

THE ACUTE EFFECT OF KINESIO TAPING ON THROWING VELOCITY IN
NCAA DIVISION I, II, and III BASEBALL PITCHERS

A THESIS

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by
Yohei Hikita

Research Advisor, Thomas G. Kinsey

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CALIFORNIA UNIVERSITY of PENNSYLVANIA
CALIFORNIA, PA

THESIS APPROVAL

Graduate Athletic Training Education


We hereby approve the Thesis of

Yohei Hikita, ATC, CKTP
Candidate for the degree of Master of Science

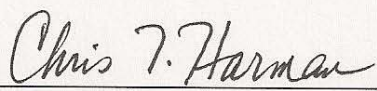
Date

Faculty

4-9-09


Thomas G. Kinsey, PhD (Chairperson)

4-9-09


Chris T. Harman, EdD, ATC

4-9-09


Edwin M. Zuchelkowski, PhD

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INTRODUCTION

Optimal athletic performance requires athletes to be in their best condition but that becomes unrealistic in the presence of physiological problems. It is essential for all athletes to understand specific demands of their sports in order to minimize the risk of injury.¹⁻⁸ There are various kinds of athletic tapes that help an athlete's performance by supporting the physiological problem(s) athletes have.⁹⁻¹¹ Those who watched the 2008 Olympics in Beijing may have been wondering about the tape application on the participating athletes, for example Kerri Walsh, a beach volleyball player for the United States. Kinesio tape (KT) was used in the 2008 Olympics, and is becoming increasingly popular in athletic settings because of its unique therapeutic approach to physiological problems, including acute and chronic injury and muscular imbalance.^{9,11-13} Application of KT has been hypothesized to assist athletes' performance by correcting underlying physiological problems, but no research has been documented to support the hypothesis.^{3,9,13-17}

KT is a relatively new taping technique in athletic settings that was first introduced by Kenzo Kase in 1980.

^{12,18} KT is a thin elastic tape with water-proof ability

which contains no latex material.^{9.17} KT is able to stretch up to 140% from its resting state in the longitudinal plane.^{12.16.17.19.20} KT can be used during athletic activity which focuses on facilitating the physiological functions that are impaired due to fatigue and/or overuse.^{9.12.16.20} KT can stay on the skin for three to four consecutive days before another application is needed, whereas the effect of traditional athletic tape lasts approximately 20 minutes.^{11.14.21}

According to Kenzo Kase, there are four intended functions of KT application: 1) increasing venous and lymphatic circulation, 2) stimulating the neurological perception of athletes, 3) correcting joint mal-alignment, and 4) supporting weakened muscles from fatigue.^{9.12-14.16.19.20} First, KT application causes the skin to be raised toward the outside of the body, increasing the interstitial space between the skin and underlying connective tissues such as muscles, ligaments, and tendons. This action allows blood and lymph fluids to travel smoothly through the treated area. Therefore, it can improve the venous and lymphatic circulation of the area being treated which is the primary function of kinesio taping.^{9.13.17.18} Second, the neurological system is stimulated by the application which alters the subject's perception of pain. Stimulation of the

neurological system causes the brain to send the efferent signal which does not allow the afferent signal, pain perception, to go up to the brain. ^{9.13.16} Third, muscle spasm is reduced by the correction of joint mal-alignments. When a joint is in an abnormal position, the muscles surrounding the joint must work to compensate. As a result, the muscles contract either stronger or weaker than normal which can cause spasm of the muscles. KT may help with muscle spasm or pain raised from a joint mal-alignment by correcting the joint mal-alignment and supporting weakened muscles. ^{13.16.19} Lastly, existing muscle imbalance from improper training techniques and/or biomechanics is improved by supporting weakened muscles or over-trained muscles. ^{9.14.16} Normal movement facilitation can be accomplished by the other functions of KT. ^{12.13.19} KT application might relieve the symptoms caused from repetitive throwing by enhancing the blood flow to the shoulder complex and supporting the fatigued muscles. ^{9.12.13.16}

Baseball pitching is a sequential movement during which entire body segments must work in an efficient manner at a high speed to produce the desired outcome: high throwing velocity with control of the direction of a ball.

The stability of the glenohumeral (GH) joint mostly comes from dynamic stabilizers and less from static stabilizers.^{1.25.26} A large portion of dynamic stability comes from the rotator cuff (RC) musculature; supraspinatus, infraspinatus, teres minor, and subscapularis. On the other hand, the anterior band of the inferior GH joint primarily provides static stability.^{1.27.28} In Collegiate baseball pitchers stress created at the GH joint by shoulder distraction that occurs during pitching is equal to approximately 80% of their body weights.²⁹ As the intensity of the pitching motion increases, the eccentric activity levels of the RC musculatures also increase in systematic fashion to compensate for the stress.²⁷ Repetitive stresses cause the rotator cuff musculature to fatigue and the GH joint to become loose, leading to shoulder dysfunction and altered pitching mechanics.^{1.2.30.31} The physiological alterations include hypertrophy of muscles by which vascular structures surrounding the GH joint are irritated and compressed, changing the blood flow volume in the region.^{1.3.4}

The shoulder complex must work together in order to allow a great amount of range of motion (ROM) as well as a satisfactory level of stability at the GH joint.^{1.22} The tendency of increased flexibility comes from repetitive

throwing and contributes to the eccentric phase of plyometric activity during the cocking phase of pitching which eventually influences the throwing velocity.^{2.27.28.32} Increased external rotation and decreased internal rotation at 90-degrees of abduction are often seen in the dominant shoulder of baseball pitchers and other overhand throwing athletes.^{2.15.32} Alteration of the shoulder ROM leads to shoulder injury and decreased athletic performance.^{1.2.15.27}

Common chronic shoulder injuries among baseball pitchers are to the RC musculatures, instability of the GH joint, and neurovascular dysfunctions.^{1.3.14.33} Rotator cuff impingement syndrome has been ranked as the most common pathology from which baseball pitchers experience shoulder pain.^{33.34} Radiating pain to the lateral side of the arm can be observed and pitching mechanics are altered in athletes in an attempt to relieve shoulder impingement pain.^{1.15.30.31} As alterations in the RC musculature can develop, GH joint instability may also develop as a secondary problem; therefore, conditions must be considered when treating athletes.^{26.34.35} In baseball pitchers with fatigued muscles, the suprascapular nerve may be compressed at the spinoglenoid notch of the scapula causing atrophy in the infraspinatus and decrease in strength during external rotation and abduction.^{4.22.31} Injuries to these vascular

structures are related to internal force production by muscular and bony structures during pitching.^{25.29.34} Either compression or traction force will be created within the shoulder complex, especially during the late stage of cocking and early stage of acceleration phases in which the amounts of the two different types of forces reach their peak.^{24.25.29.36} KT application has been shown to relieve repetitive throwing symptoms by enhancing the blood flow to the shoulder complex and by supporting the fatigued muscles.^{9.12.13.16}

Tremendous amounts of stress placed upon the shoulder complex during baseball pitching cause various shoulder problems for pitchers, influencing the level of athletic performance.^{1.5-8.13.14} The level of athletic performance of pitchers declines as the shoulder complex fatigues from repetitive stress.^{1.10-12} The primary function of KT is to increase the blood circulation of area(s) being treated. More oxygen and nutrients would be available from the blood to the active muscles if athletic trainers can facilitate the blood circulation of the shoulder complex with application of KT.^{25.30.31.33} If so, pitchers may be able to pitch in their best condition in terms of blood circulation of the shoulder complex which helps create powerful outcomes. No research has documented the effects of KT on

athletic performance.^{3.9.13-17} The purpose of this study is to examine if the throwing velocity of NCAA collegiate baseball pitchers increases acutely due to the KT application for rotator cuff impingement syndrome.

METHODS

The purpose of this study was to examine if the kinesio taping application acutely increases throwing velocity of college baseball pitchers. The following will be discussed: Research Design, Subjects, Preliminary Research, Instruments, Procedures, Hypothesis, and Data Analysis.

RESEARCH DESIGN

This study was a repeated measure/cross-over design. The independent variable was condition (non-application/application). The dependent variable was throwing velocity. Measurements were obtained under two different conditions (non-application/application) in one day. Each subject was randomly assigned for one of the two groups by the researcher. Advantages of this research study were that each subject served as their own control. The number of kinesio tape (KT) application type and the number of pitches performed in each session was the limitations of this study.

SUBJECTS

A total of 21 National Collegiate Athletic Association (NCAA) Division I, II, III baseball pitchers from the University of Northern Iowa (I), Upper Iowa University (II), and Washington and Jefferson College (III) participated in this study. The inclusion criteria were: 1) NCAA athletes, 2) being 18 to 24 years of age, 3) willingness to participate even if having a musculoskeletal injury which does not get worse during the study and 4) no history of shoulder surgery within the previous six months. The exclusion criterion was shoulder and/or any other pathology that might be exacerbated by participating in this study. Physical evaluation of the subjects did not performed by the researcher for this study. The demographic information included: 1) age, 2) year in school, 3) throwing arm, 4) current body condition assessed by a certified athletic trainer or diagnosed by a physician, 5) history of surgery within previous six months, and 6) history of injury. Informed consent (Appendix C1) was read and signed by all subjects prior to participation in this study.

PRELIMINARY RESEARCH

The purpose of preliminary research was to familiarize the researcher with the kinesio taping method as well as the whole process of this study. In order to conduct this study efficiently, it was necessary for the researcher to improve speed in the KT application for rotator cuff (RC) impingement syndrome (Appendix C2), to understand the use of the radar gun (Appendix C3) and to approximate the testing time for the entire study. The five static stretching techniques (Appendix C4) included in the warm-up protocol were well understood by the researcher during the preliminary research. Two healthy subjects (two males) participated in the preliminary research using the same methods for this study.

INSTRUMENTS

Kinesio® Tex Gold Extra Water-Resistant, Kinesio® Pro Scissors, the kinesio tape application book written by Kenzo Kase (Appendix C2), a radar gun (Appendix C3), the warm-up protocol, a demographic and score sheet (Appendix C5), and official NCAA baseballs were used in this study.

Warm-Up Protocol

All subjects were required to perform the 15 minute warm-up protocol designed by the researcher prior to each testing session which consisted of three minutes of jogging and a nine minute static stretching followed by three minutes of partner throwing.

The purpose of the static stretching was to warm-up the major shoulder muscles that are activated during the pitching motion. Five different stretching techniques (Appendix C4) were performed bilaterally for 30 seconds each, except for two stretching techniques which were not necessary to perform bilaterally. Each stretching technique was repeated for two times with a five second rest between each stretching. The methods of stretching techniques are explained in detail in Appendix C4. The major muscles stretched in the warm-up protocol included the infraspinatus, teres major, pectoralis major, pectoralis minor, deltoid, trapezius, biceps brachii, triceps brachii, coracobrachialis, latissimus dorsi, and rhomboid.

Kinesio Taping Technique

Standard two inches KT (Appendix C2) was utilized for the application in this study. Three different colors, including black, red, and blue, were used to easily

identify the process of each individual application. Controlling the tension of KT was important as changes in tension could influence the results of this study. Each individual application ended with initially activating the glue function by gently rubbing the surface of the application.

Application for RC impingement syndrome (Appendix C2) consisted of three separate Y-strips. A Y-strip refers to a piece of KT that has equal width and length of two tails with a base which is used for either muscle stimuli facilitation or inhibition. A kinesio Y-strip was administered from insertion to origin. The following was the process of the application:

A-1) The base of a kinesio Y-strip was applied two inches below the greater tuberosity of the humerus without tension. A-2) The athlete was asked to stretch the supraspinatus by performing lateral flexion of the neck away from the treated area and shoulder adduction behind the back. A-3) Without putting tension of the tape, the superior tail was applied toward the supraspinous fossa on the superior medial border of the scapula, and the inferior tail was applied on the length of the spinous process of the scapula (Appendix C2, p67).

B-1) The base of a kinesio Y-strip was applied two inches below the deltoid tuberosity of the humerus without tension. B-2) The athlete was asked to stretch the anterior portion of the deltoid by performing shoulder abduction to 90 degrees with external rotation and horizontal abduction. B-3) Without tension, the anterior tail was applied along with the anterior border of the deltoid toward the acromioclavicular (AC) joint. B-4) The athlete was asked to stretch the posterior portion of the deltoid by performing shoulder abduction to 90 degrees with internal rotation and horizontal abduction. B-5) Without tension, the posterior tail was applied along with the posterior border of the deltoid toward the AC joint (Appendix C2, p68).

C-1) The base of a kinesio Y-strip was applied on the anterior shoulder just above the coracoid process without tension. C-2) The athlete was asked to perform shoulder flexion and horizontal adduction. C-3) With 50-75% of available tension and inward pressure, both the superior and inferior tails were applied toward the posterior aspect of the shoulder; the superior tail went by just inferior to the acromion process of the scapula while the end of the inferior tail ended approximately 1 ½ inches below the end of superior tail. C-4) There was no tension applied to

either the end of the superior or posterior tail (Appendix C2, p69).

PROCEDURES

Approval from the California University of Pennsylvania Institutional Review Board (IRB) (Appendix C6) was obtained for this study. Approvals from the athletic directors of the University of Northern Iowa, Upper Iowa University, and Washington and Jefferson College (Appendix C7) were also obtained. After this study had been approved by the IRB and each institution that participated, allergic reaction to kinesio tape was tested by placing 10 inches of kinesio tape to the subjects' inner forearm for 90 minutes. Subjects who showed allergic reactions were not allowed to participate in this study. The symptoms due to kinesio tape include excessive redness, skin rash, and itchiness. All research testing was conducted from 3:00 pm to 7:00 pm in early December (4th, 5th, and 10th), 2008 during which all subjects were in their off-season. A team meeting with each institution was held during which the concepts and procedures of this study were introduced by the researcher, and the informed consent form (Appendix C1) was read and signed by each subject.

During the meeting, the researcher demonstrated the KT application (Appendix C2) and stretching techniques (Appendix C4) that were used for the warm-up protocol. A kinesio Y-strip was applied around the supraspinatus, deltoid, and from over the coracoid process to the posterior shoulder. A subject was asked to stretch the structures where KT was applied for obtaining optimal effects of the tape. Each subject was randomly assigned to one of the two groups. There were a total of two pitching sessions in one day. The researcher allowed all subjects to use whichever type of grip they preferred during pitching, but they had to use only one type of grip as it could change their throwing velocity. Each subject performed pitching under two different conditions (non-application/application). Pitchers in group A threw without application first, and then threw with application while pitchers in group B threw with application first, and then threw without application. Application of KT was administered 30 minutes prior to pitching to allow for glue activation of the tape to the skin. The taping area was dry and free of hair. Hair in the shoulder region may be removed by the researcher or subject to allow the glue activation. Between the time of application and warm-up, subjects were not allowed to perform any activity that may

interfere with the glue activation. In order to minimize the risk of injury during the testing, 15 minutes prior to each testing session, all subjects were asked to perform the warm-up protocol designed by the researcher. The warm-up protocol consisted of three minutes of jogging and a nine minute static stretching followed by three minutes of throwing with a partner. A minimum of 15 pitches was required during the partner throwing. All subjects were allowed to perform any stretching that they felt necessary after the warm-up for the purpose of injury prevention.

Group A warmed up 15 minutes prior to the first pitching session. Without KT application, group A performed three sets of three pitches at a maximum speed with a five minute interval between each set. After the first pitching session, the researcher applied KT for the next 30 minutes. Pitchers were asked to rest during the application time. Another 30 minutes presumed for KT glue activation, during which the last 15 minutes also included pitchers' warm-up in order to prepare for the next pitching session. Group A performed three sets of three pitches with application. Throwing velocity was measured with a radar gun (Appendix C3), and the velocity of all pitches was recorded on the score sheet (Appendix C5). Average throwing velocity of each set from each subject was utilized for data analysis.

Group B went through the same process in reverse order. The researcher applied KT first, and pitchers warmed up 15 minutes prior to the first pitching session. Group B performed three sets of three pitches with application. The KT application was removed from each pitcher after the first pitching session and they warmed up again 15 minutes prior to the second pitching session. Group B performed three sets of three pitches without application.

The testing for each group was performed at the same time inside the gym or recreation center to avoid wind affecting the measurement outcomes. Each pitcher threw 60'6" away from a catcher off the mound. A bag of ice was available for all pitchers at the end of the last pitching session for pain and soreness management.

HYPOTHESIS

The following research hypothesis was tested in this study:

Throwing velocity of baseball pitchers increases with the KT application.

DATA ANALYSIS

A repeated measure/cross-over design was used to determine the difference within the two different groups (No-application/Application). SPSS 16.0 statistical software package was used for data analysis. An alpha level of ($P \leq 0.05$) was used to determine significance.

RESULTS

The purpose of the study was to examine the acute effects of kinesio taping on throwing velocity in NCAA Division I, II, and III baseball pitchers. Kinesio tape application for rotator cuff impingement syndrome was applied on each subject's dominant shoulder. Throwing velocity was measured by the Radar gun from behind the subject's throwing arm.

DEMOGRAPHIC DATA

A total of 21 volunteer NCAA collegiate baseball pitchers participated in the study after the collection of informed consents. All subjects were cleared to participate in the study by their athletic trainer. The test was conducted at the University of Northern Iowa (12/04/08), Upper Iowa University (12/05/08), and Washington & Jefferson College (12/10/08) in the same way. The demographic data of each subject was collected and confirmed by the researcher prior to the testing. Table 1 shows the number of subjects according to NCAA Division.

Table 1. Number of Subjects
According to NCAA Division

	Division I	Division II	Division III
N	6	3	12

Six subjects from University of Northern Iowa (Division I), three subjects from Upper Iowa University (Division II), and 12 subjects from Washington and Jefferson College (Division III) participated. Eighteen pitchers were right-handed and three pitchers were left-handed. The mean of age was 19.5 and the SD was 1.16.

HYPOTHESIS TESTING

Hypothesis testing was performed from the results of 21 subjects that participated in the study. The alpha level of .05 using SPSS software was used to test for the significance of the hypothesis.

Hypothesis: The application of rotator cuff impingement will increase the throwing velocity of the baseball pitchers. Table 2 shows the means of throwing velocity under each condition.

Table 2. Means of Throwing Velocity Under Each Condition (mph)

Condition	Mean	SD	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Application	77.7	3.67	0.801	76.1	79.4
Non-Application	77.6	4.63	1.011	75.1	79.7

A repeated measure, ANOVA was used to compare the mean difference of the two conditions: non-application and application. The mean of the tape application was $77.7 \pm .801$. The standard deviation was 3.67. There was no significant difference due to the tape application ($F = .147$, $p = .705$). Table 3 shows the ANOVA for maximum velocity with and without tape application.

Table 3. ANOVA for Maximum Velocity With and Without Tape Application (mph)

Source	Condition	Type III Sum of Squares	df	Mean Square	F	Sig.
Condition	Linear	0.25	1	0.25	0.147	0.705
Error	Linear	34.14	20	1.71		

Some subjects showed increase or decrease in throwing velocity with the tape application, but most subjects had their average throwing velocity under each condition within

one mph. Table 4 shows the means of throwing velocity grouped according to the results.

Table 4. Means of Throwing Velocity Grouped According to the Results (mph)

		Non-Application		Application		
	N	Mean Velocity	SD	Mean Velocity	SD	Difference
Improved	5	72.9	5.24	75.5	5.02	2.6
No Change	11	77.9	3.12	77.9	2.93	.0
Decreased	5	81.5	2.92	79.5	3.26	-2

Five subjects increased, 11 subjects did not change, and five subjects decreased more than one mph their throwing velocity with the tape application. All (five) subjects who increased their throwing velocity with the application were from Washington and Jefferson College. Four out of five subjects who decreased their throwing velocity with the application were from either University of Northern Iowa or Upper Iowa University and the other one was from Washington and Jefferson College.

For the subjects with improvement, the mean velocity with the application was 2.6 mph faster than the mean velocity with non-application. However, five subjects decreased their throwing velocity by 2.0 mph with the application. Table 4 revealed that there were some changes

in their throwing velocity during this study, but no significance was found.

DISCUSSION

This study was intended to investigate the acute effects of kinesio taping on throwing velocity in NCAA Division I, II, and III baseball pitchers. Although several studies found the positive therapeutic effects of kinesio taping such as increased range of motion at particular joints and reduction of pain, no studies have been published that investigate the effects of kinesio taping on athletic performance.^{3.9.13-17} Kinesio tape application for rotator cuff impingement syndrome was applied to each subjects' dominant shoulders since the most common injury among baseball pitchers is the rotator cuff impingement syndrome, according to a number of studies.^{1.3.14.33.34}

The findings of this study did not support the hypothesis that kinesio taping would acutely increase throwing velocity of collegiate baseball pitchers. A total number of 21 subjects voluntarily participated in this study which could be a limiting factor of the findings. None of the subjects showed allergic reactions to the kinesio tape and did not injure themselves during the testing.

CONCLUSION

The findings of this study suggest that kinesio tape application for rotator cuff impingement syndrome has no acute effects on throwing velocity in NCAA Division I, II, and III baseball pitchers.

RECOMMENDATIONS

Based on the findings of this study, there are no acute effects of kinesio taping on throwing velocity in NCAA collegiate baseball pitchers for the first nine pitches. Kinesio tape application for rotator cuff impingement syndrome does not have significant effects and is not expected to increase throwing velocity of baseball pitchers acutely.

For future studies, it is suggested to increase the number of pitches the subjects throw as well as the number of subjects in order to find the long-term effects of kinesio taping. There is no acute effect of kinesio taping on the short-term throwing velocity from the findings of the study; however, the long-term effects may be seen after a certain number of continuous pitches. Four of the five

subjects who improved their throwing velocity had an increase in the last 3 pitches. Starting pitchers would be better suited for future studies to investigate long-term effects of kinesio taping on the dominant shoulder. They may throw up to 100 pitches during competition, and kinesio taping may show the long-term effects by preventing fatigue or injury.

Future studies should include the physical evaluation prior to testing to determine the subject's condition and a preferred application technique for each individual. The researcher did not evaluate the subjects for the study to find out if they have rotator cuff impingement syndrome. Physical evaluation may reveal how kinesio tape influences the throwing velocity of pitchers. Kinesio tape may be beneficial to pitchers with muscle fatigue, joint instability, and/or lack of proprioception at the shoulder joint. Future studies should involve subjects with sport-related physiological problems and evaluation of the subjects to assess their problems in order to determine a preferred application technique.

All research testing was conducted in early December, 2008 during which all subjects were in off-season. Rotator cuff impingement syndrome is often seen in baseball pitchers in actual competitive season because of the

repetitive stress placed upon the throwing shoulder and muscle fatigue accumulated over the time. It is suggested to perform future studies in actual competitive season since baseball pitchers may show physiological dysfunctions, commonly rotator cuff impingement syndrome, as they go through the competitive season.

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APPENDIX A
REVIEW OF THE LITERATURE

REVIEW OF THE LITERATURE

The purpose of this review of the literature is to introduce information of baseball pitching and the effects of kinesio tape (KT) application. The use of KT is becoming popular in athletic settings, but a few researches have been performed to support the hypothesized functions of KT by Kenzo Kase, the first investigator of KT. If KT is able to help with the blood circulation of the shoulder of a baseball pitcher that is impaired due to repetitive throwing, original level of athletic performance would be achieved with KT application. This review of the literature will discuss: 1) Functional Anatomy of the Shoulder Complex, 2) Throwing Velocity, 3) Shoulder Pathology in Baseball Pitchers, 4) Kinesio Taping, and 5) Injury Prevention.

FUNCTIONAL ANATOMY OF THE SHOULDER COMPLEX

Most stability of the glenohumeral (GH) joint comes from surrounding soft tissues, including the rotator cuff (RC) musculature and ligaments.^{1,2} The stability of the GH joint mostly comes from dynamic stabilizers and less from

static stabilizers.^{1.3.4} The anterior band of the inferior GH joint is considered to be the primary static stabilizer while the RC musculature provide a large portion of dynamic stability. The subscapularis, supraspinatus, infraspinatus, and teres minor are categorized as the RC musculatures. All of them originate from the anterior or posterior aspect of the scapula and insert on the head of the humerus.^{1.5.6} Because of the structural nature, the RC musculature are extremely important for positioning the glenoid and the head of the humerus in place and also allowing a great amount of ROM while providing optimal stabilization at the GH joint.^{1.6.7} The RC muscles are responsible for creating rotational force at the shoulder during pitching.⁵ There is concentric contraction of the subscapularis for increasing the throwing velocity as well as eccentric contraction of the other RC musculature to reduce the tremendous pressure placed on the shoulder during the deceleration phase of the pitching motion.^{5.8.9} In Collegiate baseball pitchers stress created at the GH joint by shoulder distraction that occurs during pitching is equal to approximately 80% of their body weights.⁹ As the intensity of the pitching motion increases, the eccentric activity levels of the RC musculature also increase in systematic fashion to compensate for the pressure created.⁵

When the body is unable to absorb the stresses placed on the shoulder, the risk of injury increases as the result.⁹

The shoulder complex must work together in order to allow a great amount of ROM as well as a satisfactory level of stability at the GH joint.^{1.5} Stresses placed on the GH joint of the dominant side during the pitching motion are extreme and accumulated from repetitive throwing over prolonged periods of time.^{1.5.6.8} Those repetitive stresses cause the rotator cuff musculatures to fatigue and the GH joint to become loose, leading to shoulder dysfunction and altered pitching mechanics.^{1.10-12}

Baseball pitchers are vulnerable to injury to the shoulder complex, especially to the GH joint and the RC musculatures.^{1.7.13.14} As the articulation surface between the glenoid and humeral head is relatively small, the GH joint can provide a great amount of range of motion (ROM) in three dimensions: sagittal (240), frontal (180), and transverse (165) planes.^{1.6.15} Johnson analyzed ROMs at the GH joint of 26 college baseball players. Shoulder flexion, extension, and internal and external rotation at a 90-degree abduction were measured using a JAMAR®, six-inch, double-arm goniometer. The results of Johnson's study indicated that pitchers had outstanding ROM of flexion in both shoulders, approximately 20 degrees more than the

other position players.¹⁶ The dominant shoulder of pitchers tends to have greater flexibility for flexion and external rotation at a 90-degree abduction than the non-dominant shoulder does.^{8.16} The tendency of increased flexibility comes from repetitive throwing and contributes to the eccentric phase of plyometric activity during pitching which eventually influences the throwing velocity.

8.10.16.17

THROWING VELOCITY

Baseball pitching is a sequential movement during which entire body segments must work in an efficient manner at a high speed to produce the desired outcome: high throwing velocity with control of the direction of a ball.

^{1.5.18.19} Hirashima et al. found that proximal to distal sequential muscle contractions occur in the upper extremity and the sequence plays an essential role in increasing throwing velocity.¹⁸ For optimal athletic performance and injury prevention, it is crucial for pitchers to have a wide degree of range of motion (ROM) and satisfactory level of stability at the glenohumeral (GH) joint.^{1.4.8.10}

Increased external rotation and decreased internal rotation at 90-degree of abduction are often seen in the dominant shoulder of baseball pitchers and other overhand throwing athletes.^{8.10.20} The ROM alteration identified as a result of intense eccentric muscle contraction of shoulder external rotators which occurs in the deceleration phase of the throwing motion.^{1.8.20} Intense eccentric contraction fatigues the shoulder external rotators over time, resulting in tightness of posterior shoulder. Another reason of the ROM alteration is anterior-inferior capsular laxity from repetitive throwing.^{9.15.19}

Baseball pitching is complicated and can be divided into six phases: wind-up, stride, cocking, acceleration, deceleration, and follow-through.^{1.19.21} Wind-up is the initiation phase of pitching during which a backward step by the stride foot is initiated and 90-degree body rotation and elevation of the stride foot are performed. As change in the center of gravity from the stride foot to the pivot foot happens toward the end of wind-up phase, the pivot foot plays a role in controlling the balance when the elevation of the stride foot reaches to the highest point.^{18.19} A successful stride is essential to produce powerful outcome of pitching. The length of the stride slightly less than the pitcher's height often accomplishes good stride,

and the stride foot should land in front of the pivot foot with slight internal rotation. When the stride foot is positioned toward right or left from the desired position, the efficiency of hip rotation is reduced resulting in lack of energy production from the stride.^{18.19.21} Hip rotation followed by upper trunk rotation and extension, elbow flexion, and maximum external rotation are performed during the arm cocking phase. Hyperextension of upper trunk is observed in high-level performance which affects the magnitude of a thrown ball.^{3.7.15} Acceleration is when internal rotation of the shoulder and extension of the elbow are initiated and the arm is fully extended at the release of ball. Timing of motion activation is important. The elbow extension should begin before the shoulder internal rotation to reduce the stresses placed on the shoulder which creates a greater angular velocity.^{2.9.19.21} After the release of the ball, eccentric contractions of external rotators of the shoulder decelerate the tremendous force created from the previous phases. Posterior shoulder tightness arises from the eccentric contractions which can cause chronic shoulder injuries such as rotator cuff impingement syndrome and GH joint instability.^{1.3.4.10} Follow-through minimizes the risk of injury by releasing

the pressure produced during pitching from inside of the body.^{19.21}

SHOULDER PATHOLOGY IN BASEBALL PITCHERS

Common chronic shoulder injuries among baseball pitchers are to the rotator cuff (RC) musculature, instability of the Glenohumeral (GH) joint, and neurovascular dysfunctions.^{1.7.13.14} All the common chronic injuries are related to each other because each injury can be the predisposing factor of the others. When dealing with the chronic injuries, the neuromuscular control considerations, especially around the scapula, must be considered to reduce the potential risk of these injuries.^{1.15.18} First of all, intensity of muscular contractions between internal rotators and external rotators of the shoulder complex need to be balanced. Second, all three portions of the trapezius muscle must work efficiently to enhance the quality of scapular stability. Furthermore, synchronized motor unit recruitment of scapular muscles is necessary for dynamic stability during pitching.^{3.5.18.20}

RC impingement syndrome occurs when repetitive compression forces are applied to the structures, including

the humeral head, the subacromial bursa, the GH joint capsule, and the tendon of long head of the biceps brachii and each RC muscle.^{1.3.6.7} RC impingement syndrome has been ranked as the most common pathology from which overhead athletes experience shoulder pain. Painful overhead movements are often reported by the athletes with RC impingement syndrome.^{6.7} Radiating pain to the lateral side of the arm can be observed pitching mechanics are altered in athletes with shoulder impingement in an attempt to relieve pain.^{1.11.12.20}

Cools et al. analyzed isokinetic scapular muscle performance in overhead athletes with and without impingement symptoms. The results revealed that impaired muscular balance and strength exist among the overhead athletes with impingement symptom.³ Specifically, trapezius activity and intramuscular balance are associated with shoulder impingement. With the presence of shoulder impingement syndrome, each portion of the trapezius muscle works differently from the ordinary manner.^{1.3.7.18} Cools et al. examined trapezius activity during isokinetic exercise in overhead athletes with impingement syndrome using multiple ANOVAs for each dependant variable. They observed high levels of activity in the upper trapezius during abduction ($P < 0.001$) and external rotation ($P > 0.001$)

whereas low levels of activity in the lower trapezius when the shoulder is abducted ($P = 0.727$), and in the middle trapezius when it is externally rotated ($P = 0.092$). The different activity levels of the trapezius muscle resulted from intramuscular balance in the muscle.⁷ Rotator cuff impingement also causes decreases in ROM and force production in all directions.^{1,15}

Chronic GH instability results from repetitive stresses applied to the GH ligament and capsular tissues, which is often seen in pitchers.^{1,2} As alterations in the RC musculature may develop, GH joint instability can be caused as a secondary problem; therefore, conditions must be considered when treating athletes.^{2,4,6} Pitchers with multidirectional instability may experience vague pain around the shoulder and also have multi-joint laxity.^{1,4} The condition leads to subluxation or dislocation of the GH joint anteriorly, inferiorly, and posteriorly during activity.^{2,4,6} If anterior laxity exists, pitchers usually experience increased pain only in the cocking phase of pitching.^{1,10} Athletic trainers should rule out the mechanism of instability before treating athletes with chronic GH instability by which an appropriate rehabilitation plan is established. Poor assessment of the underlying issues worsens the conditions because a

rehabilitation program may be appropriate for certain instability, but it may not be suited for a different instability. It must be designed specifically, depending on the type of instability. ^{1.2.4.6.10}

Suprascapular neuropathy is also common in the dominant arm of pitchers. In baseball pitchers with fatigued muscles, the suprascapular nerve may be compressed at the spinoglenoid notch of the scapula causing atrophy in the infraspinatus and decrease in strength during external rotation and abduction. ^{5.12.22} Pitchers with suprascapular neuropathy experience vague pain and soreness around the posterior aspect of the scapula which can limit the activity levels of pitchers. Decrements in overall performance will be present, influencing accuracy of control and throwing velocity. ^{11.12.18.22}

Several vascular structures associated with shoulder distraction include the axillary, subclavian, subscapular, suprascapular, and posterior humeral circumflex arteries. Injuries to those vascular structures are related to internal force production by muscular and bony structures during pitching. ^{3.6.9} Either compression or traction force will be created within the shoulder complex, especially during the late stage of cocking and early stage of acceleration phases in which the amount of the two

different types of forces reach their peak. During the two phases, not only the subclavian artery is highly affected by compression of the scalenus muscles but also pressure to the third segment of the axillary artery becomes vigorous.

^{3.9.19.23} Arterial occlusion of the two arteries is commonly seen in overhead throwing athletes. ^{3.23}

Kinesio tape application will relieve the symptoms raised from repetitive throwing by enhancing the blood flow to the shoulder complex and supporting the fatigued muscles. ²⁴⁻²⁷

KINESIO TAPING

Kinesio taping is a relatively new taping technique in athletic settings that was first introduced by Kenzo Kase in 1996. ^{25.28} Kinesio tape (KT) is a thin elastic tape with water-proof ability which contains no latex material. ^{26.29} Depending on the type of taping application, KT is able to stretch up to 140% from its resting state in the longitudinal plane. ^{21.24.29-31} Over 100 different kinesio taping techniques have been investigated, which can help with treating many kinds of athletic injuries. The specific goal(s) of application determines what type of application

technique is utilized.^{26.27.31} KT provides its effects to the body from completely different mechanisms when compared to those traditional athletic tapes. Those traditional athletic tapes focus on the structural support which compresses a muscle group or joints, limits the joint range of motion, or repositions the treated structure back to the normal place.^{13.26.32} However, the effect on joint structure support diminishes after approximately 20 minutes of activity.³³ Zanella et al. used repeated measures in the study and found that there was no effect of scapular taping on repositioning during active shoulder flexion ($P = 0.92$) or abduction ($P = 0.40$); therefore, application of traditional athletic tape for athletic performance seems to be rare on baseball pitchers.³² On the other hand, KT can be used during athletic activity which focuses on facilitating the physiological functions that are impaired due to fatigue and/or overuse.^{24-26.31} KT can stay on the skin for three to four consecutive days before another application is needed, whereas the effect of traditional athletic tape lasts approximately 20 minutes.^{13.21.33} The optimal effect will appear approximately 30 minutes after the kinesio tape is applied as adequate glue activation is accomplished around that time.²⁷

According to Kenzo Kase, there are four intended functions of KT application: 1) increasing venous and lymphatic circulation, 2) stimulating the neurological perception of athletes, 3) correcting joint mal-alignment, and 4) supporting weakened muscles from fatigue. ^{13.24-27.30.31}

First, KT application causes the skin to be raised toward the outside of the body, increasing the interstitial space between the skin and underlying connective tissues such as muscles, ligaments, and tendons. This action allows blood and lymph fluids to travel smoothly through the treated area. Therefore, it can improve the venous and lymphatic circulation of the area being treated which is the primary function of kinesio taping. ^{21.26.27.29}

Second, the neurological system is stimulated by the application which alters the subject's perception of pain. Stimulation of the neurological system causes the brain to send the efferent signal which does not allow the afferent signal, pain perception, to go up to the brain. ^{24.26.27}

Third, muscle spasm is reduced by the correction of joint mal-alignments. When a joint is in an abnormal position, the muscles surrounding the joint must work to compensate. As a result, the muscles contract either stronger or weaker than normal which can cause spasm of the muscles. KT may help with muscle spasm or pain raised from a joint mal-alignment by

correcting the joint mal-alignment and supporting weakened muscles surrounding the joint.^{24.27.30} Lastly, existing muscle imbalance from improper training techniques and/or biomechanics is improved by supporting weakened muscles or over-trained muscles.^{13.24.26} Normal movement facilitation can be accomplished by the other functions of KT.^{25.27.30}

Several researchers supported the hypothesized KT functions proposed by Kenzo Kase and have revealed the effectiveness of the technique for athletes.^{24.29.30} In research conducted by Zajt-Kwiatkowska et al, a variety of athletic injuries were treated, including acute ankle sprain, tendinitis of the long head of the biceps brachii muscle, lower leg lateral compartment syndrome, and inflammation of the plantar aponeurosis. Zajt-Kwiatkowska et al reported in their research that there was a decrease in both pain and edema accumulation in all injured athletes. Additionally, No allergic reactions were observed in the patients during the research.²⁹

Bast et al. analyzed the blood flow of the dominant and non-dominant upper extremities in baseball pitchers, by using color flow duplex ultrasound imaging. They found that the arterial blood flow of the dominant arm increased until approximately the 40th pitch, but it gradually declined as the number of pitches increased after it reached the peak

point (549 ml/min) around 40th pitch. In contrast, the peak blood flow of the non-dominant arm (448 ml/min) was observed immediately after warm-up, and then it declined gradually throughout the rest of pitching.¹⁴ Repetitive overhand throwing put extraordinary pressure on the GH joint which causes physiological alterations in musculoskeletal structures.^{1.10.16} The physiological alterations include hypertrophy of muscles by which vascular structures surrounding the GH joint are irritated and compressed, changing the blood flow volume in the region.^{1.14.22} The axillary artery becomes vulnerable to a compression force during the transition phase from cocking to acceleration when abduction, horizontal extension, and maximum external rotation of the arm occur.^{2.14.19.23} All three segments of the axillary artery are compressed at that position. The clavicle compresses the first segment, the pectoralis minor puts pressure on the second segment, and the humeral head pushes the third segment anteriorly and inferiorly. According to the result of the study, the throwing velocity average was high when the blood flow average was also high; therefore, there was a relationship between the throwing velocity and the blood volume. Based on the fact, the throwing velocity will increase if the

application of KT successfully facilitates the blood flow around the GH joint. ^{3.10.14.15.22.23}

KT application increases superficial blood circulation of the treated area which is believed to allow muscles to absorb nutrients and oxygen from the blood. ^{14.27.29} The KT application of rotator cuff impingement syndrome affects the superficial blood vessels that supply the lateral and posterior shoulder muscles. Throwing velocity of baseball pitchers, who have impaired blood circulation due to repetitive throwing, may be increased if there is a sufficient amount of blood circulation around the shoulder complex. ^{13.24-27}

Improvement in active range of motion (ROM) of trunk flexion (17.8 cm) was observed with the application of KT in the research conducted by Yoshida et al, using a dependent t test. It is considered as the result of increased blood flow and cutaneous mechanoreceptor stimulation of posterior trunk. There were no significant differences in active range of motion of trunk lateral flexion ($P > 0.05$) and extension ($P > 0.05$). ²⁴ Thelen reported that the participants performed pain-free shoulder abduction ($P = 0.05$) with KT immediately after the application. ¹³ Stretching the shoulder complex can lead to acute increase in external and internal rotations at 90-

degree abduction; however, the duration of the effects gradually decreases as pitchers increase the number of pitches.^{8.14.34.35} Unlike the effects of stretching, KT may be able to improve ROM and keep the effects for three to four days which could help pitchers' performance throughout practice or competitions.^{13.21.24.27}

According to the Halseth study, the effects of KT on proprioception are still under investigation; however, increase in proprioception will be another function of the application if future research confirms vital information about the relationship between KT and proprioception.³¹ Regaining proprioception is essential for injured athletes during a rehabilitation program. KT might become important as a helpful therapy technique for athletic trainers and other health care providers in order to improve athletes' proprioception effectively.^{17.27.31} Utilizing KT therapy with other physical therapy techniques, such as electrical current stimulation and ultrasound, may enhance the outcomes of both therapies which would eventually lead to early return to play or competition.^{14.24.26.27.30}

INJURY PREVENTION

Injury prevention becomes an important component when considering baseball pitching or any athletic performance. Preventing all athletic injuries would be unrealistic, but minimizing the risk of injury will be accomplished by having an athlete perform warm-up properly before any types of activities. There will be less chance of injury if athletes understand specific training demands of their sports in order to prepare for competitions. ^{1.15.18.34.36} Warm-up is the standard practice for all athletes at any level of sports prior to participation, but a warm-up protocol should be designed specifically to each sport in which athletes are required to perform different sport-specific skills. ^{34.35.37.38}

There is a lack of scientific evidence from previous research in the effectiveness of warm-up protocol on injury prevention even though warm-up protocol, theoretically, helps athletes with preventing injury and preparing for athletic performance in their sports. ^{35.37} An increase in the body temperature is observed during warm-up as the result of vasodilation of blood vessels which increases blood circulation of muscle groups working and there is also facilitation of metabolic processes, causing smooth

muscle contractions. When the body temperature increases, more oxygen is available to the active muscles since hemoglobin releases binding oxygen. The nerve transmission may speed up as the temperature increases which improves the ability to react to a stimulus. ^{34.39.40} Smith found that a high incidence of musculoskeletal injuries is associated with inadequate warm-up. Inadequate warm-up leads to lack of elongation of muscles which makes athletes vulnerable to strains to muscles and tendons. ³⁸

Static stretching is less likely to cause injury than other types of stretching such as dynamic and ballistic stretching. An athlete performs static stretching in slow and constant manner and holds a stretch for 30 seconds at a position with mild discomfort. ^{35.39.40} Since two to three repetitions of 30 second static stretching has been reported that facilitate the ability of muscle being stretched to elongate, pitchers should perform static stretching, especially of shoulder internal and external rotators in order to achieve optimal elongation of the muscles with low-risk of injury during the stretch. ^{34.37.39} During stretching of the shoulder, the scapula should be stabilized when it can negatively influence the benefits of a stretch of target muscle group. Stabilization of the scapula typically is performed by the hand of a clinician

or having the athlete lay supine on a treatment table.^{17.34}
 The ability of muscles to elongate gradually increases and reaches its peak at first 15 minutes after stretching; therefore, stretching should be initiated ideally about 15 minutes prior to participation in order to obtain the best effect.^{36.38}

Baseball pitchers should attempt to warm-up the entire body while focusing on stretching the shoulder muscles used during the pitching motion. Throwing requires pitchers to contract a variety of muscles in the upper and lower extremities in a sequential manner during which all muscles that are activated must work efficiently to produce the desired outcome.^{6.18.19} It is important to stretch the rotator cuff musculatures as they produce a tremendous amounts of stresses on the glenohumeral (GH) joint.^{1.10.20.34}
 An inadequate warm-up can result in failure of obtaining the physiological effects due to a warm-up, increasing the risk of shoulder injury.³³ However, an adequate warm-up allows the shoulder internal and external rotators to work together concentrically as well as eccentrically throughout the pitching motion to reduce the stresses placed on the GH joint.^{2.5.18.19.40}

A well-designed warm-up protocol consists of an adequate warm-up session and stretching which reflects the

demands of athletes without making them fatigued. The optimal goal of warm-up is to minimize the risk of injury while preparing athletes for being the best condition before activities. ^{17.37.38.40}

APPENDIX B
THE PROBLEM

Statement of the Problem

The amount of stress placed upon the shoulder complex during baseball pitching is tremendous which can cause various shoulder problems for pitchers, influencing the level of athletic performance.^{1.5-8.13.14} When the shoulder complex fatigues from repetitive stress, the level of athletic performance of pitchers would decline.^{1.10-12} The primary function of kinesio tape is to increase the blood circulation of area(s) being treated. If athletic trainers can facilitate the blood circulation of the shoulder complex by applying kinesio tape, more oxygen and nutrients would be available from the blood to the active muscles.^{21.26.27.29} That means pitchers will be able to pitch in their best condition in terms of blood circulation of the shoulder complex. No research has been performed the effect of kinesio tape on athletic performance.^{3.9.13-17} The purpose of this study was to examine if kinesio tape application acutely increases the throwing velocity of NCAA collegiate baseball pitchers.

Definitions of Terms

The following are definitions of operational terms defined accordingly for this study:

- 1) Physiological problems - injuries, problems, or dysfunctions to musculoskeletal structures or internal body system.
- 2) The shoulder complex - shoulder joints, including acromioclavicular, sternoclavicular, glenohumeral, and scapulothoracic joints, and surrounding musculoskeletal structures. ¹
- 3) Throwing Velocity - velocity of a thrown ball which is measured by a Bushnell Radar Gun using the measurement of miles per hour (mph).
- 4) Kinesio tape - an athletic tape investigated by Kenzo Kase which can produce four different functions depending on the purpose to correct underlying issues of athletes.
13.24-27.30.31
- 5) Traditional athletic tape - athletic tape which compresses, supports, and limits range of motion to prevent athletic injury. ^{13.26.32}
- 6) Kinesio tape application for rotator cuff impingement syndrome - a kinesio tape application that is used to treat symptoms of rotator cuff impingement syndrome using the method which is introduced in "Clinical Therapeutic Applications of the Kinesio Taping Method" written by Kenzo Kase. ²⁷

- 7) Glue activation - the adhesive ability of kinesio tape reaching its peak for optimal effects.
- 8) Eccentric phase of plyometric activity - a phase during which muscles lengthen to produce powerful outcome at the end of activity. ⁶
- 9) Static stretching - a stretching technique which is performed in slow and constant manner and held for 30 seconds to lengthen target muscle group at a low risk of injury. ^{35.39.40}

Basic Assumptions

The following are basic assumptions for this study:

- 1) The subjects will report honestly about their shoulder conditions that will not be exacerbated by participating in this study.
- 2) The subjects will throw with their maximum effort each time.
- 3) The subjects will be able to throw at a maximum speed each time since there will be limited number of pitches in each set (three pitches) and sufficient amount of rest period between each set (15 minutes) in order to prevent fatigue of the pitchers.

- 4) Collegiate baseball players would have at least a shoulder problem which causes impaired blood circulation to the shoulder region, and may affect throwing velocity.
- 5) The JUGS® Radar Gun will be properly calibrated, and be able to register the velocity accurately.

Limitations of the Study

Limitations of this study are the following:

- 1) Limited number of pitches will be performed for injury prevention.
- 2) The effects of kinesio taping will vary from individual to individual.
- 3) Testing date of this study will be the pre-season period during which pitchers' condition will not be same as their condition during the season.
- 4) All subjects will volunteer to participate in this study.

Delimitations of the Study

- 1) The subjects will be NCAA Division I, II, and III baseball pitchers.
- 2) Only one of the several possible kinesio tape applications for shoulder will be used in this study.

Significance of the Study

Kinesio taping is a relatively new application which is increasingly becoming popular in athletic settings. Kenzo Kase, founder of kinesio tape, has hypothesized four functions of kinesio tape application: 1) increasing venous and lymphatic circulation, 2) stimulating the neurological perception of athletes, 3) correcting joint malalignment, and 4) supporting weakened muscles from fatigue. ^{13.24-27.30.31} Although several researchers have supported the hypothesized functions, no research has been published the effects of kinesio taping on athletic performance. ^{3.9.13-17}

Baseball pitching puts an excessive amount of stress on the shoulder complex which can lead to shoulder injury. ^{1.5.6.8.10-12} The most common shoulder injuries among baseball players are rotator cuff impingement syndrome and glenohumeral joint instability. Those shoulder injuries decrease the performance level of pitchers which may result in impaired blood circulation to the shoulder complex. ^{1.7.13.14} The primary function of kinesio taping is to increase blood circulation of area(s) being treated; therefore, kinesio tape application may be able to help pitchers performance by facilitating blood circulation. ^{21.26.27.29}

The fundamental purpose of the study is to explore the possibility of kinesio tape improving athletic performance. Specifically in the study, throwing velocity of baseball pitchers will be investigated. If the results of the study are found to increase in throwing velocity of baseball pitchers, the use of kinesio tape will be widespread throughout baseball. If these results are observed in baseball pitchers, then further research will be needed to examine the effects of kinesio tape on sport-specific skills such as kicking, jumping, and hitting.

APPENDIX C
ADDITIONAL METHODS

APPENDIX C1

INFORMED CONSENT FORM

Informed Consent Form

Yohei Hikita, a Graduate Assistant Athletic Training Student at California University of Pennsylvania, has requested my participation in a research study. The title of this study is The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Division I, II, and III Baseball Pitchers.

I have been informed that the purpose of this study is to examine if the kinesio tape application used for this study have an effect on throwing velocity in NCAA baseball pitchers.

My participation will include two testing sessions with and without the kinesio tape application. Each testing section will consist of a 15 minute warm-up and three sets of three pitches at a maximum speed with a 15 minute interval between each set. I will be randomly assigned to one of the two groups in each session by the researcher: No-Application and Application groups. I will perform three sets of three pitches under the two different conditions for the researcher. The expected duration of the participation will be total of four hours.

The warm-up protocol designed by the researcher will involve three minutes of jogging and a nine minute static stretching followed by three minutes of partner throwing. During the static stretching, the entire shoulder will be stretched. I will be allowed to perform any stretching that I feel necessary after the warm-up for the purpose of injury prevention.

Application of kinesio tape will be administered 30 minutes prior to pitching to allow glue activation of the tape. Between the time of application and warm-up, I will not be allowed to perform any activity that may interfere the glue activation.

Three separate pieces of kinesio tape will be applied to the dominant shoulder. I will be asked to stretch the structures where kinesio tape will be applied. The taping area should be dry and free of hair. I understand that hair in the shoulder region may be removed by the researcher in order to allow the glue activation.

I understand there are foreseeable risks or discomforts to me if I agree to participate in this study. The possible risks and/or discomforts include experiencing pain and/or soreness due to the throwing activity, and/or being taped directly on the skin. In order to minimize these risks and discomforts, the researcher has included the warm-up protocol and adequate interval between each performance.

I understand the researcher is a certified kinesio taping trainer, and is able to prevent allergic reactions due to kinesio tape application.

I understand that in case of injury or continued, unexplained muscle or joint soreness, I will be referred to the team physician for treatment. I understand that I will be responsible for payment of any services provided by the team physician or other medical professional.

There are no feasible alternative procedures available for this study.

I understand that the possible benefits of my participation in this study will be to examine if the kinesio tape application used for the research study have an effect on throwing velocity in NCAA baseball pitchers.

I understand that the results of this study may be published, but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Yohei Hikita will maintain all documents indefinitely in a secure location in which only the student researcher and research advisor can access.

I have been informed that I will not be compensated for my participation.

I have been informed that any questions I have concerning the research study or my participation in it, before and after my consent, will be answered by:

Yohei Hikita,

947 Cross Street, Apt2

California, PA, 15419,

(724) 415-7515

hik6936@cup.edu,

Or by the Graduate research advisor

Dr. Thomas Kinsey,

Department of Health Science and Sport Studies,
Hamer, Box 14, California University of Pennsylvania,
15419,
(412) 720-1037
Kinsey@cup.edu

I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit.

My participation in this study will be voluntary and also will be confirmed by signing my signature below.

Subject's
name (print) _____

Subject's
signature _____ Date _____

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this study, have answered any questions that have been raised, and have witnessed the above signature.

I have provided the subject/participant a copy of this signed consent document if requested.

Investigator's
Signature _____ Date _____

Approved by the California University of Pennsylvania IRB

The study approval is effective from 12/01/08 and expires on 11/30/09.

APPENDIX C2

KINESIO TAPE, SCISSORS, AND APPLICATION

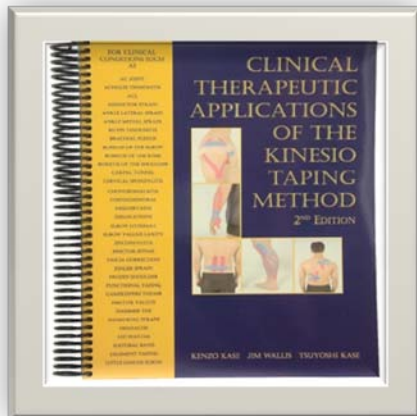
Kinesio® Tex Gold Extra Water-Resistant



Kinesio® Pro Scissors



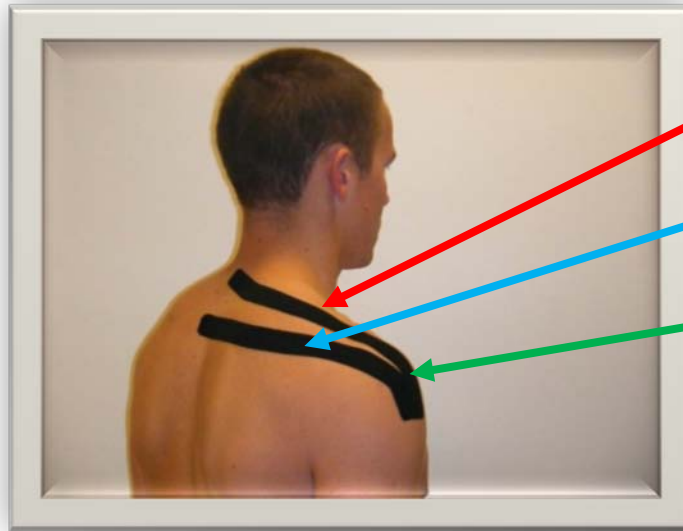
The kinesio tape application book written by Kenzo Kase



Kinesio Tape Application for Rotator Cuff Impingement Syndrome

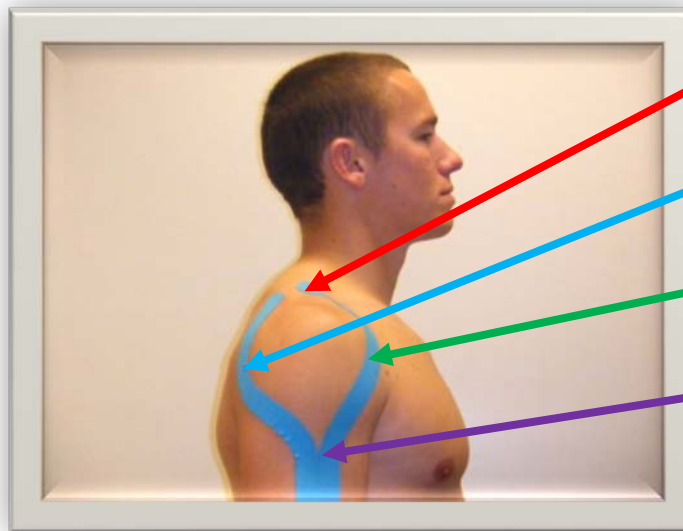
Individual Strips

Application A (Suprapinatus)



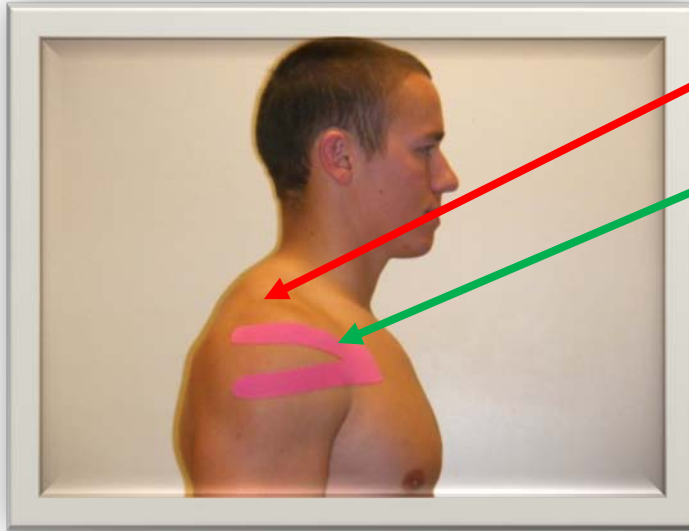
- Superior border of the supraspinatus
- Spine of the Scapula
- Greater Tuberosity of the humerus

Application B (Deltoid)



- Acromioclavicular joint
- Posterior border of the deltoid
- Anterior border of the deltoid
- Deltoid tuberosity of the humerus

Application C (Coracoid Process)



Acromioclavicular
joint

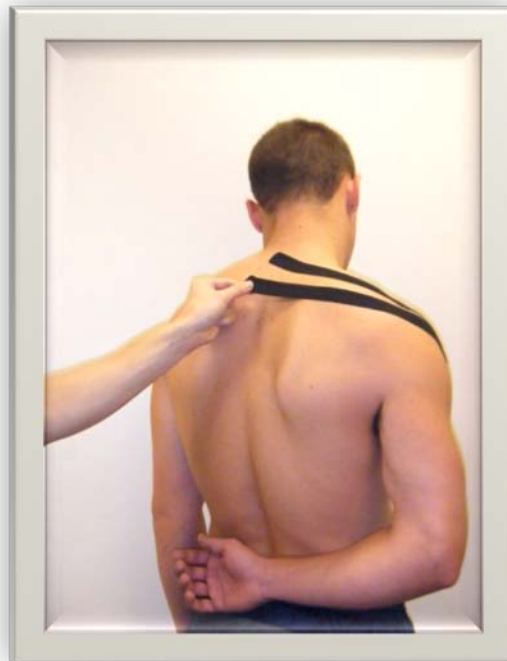
Coracoid process
of the scapula

Kinesio Tape Application for Rotator Cuff Impingement Syndrome

The Process

The base of a kinesio Y-strip is applied two inches below the greater tuberosity of the humerus without tension.

The athlete is asked to stretch the supraspinatus by performing lateral flexion of the neck away from the treated area and shoulder adduction behind the back.

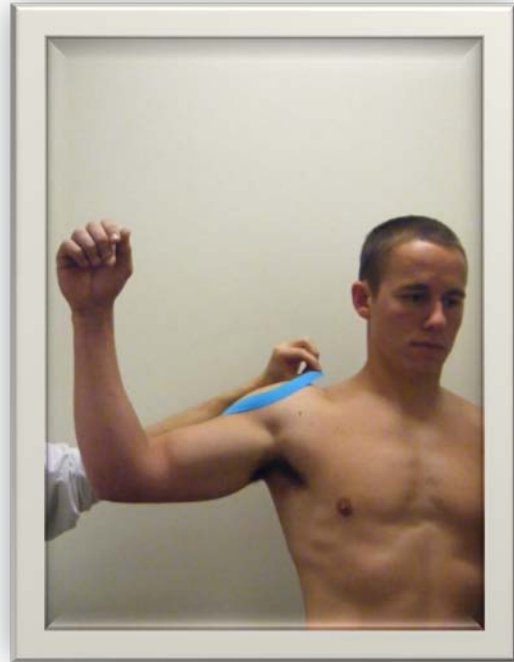


Without putting tension of the tape, the superior tail is applied toward the supraspinous fossa on the superior medial border of the scapula, and the inferior tail is applied on the length of the spinous process of the scapula.



The base of a kinesio Y-strip is applied two inches below the deltoid tuberosity of the humerus without tension.

The athlete is asked to stretch the anterior portion of the deltoid by performing shoulder abduction to 90 degrees with external rotation and horizontal abduction.



Without tension, the anterior tail is applied along with the anterior border of the deltoid toward the acromioclavicular (AC) joint.

The athlete is asked to stretch the posterior portion of the deltoid by performing shoulder abduction to 90 degrees with internal rotation and horizontal abduction.

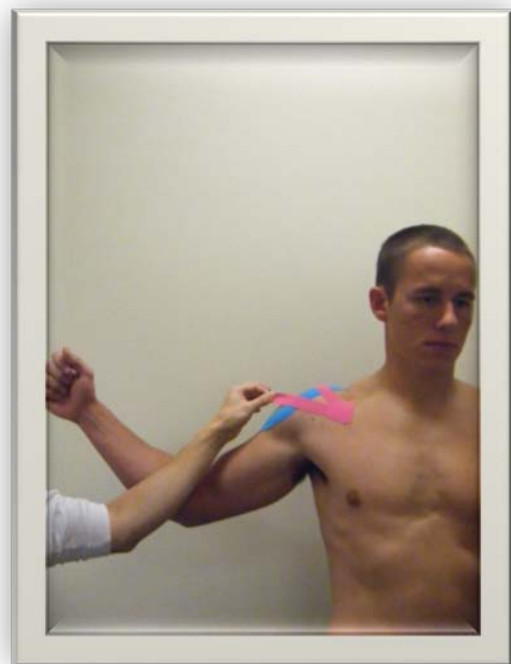


Without tension, the posterior tail is applied along with the posterior border of the deltoid toward the AC joint.

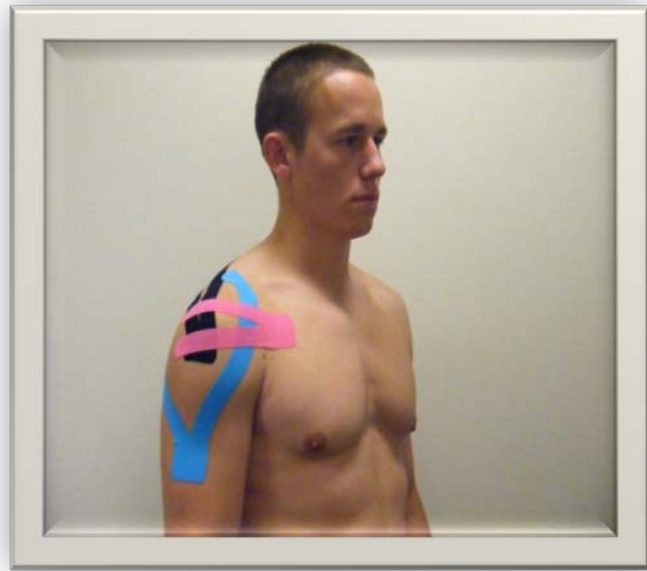


The base of a kinesio Y-strip is applied on the anterior shoulder just above the coracoid process without tension.

The Athlete is asked to perform shoulder flexion and horizontal abduction. With 50-75% of available tension and inward pressure, both the superior and inferior tails are applied toward the posterior aspect of the shoulder; the superior tail goes by just inferior to the acromion process of the scapula while the end of the inferior tail ends with at approximately 1 ½ inches below the end of superior tail.



There is no tension applied to the end of the superior and posterior tails.



APPENDIX C3

RADAR GUN

The JUGS® Radar Gun



APPENDIX C4

STATIC STRETCHING PROTOCOL

Static Stretching Protocol

Five different static stretching techniques

- 1) Anterior Shoulder Stretch
- 2) Cross-Arm Stretch
- 3) Posterior Shoulder Stretch
- 4) Arm-Behind Stretch
- 5) Triceps Brachii Stretch

Major muscles will be stretched include:

- ✓ Pectoralis Major and Minor
- ✓ Deltoid
- ✓ Trapezius
- ✓ Coracobrachialis
- ✓ Biceps Brachii
- ✓ Triceps Brachii
- ✓ Latissimus Dorsi
- ✓ Teres Major
- ✓ Rhomboids
- ✓ Infraspinatus

Bilateral stretching

Two repetitions of 30 seconds

A five second rest between each stretching

Anterior Shoulder Stretch

Muscles primarily stretched:

Pectoralis Major, Anterior Deltoid, Coracobrachialis,
Biceps Brachii, and Pectoralis Minor.



Stand upright and find a wall.

With the feet in shoulder-width apart, place left foot slightly in front of the right foot.

Raise the left arm to 90 degrees, and place the palm on the wall.

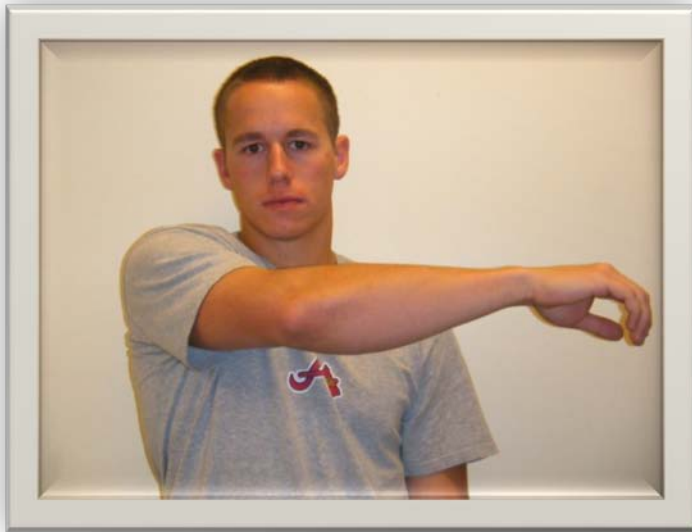


Rotate the body to right and lean the entire body forward until the stretch is felt. Repeat the same stretch for the other side.

Cross-Arm Stretch

Muscles primarily stretched:

Posterior Deltoid, Latissimus Dorsi, Triceps Brachii,
Middle Trapezius



Stand upright with the feet shoulder-width apart.

Bring the right arm across the front of the body. Pull the right elbow toward the body with the left forearm until the stretch is felt.

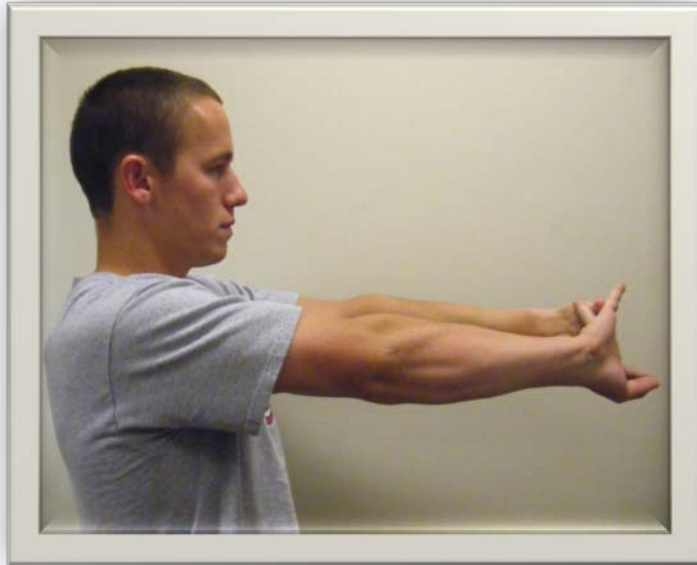


Repeat the same stretch for the other side.

Posterior Shoulder Stretch

Muscles primarily stretched:

Posterior Deltoid, Middle Trapezius, Triceps Brachii, Teres Major, Rhomboids, Infraspinatus.



Stand upright with the feet shoulder-width apart.

Bring the both arm in front the body and clasp fingers at level of the shoulder.

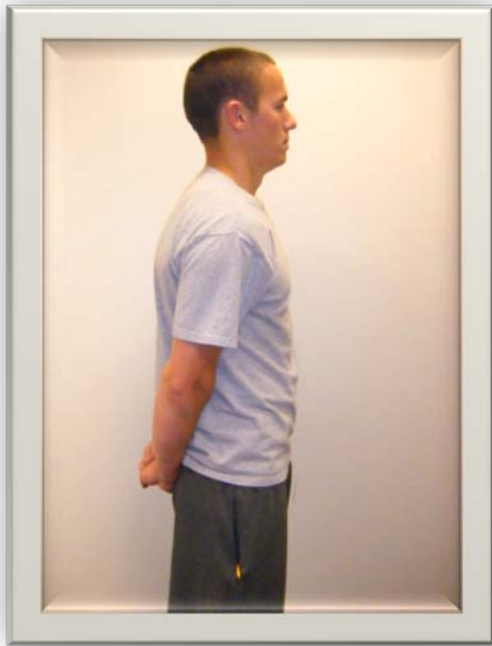


Gradually extend the arms away from the body until the stretch is felt.

Arm-behind Stretch

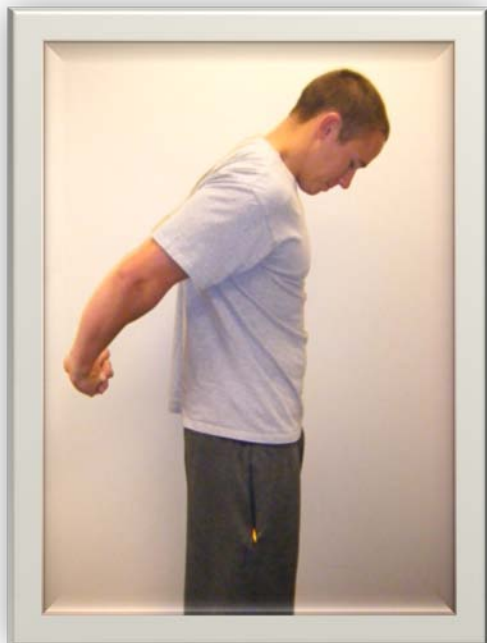
Muscles primarily stretched:

Pectoralis Major, Anterior Deltoid, Coracobrachialis,
Biceps Brachii, Pectoralis Minor.



Stand upright with the feet in shoulder-width apart. Bring the both arms behind the body while clasping fingers.

Gently bring the both arms upward until the stretch is felt.



Triceps Brachii Stretch

Muscles primarily stretched:

Triceps Brachii



Stand upright with the feet in shoulder-width apart. Raise the right arm over your head and bend the elbow.



Place the left hand over the right elbow, and gradually pull the right arm down until the stretch is felt. Repeat the same stretch for the other side.

APPENDIX C5
DEMOGRAPHIC AND SCORE SHEET

No _____

Demographic Information

Age: 18 / 19 / 20 / 21 / 22 / 23 / 24

Year in School: Freshman / Sophomore / Junior / Senior

Which arm is your dominant arm? Right / Left

Do you currently have any injuries which has assessed by a
certified athletic trainer or diagnosed by a team
physician?

Yes / No If yes, what is it? _____

Did you have shoulder surgery within the previous six
months?

Yes / NO

Please list your history of shoulder injury if any.

Score Sheet

Subject No	Non-Application Order:	Application Order:
Throw 1		
Throw 2		
Throw 3		
Average Velocity (1)		
Throw 4		
Throw 5		
Throw 6		
Average Velocity (2)		
Throw 7		
Throw 8		
Throw 9		
Average Velocity (3)		
Average Velocity (1-3)		

APPENDIX C6

IRB: CALIFORNIA UNIVERSITY OF PENNSYLVANIA



California University
of Pennsylvania

ORIGINAL

Proposal Number

08-016

Date Received

10/31/08

PROTOCOL for Research Involving
Human Subjects

Expedited

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Baseball Pitchers

Researcher/Project Director Yohei Hikita

Phone # (724) 415-7515 E-mail Address hik6936@cup.edu

Faculty Sponsor (if required) Dr. Thomas Kinsey

Department Health Science and Sport Studies

Project Dates September 2008 to May 2009

Sponsoring Agent (if applicable) _____

Project to be Conducted at California University of Pennsylvania using subjects from Washington and Jefferson College, Upper Iowa University, and University of Northern Iowa

Project Purpose: ☒ Thesis ☐ Research ☐ Class Project ☐ Other

Keep a copy of this form for your records.

Required IRB Training

The training requirement can be satisfied by completing the online training session at <http://cme.nci.nih.gov/>. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:

Previous Project Title _____

Date of Previous IRB Protocol _____

Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(es) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual*

The purpose of this study will be to examine if kinesio tape application acutely increases throwing velocity of NCAA collegiate baseball pitchers. The subjects will be baseball pitchers from Washington and Jefferson College, Upper Iowa University, and University of Northern Iowa. Approval from each institution and California University of Pennsylvania Institutional Review Board approval will be collected prior to this study. Total of 30-50 baseball pitchers will be expected to participate in this study. The concepts and procedure of this study will be introduced at a team meeting prior to testing. During the team meeting, the researcher will demonstrate the kinesio tape application for rotator cuff impingement syndrome (Appendix 2) and the five static stretching techniques (Appendix 3) that will be performed in this study. Informed consent form (Appendix 1) will be read and signed by each subject, and will be collected by the researcher at the end of the team meeting.

Each subject will be randomly assigned to one of the two groups (non-application/application). They will go through the warm-up protocol designed by the researcher in order to get ready to pitch and also to prevent injury during this study prior to each pitching session. The warm-up protocol consists of three minutes of jogging and a nine minute static stretching followed by three minutes of throwing with a partner. Each stretching technique will be hold for 30 seconds and repeated for twice. All subjects will be allowed to perform any stretching that they feel necessary after the warm-up for the purpose of injury prevention. There will be two pitching sessions in one day. Each subject will pitch as hard as he can under two different conditions (non-application/application). There will be three sets of three pitches under each condition which means each subject will throw 18 times in this study. The following is the specific procedure of each testing group.

Group A will warm-up 15 minutes prior to the first pitching session. Without kinesio tape application, group A will perform three sets of three pitches at a maximum speed with a 15 minute interval between each set. After the first pitching session, the researcher will apply kinesio tape for next 30 minutes. Pitchers will be asked to rest during the application time. Another 30 minute will be presumed for kinesio tape glue activation during which pitchers warm-up in last 15 minutes in order to prepare for the next pitching session. Group A will perform three sets of three pitches with application.

Group B will go through the same process in reverse order. The researcher will apply kinesio tape first, and pitchers will warm-up 15 minutes prior to the first pitching session. Group B will perform three sets of three pitches with application. Kinesio tape application will be removed from pitchers after the first pitching session and they will warm-up again 15 minutes prior to the second pitching session. Group B will perform three sets of three pitches without application.

The testing for each group will be performed at a same time inside a gymnasium or recreation center to avoid wind affecting the outcomes. Each pitcher will throw 60 feet and six inches away from a catcher off the mound. Throwing velocity will be measured using a radar gun, and the velocity of all pitches will be recorded on the score sheet. Averages of each pitching set will be utilized for data analysis. SPSS 16.0 statistical software package will be used for data analysis. An alpha level of ($P \leq 0.05$) will determine significance. It is hypothesized that throwing velocity of baseball pitchers increases with the kinesio tape application .

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*

a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

The possible risks and/or discomfort involved are stated in the informed consent (Appendix 1). The warm-up protocol will help minimize the risk of injury during this study by warming up the tissue temperature and stretching of the major muscles used during the pitching motion. The risk of injury due to pitching at a maximal speed will be no more than the risk associated with a regular competition or practice for collegiate baseball pitchers. When injury or prolonged muscle or joint soreness is experience by the subjects, the researcher, who obtained Bachelor of Science Degree in Athletic Training, will refer to their team physician or medical professional available by each institution. The researcher is a certified kinesio taping trainer, and will be able to prevent allergic reactions due to kinesio tape application.

b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

All subjects will be NCAA collegiate baseball pitchers who volunteer to participate in this study. Any baseball pitchers with shoulder and/or any other pathology that might be exacerbated by throwing at a maximal speed will not be allowed to participate in this study. In case of injury or discomfort during a testing session, the subject will be allowed to stop his participation any time he requests.

- c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

There will be a team meeting during which the concepts and procedure of the study will be introduced, and each subject will read and sign the informed consent (Appendix 1). All informed consent will be submitted directly to the researcher who will keep them in a secure location.

- d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

All data will be collected and kept in a secure location where only the researcher and the research advisor will have an access to the records. Confidentiality will be maintained by a subject number which replaces each subject's name and identifies the subject.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

<input checked="" type="checkbox"/> <i>Adult volunteers</i>	<input type="checkbox"/> <i>Mentally Disabled People</i>
<input type="checkbox"/> <i>CAL University Students</i>	<input type="checkbox"/> <i>Economically Disadvantaged People</i>
<input type="checkbox"/> <i>Other Students</i>	<input type="checkbox"/> <i>Educationally Disadvantaged People</i>
<input type="checkbox"/> <i>Prisoners</i>	<input type="checkbox"/> <i>Fetuses or fetal material</i>
<input type="checkbox"/> <i>Pregnant Women</i>	<input type="checkbox"/> <i>Children Under 18</i>
<input type="checkbox"/> <i>Physically Handicapped People</i>	<input type="checkbox"/> <i>Neonates</i>

4. *Is remuneration involved in your project?* ☐ *Yes* or ☒ *No*. *If yes, Explain here.*
5. *Is this project part of a grant?* ☐ *Yes* or ☒ *No* *If yes, provide the following information:*
Title of the Grant Proposal _____
Name of the Funding Agency _____
Dates of the Project Period _____
6. *Does your project involve the debriefing of those who participated?* ☐ *Yes* or ☒ *No*
If Yes, explain the debriefing process here.
7. *If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix __ in the Policies and Procedures Manual.*

Project Director's Certification Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

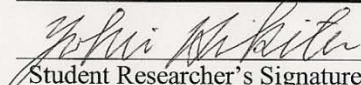
I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

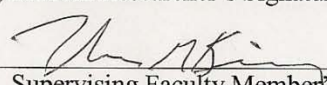
Project Director's Signature

Department Chairperson's Signature

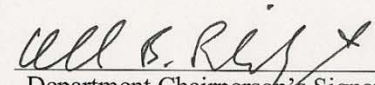
Student or Class Research



Student Researcher's Signature



Supervising Faculty Member's
Signature if required



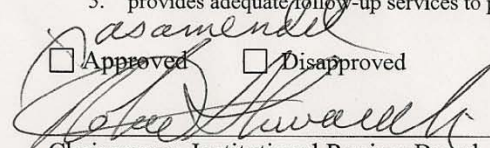
Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☒ Approved ☐ Disapproved



Chairperson, Institutional Review Board



Date

APPENDIX C7

LETTER OF APPROVAL AND APPROVAL LETTERS FROM INSTITUTIONS

California University of Pennsylvania

Department of Health Science
and Sport Studies 



To: Whom It May Concern

From: Yohei Hikita

947 Cross st
California, PA 15419

Thesis Approval

Date: October 20, 2008

My name is Yohei Hikita, a Graduate Assistant Athletic Training Student from California University of Pennsylvania. I am currently working toward my Master of Science Degree in Athletic Training, and a thesis must be done to obtain the degree. The title of my thesis is, " The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Division I, II, and III Baseball Pitchers." I would like to request the use of the baseball pitchers at Washington and Jefferson College.

Kinesio tape is an elastic tape which primarily increases blood circulation of areas being treated. Three separate pieces of tape will be applied to the dominant shoulder of each pitcher in order to examine the effects of the tape application on throwing velocity.

Once informed consent from each participant has been collected, I would like to set a testing day which will be convenient for your baseball team. There will be a meeting prior to the testing to explain the concepts and procedure of the research study. This study asks the baseball pitchers to throw 18 times as hard as they can in one day. They will perform 3 sets of 3 pitches with and without kinesio tape application. A warm-up protocol designed by myself and adequate amount of rest between each set will be provided in order to minimize the risk of injury during this study. The testing method was primarily designed for the participants' health.

If you have any questions regarding to my study, please e-mail me at hik6936@cup.edu or call me at (724) 415-7515.

I look forward to your approval of this important educational research.
Sincerely,

Yohei Hikita

The study approval is effective from 12/01/08 (date) and expires on 11/30/09.

250 University Avenue
California, PA 15419-1394
724-938-4562/4350
724-938-4342 FAX
www.cup.edu

A proud member of Pennsylvania's State System of Higher Education




December 4, 2008

To Whom It May Concern:

Yohei Hikita has the permission from The University of Northern Iowa Athletic Department to conduct research on UNI baseball pitchers at UNI for his thesis which is "The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Division I, II, and III Baseball Pitchers."

UNI accepts the Institutional Review Board of Human Protection (IRB) from California University of Pennsylvania.

Sincerely,



Troy Dannen
Director of Athletics
University of Northern Iowa



December 5, 2008

To whom it may concern:

Upper Iowa University Athletics Department grants permission to Yohei Hikita to use Upper Iowa University student-athletes in his master's theses study: The acute effects of kinesio tape on throwing velocity in NCAA Division I, II, and III baseball pitchers.

Sincerely,



Kent McElvania

Associate Athletic Director

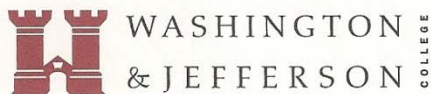
Interim Athletic Director



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Phone: 563-425-5700 • 800-553-4150 • Fax 563-425-5334 • www.uiu.edu/athletics



Department of Athletics



60 South Lincoln Street
Washington, Pennsylvania 15301
tel/ 724-223-6054
fax/ 724-250-3329
www.washjeff.edu

December 9, 2008

To Whom It May Concern:

I, William Dukett (Athletic Director at Washington & Jefferson College), give Yohei Hikita my approval to use the Washington & Jefferson College baseball pitchers as subjects for his Master's thesis entitled, "The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Division I, II, and III Baseball Pitchers".

Washington and Jefferson College accepts the Institutional Review Board from California University of Pennsylvania.

Sincerely,

A handwritten signature in black ink that reads "Bill Dukett".

William Dukett

Athletic Director

Washington & Jefferson College

REFERENCES

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11. Tripp B, Yochem E, Uhi T. Functional fatigue and upper extremity sensorimotor system acuity in baseball athletes. *J Athl Training*. 2007; 42: 90-98.
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ABSTRACT

TITLE: The Acute Effects of Kinesio Taping on Throwing Velocity in NCAA Division I, II, and III Baseball Pitchers

RESEARCHER: Yohei Hikita

ADVISOR: Thomas G. Kinsey

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PURPOSE: The purpose of this study was to examine if kinesio tape application acutely increases throwing velocity in NCAA collegiate baseball pitchers.

PROBLEM: The effects of kinesio taping will vary from individual to individual.

METHOD: A repeated/cross-over design was conducted. All subjects pitched at their maximum velocity under two conditions (Non-application/Application). Application for rotator cuff impingement syndrome was applied to each subject's dominant shoulder. A 15 minute warm-up was performed prior to the testing. All subjects pitched nine times with and without the application. Throwing velocity was measured with the JUGS® Radar Gun (an accuracy of $\pm\frac{1}{2}$ mph) from behind subjects' throwing arm.

FINDINGS: Kinesio tape application for rotator cuff impingement syndrome had no significant effects on throwing velocity of collegiate baseball pitchers ($F = .147$, $p = .705$).

CONCLUSION: Based on the findings of this study, there are no acute effects of kinesio taping on throwing velocity in NCAA collegiate baseball pitchers for the first nine pitches.