_____ NEW PROJECT _____ CONTINUATION _____ RENEWAL _____ DISSERTATION OR STUDENT
_____ THESIS RESEARCH RESEARCH PROJECT
_____ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Dr. Thomas Mohr

PROPOSED PROJECT: _____ INVOLVES NEW DRUGS (IND) _____ INVOLVES NON-APPROVED
_____ INVOLVES A COOPERATING INSTITUTION _____ USE OF DRUG

IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):

_____ MINORS (< 18 YEARS) _____ PREGNANT WOMEN _____ MENTALLY DISABLED _____ FETUSES
MENTALLY RETARDED
_____ PRISONERS _____ ABORTUSES UND STUDENTS (> 18 YEARS)

IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS,
DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE _____

IF YOUR PROJECT HAS BEEN/WILL BE SUBMITTED TO ANOTHER INSTITUTIONAL REVIEW
BOARD(S), PLEASE LIST NAME OF BOARD(S):

Status: _____ Submitted; Date _____ _____ Approved; Date _____ _____ Pending

1. ABSTRACT:(LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR
USING HUMAN SUBJECTS.)

Codman shoulder exercises are widely known and commonly used in physical therapy as a passive shoulder activity to help increase range of motion without causing detrimental damage to injured tissue or a surgical graft. Passive exercises are initiated to provide movement within the synovial tissues of the joint and to prevent adhesions. Codman exercises are often the first exercise used post operatively because they are a very mild form of shoulder exercises. They are used to regain range of motion in the shoulder and are not used to regain strength.

E. A. Codman described these exercises as "stooping exercises," also known as pendular exercises. To perform these exercises the patient must bend over at the waist dangling the involved arm in a position perpendicular to the floor. The uninvolved arm can be placed on a table to support

the body. The patient then begins to move his/her body forward and backward or side to side. Moving the body forces the involved limb to swing passively or without muscle contraction of the shoulder musculature.

The purpose of this study is to determine whether Codman exercises are an active or passive activity. Muscle activity of the shoulder musculature will be analyzed via electromyography. The information gained from this study may impact the rehabilitation protocols of injured or post-surgical shoulder patients.

Healthy, subjects without previous shoulder pathology will be used in this research project. This project is dependent on the use of human subjects to collect EMG data from the muscles of the shoulder while performing Codman exercises.

PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

2. PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

SUBJECTS:

Ten male subjects, (ages 20–45), will be recruited from the University of North Dakota Physical Therapy School. The subjects will be asked to volunteer to participate in a research project involving the study of the shoulder during Codman exercises using electromyography (EMG). Subjects with a previous history of orthopedic or neurological pathologies will be excluded.

METHODS:

We will measure electromyographic activity in selected shoulder girdle musculature. We propose to measure EMG activity during Codman exercises which involves shoulder flexion-extension and horizontal abduction-adduction. The following muscles will be monitored: 1) anterior deltoid, 2) middle deltoid, 3) posterior deltoid, 4) trapezius, 5) pectoralis major, and 6) latissimus dorsi.

Each subject's age, height, and weight will be recorded prior to testing. A short training session will be implemented before the experimental trials begin to instruct the subjects on the proper procedure and technique to be used. During the exercise trials the dominant upper extremity will be used for data collection.

The experiment will begin with electrode placement and skin preparation. To record EMG activity, the motor points of the above muscles will be located by using standard measurements from bony landmarks. The skin of the upper extremity of each subject will be prepared by cleansing the area with alcohol before attachment of the EMG adhesive surface electrodes over the motor point. The EMG signals will be transmitted to a receiver unit and then fed into a computer for display and recording of data. Prior to beginning the experimental trial, the researcher will apply manual resistance to the subject's upper extremity in order to elicit a maximal voluntary contraction from each muscle being monitored in this study. The muscle activity recorded during the maximal voluntary contraction will be considered as a 100% EMG activity level to which the EMG activity during Codman exercises can be compared. This procedure is done to normalize the EMG data for later analysis. EMG activity measured during performance of Codman exercises will then be recorded on the computer.

DATA ANALYSIS:

Descriptive statistics describing the subjects' anthropometric profiles will be provided. Statistical analysis of the mean activity of each monitored muscle will be performed on the EMG activity. The EMG data collected during the experimental trials will be expressed as a percentage of the EMG activity recorded during the MVC prior to the experimental trials (i.e. normalized).

3. BENEFITS: (Describe the benefits to the individual or society.)

The data collected throughout this research study will be analyzed to determine the muscle activity around the shoulder while performing Codman shoulder exercises. This information will provide the basis for developing protocols specifically geared toward rehabilitating an injured or post-surgical shoulder.

4. RISKS: (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risks involved in this research project are minimal. The EMG should not cause any discomfort to the subject, since it is a monitoring device. The process of physical performance testing does impose a potential risk of injury to the muscle. The subjects in this study will only perform maximal voluntary contraction for comparison purposes. The testing for maximal voluntary contraction will occur in a controlled setting, and the investigator feels that the potential for injury to the muscle is very minimal. The remainder of the trial will consist of minimal to submaximal muscular contractions during the experimental exercise. The investigator or participant may stop the experiment at any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his/her health. All sessions will be monitored by a licensed physical therapist.

The subjects' names will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with the subject will remain confidential and will be disclosed only with the subject's permission. The data will be identified by a number known only by the investigator.

5. CONSENT FORM: A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.

All subjects will sign a consent form prior to participating in the study. The consent forms will be kept in the Physical Therapy department at the University of North Dakota. The forms will be kept for 2 years following the completion of the independent study and will then be destroyed.

6. For FULL IRB REVIEW forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
University of North Dakota
Grand Forks, North Dakota 58202-7134

On campus, mail to: Office of Research & Program Development, Box 7134, or drop it off at Room 105 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:

Principal Investigator: _____ Date: _____

Project Director or Student Adviser: _____ Date: _____

Training or Center Grant Director: _____ Date: _____

(Revised 3/1996)

STUDENT RESEARCHERS: As of June 4, 1997 (based on the recommendation of UND Legal Counsel) the University of North Dakota IRB is unable to approve your project unless the following "Student Consent to Release of Educational Record" is signed and included with your "Human Subjects Review Form."

STUDENT CONSENT TO RELEASE OF EDUCATIONAL RECORD¹

Pursuant to the Family Educational Rights and Privacy Act of 1974, I hereby consent to the Institutional Review Board's access to those portions of my educational record which involve research that I wish to conduct under the Board's auspices. I understand that the Board may need to review my study data based on a question from a participant or under a random audit. The study to which this release pertains is A Electromyographic Study of the Shoulder Girdle Musculature During Codman Exercises.

I understand that such information concerning my educational record will not be released except on the condition that the Institutional Review Board will not permit any other party to have access to such information without my written consent. I also understand that this policy will be explained to those persons requesting any educational information and that this release will be kept with the study documentation.

Date

Signature of Student Researcher

¹Consent required by 20 U.S.C. 1232g.

INFORMATION AND CONSENT FORM

TITLE: An Electromyographic Study of the Shoulder Girdle Musculature during Codman Exercises.

You are being invited to participate in a study conducted by Myndi Frey, a physical therapy student at the University of North Dakota. The purpose of this study is to study muscle activity in your upper extremity while you are performing shoulder exercises. We hope to describe the muscle activity to determine which muscles are either active or passive during the trial of exercises. Only normal, healthy male subjects will be asked to participate in this study.

You will be asked to complete two trials of ten repetitions, one time with a weight and one time without a weight. The exercise will involve shoulder flexion-extension, which is swinging your arm forward and backward. You will be given a short rest period between exercises.

The study will take approximately one half hour of your time. You will be asked to report to the Physical Therapy Department at the University of North Dakota at an assigned time. You will then be asked to change into gym shorts for the experiment. We will first record your age, height, and weight. During the experiment, we will be recording the amount of muscle activity you have when you perform the experimental exercises.

Although the process of physical performance testing always involves some degree of risk, the investigator in this study feels that the risk of injury or discomfort is minimal. In order for us to record the muscle activity, we will be placing electrodes on your upper extremity. Before we can apply the electrodes, we will measure and mark standard distances from bony landmarks to locate the best spot to place the electrodes. The recording electrodes are attached to the surface of the skin with an adhesive material. These devices only record information from your muscles and joints, they do not stimulate the skin. We will give you a brief training session to teach you how to perform the exercises. The amount of exercise you will be asked to perform will be minimal.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The data will be identified by a number known only to the investigator. The investigator or participant may stop the experiment at any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his health. Your decision whether or not to participate will not prejudice your future relationship with the Physical Therapy Department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigator involved is available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that

you may have in the future. Questions may be asked by calling Myndi Frey or Dr. Thomas Mohr at (701) 777-2831. A copy of this consent form is available to all participants in the study.

In the event that this research activity results in a physical injury, medical treatment will be available, including first aid, emergency treatment and follow up care as it is to a member of the general public in similar circumstances. Payment for any such treatment must be provided by you and your third party payer, if any.

ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE CONCERNING THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT, HAVING READ THE ABOVE INFORMATION, I HAVE DECIDED TO PARTICIPATE IN THE RESEARCH PROJECT.

I have read all of the above and willingly agree to participate in this study explained to me by Myndi Frey.

Participant's Signature Date

Witness (not the scientist) Date

CONSENT FOR TAKING
AND
PUBLICATION OF PHOTOGRAPHS

In connection with Myndi Frey's independent study project entitled, "An Electromyographic Study of the Shoulder Girdle Musculature during Codman Exercise," I consent that photographs may be taken of me and may be published under the following conditions:

1. The photographs shall be used if the researcher, Myndi Frey, deems that medical research, education, or science will be republished, either separately or in connection with each other, in professional journals or medical books; provided that it is specifically understood that in any such publication or use, I shall not be identified by name.
2. The aforementioned photographs may be modified or retouched in any way that the researcher, Myndi Frey, may consider desirable.

Signed Jason Anderson Date 10-15-97
Witness Kenneth [Signature] Date 10-15-97

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