AN ABSTRACT OF THE THESIS OF

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Title: A COMPARATIVE STUDY OF A TRADITIONAL ISOMETRIC CONDITIONING PROGRAM VERSUS A WEIGHTED HELMET CONDITIONING PROGRAM ON CERVICAL STRENGTH

Abstract approved: Ronald L. Slaymaker

Statement of the Problem

The problems of this investigation were to determine: (1) whether or not there is any difference in cervical strength when an isometric program is used in comparison with a weighted helmet conditioning program, and (2) whether or not within the weighted helmet conditioning program, three sets of three repetitions at 90% of maximum weight versus three sets of ten repetitions at 50% of maximum weight produce any significant difference in cervical strength gain criteria in the ranges of movement of flexion and extension.

Summary of Procedure

The test and retest method and a comparison of pre- and post-test were used in this study. Training programs consisted of one group performing isometric exercises and

two groups performing two different isotonic training methods. The duration of the program was six weeks, with sessions each Monday, Wednesday and Friday.

## Review of Conclusions

1. Isotonic exercise remains superior to isometric exercise for increasing strength.

2. A high resistance-low repetition conditioning program is more efficient than a low resistance-high repetition conditioning program in increasing cervical (neck) strength in the range of movement of extension.

# A COMPARATIVE STUDY OF A TRADITIONAL ISOMETRIC CONDITIONING PROGRAM VERSUS A WEIGHTED HELMET CONDITIONING PROGRAM ON CERVICAL STRENGTH

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A Thesis

Presented to

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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## Chapter 1

## INTRODUCTION TO THE PROBLEM

Athletics of present times finds that athletes are becoming bigger, faster and more skilled. With these factors being equal, the stronger and more well-conditioned athlete proves to be the most successful. Strength is becoming the factor that distinguishes the successful athletic achiever.

Today the athletic achiever, steeped in competition, works continually at improving his ability, his performance, that "edge" with which to dominate his opponent.

> In today's competitive atmosphere of big-time sports, there is a constant battle to improve the abilities of the competitors. To improve strength, speed, endurance and agility, new methods of conditioning had to be devised. Systematic weight training, along with advanced coaching techniques, equipment and nutrition are the most important improvements. The one area that really stands out as the leader is systematic weight training.[1]

In recent years authorities and consultants in the area of strength training have been used by professional athletic organizations. Strength coaches have been hired by professional organizations as well as by colleges for their athletic programs. On February 6, 1979, for example, Wichita

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[1]Patera, Ken, Weight Training Systematized, foreword, Bjornaraa, Bud S. (Stillwater: Croixdale Press, 1975), foreword.

State University announced the hiring of an assistant coach in charge of linebackers and strength. This seems to affirm that strength is an important trend in football today.

In 1977, a National Strength Coaches Association was formed in order to help coaches compare methods and types of conditioning programs for various sports.

Within the past ten years strength training has developed from more than just lifting weights for brute strength, to training for improving performance, stabilizing joints and for prevention of injuries. Prevention of injuries has been and still remains a major consideration in coaching. This is emphasized by the many courses in prevention and care of athletic injuries offered by colleges and universities across the nation.

> Control of cervical (neck) injury requires a careful appraisal of every football candidate. If he is thin, poorly developed, has a long neck, and observation of his performance reveals only a minimal coordination, he should be discouraged from further play. Build-up of the cervical (neck) musculature should be an integral part of a football conditioning program.[2]

It becomes necessary for coaches to be aware of the causes of injuries, treatment of such, and preventive measures which can be taken. Weight training for strength improvement is among beneficial injury preventive methods.

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[2]Hirata, Isao Jr. M. D., The Doctor and the Athlete (New York: J. B. Lippincott Co., 1979), pp. 130-31.

Football players should strength train at least twice a week. A large and strong neck can often prevent crippling injuries or even death. Since 1932, more than 676 athletes have died of football head and neck injuries.[3]

In Sports Conditioning and Weight Training by Stone and Kroll, there is an entire chapter given to strength training for football at the junior high school, high school, college and professional levels, yet there is not one neck conditioning program.[4] Focus on neck musculature and strength development of the neck have been sorely lacking in athletic strength training.

The previous references point out the need for strengthening the neck, and the fact that in such a thorough football conditioning program as Stone and Kroll's[5] there is no mention of conditioning the neck, indicate the contradictory problems facing the coach today. One source indicates the importance of increasing cervical (neck) strength, while another leaves the cervical area out of its conditioning program entirely. Therefore, coaches must make their own decisions regarding methods for neck strengthening.

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[3]Darden, Ellington, PhD., Conditioning for Football (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1979), p. 14.

[4]Stone, Wm. J. and Wm. A. Kroll, Sports Conditioning and Weight Training (Boston: Allyn and Bacon, 1978), pp. 135-56.

[5]Ibid.

In searching for methods to increase cervical strength many coaches vary their training methods from year to year, depending upon what the latest athletic journal is pushing that year. With legal actions pending against coaches and schools when athletes become injured or have died because of a neck injury, the coach should take all precautions to prevent this type of accident: from teaching proper technique to increasing strength.

This researcher is interested in two forms of neck conditioning programs: a traditional isometric conditioning program versus a weighted helmet conditioning program. Further, in the weighted helmet groups, the researcher is interested in which of two procedures (three sets of three repetitions or three sets of ten repetitions) is the most efficient way to increase cervical (neck) strength.

Weight used for the helmeted conditioning program will be 90% of maximum for three sets of three repetitions, and 50% of maximum for the three sets of ten repetitions exercises. Maximum weight will be determined by the amount of weight that can be handled for one repetition.

## Purpose

The purposes of this study were: (1) to compare a traditional isometric conditioning program versus a weighted helmet conditioning program on cervical (neck) strength gain criteria, and (2) to compare within the weighted helmet conditioning program, a three sets of ten repetition conditioning program versus a three sets of three repetition conditioning program on cervical (neck) strength gain criteria.

Problem

The problems of this investigation were to determine: (1) whether or not there is any difference in cervical (neck) strength when an isometric program is used in comparison with a weighted helmet conditioning program, and (2) whether or not within the weighted helmet conditioning program, three sets of three repetitions at 90% of maximum weight versus three sets of ten repetitions at 50% of maximum weight produce any significant difference in cervical (neck) strength in the ranges of movement of flexion and extension.

Null Hypotheses

There is no significant difference in cervical (neck) strength using a traditional isometric conditioning program versus a weighted helmet with three sets of three and three sets of ten repetitions in the range of movement of flexion.

There is no significant difference in cervical (neck) strength using a traditional isometric conditioning program versus a weighted helmet conditioning program with three sets of three and three sets of ten repetitions in the range of movement of extension.

There is no significant difference in cervical (neck) strength using a three sets of three repetitions weight training program with 90% of maximum weight versus a three sets of ten repetitions weight training program with 50% of maximum weight in the range of movement of flexion.

There is no significant difference in cervical (neck) strength using a three sets of three repetitions weight training program with 90% of maximum weight versus a three sets of ten repetitions weight training program with 50% of maximum weight in the range of movement of extension.

## Assumptions

1. There is a need for an increase in cervical (neck) strength for football players.

2. Each subject had the same advantage in making progress.

3. The subjects did not undertake additional conditioning programs.

4. The method of dividing the groups and the type of off-season weight training program will not affect cervical strength.

## Definitions

Cervical. Cervical refers to the top region of the spinal column consisting of seven cervical vertebrae.

Dynamometer. A dynamometer is an apparatus for measuring the force of a muscle contraction.

Extension. Extension is straightening or stretching out, increasing the angle between the parts of the body.

Flexion. Flexion is bending or decreasing the angle between the parts of the body.

Free Weights. Free weights are bar bells and dumbbells used for exercise.

Isokinetic. Isokinetic is similar to isotonic contraction except that isokinetic has only a one way resistance.

Isometric. Isometric is a muscle contraction with no changing of the joint angles.

Isotonic. Isotonic is a muscle contraction involving movement and a changing of joint angles.

Percent of Maximum Weight. Percent of maximum weight is the percent of the amount of weight that can be moved for one repetition.

Repetition. A repetition is the completion of one entire cycle of an exercise.

Set. A set is the completion of one "turn or bout." It can also be defined as a consecutive series of repetitions.

Strength. Strength is the capacity to exert force; the ability to do work against resistance.

Weighted Helmet. A weighted helmet is a football helmet with a dumbbell bar attached to the center, top of the helmet.

Weight Lifting. Weight lifting is the athletic exercise or competitive sport of lifting disk-shaped metal weights balanced on either end of a long bar.

Weight Training. Weight training is a system in which a series of progressive resistance exercises are used on the body for muscle strength development.

## Limitations

The limitations of this study were:

1. It was not possible to control the previous experience of the subjects in regard to strength training.

2. The sample size was limited to the number of participants in spring football at Emporia State University.

3. The study was limited by the lack of a specific device for testing cervical (neck) strength.

## Delimitations

The delimitations of this study were:

1. Subjects of this study included the total number of football players at Emporia State University participating in the spring, 1979 conditioning program.

2. The weight on the helmet rested flush on the top of the helmet, thereby reducing the angle of resistance in the ranges of motion.

3. The subjects in the weighted helmet groups were instructed to sit in a straight-back chair while performing the exercises, to further control the study.

4. The study was limited to the use of a weighted helmet and isometric conditioning programs.

5. The duration of the study was limited to six weeks.

6. The study was limited to two movements: flexion and extension.

7. This study compared only isometric versus traditional conditioning programs.

8. This study did not contain a control group.

9. Women were not included in this study, as they do not participate in football at Emporia State University.

## Method

The method of this study was the test and re-test type. The device used for testing strength was a dynamometer. Each subject was given one trial in flexion and one trial in extension to determine his maximum strength.

The training program was conducted during spring football, spring semester, 1979, on Mondays, Wednesdays and Fridays. All groups participated in the neck exercises immediately following practice.

The subjects were first divided into two groups: offensive and defensive players. They were later divided into two additional groups: those who could bench 225 pounds went to the free weight room; those who could not went to the universal gym weight room.

The researcher chose to use the 225 bench group in the weighted helmet conditioning program because they were already working with free weights. The group working with the universal gym performed the isometric conditioning program. Each group consisted of fifteen members.

The weighted helmet groups took part in two different programs. Program I consisted of three sets of three repetitions using 90% of maximum weight the individual was able to lift for one repetition. Program II consisted of three sets of ten repetitions at 50% of maximum weight the individual was able to lift for one repetition.

The weight was increased throughout the conditioning program at five pound intervals. When the participant in the three sets of three repetitions program was able to complete five repetitions in the last set, he increased the weight by five pounds. In the three sets of ten repetitions program, when the participant was able to do twelve repetitions on the last set, he also increased the weight by five pounds.

The isometric group performed one set of one repetition for a ten second count.

The movement for all three groups was flexion and extension of the cervical (neck) area. There were no lateral or rotation movements.

Each group trained out of sight of the other groups. In addition, each group was also instructed not to do any further neck exercises other than those prescribed for them.

The subjects were post-tested at the end of the six week conditioning program using the same method as the pre-test.

## Chapter 2

## REVIEW OF RELATED LITERATURE

### Introduction

By definition, weight lifting is the athletic exercise or competitive sport of lifting disk-shaped metal weights balanced on either end of a long bar. While weight lifting has a long heritage in the United States, weight training, using weights to develop strength and endurance, is a fairly recent development. Weight training began in 1888 through the efforts of Father Bill Curtis who was one of the founders of the AAU.

> He did much to organize and promote weight training. He was one of the first to use a system of training to enhance health and strength, rather than just attempt more and more (poundage) in a particular lift.[6]

At that time it was common practice to increase poundage as much as possible to achieve a maximum weight that a man was capable of lifting. Father Curtis modified this approach by performing more sets and more repetitions in order to increase strength and endurance.

From 1888 to 1960 the only recognized form of weight lifting was Olympic lifting, performed for the purpose of

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[6]Hoffman, Bob, "A Century of American Weightlifting" _Strength and Health_ (June-July, 1976), p. 35.

competitively achieving maximum lifts, rather than for increasing strength or endurance. Internationally recognized, Olympic weight lifting included two lifts: the clean and jerk, and the snatch, both of which involved skill and coordination in addition to the actual lifting of the weight. Only a very few athletes engaged in Olympic weight lifting; the chief competitors being weight lifters who participated for the sport itself. In addition, a few football players and wrestlers shared this interest, but did not employ weight lifting to improve their athletic skill.

Power lifting, which began in 1960, has as its purpose to lift weights solely for greater poundage and for increasing strength, rather than for athletic skill. Having originated in America, power lifting included three lifts: the bench press, the squat, and the dead lift, all of which involved pure power rather than skill or coordination to lift the specified weight.

Weight training for the purpose of increasing athletic skill is still in the developing process. It was only as recently as 1977 that the National Strength Coaches Association came into existence. Prior to this, there were numerous approaches to weight training for the purpose of increasing athletic skill, each based on personal experience. The National Strength Coaches Association promotes the use of weight training for athletes in all sports.

In training for the purpose of increasing athletic skill, routines have varied depending upon the desired result. Using weights at less than the maximum, and increasing the number of sets and repetitions, have proven to increase endurance, a trait necessary in any activity where muscular contraction is carried on for a length of time, such as wrestling or swimming. Explosive leg power, essential in football linemen, has been achieved by a routine of using heavy weights at a low number of sets and repetitions.

In other words, weight training programs have produced various effects upon athletes depending upon the type of program or routine employed. And only recently have coaches utilized the new-found knowledge by adapting it to best suit the needs of their athletes.

## Approaches

Over the years, due to a lack of formulated knowledge concerning weight lifting, coaches employed whatever techniques were currently in vogue, ranging from no-training to over-training. Gradually, two major techniques evolved: isometrics and isotonics.

Isometric exercises have been defined as muscular contractions with no changing of the joint angles. Isotonic exercises have been defined as muscular contractions involving movement and a changing of joint angles.

Isometrics

Hetlinger and Mueller, of Germany, pioneered some of the early research regarding muscle physiology. Their research,

> which formed the basis for the current popularity of isometrics, indicated that the threshold value of the resistance necessary to bring about (strength) gains is approximately one-third the maximal contraction strength of the muscle under consideration. It was their opinion that the training stimulus for strength gain was the occurrence of an oxygen deficit in the tissue involved.[7]

They advocated one daily six-second isometric contraction against two-thirds of an individual's maximum contraction strength. When this type of training program was performed five times a week, the rate of strength gain averaged five percent per week. Using this routine, they found that strength in various muscles increased from 33 to 181 percent.

"Isometric exercise has been found to result in strength gains, but the amount of this gain may not be predictable," according to David H. Clark.[8] He pointed out that the amount of tension applied might vary from 50% to maximum, while the duration of the contraction might be five seconds, given as frequently as one contraction per day, or

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[7] Clarke, H. Harrison, Muscular Strength and Endurance in Man (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1966), p. 157.

[8] Clark, David H., "Adaptations in Strength and Muscular Endurance Resulting from Exercise" Exercise and Sport Science Reviews, 1 (1973), p. 176.

in various combinations. In essence, Clark felt that the amount of strength gain could vary considerably from one individual to another depending upon the amount of tension and the duration and frequency of the contractions, which therefore, made the outcome difficult to predict.

Isometric exercise programs have been known for their advantages in time spent and the amount of equipment necessary. When only one contraction per day was used, or even a few more than just the single contraction recommended by proponents, great savings in time were possible.

In addition, the equipment needed was able to be reduced to only a few pieces of apparatus already found in the gym or on the practice field. By eliminating the need for more equipment, it was discovered that it was possible to work out large groups in shorter periods of time.

## Isotonics

Isotonic exercise employed resistance, repetitions and a specified number of sets for the purpose of strength gain. By varying the amount of resistance, repetitions, or the number of sets, many combinations were made possible, and therefore isotonic exercise programs have been numerous.

The classic research of DeLorne and Watkins recommended the following program:

1 set of ten repetitions at 1/2 of maximum weight

1 set of ten repetitions at 3/4 of maximum weight

1 set of ten repetitions at maximum weight[9]

DeLorne found a clear distinction between the relationship of repetition to resistance. He learned that "low repetition-high resistance exercises produce power, whereas high repetition-low resistance exercises result in endurance."[10] He claimed that each type of routine was mutually exclusive, and therefore incapable of producing both results.

The effectiveness of DeLorne and Watkins' program has been supported by other investigators. However, investigations of the value of varying the number of repetitions indicated that fewer repetitions, for example four, five or six may be even more effective.

Berger's studies, for example, have shown that maximal results in terms of strength gains are achieved by between four and eight repetitions.[11]

In another study, however, O'Shea compared the use of two to three repetitions, five to six repetitions, and

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[9] deVries, Herbert A., Physiology of Exercise, Second Edition (New York: Wm. C. Brown Company, 1974), p. 87.

[10] Clark, David H., "Adaptations in Strength and Muscular Endurance Resulting from Exercise" Exercise and Sport Science Reviews, 1 (1973), p. 153.

[11] deVries, Herbert A., Physiology of Exercise, Second Edition (New York: Wm. C. Brown Company, 1974), p. 104.

nine to ten repetitions, all at maximum weight.[12] In this study thirty students participated for six weeks in a program for developing leg strength. Group A performed three sets of from nine to ten repetitions. Group B performed three sets of from five to six repetitions. Group C performed three sets of from two to three repetitions. O'Shea found no significant difference between the three systems of training, as all of them resulted in the improvement of static and dynamic strength.

In comparing isometric and isotonic methods, deVries found that both

> have been shown to bring about significant gains in strength in short periods of time, but in investigations where direct comparisons have been made the difference, although not large, favors the isotonic method.[13]

deVries stated that

> the greatest advantage in isotonic methods is that strength gains are specific to the angle at which the resistance is encountered. Thus, isotonic exercise can be designed to work the entire range of motion in one contraction, but several contractions would be needed at different angles to work the whole range of motion with isometric exercises.[14]

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[12] O'Shea, Patrick, "Effects of Selected Weight Training Programs on the Development of Strength and Muscle Hypertrophy" Research Quarterly 37:1, March, 1966, p. 52.

[13] deVries, Herbert A., Physiology of Exercise, Second Edition (New York: Wm. C. Brown Company, 1974), p. 123.

[14] deVries, Herbert A., Physiology of Exercise, Second Edition (New York: Wm. C. Brown Company, 1974), p. 125.

In other words, isotonic exercise works the muscle through an entire range of joint motion. Isometric exercise requires several contractions throughout the range of motion to achieve similar effects. Therefore, isotonic exercise appears to be more efficient in terms of performance and time spent.

Neck Musculature and Development Programs

As Arthur Jones points out, until only recently there have been no practical methods of development for the neck musculature. Yet he states, "the muscles of the neck and shoulders are perhaps the easiest muscles in the body to develop . . . when they are provided with direct exercise."[15] The problem has been that since these direct exercises have in the past been difficult to perform and often dangerous, they have therefore been ignored, leaving the neck extremely vulnerable to injury.

> The muscles of the neck are capable of producing movement in seven different directions: 1) elevation of the shoulders (shrugging), 2) flexion of the neck (moving the head down towards the chest), 3) extension of the neck (moving the head to the rear), 4) lateral contraction of the neck to the right (moving the head down to the right shoulder), 5) lateral contraction of the neck to the left, 6) rotation of the head to the right (moving the head to look over the right shoulder),

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[15] Jones, Arthur A., _A New Approach . . . to the Problems of Neck Injuries in Sports_ (DeLand, Florida: Nautilus Sports/Medical Industries, 1977), p. 2.

7) rotation of the head to the left.[16]

Jones advocates direct, full range exercise for each of these neck functions in order to provide the greatest possible protection to the neck.

> When such exercise is properly provided, the response of the neck muscles is immediate; probably because the muscles of the neck are exposed to so little in the way of hard work during the course of normal living, these muscles respond to exercise very rapidly.[17]

Jones uses as the basis of his support a research program conducted in April and May of 1975. In this study nineteen subjects increased the strength of their necks an average of more than 91% after only twelve isokinetic workouts conducted over a period of six weeks. The workouts were conducted two times a week, with only one set of each exercise being performed during each workout.

In further investigation of neck development programs, Joseph C. Maroon, M. D. describes the "superneck" device developed by Coach William Atkins of the Buffalo Bills.

> This system consists of two pieces of equipment. One is a "superneck lever" in which the head exerts pressure on one arm of a weighted steel fulcrum. The

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[16]Jones, Arthur A., _A New Approach . . . to the Problems of Neck Injuries in Sports_ (DeLand, Florida: Nautilus Sports/Medical Industries, 1977), p. 2.

[17]Ibid.

> other is a "superneck pad" which is essentially a padded square used for isometric contractions and is wall-mounted.[18]

His system costs about $130.00.

While Atkins' system has proven successful, the cost factor is often a limitation to high school programs which typically operate on limited budgets. Maroon suggests, therefore, a similar system which can be self constructed. It includes a head harness attached to a cord mounted on a wall and fixed at the base. At the end of the cord is a device to hold any number of weights used with standard barbells. This system could be devised for approximately $50.00, making it a feasible alternative for the high school.

In a six week study of this system at the University of Pittsburgh, thirty-six college football players were divided into three equal groups. One group performed isotonic exercises consisting of three sets of six repetitions each of flexion, extension and lateral flexion of the neck three days per week. Progressive resistance exercises were used, with gradual weight increments as strength improved. In addition, shoulder shrugs and high pulls with standard barbells supplemented the routine.

A second group performed isometric exercises consisting of maximal muscle contraction for ten seconds against

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[18]Maroon, Joseph C., M. D., et al, "A System for Preventing Athletic Neck Injuries" The Physician and Sports Medicine, (October, 1977), p. 47.

a fixed resistance. It involved workouts three days a week performing six repetitions in each position (flexion, extension, lateral flexion and rotation). A control group performed only wind sprints and jogging.

After the six week period, the isotonic group showed an average of one-fourth inch increase in neck circumference. The isometric group showed an average increase of three-eighths inch, while there was no significant change in the control group.

> In addition, there was a progressive increase in strength and endurance in the isometric and isotonic groups, but this was more readily measurable in the isotonic group by the athletes' more rapid progression to high weights.[19]

In summary, Maroon states,

> Proper conditioning of the head and neck musculature is essential to prevent those extreme degrees of motion that may lead to cervical fracture dislocations and spinal cord injuries. Isotonic exercises are effective in obtaining increased strength and endurance as well as secondary increase in muscle mass of the cervical muscles.[20]

## Summary

In summary, weight training for the purpose of increasing athletic skill is a relatively recent development.

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[19]Maroon, Joseph C., M. D., et al, "A System for Preventing Athletic Neck Injuries" The Physician and Sports Medicine, (October, 1977), p. 48.

[20]Jones, Arthur, A New Approach . . . to the Problems of Neck Injuries in Sports (DeLand, Florida: Nautilus Sports/Medical Industries, 1977), p. 1.

Having evolved from Olympic weight lifting (competitively achieving maximum lifts) and power lifting (to achieve greater strength and in turn maximum poundages), weight training has employed these basic principles along with the low resistance-high repetition theories in order to increase endurance and athletic skill. As a result, coaches can now adapt this knowledge to create weight training programs which best suit the needs of their athletes.

Historically, weight lifting involved two fundamental approaches: isometrics (exercises involving muscular contractions with no changing of the joint angles) and isotonics (muscular contractions involving movement and a changing of the joint angles).

Isometric exercises as advocated by Hetlinger and Mueller, and supported by Clark can dramatically increase strength in the muscle involved. However, the actual amount of strength gain could vary considerably from one individual to another. Advantages of isometric exercise include: a smaller amount of equipment necessary for performance of the routine, and a greater savings in time spent performing the exercises.

Isotonic exercise programs are numerous due to the many combinations made possible by varying the amount of resistance, the repetitions and the number of sets. DeLorne initially found that low repetition-high resistance exercises produce power, whereas high repetition-low resistance exercises increase endurance. He further found that each type of routine is mutually exclusive and cannot produce both results. Since then, he and others have found that various combinations of the aforementioned factors (amount of resistance, repetitions and number of sets) have resulted in strength gains.

The comparison of isometric and isotonic programs by deVries favored slightly the isotonic method. Advantages include the fact that isotonic exercises are capable of working an entire range of motion, whereas isometric exercises are limited to one position. Comparative research, however, is not conclusive, and this researcher will further compare the two programs at a future time.

Neck development programs are limited in research due to the lack of a practical muscle development method. Direct exercise of the neck has been difficult to perform and often dangerous, resulting in elimination from conditioning programs. The construction of Nautilus equipment by Arthur Jones, an advocate of isokinetic exercise, now includes apparatus for direct exercise of the neck with extremely beneficial results. In addition, others have designed similar equipment for neck development ranging from wall mounted head harnesses to the "superneck lever" and "superneck pad" created by Coach William Atkins of the Buffalo Bills.

Neck development research conducted by Dr. Joseph C. Maroon, M. D., led him to conclude that proper conditioning of the head and neck musculature is essential to prevent critical injury. He further found isotonic exercises effective in increasing strength and endurance of the neck muscles.

A review of Research Quarterlies from 1966 to the present reveals that there have been no other studies conducted regarding neck musculature nor neck development programs. Considering the complexity of the neck musculature as indicated by Jones, it is difficult to isolate one muscle for testing strength. Further, in reviewing the literature, the researcher found no testing device or method available. Therefore, the researcher developed a testing table and method of testing neck strength.

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Ages of the subjects ranged from seventeen to twenty one with the average age being nineteen years. Weights of the subjects ranged from 152 pounds to 250 pounds, with an average weight of 191.2 pounds. The average height was 6'0" with a range from 5'7" to 6'7".

Forty five subjects took the pre-test, whereas thirty five subjects completed the post-test. One subject suffered a broken leg, another contracted mononucleosis; one injured his neck; two were not available for testing; and five subjects quit the team before the conclusion of the study.

## EQUIPMENT AND FACILITIES

Since no prior neck studies had been conducted in a similar fashion to the one the researcher was conducting, he was forced to create his own testing table and procedure.

The first thought on the testing table was to extend one end of the table and use a cable tensiometer as the measuring device. This process proved to be too complicated and unstable. The next idea, which was the process used, involved cutting a four inch by four inch hole near one end of the table and using a dynamometer as the measuring device. (See Appendix A.)

First the researcher used an S-hook on the strap, followed by a second S-hook, chains and another S-hook. However, it was not possible to make fine adjustments, and therefore the subjects could not all start at the same angle. To solve this problem a five-sixteenth turnbuckle was placed at the bottom of the testing device. Therefore, the hook-up consisted of the head strap, connected with an S-hook to the dynamometer which was then connected to the turnbuckle by a second S-hook. The turnbuckle was connected with a third S-hook to an eye-bolt which was attached to the brace at the bottom of the table. Now fine adjustments could be made for each indivual. (See Appendix B.)

Equipment used in this study consisted of: 1) four weighted football helmets, a football helmet without a face mask, with a one inch hole drilled in the top, through which a six inch pipe was inserted (See Appendix C); 2) 150 pounds of weights, one 50 pound plate, two 25 pound plates, three 10 pound plates, three 5 pound plates, and two 2½ pound plates; 3) two metal folding chairs; 4) a fiber metric measuring tape; 5) a leather head harness with a D-ring; 6) one eye bolt; 7) three S-hooks; 8) a one inch turnbuckle; 9) two four-foot belts; 10) a dynamometer; 11) a treatment table eight feet long and two and a half feet wide with a four by four inch hole two feet from one end (See Appendix D); 12) one Continental Adjustable Weight and Height scale; and 13) four by four inch gauze pads.

The pre- and post-tests were conducted in the Physiology of Exercise laboratory at Emporia State University physical education building, room 197. The laboratory contained a treadmill, a skeleton, and several work tables. It was selected as the testing area because its atmosphere was more conducive than a weight room to the testing procedure. The weighted helmet workouts were conducted in the free weight room, located in the Emporia State University stadium, classroom 4. The isometric program was conducted on the practice field.

## TESTING PROCEDURE

All subjects were first weighed on the Continental scale and their weights were recorded to the nearest pound. Their height was measured to the nearest inch. This took place in the hall adjacent to the testing area.

The subjects then proceeded one at a time to the testing area, where there was a radio playing tuned to a local rock station. The radio served to relax the subjects during the testing procedure. First the subject laid down on the table putting his nose in the corner of the square cut in the table. The subject's arms were straight at his side, with the tie down strap being tightened across his back just below the scapula, in order to further isolate the neck muscles by eliminating trunk extension. The head harness was placed on the back of the head so as to touch the occipital bump. The assistant held the head harness to prevent it from sliding over the crown of the head.

The subject was then instructed to give a straight, steady pull. The researcher then read the score off the dynamometer, giving it to the assistant who then recorded it. The dynamometer was then zeroed, and the instruction was given for the subject to roll over onto his back.

With the subject lying on his back, his head was placed in the four by four inch hole with the occipital bump touching the side of the square. The head harness was attached to the forehead. Again, the arms were straight at the subject's side, with the tie down straps secured around the chest just below the areolas. Straps were used to further isolate the neck muscles by eliminating trunk flexion. The assistant held the strap to prevent any slipping. (See Appendix E.)

The subject was then instructed to give a straight, steady pull, chin to chest. Again, the researcher gave the score to the assistant who then recorded the score.

## TRAINING PROCEDURE

The subjects worked out three days a week: Mondays, Wednesdays and Fridays. They were placed into three groups, each consisting of fifteen members. Due to time element, all groups conducted their workouts immediately following practice. The researcher conducted the weighted helmet groups and coach Alan Cornelius conducted the isometric exercises. The weighted helmets were available only at work out times. At other times they were stored away from the weight room.

The isometric group exercised their necks in two directions, flexion and extension, for a ten second count using one repetition only.

The weighted helmet groups found the maximum weight that each subject could handle for one repetition. Based on that weight, each subject was able to establish his work out weight. Group II performed three sets of ten repetitions at 50% of maximum weight. If on the last repetition the subject could complete twelve additional repetitions (ten plus two), he would then add five pounds to his work out weight. Group III performed three sets of three repetitions at 90% of maximum weight. When the subject was able to complete five additional repetitions on the last repetition (three plus two), he would add five pounds to his work out weight.

The movement for the two isotonic groups included flexion and extension. The flexion movement was from chin to chest and back again. The subject removed the helmet and rested one minute before performing the next set. The subject completed the required number of repetitions for the set in flexion, and then would perform the movement in extension for the required number of repetitions. Extension was from head erect, to a backward movement, and to head erect again. The subjects then removed the helmet and rested the neck for at least one minute before performing the next set.

Six weeks later the post-test was administered. It was conducted on a Tuesday and Wednesday following a Monday scrimmage. The same procedure as the pre-test was conducted, with the exception of recording the weight and height.

## STATISTICAL PROCEDURE

Following the test period, the information was placed on four by six inch cards. Information recorded included height, weight, age, previous football experience, previous neck injuries, pre- and post-neck size, and pre- and post-test flexion and extension maximums. This data was analyzed by an analysis of variance to determine whether any differences existed between and within the three groups. Following this, a Scheffé test of variance further determined exactly where these differences existed. Finally, the t-test procedure was used to determine any differences between all pre- and post-test scores.

# Chapter 4

## ANALYSIS OF DATA

This chapter contains the analysis of data for the flexion and extension pre- and post-tests. The statistical procedures used for analysis included analysis of variance, the Scheffé analysis of variance and the *t*-test.

Flexion Pre-test. Analysis of variance of the pre-test showed a between groups variance sum of squares equal to 520.08, with two degrees of freedom, and a mean square of 260.04. The within groups variance had a sum of squares equal to 4211.52, with thirty two degrees of freedom and a mean square of 131.61. The sum of squares for total variance was 4731.60. The means for the three groups on this pre-test were 37.5 (1), 46.2 (2) and 45.1 (3).

Table 1

Analysis of Variance for the Flexion Pre-test for All Groups

| Source | df | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 2 | 520.08 | 260.04 | 1.9758 |
| Within Groups | 32 | 4211.52 | 131.61 | |
| Total | 34 | 4731.60 | | |

Not significant at the .05 level

The F-ratio for the flexion pre-test was 1.9758 for the pre-test scores. An F≥3.32 was necessary at the .05 level to be significant. Therefore, it would be concluded that there was no significant difference between the three groups on the flexion pre-test.

Flexion Post-test. The sum of squares for between groups variance for the post-test was 1465.7421. The mean square was 732.8710. For within groups variance, the sum of squares was 6482.1435 and the mean square was 202.8857. The means of the three groups on the flexion post-test were 34.1 (1), 51.6 (2) and 44.4 (3).

Table 2

Analysis of Variance for the Flexion Post-test for All Groups

| Source | df | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 2 | 1465.7421 | 732.8710 | 3.6179* |
| Within Groups | 32 | 6482.1435 | 202.5669 | |
| Total | 34 | 7947.8856 | | |

*Significant at the .05 level

The F-ratio for the flexion post-test was 3.6179. An F≥3.32 was necessary at the .05 level to be significant. Therefore, there appeared to be a significant difference between the three group means on the flexion post-test.

The Scheffé test for analysis of variance was then used to determine where the difference in post-test group means existed. The highest value was found between groups I and II, with an F-value of 3.9369.

Table 3

Post-test Flexion Sample Means and F-Values Obtained from the Scheffé Test

| Group Means | Mean Differences | F |
|---|---|---|
| $\bar{X}_1 - \bar{X}_2 = 34.50 - 51.60$ | - 17.50 | 3.9369* |
| $\bar{X}_1 - \bar{X}_3 = 34.50 - 44.38$ | - 9.88 | 1.3155 |
| $\bar{X}_2 - \bar{X}_3 = 51.60 - 44.38$ | - 7.22 | 0.7263 |

*Significant at the .05 level; $F \geq 3.32$

An $F \geq 3.32$ was necessary to be significant at the .05 level. Therefore, there was a significant difference only between groups I and III on the flexion post-test.

Extension Pre-test. Analysis of variance of the pre-test showed a between groups variance sum of squares equal to 1170.1355, with two degrees of freedom, and a mean square of 585.0677. The within groups variance had a sum of squares equal to 2162.8358, with thirty two degrees of freedom, and a mean square of 67.5886. The sum of squares for the total variance was 3332.9713. The means for the three groups were 57.8 (1), 69.6 (2) and 70.3 (3).

Table 4

Analysis of Variance for the Extension Pre-test for All Groups

| Source | df | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 2 | 1170.1355 | 585.0677 | 8.6563* |
| Within Groups | 32 | 2162.8358 | 67.5886 | |
| Total | 34 | 3332.9713 | | |

*Significant at the .05 level

The F-ratio for the extension pre-test was 8.6563. An $F \geq 3.32$ was necessary at the .05 level to be significant. Therefore, it would be concluded that there was a significant difference between the three group means on the extension pre-test.

The Scheffé test for analysis of variance was then used to determine where the difference in pre-test group means existed. The highest value found was between groups I and III, with an F-value of 6.1790. An F-value of 5.5868 was found between groups I and II.

Table 5

Pre-test Extension Sample Means and F-Values Obtained from the Scheffé Test

| Group Means | Mean Differences | F |
|---|---|---|
| $\bar{X}_1 - \bar{X}_2$ = 57.8333 - 69.6000 | -11.7667 | 5.5868* |
| $\bar{X}_1 - \bar{X}_3$ = 57.8333 - 70.3076 | -12.4743 | 6.2790* |
| $\bar{X}_2 - \bar{X}_3$ = 69.6000 - 70.3076 | - 0.7076 | 0.0209 |

*Significant at the .05 level; $F \geq 3.32$

An $F \geq 3.32$ was necessary to be significant at the .05 level. Therefore, there was a significant difference between groups I and III on the extension pre-test. There was also a significant difference between groups I and II on the extension pre-test. There was no significant difference between groups II and III on the extension test.

Extension Post-test. The sum of squares for the between groups variance for the post-test was 1142.5992. The mean square was 571.2996. For within groups variance, the sum of squares was 2840.1435, and the mean square was 88.7544. With thirty degrees of freedom, the total variance sum of squares was 3982.7428. The means of the three groups on the extension post-test were 61.7 (1), 72.6 (2) and 74.4 (3).

Table 6

Analysis of Variance for the Extension
Post-test for All Groups

| Source | df | Sum of Squares | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 2 | 1142.5992 | 571.2992 | 6.4368* |
| Within Groups | 32 | 2840.1435 | 88.7544 | |
| Total | 34 | 3982.7427 | | |

*Significant at the .05 level

Post-test analysis of variance showed a significant difference between groups. The $F \geq$ Value for the post-test was 6.4368. An $F \geq 3.32$ was necessary to be significant at the .05 level. Therefore, it would appear that there was a significant difference between the group means on the extension post-test.

The Scheffé test for analysis of variance was then applied to determine where the difference in post-test groups means existed. The highest value was found between groups I and III, with an $F \geq$ value of 4.9702. An $F \geq$ value of 3.6732 was found between groups I and II.

Table 7

Post-test Extension Sample Means and F-Values Obtained from the Scheffé Test

| Group Means | Mean Differences | F |
|---|---|---|
| $\bar{X}_1 - \bar{X}_2$ = 61.6666 - 72.6000 | -10.9334 | 3.6732* |
| $\bar{X}_1 - \bar{X}_3$ = 61.6666 - 74.3846 | -12.7180 | 4.9702* |
| $\bar{X}_2 - \bar{X}_3$ = 72.6000 - 74.3846 | + 1.7846 | 0.1014 |

*Significant at the .05 level; $F \geq 3.32$

An F-value $\geq$ 3.32 was necessary to be significant at the .05 level. Therefore, there was a significant difference between groups I and III. There was also a significant difference between groups I and II. There was no significant difference between groups II and III.

t-Test Analysis of Data. Mean pre- and post-test scores for each group's performance of the flexion and extension tests were analyzed by the t-test procedure. There was a significant difference at the .05 level for group III on the extension test. There was no significant difference at the .05 level for any of the other groups.

Flexion Tests. The mean pre-test score for group I was 37.50 with a standard deviation of 8.684. The post-test mean was 34.50, and a standard deviation of 6.922.

Table 8

Table of Pre- and Post- Flexion
t-Tests for Group I

| Source | Mean | Standard Deviation | *t* |
|---|---|---|---|
| Pre-test | 37.50 | 8.684 | 1.4332 |
| Post-test | 34.50 | 6.922 | |

Not significant at the .05 level; df = 11

A t-value of 1.4332 was found for group I on the flexion tests. A $t \geq 2.201$ was necessary to be significant at the .05 level. Therefore, there was no significant difference in pre- and post-test flexion scores for group I.

Analysis of the pre- and post-test scores for group II showed a pre-test mean of 46.20, with a standard deviation of 11.915. The post-test mean was 51.60 and the standard deviation was 18.216.

Table 9

Table of Pre- and Post- Flexion
t-Tests for Group II

| Source | Mean | Standard Deviation | *t* |
|---|---|---|---|
| Pre-test | 46.20 | 11.915 | 1.7546 |
| Post-test | 51.60 | 18.216 | |

Not significant at the .05 level; df = 9

A t-value of 1.7546 was found for group II on the flexion tests. A $t \geq 2.262$ was necessary to be significant at the .05 level. Therefore, there was no significant difference in the pre- and post-test flexion scores for group II.

The mean pre- and post-test score for group III was 45.08, with a standard deviation of 12.048. The post-test mean was 44.38, and the standard deviation was 14.270.

Table 10

Table of Pre- and Post- Flexion
t-Tests for Group III

| Source | Mean | Standard Deviation | *t* |
|---|---|---|---|
| Pre-test | 45.08 | 12.048 | 0.2051 |
| Post-test | 44.38 | 14.270 | |

Not significant at the .05 level; df = 12

A t-value of 0.2051 was found for group III on the flexion tests. To be significant at the .05 level, a $t \geq 2.179$ was necessary. Therefore, there was no significant difference in pre- and post-test flexion scores for group III.

Extension Tests. Analysis of the pre- and post-test scores for group I showed a pre-test mean of 57.83 and a standard deviation of 8.315. The post-test mean was 61.66 with a standard deviation of 9.186.

Table 11

Table of Pre- and Post Extension
t-Tests for Group I

| Source | Mean | Standard Deviation | t |
|---|---|---|---|
| Pre-test | 57.83 | 8.315 | 1.7305 |
| Post-test | 61.66 | 9.186 | |

Not significant at the .05 level; df = 11

A t-value of 1.7305 was found for group I on the extension tests. To be significant at the .05 level, a $t \geq 3.32$ was necessary. Therefore, there appeared to be no significant difference in pre- and post-test extension scores for group I.

The mean pre-test score of group II was 69.60 and the standard deviation was 6.785. The post-test mean was 72.60, with a standard deviation of 8.823.

Table 12

Table of Pre- and Post- Extension
t-Tests for Group II

| Source | Mean | Standard Deviation | t |
|---|---|---|---|
| Pre-test | 60.60 | 6.785 | 1.5860 |
| Post-test | 72.60 | 8.823 | |

Not significant at the .05 level; df = 9

A t-value of 1.5860 was found for group II on the extension tests. A $t \geq 2.262$ was necessary to be significant at the .05 level. Therefore, there was no significant difference in pre- and post-test extension scores for group II.

The mean pre- and post-test score for group III was 70.31 and the standard deviation was 8.194. The post-test mean was 74.38, with a standard deviation of 8.983.

Table 13

Table of Pre- and Post- Extension t-Tests for Group III

| Source | Mean | Standard Deviation | *t* |
|---|---|---|---|
| Pre-test | 70.31 | 8.194 | 2.9353* |
| Post-test | 74.38 | 8.983 | |

*Significant at the .05 level; df = 12

A t-value of 2.9353 was found for group III on the extension tests. To be significant at the .05 level, a $t \geq 2.179$ was necessary. Therefore, there appeared to be a significant difference in the pre- and post-test extension scores for group III.

Summary. Analysis of variance for all groups on flexion and extension showed significant differences in the flexion post-test and the extension pre- and post-tests.

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26 and 44

in cervical (neck) strength using a traditional isometric conditioning program versus a weighted helmet with three sets of ten and three sets of three repetitions in the range of movement of flexion.

The second null hypothesis was rejected. There was a significant difference in cervical (neck) strength using a traditional isometric conditioning program versus a weighted helmet conditioning program with three sets of ten and three sets of three repetitions in the range of movement of extension. Group III (three sets of three repetitions at 90% of maximum weight) significantly increased cervical (neck) strength, whereas the other groups did not show an increase.

The third null hypothesis was accepted. There was no significant difference in cervical (neck) strength using a three sets of three repetitions weight training program at 90% of maximum weight versus a three sets of ten repetitions weight training program at 50% of maximum weight for the range of movement of flexion. t-tests revealed no increase in cervical (neck) strength between group II (three sets of ten repetitions at 50% of maximum weight) and group III (three sets of three repetitions at 90% of maximum weight) in the range of movement of flexion.

The fourth null hypothesis was rejected. There was a significant difference in cervical (neck) strength using a three sets of three repetitions weight training program at 90% of maximum weight versus a three sets of ten repetitions weight training program at 50% of maximum weight in the range of movement of extension. t-tests showed a significant increase in cervical (neck) strength between group II (three sets of ten repetitions at 50% of maximum weight) and group III (three sets of three repetitions at 90% maximum weight) in the range of movement of extension, in that group III significantly increased certical (neck) strength whereas group II did not.

## Chapter 5

## SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

### SUMMARY

The purpose of this investigation was to make a comparative study of the effects of three weight training programs on cervical (neck) strength. It was also the investigator's intention to determine, if possible, a superior method of increasing cervical (neck) strength.

Prior to the training program three groups of fifteen college football players were given the previously described test for strength. The groups trained with their respective specialized programs three days a week for six weeks, during spring football. The training period for the weighted helmet groups consisted of three sets of either three repetitions or ten repetitions, and isometric contractions of one repetition for a ten second count. At the completion of the training period, the subjects were administered the post-test for strength.

An analysis of variance, the Scheffé test and the t-test were used as the statistical procedures.

## FINDINGS

The following are the finds of this study:

1. Both isotonic conditioning programs proved superior (with a significance at the .05 level) to the isometric conditioning program in increasing cervical (neck) strength in both ranges of motion: flexion and extension.

2. In the movement of flexion, there was no significant difference at the .05 level in cervical (neck) strength for either of the isotonic groups.

3. In the movement of extension, the three sets of three repetitions at 90% of maximum weight showed a significant increase at the .05 level in cervical (neck) strength, as compared to the three sets of ten repetitions at 50% of maximum weight.

## CONCLUSIONS

Within the limits of this study the following conclusions are justified:

1. Isotonic exercise remains superior to isometric exercise for increasing neck strength.

2. A high resistance-low repetition conditioning program is more efficient than a low resistance-high repetition conditioning program in increasing cervical (neck) strength in the range of movement of extension.

## RECOMMENDATIONS

This study, conducted in the area of cervical (neck) strength testing, was extremely difficult. Many problems occurred which were not anticipated prior to conducting the study. The first problem was the table design and testing procedure. However, with careful thought and trial and error revisions made prior to testing, this was overcome. The result was a table and head harness device that allowed each subject to test the same angles and ranges of motion regardless of height and other physical differences.

The next problem was the work out time. At first the study was to be conducted prior to spring football; however, with the problems of creating a table and testing procedure the study was delayed and therefore conducted during spring football. The class schedules of the players made it impossible to conduct the sessions prior to football practice time, so a training session was conducted after the two hour practice session. This created an additional problem: the factor of muscle fatigue. In talking with Keith Kephart, strength coach at the University of Kansas, he later suggested that the neck be worked one hour before practice for best results.

Other recommendations for further study include the following. The training period might be conducted prior to spring football during the off-season. This would overcome any muscle fatigue problems as a result of football practice.

A larger sample group might affect the outcome of the specialized training program. Increased sample size would be more statistically reliable.

The weighted helmet could be modified by welding a washer two inches from the top of the helmet in order to increase the leverage angle. As indicated by John Baxter, head athletic trainer, the greater the distance the weight is from the neck, the greater the amount of resistance.

The back of the helmet could be modified by cutting approximately two inches out of the back where it touches the neck, enabling the subject to achieve more movement in the extension phase of the exercise. The helmet was hitting the back of the neck and not allowing a full range of motion.

A face mask could be added to the helmet to make it fit more securely.

The subjects of the weighted helmet groups could perform the exercises while lying down, in order to further isolate the neck muscles.

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BIBLIOGRAPHY


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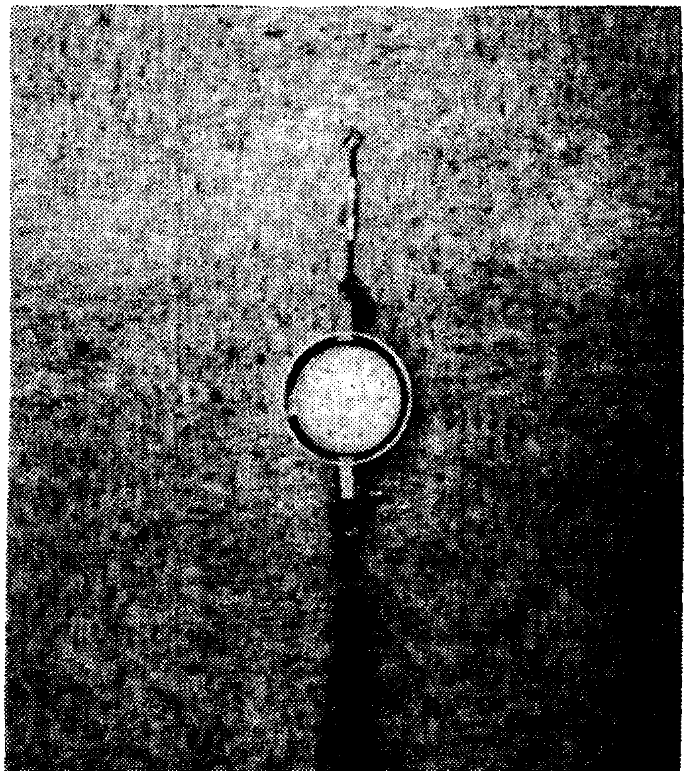
# APPENDIX

APPENDIX A

Dynamometer Measuring Device

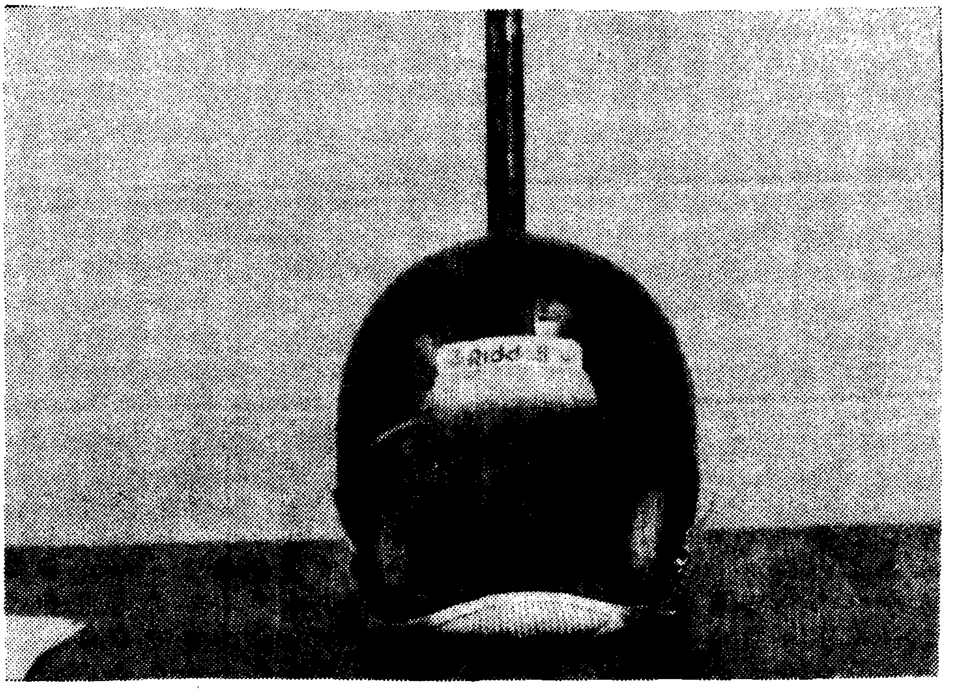


## APPENDIX B

Head Harness Hook-up to Allow for Fine Adjustments

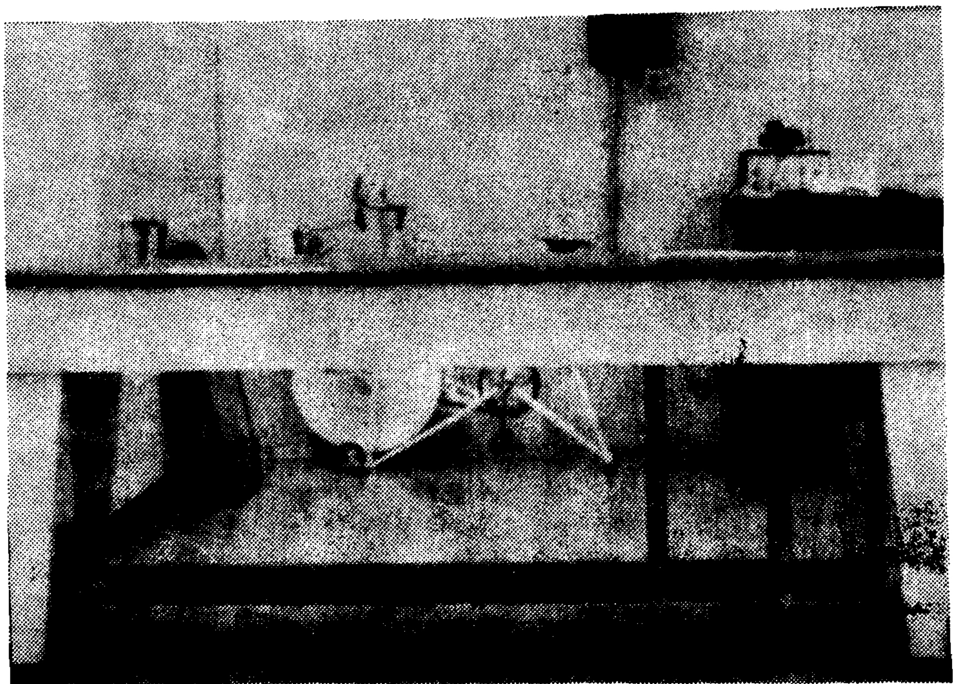
## APPENDIX C

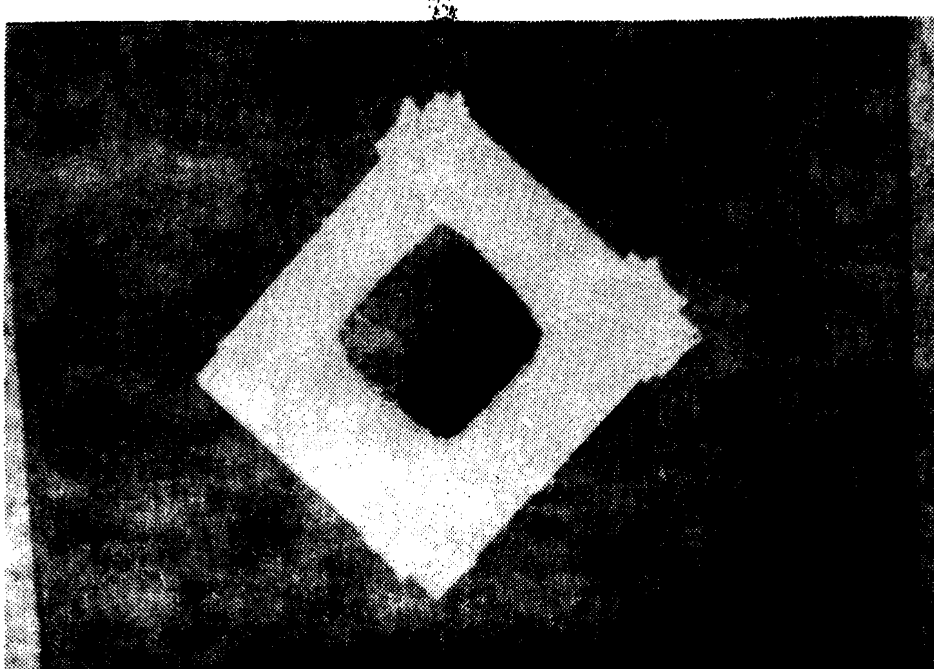
## The Weighted Helmet



APPENDIX D

The Testing Table





# APPENDIX E

## Position for Testing Flexion

APPENDIX F

Position for Testing Extension