The Effects of Training on Cervical Range of Motion between Unilateral Breathers and Bilateral Breathers in Collegiate Swimmers during Freestyle Swimming

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THE EFFECTS OF TRAINING ON CERVICAL RANGE OF MOTION BETWEEN UNILATERAL BREATHERS AND BILATERAL BREATHERS IN COLLEGIATE SWIMMERS DURING FREESTYLE SWIMMING

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This independent Study, submitted by Anjanette C. Wong 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.

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Title The Effects of Training on Cervical Range of Motion Between Unilateral Breathers and Bilateral Breathers in Collegiate Freestyle Swimmers

Department Physical Therapy

Degree Master of Physical Therapy

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Date 3/18/98

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For Derek, Kelly, Mom and Dad
ABSTRACT

The purpose of this study was to establish data on active cervical range of motion for collegiate freestyle swimmers, to determine if training has an effect on cervical range of motion, and to investigate if breathing style influences cervical rotation to the right and left after training. The sample consisted of 29 varsity swim team members from the University of North Dakota (12 females and 17 males) who had participated in experiment IRB-9504-257. This past study was performed at the start of the competitive swim season, and its measurements used as pre-season data. The same CROM device was used to measure cervical rotation in both experiments.

A related-samples t test for matched pairs showed no significant difference in right rotation (p=.5119) and total rotation (p=.0756) with training. A significant increase did occur in left rotation (p=.0211) after training. Following an ANOVA, no significance in cervical range of motion based on breathing style was found (p<.05). However, trends showed increased left cervical rotation in left unilateral breathers after training. It could not be established if increases specific to breathing patterns were significant due to the small sample size of bilateral, right unilateral and left unilateral breathers (n=12, n=14, n=3 respectively). A t-test for independent samples showed no significant differences (p<.05) in cervical range of motion after training based on the gender of the subjects.
With these findings, it was speculated that increases in left cervical rotation were a result of training.

Increased values in cervical rotation may identify a swimmer prone to developing musculoskeletal injury. Specific normative values may be indicated when interpreting data of a swimmer who participates at high training levels. Taking these precautions will provide a more accurate diagnosis and give better direction in treatment planning for a swimmer with cervical pathology.
CHAPTER 1
LITERATURE REVIEW

In the last few decades, it has been recognized that increased training regimens are necessary to achieve peak athletic performance. Attaining a balance between high level training and rest is the goal for elite competitors. However, as athletes push their bodies to seek their ultimate fitness potential, they place themselves at risk for overtraining. Therefore, understanding the consequences of chronic exercise upon physiological systems is practical to athletes, coaches, and medical professionals alike. In sports such as swimming and gymnastics, high level performance requires hard training beginning in the adolescent years. As such, the consequences can be serious with repetitive loads imposed on growing bodies.\textsuperscript{1,2}

Though swimmers may compete in four strokes, the butterfly, backstroke, breaststroke, and freestyle,\textsuperscript{3,4} the freestyle or front crawl is the most widely used stroke in training regardless of the swimmer's specialty.\textsuperscript{5,6} For the competitive swimmer, an estimated 60-90\% of practice time is devoted to performing the freestyle stroke.\textsuperscript{5,6} The biomechanics of freestyle are characterized by alternating overhead stroking of the arms with alternating (flutter) kick of the legs, and cervical rotation to take a breath of air.
Fig. 1.—Sequence of Freestyle swimming. Councilman JE, The Science of Swimming 1968. Reprinted/Adapted by permission from Allyn and Bacon.
During a season, competitive swimmers are engaged in high levels of training. Practices held five to seven days per week, with double or triple workouts at peak season, are not uncommon. The swim season lasts 10-12 months per year with a recorded average yardage for collegiate swimmers to be 8,000 to 10,000 yards (11.4 miles) per day. Some teams report weekly training yardage of up to 100,000 yards. On average, it has been estimated that swimmers take six to ten stroke cycles per length (25 yards). According to some authors, an average swimmer who trains 10,000 yards daily, with an estimated 10 arm cycles for every 25 yards, has an approximate 4,000 repetitive arm cycles on a daily basis. With a calculated breath every third stroke for the bilateral breather, this averages to 2,000 breaths or 2,000 cervical rotations per day. (This estimate does not reflect the decrease in stroke efficiency as fatigue sets in and causes a swimmer to take additional strokes and breaths per length).

Musculoskeletal Physiological Adaptations to Training

Any sport that stresses the musculoskeletal system with continuous high level training will predispose athletes to injuries secondary to the inability of muscles, bones, and joints to withstand those loads. Runners for example, develop stress fractures with overuse of their lower extremities secondary to the constant pounding the legs experience with training. In swimming, the dominant use of the upper body may cause swimmers to suffer the effects of repetitive motion on several joints and ligaments in the upper extremity, particularly the shoulders and cervical spine. The physiological make up of biological tissue allows it to withstand a certain amount of stress, as well as the ability to adapt to high training levels. Sport specific adaptation secondary to training has been
widely recognized. However, if loads are too great, if stresses are imposed repetitively over a lengthy period of time, or if loads are increased too quickly, tissues may not be able to adapt to the imposed demand. If tissues fail to recover to their original state, microtrauma, increased flexibility, and increased joint laxity may result, and progress to overuse injuries. Thus, understanding the mechanism of overuse injuries and having the ability to identify when abnormalities in joint motion are present, are valuable tools in the prevention, treatment, and rehabilitation of injuries. In a study performed by Fleisig, Andrews, and Dillman et al., kinetics and muscle activity of baseball pitching were analyzed to determine the biomechanics of throwing and its implications to injury. In this study, critical loads related to shoulder and elbow injuries were identified at specific points in time during the throwing motion and indicated as sites for increased risk for injury. This study underlined the need to recognize proper mechanics and its importance to the medical clinician in understanding the mechanism of overuse injuries.

Mechanics of Swimming/Biomechanics of Breathing

As with many other sports, the mechanics of the whole body must be considered when analyzing stresses imposed on the joints. The power of swimming is gained through mechanical advantages which are achieved through proper technique. Maximum power in the freestyle stroke is achieved with ideal placement of the extremities, head, and trunk which are dictated by a swimmer’s movement of limbs and spine when going to and from end range position. Ideally, to take a breath of air, rotation at the cervical spine should occur along the longitudinal axis and in the horizontal plane of the prone swimmer. Furthermore, just as in the sports of baseball and golf, core strength of the
trunk is important to swimming. Rotational movement from the hips and trunk segmentally generate power through the swimmer’s longitudinal axis. This rotation generated at the hips, otherwise known as hip “pop,” is recognized to increase hand speed in the power phase of the stroke.\textsuperscript{16(p.70)} According to Stanley Paris, “The spine is, on the one hand, the passive link between the powerhouses of the legs and more especially the arms, but by its contortions it is also the engine that places the limbs in a position to maximally achieve their power. It is the spine that both drives and is driven.”\textsuperscript{17(p.351)} Therefore sites such as the spine, which are exposed to these powerful actions, are vulnerable to stress and strain from power developed at other sites of the body and are susceptible to overuse injuries.\textsuperscript{1,2,11,12,17}

In the sport of swimming, the cervical spine is predisposed to stresses secondary to breathing mechanics. There are two types of breathing styles in the front crawl 1) bilateral breathing: where the swimmer breathes to both sides of his or her body and 2) unilateral breathing: where the swimmer breathes to only one side of the body during the entire course of training. Technically, a consistant bilateral breather will perform a sequence of three strokes with a breath on the third stroke. Bilateral breathing has been found to have two consequences on the mechanics of swimming. These are: 1) increased balance of a swimmers stroke by encouraging symmetrical body roll which may promote a more efficient stroke\textsuperscript{4,7,18} and 2) decreased number of breaths taken per length.\textsuperscript{4,7} In contrast, unilateral breathers (right side or left side), take their breath every even numbered stroke to the same side. The repetitive sport specific movement of cervical rotation with breathing during freestyle training as stated above, may place the
competitive swimmer at greater risk of developing musculoskeletal injuries about the cervical spine.

**Training Effects on Flexibility**

According to many authors, repetitive stresses in themselves (occupational or recreational activities), may induce trauma to the cervical spine.\textsuperscript{12,19,20,21,22} Many support the idea that training affects an athlete's flexibility as seen with the repetitive mechanical activity of breathing in freestyle swimming.\textsuperscript{9,10,11,12,13,14} Wallace et al\textsuperscript{14} investigated upper extremity flexibility in female high school competitive swimmers. Sixteen of the 17 swimmers demonstrated flexibility asymmetry. These results help support the idea that an individual's activity facilitates physiological changes.

In a study by Guth\textsuperscript{12}, active physiological rotation in 14 to 17 year old male competitive swimmers (N=40) and controls (N=40) were compared to investigate the relationship between freestyle stroke breathing patterns and differences in right and left cervical rotation. The criteria for the trained experimental group include: 1) currently involved in competitive swimming 2) training greater than eight hours a week or greater than 15 kilometers per week and 3) consistently training for more than three years which involved greater than 50 percent of freestyle. Analysis of variance determined that a significant difference existed in goniometric measurements of physiological cervical rotation between the trained swimmers and nonswimmers. The experimental group demonstrated a significantly higher mean range of total active cervical rotation right (p=0.002) compared to the control group. The swimmers also demonstrated evidence that breathing style significantly affected their active cervical range of motion on their
breathing side. Guth’s results support findings that training affects flexibility of connective tissue which increases range of motion, and evidence that clinicians need to consider the influence of activity when assessing range of motion of the cervical spine.

Jack Leighton also observed increased flexibility in college swimmers, basketball players, football players, and track and field athletes. Leighton compared collegiate athletes with a control group of 16 year old males to demonstrate the effect sport specific training has on joint flexibility. The population of 16 year old boys was selected as the control group because certain flexibility trends were found at this age level and thus could be used as a basis for comparison. The swimmers who participated, trained and competed for a minimum of two years. This requirement was speculated to be a long enough period to allow for structural changes that might occur on or affect the joint. This study presented evidence that significant characteristics of flexibility occur for specialized training groups that practice particular skills. Results showed swimmers had the greatest cervical rotation, and athletes in other sports demonstrated similar qualities of flexibility specific to certain joints utilized in their sport. The results of this study support the theory that specific training activities influence flexibility performance. According to Paris, “Perhaps the most vulnerable area of the swimmer’s spine is at the junction of the mobile neck with the relatively inflexible thoracic spine.” Based on these observations, this study will focus on measuring cervical rotation of swimmers.
Evaluation of Cervical Range of Motion

Clinicians take cervical range of motion measurements of patients to assess a patient’s status, develop treatment plans, evaluate treatment effectiveness and determine patient progress. Therefore, accuracy of baseline measurements and determining the norms by which patient data will be compared is of foremost importance. For example, an elderly person of 75 years of age may improve cervical range of motion by twenty degrees following treatment. However, a misinformed clinician may be inclined to continue treatment without proper knowledge that the patient has reached his or her normal range of motion. Clinicians often turn to the American Academy of Orthopaedic Surgeons (AAOS) or the American Medical Association’s (AMA) Guides to the Evaluation of Permanent Impairment as sources for normal values of cervical active range of motion (AROM). However, these sources do not take into account important information such as age and gender that validate values to be “normal.” The values given by the AAOS describes the six components of cervical AROM (flexion, extension, rotation right, rotation left, side bending right, side bending left), but no information is given about age or gender of the subjects which have clearly been shown to have implications on normative value data for cervical range of motion. Information about the sample size used to determine these “normal values” was also lacking. Furthermore, reliability of these measurements are not substantiated. The AMA publication describes impairment associated with certain range of motion measurements, yet no normative
values of cervical range of motion or information to validate the procedure used in collecting this data is reported. In addition, both sources do not consider the effects of age or gender.

Fortunately, variability of cervical rotation by age and gender has recently been the focus of much research. \(^{27,28,29,30}\) Rheault et al\(^{31}\), Capuano-Pucci et al\(^{32}\), and Youdas et al\(^{26}\) have established norms for active cervical range of motion, and have provided adequate information regarding the reliability of their data. These studies have illustrated a decrease in cervical range of motion between age groups within gender, and between gender groups in corresponding age groups.

Youdas and colleagues\(^{33}\) determined normal values for cervical AROM using a Cervical Range of Motion (CROM) device. Investigators performed active cervical range of motion measurements on the cervical spine on 337 subjects (171 females and 166 males) whose ages ranged from 11 to 97 years. It was concluded that cervical range of motion was greater in females than males of the same age and that cervical range of motion decreased significantly with an increase in age between 10 year intervals for both genders. Good intratester and intertester reliability of AROM on the cervical spine with the CROM instrument was illustrated with interclass correlation coefficients greater than .80 for this study. Finally, authors have speculated that in both males and females, a loss of 3 degrees in active cervical range of motion occurs every 10 years beginning at the age of 10.\(^{26}\)

Kurt Kulhman\(^{27}\) established normative cervical range of motion values for the elderly and compared these values to standard young adult cervical range of motion.
values. A gravity goniometer was used to measure 42 subjects 70 to 90 years and 31 subjects 20 to 30 years. Results revealed that older persons had decreased range of motion for all six cervical motions (p<.001) and females reported greater cervical range of motion values compared to men in both age groups. These current studies illustrate the necessity for clinicians to consider age and gender in the interpretation of cervical range of motion. For the purpose of this study however, age was not considered a variable in the analysis of our data. The pool of participants in this study involved 18 to 24 year old collegiate swimmers, a seven year age span which categorized all subjects closely in the 10 year age brackets established by Youdas et al33 (table 1).

Different methods (i.e. positioning, active or passive participation), and instrumentation (i.e. gravity goniometer, CROM, visual estimation (VE), universal goniometer (UG)) have been studied by various researchers. Results from these experiments have established normative values specific to the methods used.27,28,29,31,33 In a study performed by Youdas et al,33 the CROM was found to be highly reliable and had the highest intratester reliability (ICC>.80) of the three instruments studied (CROM, VE, and UG).

The studies mentioned above indicate that instrumentation and source of normative values should be taken into consideration to validate the standard used when interpreting a patient’s range of motion. If a therapist utilizes the CROM as instrumentation in an experiment, the norms established with the device should be obtained for appropriate interpretation of results. Table 1 contains data collected from cervical rotation studies which utilized the CROM device for instrumentation.
Table 1.—Normative data on cervical rotation using the CROM instrument

<table>
<thead>
<tr>
<th>Author of source</th>
<th>Right Rotation</th>
<th>Left Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ROM*</td>
<td>SD*</td>
</tr>
<tr>
<td></td>
<td>ROM*</td>
<td>SD*</td>
</tr>
<tr>
<td>Rheault, et al\textsuperscript{31}</td>
<td>61.7</td>
<td>11.8</td>
</tr>
<tr>
<td>Capuano-Pucci et al\textsuperscript{32}</td>
<td>70.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Youdas, et al\textsuperscript{33}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-19 yrs.-male</td>
<td>74.1</td>
<td>7.6</td>
</tr>
<tr>
<td>11-19 yrs.-female</td>
<td>74.9</td>
<td>9.8</td>
</tr>
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<td>20-29 yrs.-male</td>
<td>69.9</td>
<td>6.0</td>
</tr>
<tr>
<td>20-29 yrs.-female</td>
<td>74.6</td>
<td>5.9</td>
</tr>
<tr>
<td>30-39 yrs.-male</td>
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<td>30-39 yrs.-female</td>
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<td>90-97 yrs.-female</td>
<td>51.8</td>
<td>8.7</td>
</tr>
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*Range of motion in degrees
The CROM was the device utilized in the current study to measure active cervical range of motion of swimmers.

The purpose of this study was to establish normative data of active cervical range of motion and determine if training had an effect on cervical range of motion in collegiate freestyle swimmers. Pre-season and post-season measurements were also compared to determine if training had a significant effect on left and right cervical range of motion based on breathing style.
CHAPTER 2

METHODS

Subjects

Twenty-nine University of North Dakota swim team members volunteered to participate in this study (12 female and 17 male). The subjects' ages ranged from 18 to 24 years. The average age was 20.5 years with a standard deviation of 1.6 years. All participants were tested 2 to 3 weeks after their last day of competition for the season. The season lasted between seven and nine months.

Criteria for participation was established for this study, and individuals excluded from the study were those who did not meet these requirements. Participation in this study required having no history of cervical pathology, being over the age of 18 years, and having participated in study number IRB-9504-257. This past study, was performed at the beginning of the competitive season, and gathered cervical range of motion measurements in order to establish data on bilateral and unilateral breathers of collegiate caliber. For both studies, cervical pathology was defined as any neck injury requiring medical attention. Approval for this study was consented by the University of North Dakota Institutional Review Board project number IRB-9602-0149 (Appendix D).
Instrumentation

The CROM (Cervical Range of Motion) device is made up of a light, durable, plastic frame, with three magnetic dials (Fig.2). The device is placed over the subject's nose and ears similar to wearing eyeglasses, and Velcro straps are affixed snugly around the back of the subject's head for security. A magnetic yoke, used to increase the accuracy of the magnetic dials, is mounted on the subject's shoulders and secured with Velcro straps. The cervical rotation meter, located in the transverse plane, operates in conjunction with the magnetic yoke. The CROM also has two other gravity dials; one in the frontal plane to measure lateral flexion and one in the sagittal plane to measure cervical flexion and extension. Two degree increments are marked on the dials for easy visual measuring. The actual CROM device used in the pre-season study was used throughout this study.

Procedure

Pilot Study

A graduate student from the University of North Dakota was the single tester involved in the data collection process. An observer was present during the data collection process to ensure that the gravitational dials which measured lateral flexion and cervical flexion/extension of the CROM device remained at zero during trials. The tester was instructed in the use of the CROM during an evaluation class at the University of North Dakota Physical Therapy School. Before data collection, the tester reviewed a video on the use of the CROM. The tester's prior experience using the CROM device
Fig. 2—Subject wearing a CROM (Cervical Range of Motion) device.
included an approximate 10 total cervical range of motion measurements. These measurements involved five individuals from clinical experience on student affiliations, and five measurements taken on physical therapy classmates.

To determine intratester and intertester reliability, measurements were performed on five junior physical therapy students who volunteered as subject models and who had formerly volunteered in project number IRB-9504-25. Measurements were computed through the SPSSX\textsuperscript{35} program to determine intertester and intratester reliability. Results demonstrated that the tester's intratester ($F=2.0526$, $p=0.1574$, $a=0.9959$) and intertester ($F=0.1134$, $p=0.75$, $a=0.8478$) measurements were very reliable.

**Procedure for Current Study**

Fifteen minute intervals were established for testing each subject. Prior to testing, each subject signed a consent form and completed a questionnaire (Appendix A and C). Each subject was assigned a sequential code number to maintain confidentiality. To eliminate the possibility of tester bias, questionnaires were kept separate from the data collection form (Appendix B) and were not reviewed by the tester until after the completion of data collection. Just before the testing procedure, all participants were restricted from warming up in the pool. Each subject was asked to remove all objects or clothing that would impede their movement or interfere with the experiment (i.e. eyeglasses, sweatshirts, and jackets). The subject was then led into the testing area where an explanation of the procedure was given by the tester (Appendix E).
A horizontal line was set up on the walls of the testing area to help with tracking during range of motion testing. All subjects sat in a standard metal-frame chair. The subject’s spine maintained contact with the back of the chair throughout the experiment to keep an upright position. Their feet were positioned flat on the floor, and their arms relaxed at their sides. Instructions were given to face the front of the room, keep their shoulders parallel to the wall, and to sit up straight when performing rotations of their cervical spine. The magnetic yoke was applied around the subject’s neck with the arrow pointing north. The CROM was placed securely onto the subject’s head.

Each subject was allowed one trial rotation to the right and one to the left. The subject was instructed to “turn your head as far as you can to the right/left without tilting your head, using the tape on the wall for tracking, keep your shoulders parallel to the wall and sit up tall throughout the experiment.” The subject was asked to hold the terminal rotation until they were told to “relax and return to the front.” The procedure took no longer than eight seconds. All dials were monitored for zero position by the observer before each rotation to ensure neutral alignment of the cervical spine in the starting position. Head movement was closely observed to assure movement took place strictly in the horizontal plane and verbal cues were given if adjustment was needed. Following the practice trial, each subject was asked to perform three active physiologic cervical rotations to the right and three to the left. Measurements were recorded for each rotation. After all measurements were recorded, the CROM and yoke were removed and the subject was thanked for their participation.
Data Analysis

The mean value of the three trials for each rotational direction was calculated using a standard calculator and rounded to the nearest tenth. Preseason data collected from #IRB-9504-257 was obtained and the mean values for each trial were recorded on the same data form (Appendix B). Computer software SPSSX\textsuperscript{35} was used to calculate the frequency variables from data obtained through the questionnaires. Furthermore, a related-samples t test for matched pairs was used to determine if a significant difference existed in cervical range of motion between preseason and postseason training measurements. An ANOVA analysis was performed to determine if a significant difference between right and left cervical rotation existed among those with different breathing styles. Post-hoc Tukey and Scheffé tests were performed to determine a significance between the two treatment conditions based on training. A Scheffé test was performed to determine significance between breathing styles. These tests reduced the chance for a Type I error to occur. A p value of <.05 was considered to be significant. Finally, a t-test for independent samples was used to investigate if gender had an effect on range of motion after training. A Levene's test for equality of variance was performed with a p value of <.025.
CHAPTER 3

RESULTS

Subject’s Demographics

Demographics of the subjects were obtained from the questionnaire, and frequency variables were computed utilizing the SPSSX program. Twenty-nine swimmers participated (12 females and 17 males). The mean age was 20.5 years with a standard deviation of 1.6 years. The swimmers reported the number of years they participated in competitive swimming, approximate daily yardage, the number of breaths in freestyle per 25 yards, and the length of their season. They also were asked to indicate if they had experienced any shoulder injury and specify which shoulder or shoulders were involved. The subjects were required to be free of cervical pathology. Pathology was defined as any neck injury requiring medical attention. The mean years of swimming participation was 10.4 years with a standard deviation of 2.9 years. The mean training yardage was 7,190 yards with a standard deviation of 1,937 yards. The average number of breaths per length (25 yards) was six breaths with a standard deviation of 2.0 breaths. The reported mean 1995-96 training season lasted 7.2 months with a standard deviation of 1.3 months. Out of the 29 swimmers, there were 12 bilateral breathers, 14 right unilateral breathers, and 3 left unilateral breathers. Twenty-two swimmers reported that
they did not experience any previous shoulder injury that required medical attention. Five reported injury to both shoulders, and two reported left shoulder injuries.

**Results After Training**

The results of cervical rotation before and after training is summarized in table 2. This table shows the mean values of right rotation, left rotation, and total cervical rotation before and after training. Based on a related-samples t test for matched pairs, there was a significant increase in cervical range of motion for left rotation for the total group (t=2.44, p=0.021). However, no significant effect was found for right cervical rotation (t=0.66, p=0.512) or total rotation (t=2.04, p=0.051).

A comparison of cervical rotation by breathing style was performed to see if breathing style influenced the amount of left and right cervical rotation after training (table 3). Following a oneway ANOVA, no significant increase in total rotation (F=2.791, p=0.080), right rotation (F=2.132, p=0.139), or left rotation (F=1.247, p=0.304) based on breathing style was found. However, our data showed a trend towards increased left cervical rotation by left unilateral breathers which supports literature indicating that breathing style influences cervical rotation.\(^{12}\) An increase in left cervical rotation by left unilateral breathers had a mean of 7.01 degrees and a standard deviation of 5.87 degrees. Increased left rotation by bilateral breathers had a mean of 1.55 degrees and a standard deviation of 6.78 degrees, and increased left rotation by right unilateral
breathers had a mean of 1.55 degrees and a standard deviation of 5.41 degrees. Significance could not be established by breathing style due to the small sample size of bilateral (n=12), right unilateral (n=14), and left unilateral breathers (n=3).

**Results by Gender**

A t-test for independent samples was performed to determine if a difference existed between cervical rotation after training between genders (p<.025)(table 4). No significant difference in the mean cervical range of motion secondary to training was found when comparing the gender of the subjects in right rotation (F=0.574, p=0.455), left rotation (F=0.289, p=0.595), or total rotation (F=0.168, p=0.685). However, our data does support the literature which has concluded that females have greater range of motion than males in cervical range of motion.26,27,33
Table 2.—Comparison of Cervical Rotation: Preseason v. Postseason

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>R Rot</th>
<th>SD*</th>
<th>t</th>
<th>p</th>
<th>L Rot</th>
<th>SD*</th>
<th>t</th>
<th>p</th>
<th>T Rot</th>
<th>SD*</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mean*</td>
<td></td>
<td>t</td>
<td>p</td>
<td>mean*</td>
<td></td>
<td>t</td>
<td>p</td>
<td>mean*</td>
<td></td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>Preseason:</td>
<td>29</td>
<td>69.6</td>
<td>8</td>
<td>.66</td>
<td>.512</td>
<td>72.8</td>
<td>9</td>
<td>2.44</td>
<td>.021</td>
<td>142.4</td>
<td>15</td>
<td>2.04</td>
<td>.051</td>
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<tr>
<td>Postseason:</td>
<td>29</td>
<td>70.4</td>
<td>8</td>
<td></td>
<td></td>
<td>75.2</td>
<td>10</td>
<td></td>
<td></td>
<td>145.6</td>
<td>18</td>
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</table>

R Rot = Right Rotation
L Rot = Left Rotation
T Rot = Total Rotation
*Range of Motion in degrees
## Table 3.—Comparison of cervical rotation by breathing style

<table>
<thead>
<tr>
<th>Breathing Style</th>
<th>n</th>
<th>R Rot mean*</th>
<th>SD*</th>
<th>F</th>
<th>p</th>
<th>L Rot mean*</th>
<th>SD*</th>
<th>F</th>
<th>p</th>
<th>T Rot mean*</th>
<th>SD*</th>
<th>F</th>
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<tr>
<td>Bilateral</td>
<td>12</td>
<td>1.67</td>
<td>5.76</td>
<td>2.132</td>
<td>0.139</td>
<td>4.11</td>
<td>6.78</td>
<td>1.247</td>
<td>0.304</td>
<td>5.78</td>
<td>9.57</td>
<td>2.791</td>
<td>0.080</td>
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<tr>
<td>Right Unilat.</td>
<td>14</td>
<td>-1.50</td>
<td>5.48</td>
<td>1.55</td>
<td>5.41</td>
<td>.06</td>
<td>7.87</td>
<td>.06</td>
<td>7.87</td>
<td>.06</td>
<td>7.87</td>
<td>.06</td>
<td>7.87</td>
</tr>
<tr>
<td>Left Unilat.</td>
<td>3</td>
<td>5.67</td>
<td>9.30</td>
<td>7.01</td>
<td>5.87</td>
<td>12.68</td>
<td>14.52</td>
<td>.06</td>
<td>7.87</td>
<td>.06</td>
<td>7.87</td>
<td>.06</td>
<td>7.87</td>
</tr>
</tbody>
</table>

R Rot = Right Rotation  
L Rot = Left Rotation  
T Rot = Total Rotation  
*Range of motion in degrees
Table 4.—Comparison of cervical rotation by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>n</th>
<th>R Rot mean*</th>
<th>SD*</th>
<th>F</th>
<th>p</th>
<th>L Rot mean*</th>
<th>SD*</th>
<th>F</th>
<th>p</th>
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<td>6.46</td>
<td>.289</td>
<td>.595</td>
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<td>10.55</td>
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<td>.685</td>
</tr>
<tr>
<td>male</td>
<td>17</td>
<td>-.584</td>
<td>5.951</td>
<td></td>
<td></td>
<td>2.279</td>
<td>5.742</td>
<td></td>
<td></td>
<td>1.695</td>
<td>9.077</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R Rot = Right Rotation  
L Rot = Left Rotation  
T Rot = Total Rotation  
*Range of motion in degree
CHAPTER 4

DISCUSSION

The Process

This study compared cervical rotation of swimmers before and after their training season, based on breathing style, and gender. The same CROM device used in experiment number IRB-9504-257 from which pre-season data was obtained, was also used in this experiment to replicate procedures as closely as possible. The CROM device was chosen because it has been found to be a very reliable tool in measuring cervical range of motion.\textsuperscript{18,26,31,32,33}

The Results

The results of this study do not support previous findings that demonstrate specific characteristics of training effects flexibility performance. A study by Guth\textsuperscript{12} compared active cervical rotation in 14 to 17 year old male competitive swimmers to investigate the relationships between breathing patterns and differences in right and left rotation. She found that trained individuals demonstrated greater cervical range of motion compared to the nonswimmer population, and evidence that breathing style during training affected their active cervical range of motion on their breathing side.
The results of this study showed that total rotation was not significantly affected by training for one season. Training did show an increase in left cervical range of motion for the total group, but was not significant enough to effect total rotation. Furthermore, our data showed a trend towards breathing style having an effect on cervical range of motion; rotation to the left increased with left unilateral breathers after training. Significance however, could not be determined due to the small samples of bilateral (n=12), right unilateral (n=14), and left unilateral (n=3) breathers. Additional studies of breathing style and its effect on range of motion would be useful for further investigation on this topic.

This study helped to support previous research findings that females have more range of motion than males\textsuperscript{13,24} (table 4). However, analysis revealed no significant effect on cervical range of motion between genders secondary to training. Therefore, gender as a factor in eliciting the changes in cervical rotation was not considered, and training was speculated as the agent responsible for increases found in cervical rotation.

The self-reported data collected from the participants in this study revealed great variability in reference to the years of competitive training experience, daily yardage, breaths per length, and the span of their season. Each of these factors may have influenced the results. Furthermore, this study may also be limited by other factors that may have an influence on a swimmer's cervical rotation. These factors, which will be discussed, include posture, swimming technique, and fatigue.

Upon visual inspection of body alignment, the tester noted that more than one-half of the participants had “rounded” shoulders and a forward head posture. This posturing
has been found to exert influence on the cervical spine. According to authors, abnormal posturing may increase the risk for progressive overuse problems when describing associated pectoralis minor tightness, thoracic outlet symptoms, and gross scapular instability. Physiologically, Porterfield, and DeRosa state that a relationship between dysfunction of the scapulohumeral region and cervical pain is common among those with forward head posture. According to these authors, if one has a shoulder problem that results in substitution of muscles, the cervical spine tissue may be compromised.

Swimming technique may also play a role in compromising cervical rotation. Many authors have described stroke technique on the basis of body position, leg action, arm action, and breathing. Because the synchronized nature of these components in freestyle determine a swimmer's overall stroke mechanics, it is critical to consider each of these factors that may lead to faulty biomechanics. Body position and mechanics influence a swimmer's body roll, thus ultimately affecting the amount of cervical rotation a swimmer will perform to take a breath of air. In addition to the repetitive nature and specificity of training required, faulty mechanics in swimming have been noted to contribute to several pathologies associated with this sport. According to several authors on proper mechanics of taking a breath of air, the head should roll to breathe at the point of maximum body rotation. A swimmer should not have to lift the head or roll excessively, and good horizontal and vertical alignment of the torso should be practiced (Fig. 3). It is important that the swimmer turn their head to the side by rotating the neck on its longitudinal axis without extending or side bending the head.
Fig. 3—A swimmer using proper breathing mechanics: rotating along his longitudinal axis to take a breath of air (top). Improper mechanics of freestyle breathing: swimmer extending and rotating his cervical spine (bottom).
Numerous studies have shown that improper stroke mechanics predispose swimmers to mechanical impingement and micro trauma of the shoulder\textsuperscript{3,4,5,6,7,19,21,39,40,41} and cervical spine.\textsuperscript{12,20} Ross\textsuperscript{42} has described the aggravation of existing cervical abnormalities caused by the rotation and hyperextension of the cervical spine during swimming as “swimmer’s neck.” He devised a simple preventative measure for this condition which involves swimmers using a mask and snorkel to eliminate the rotation at the neck by keeping it in a neutral position to alleviate further aggravation of cervical abnormalities. Furthermore, Dr. Jan Prins, Co-Director of the Aquatic Research Laboratory of the University of Hawaii, and Senior Staff at Prins Aquatherapy has identified, by underwater video analysis, improper body alignment during swimming. According to Prins, faulty mechanics that result in excessive neck and back extension, may exacerbate pathological conditions.\textsuperscript{43,44} For example, when rehabilitating neck, shoulder, and upper quadrant injuries, movements can actually increase shear and torsional forces on the spine that may aggravate a spine condition. Thus, Prins’ aquatic rehabilitative exercises carefully monitor a patient’s applied muscle forces and movements in the water through underwater observation. The two authors above conclude that there is a significant influence of technique on the freestyle breathing pattern that influences proper mechanics.

Finally, fatigue will cause a swimmer to change their stroke during the course of training which results in faulty mechanics.\textsuperscript{3,6} Fatigue will also force a swimmer to increase the number of breaths per length as their oxygen demand is increased, causing increased stress to the spine during long training sessions.
CHAPTER 5
CONCLUSION

The results of this study showed a significant increase in left cervical rotation after training. Total cervical rotation and right cervical rotation did increase, but were not found to be significant. Due to the small sample size of bilateral, right unilateral, and left unilateral breathers, the significance of breathing style on cervical rotation could not be established. However, trends of increased left rotation in left unilateral breathers was found, supporting past findings that breathing style has an effect on cervical range of motion to the breathing side. Our data also supported studies which established that cervical range of motion in females is greater than males. However, no significant differences secondary to training was found between genders in cervical range of motion, so training was noted as the agent responsible for increases in cervical range of motion.

This study revealed that freestyle swim training increases cervical rotation, and established data on active cervical range of motion for freestyle swimmers in collegiate unilateral and bilateral breathers. The study was conducted to further develop normative values for cervical range of motion in individuals who participate in swimming at the collegiate level. These values would benefit the clinician who is specifically assessing the swimming athlete of collegiate caliber.
Factors that should be taken into consideration when measuring the range of motion in the clinic include: the type of device used in measuring, age, gender, and the activities in which a patient is involved. Measuring data against appropriated normative values will allow the clinician accuracy when determining status of a patient, developing treatment plans, evaluating treatment effectiveness, and patient progress. Moreover, a clinician who works with an athlete should investigate the mechanics, intensity, and duration of training to which an athlete is exposed in terms of musculoskeletal stressors inherent to their sport. Understanding mechanisms for overuse injury indigenous to particular sports will also signal clinicians to possible increases in susceptibility to injury at certain joints. For the swimming athlete, a detailed history would include documentation of stressors applied to the cervical neck due to the repetitive nature of the breathing pattern, the forces generated through the spine, and typical training intensities to which collegiate swimmers are subject. Using normative data established from this study will allow for accurate assessments of cervical range of motion, realistic goal setting, and development of appropriate treatment specific to the swimmer. Thus, accurate baseline data, in-depth history, and understanding mechanisms of overuse injury, will allow for better patient care of an athlete as determined by providing accurate assessment and proper treatment.

This study illustrates a need for future research. Possible future studies include comparing these collegiate swimmers to other NCAA Division II swimmers in order to increase the sample size. Comparing other swimmer populations (i.e. age-group swimmers who are 18 years and younger, and master swimmer’s over the age of 25), to
provide more extensive information on the nature of the musculoskeletal changes that occur with effects of training intensity, duration, and age. Finally, combining electromyography (EMG) with underwater cinematography to analyze the extent of influence that technique, fatigue, body roll, and breathing mechanics have on cervical range of motion would be a valuable project as well.
Appendix A
Subject's questionnaire

Name: ___________________________ Code Number: ______________

Age: ______
Sex: M _____ F _____
Height: ______
Weight: ______
Hand Dominance: ______

Type of freestyle breather: (please check appropriately)
Bilateral _____ Unilateral breather-Right _____ Unilateral breather-Left _____

How many years have you been competitively swimming? ________________
How many months do you swim per year? ____________________________
What is your approximate daily yardage? ____________________________
How many breathes per length (25 yards) do you breathe? _________
How Long did your 1995-96 season last (months)? _______________________

Did you train the entire season? YES _____ NO ______
If not, how long did you sit out (give dates)? _________________________

Have you had any cervical pathology since September 1995? YES _____ NO ______
(Pathology is defined as any neck injury requiring medical attention)

Any previous incident of shoulder pathology? YES _____ NO ______
(pathology is defined as any shoulder problem requiring medical attention)
If yes, which shoulder: RIGHT _____ LEFT _____ BOTH ______

THANK YOU FOR PARTICIPATING IN THIS RESEARCH STUDY.
Appendix B  
Cervical Range of Motion

Subject's Code Number: 

Pre-season measurements:

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Right</th>
<th>Left</th>
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<tbody>
<tr>
<td>Trial 1</td>
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<td></td>
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<tr>
<td>Trial 2</td>
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<tr>
<td>Trial 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post-season measurements:

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
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<tr>
<td>Trial 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C
INFORMATION AND CONSENT FORM

Title: The Effect of Training on Cervical Range of Motion between Unilateral and Bilateral breathers in Collegiate Freestyle Swimmers.

You are being invited to participate in a study conducted by Anjanette Wong, a student in the Master of Physical Therapy Program at the University of North Dakota. The purpose of this study is to measure the change of cervical range of motion in your neck post-season, to see if training has an effect on your neck motion based on your type of breathing style during freestyle swimming. Only subjects without a history of neck pathology will be asked to participate in this study. Pathology is defined as any neck injury requiring medical attention.

I anticipate that the experimental session will last about half an hour total. You will be asked to report to the Hyslop Swimming Pool at the University of North Dakota at an assigned time. You will be asked to complete a questionnaire and then will be instructed on the process of performing cervical rotation. I will be measuring the amount of movement that will occur at your neck.

Any information that is obtained through this study that can identify you will be kept confidential and will be disclosed only with your permission.

Your decision whether or not to participate will not prejudice your future relations with the Physical Therapy Department of the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

There is always some degree of risk involved when participating in an experimental procedure. However, the investigator in this study feels that the risk of injury is minimal.

The investigator involved is available to answer any questions that 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 Anjanette Wong at 777-8524. A copy of this consent form is available to all participants in this study.

In the event that this research activity results in 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 such treatment must be provided by you and your third party payor, if any.

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

Participant’s Signature ___________________________ Date ___________________________

Witness Signature (not the scientist) ___________________________ Date ___________________________
Appendix D

EXPEDITED REVIEW REQUESTED UNDER ITEM ___ (NUMBERS) OF HAS REGULATIONS
__ EXEMPT REVIEW REQUESTED UNDER ITEM ___ (NUMBERS) OF HAS REGULATIONS

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

PRINCIPAL INVESTIGATOR: Anjette Wong
TELEPHONE: 777-8521 DATE: 2/2/96

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: P.O. box 9037 University of North Dakota

SCHOOL/COLLEGE: Medicine DEPARTMENT: Physical Therapy PROPOSED PROJECT DATES: 2/96-2/97

PROJECT TITLE: The Effect of Training on Cervical Range of Motion Between Unilateral and Bilateral Bathers in Collegiate Freestyle Swimmers

FUNDING AGENCIES (IF APPLICABLE): ________________________________

TYPE OF PROJECT:
__ NEW PROJECT _X CONTINUATION ___ RENEWAL __ THESIS RESEARCH __ STUDENT RESEARCH PROJECT
__ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Sue Jeno MA, PT

PROPOSED PROJECT: _ IN VolVES A COOPERATING INSTITUTION
__ INVOLVES NEW DRUGS (UND) ___ INVOLVES NON-APPROVED USE OF DRUG _X INSTITUTION

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 _X UND STUDENTS (>18 YEARS)

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

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

During a competitive season, swimmers are engaged in high levels of training. More than half the workout, regardless of the swimmer's specialty stroke, involves freestyle swimming. The mechanics of the freestyle stroke requires the repetitive sport specific movement of cervical rotation to take a breath of air. The swimmer has the option of breathing unilaterally or bilaterally. Unilateral breathers take their breath on either their left or right side, and bilateral breathers breathe to the right side and left side alternately. Collegiate caliber swimming often involves mileage of 8,000 yards per day, six days per week, for seven months. The average swimmer may take eight breaths per twenty five yards or 18 breaths per fifty meters.

The purpose of this study is to measure the effect of training on cervical range of motion between unilateral and bilateral breathers in collegiate freestyle swimmers. The data collected in this study will be measured against pre-season cervical range of motion data collected from project # IRB 9504-257. The information will be valuable in clinical practice when determining range of motion for those participating in swimming and whose measurements may differ from the non-swimmer population. To date, there has been little research on the investigation of the effects of training on the cervical range of motion of swimmer's. Because this research is specific to the use of swimmers, it is necessary to use human subjects.
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:
The sample will consist of 44 University of North Dakota Varsity Men's and Women's Swim Team members. Participants will be of ages 18-25 years, with no history of cervical pathology, and who have participated in project IRB #9504-257. The subjects will be voluntarily recruited.

INSTRUMENT:
A CROM (cervical range of motion) device will be used to measure the cervical range. The CROM is made of light weight plastic. It will be placed on the subjects head, and fastened securely on the nose and ears. A magnetic plane meter measures rotational movement in combination with a magnetic yoke which is securely placed on the subjects shoulders. Both the CROM and the Magnetic yoke are aligned appropriately and secured with velcro straps.

The reliability of the CROM has been tested by Capuano-Pucci, D., Rheault, W., Aukai, J., et. al. Their results showed that there was no significant difference between testers (intratester) and sessions (intratester).

METHOD:
A consent form will be signed by the subjects (see Appendix C). Verbal instructions will be given concerning the purpose and procedure of the experiment. The subjects are familiar with the data collection process because it is identical to the pre-season data collection procedure. The subjects will be given a demographic questionnaire (see Appendix A). After completing the questionnaire, the subject will then be directed to the testing area.

Before entering the testing area, the subjects will be asked to remove jewelry and clothing that may interfere with the experiment. The testing area will consist of a straight back chair facing a wall. A horizontal line will be placed on the wall in front, to the left, and to the right of the subject to ease tracking for the subject. The subjects will be instructed to follow this line when performing the cervical rotations.

The subject will be positioned in the straight chair facing 90 degrees to magnetic north, with their feet flat on the floor, arms relaxed at their sides, and eyes straight ahead. The CROM device will be positioned on the bridge of their nose and over their ears, and will be fastened to the subject's head by velcro straps. The magnetic yoke will be applied to the subject's shoulder's with velcro, and a compass goniometer needed to measure the range of motion will be used.

The subject will be instructed by the tester on the active physiological cervical rotation movement. This will be followed by a warm up period consisting of one (1) repetition of cervical rotation to the right, and one (1) repetition of cervical rotation to the left. Data collection will include three (3) trials to the left and three (3) trials to the right. The measurements will be recorded to the nearest degree. The recordings will be recorded on the pre-printed data form (see Appendix B).

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

The results on this study will establish research data on the effects of training on cervical range of motion for swimmers. It will be valuable to evaluating therapists when determining if pathology exists, by presenting normative data for the swimming population which differs from the non-swimming population. To date, there is little information on the effects of training on cervical range of motion for swimmers. Therefore, this research will add to the understanding of the effects of training has on a swimmer’s neck based on the measurements of cervical rotation.

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 psychological, 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 risk to the subjects in this experiment will be minimal. The CROM device is an assessment tool used routinely in physical therapy clinics for measuring cervical range of motion. The movement performed by the subjects will be within the normal range of motion for the cervical spine and should not cause any discomfort to the neck.

The data will be collected in a confidential manner, and the collected data will be kept confidential. The subjects will be assigned a code number and names will be withheld to ensure confidentiality.
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.

The consent forms will be kept by Sue Jeno in the Department of Physical Therapy, Medical Science North, Room 151, for a period of two (2) years. (See Appendix C).

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  
Box 8138, University Station  
Grand Forks, North Dakota  58202  

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 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:

_________________________  DATE: ____________________
Principal Investigator

_________________________  DATE: ____________________
Project Director or Student Adviser

_________________________  DATE: ____________________
Training or Center Grant Director
DATE: February 12, 1996 PROJECT NUMBER: IRB-9602-0149

NAME: Anjanette Wong DEPARTMENT/COLLEGE: Physical Therapy

PROJECT TITLE: The Effect of Training on Cervical Range of Motion Between Unilateral and Bilateral Breathers in Collegiate Freestyle Swimmers

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on February 15, 1996 and the following action was taken:

☐ Project approved. EXPEDITED REVIEW NO. ___.
Next scheduled review is on ____________________________ __

☐ Project approved. EXEMPT CATEGORY NO. 3. No periodic review scheduled unless so stated in REMARKS SECTION.

☐ Project approved PENDING receipt of corrections/additions in ORPD and approval by the IRB. This study may NOT be started UNTIL IRB approval has been received. (See REMARKS SECTION for further information.)

☐ Project approval deferred. This study may not be started until 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 Chairman or ORPD.

cc: S. Jeno, Adviser
Dean, Medical School

Signature of Chairperson or 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 596 Form may be required. Contact ORPD to obtain the required documents. (7/93)
Appendix E

Testing Procedure:

• “This is a consent form which you must read, sign, date, and have a witness sign and date.”
• “If you have any questions during the experiment, don’t hesitate to ask.”
• “Please complete this questionnaire to the best of your knowledge. All data collected during this experiment will remain confidential.”
• The subject is taken to the testing area.
• “Please remove jewelry, glasses, and clothing that might interfere with the experiment.”
• “Please sit up straight in this chair. Your feet must be flat on the floor, arms relaxed to your side, and eyes fixed straight ahead.”
• “Use the horizontal line on the wall to guide your tracking and keep your shoulders parallel to the wall during the entire procedure.”
• Application of the magnetic yoke and CROM instrument.
• Subjects given a verbal description of the yoke and CROM.
• “This is a CROM instrument which I will be using to measure your neck range of motion. The device is made of plastic and will be place on your head similarly to a pair of glasses. Velcro straps will be used to secure it to your head. The magnetic yoke around your shoulders will help the compass to measure your neck range of motion more accurately.”
• “You will complete one trial to the right and one to the left. Now turn your head to the right as far as you can without tilting your head and keeping your shoulders parallel to the wall. Please use the horizontal line as a guide for tracking.”
• “Now relax, you may return to the front. Now turn your head to the left as far as you can go, and hold. Relax, and return to the front.”
• “Now the testing will begin. You will have three trials to the right and three to the left.”
• Dials are zeroed before each measurement taken.
• TEST
• Record measurements
• “The experiment has ended, do you have any questions?”
• “Thank you for participating in my experiment.”
Anjanette Wong  
3216 Collins st.  
Honolulu, Hi. 96815  
July 22, 1996

Permission Editor  
Allyn and Bacon  
Paramount Publishing Group  
160 Gould St.  
Needham Heights, Ma. 02194-2310

Dear Permissions Editor,

I would like to request permission to reprint Fig. 11-25: "Sequence of the Crawl Stroke" from Counsilman, JE, The Science of Swimming, copyrighted 1968.

My independent study is entitled "The Effects of Training on Cervical Range of Motion Between Unilateral Breathers and Bilateral Breathers in Collegiate Swimmers During Freestyle Swimming." This study will be submitted to the graduate faculty of the Department of Physical Therapy School of Medicine at the University of North Dakota in partial fulfillment of the requirements for the degree of Master of Physical Therapy.

If there are any questions, please do not hesitate to contact myself or the Department of Physical Therapy at the University of North Dakota: c/o Sue Jenno; Department of Physical Therapy School of Medicine; University of North Dakota; Grand Forks, ND 58203.

Sincerely,

Anjanette Wong
Consent for Taking and Publication of Photographs

Name: Tom Lileikis  Place: University of North Dakota- Physical Therapy Department  Date: 9/7/96

In connection with Anjanette C. Wong’s independent study project entitled, The Effect of Training on Cervical Range of Motion Between Unilateral and Bilateral Breathers in Collegiate Freestyle Swimmers, 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, Anjanette C. Wong deems that medical research, education, or science will be benefited by their use. Such photographs may be published and 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, Anjanette C. Wong may consider desirable.

Signed

Tom Lileikis

Witness
Consent for Taking and Publication of Photographs

Name: Laura Habermann  Place: University of North Dakota- Physical Therapy Department  Date: 10/14/96

In connection with Anjanette C. Wong's independent study project entitled, The Effect of Training on Cervical Range of Motion Between Unilateral and Bilateral Breathers in Collegiate Freestyle Swimmers, 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, Anjanette C. Wong deems that medical research, education, or science will be benefited by their use. Such photographs may be published and 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, Anjanette C. Wong may consider desirable.

Signed

Laura Habermann

Witness

Amy Schneider


34. Performance Attainment Associates, 958 Lydia Dr., Roseville, MN 55113.


44. Prins J. Prins Aquatherapy. Video presented at the 1995 Mended Hearts meeting October 19, 1995; Honolulu, Hi.