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The Effect of a Specific Training Program on the Athletic Performance of Ice Hockey Players

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THE EFFECT OF A SPECIFIC TRAINING PROGRAM ON THE ATHLETIC PERFORMANCE OF ICE HOCKEY PLAYERS

by

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An Independent Study

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This independent study, submitted by Grey M. Rudolph, in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Renee Mabey
(Faculty Preceptor)

Thomas Mohr
(Graduate School Advisor)

Thomas Mohr
(Chairperson, Physical Therapy)

PERMISSION

Title The Effect of a Specific Training Program on the Athletic Performance of Ice Hockey Players

Department Physical Therapy

Degree Master of Physical Therapy

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Signature Corey Rudolph

Date 4/8/93

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ABSTRACT

The Hockey Acceleration Program is an athletic training program designed by John Frappier, M.S., of Fargo, ND, to increase the speed, strength and explosiveness of hockey players. The program involves resistance training, plyometrics and skate training on a skating treadmill. The purpose of this preliminary study was to analyze the effectiveness of the Acceleration Program by comparing the performance of athletes in a variety of areas before and after taking part in the Acceleration Program. The areas compared were strength, skating form, trunk musculature performance and flexibility. All data compared was taken from the records of Acceleration Products, Inc., the firm that oversees the Acceleration Program, and analyzed with standard statistical tests to determine if any significant change occurred. The analysis of the gathered data proved inconclusive and a larger scale study will be necessary to draw solid conclusions concerning the efficacy of the Acceleration Program.

CHAPTER 1

INTRODUCTION

Ice hockey is a fast paced, extremely physical sport popular in Canada, the United States and Northern Europe. Known for violent body checking and power skating, "a form of skating characterized by rapid changes in velocity and direction,"[1] the game requires many athletic skills to be successful. Strength and power are needed to deal with the physical nature of the game. Speed is needed for the rapid transition from one end of the rink to the other. As with other modern sports, hockey is becoming more competitive as greater numbers of naturally gifted athletes take up the game. These athletes are also increasingly willing to participate in training regimes designed to make them even better athletes. Off-season training, once done only by the truly dedicated, is now mandatory if a hockey player wishes to keep up with his peers. As this competitive cycle escalates, the demand is for advanced off-season training programs that not only maintain, but actually improve, a player's strength, speed and performance.

The Hockey Acceleration Program developed by John Frappier, M.S., of Fargo, ND, is an off-season training program designed increase a player's speed, explosiveness, strength and skating efficiency. Based on the specific demands of ice hockey as outlined by Green et al,[2] the Acceleration Program utilizes the traditional training methods of isotonic resistance exercise and plyometrics. In addition, Frappier has developed an innovative tool, a skating treadmill. This treadmill has been constructed to improve skating velocity. This is accomplished by "pushing" the skater to greater speeds than he would be capable of independently on ice. This skating is completed in a controlled environment with an emphasis on proper skating form and is designed to lead to greater speed and control on the

ice. Elastic bands called sprintcords are fastened to the skater's legs to provide resistance for specific muscle groups and to correct the skater's form while on the treadmill.

The Acceleration Program is divided into four to eight week periods called "levels". These levels are of progressive intensity and athlete's typically complete one to two of them during an off-season. The training is extremely demanding physically and is not intended to be completed during the playing season.

The purpose of this preliminary study was to attempt to scientifically document the changes seen, if any, due to the Acceleration Program in the following four areas: 1) muscular strength, as measured by a one repetition maximum lift on Eagle resistance equipment; 2) skating form, as measured by video analysis; 3) trunk musculature performance, as measured by evaluation on the B-200 Isostation and 4) lower extremity flexibility, as measured by sit and reach and goniometric tests. This work is intended as a basis for more comprehensive and larger scale research to follow.

CHAPTER 2
REVIEW OF THE RELATED LITERATURE

The literature review presented in this chapter focuses on five main areas; resistance training, plyometric training, treadmill training, B-200 Isostation assessment of trunk musculature performance and lower extremity flexibility assessment. Included in this review is the literature on both the training methods utilized by the Acceleration Program and the assessment tools used in the current investigation. First considered is resistance training, including the general physiological effects, specific background on isotonic exercise and discussion of strength assessment in previously published works. Next the effectiveness of plyometric training in sport will be examined. Third will be a section pertaining to treadmill training. This will deal with literature on running treadmills, the effects of supramaximal speeds on running treadmills, and proper skating form for use as an evaluation tool with the skating treadmill. The treadmill will be discussed in detail due to the absence of any published information regarding a skating treadmill. The use of the B-200 Isostation for the assessment of trunk musculature performance will be the fourth area addressed. Finally, evidence will be presented supporting the use of the sit and reach test and goniometric measures for the evaluation of flexibility.

Literature Pertaining to Resistance Training

General physiologic responses

Resistance training is associated with a broad spectrum of physiologic responses in the musculoskeletal and neurological systems. The most obvious adaptation is an increase in skeletal muscle mass due to hypertrophy and hyperplasia.[3] Connective tissues, meaning primarily tendons and ligaments, show

increases in strength and mass. A similar effect is seen in bones, which increase in strength, mass and density.[4]

The nervous system also adapts, allowing a person to more fully activate the muscles primarily responsible for a movement. Better coordination is present between prime movers, secondary movers and stabilizers. These neurological changes allow a greater net force to be applied within the intended movement.[5] All of the above physiologic changes are very desirable adaptations in the arena of sports performance, where larger, stronger athletes are a coveted commodity.

Isotonic exercise

The Eagle brand resistance machines utilized by the Acceleration Program are isotonic in nature, meaning a dynamic exercise that is carried out against a constant load throughout the full range of motion.[6] In a series of studies with isotonic resistance Berger showed significant increases in strength even with varied intensities, sets and repetitions.[7-12] Comparisons between isotonic exercise and the other two major types of resistance exercise, isometric and isokinetic, reveal that all produce significant strength gains and that isotonic is the most popular, possibly due to the ease of implementation and relatively lesser expense.[13,14] Thus, the Acceleration Program's use of isotonic training is an accepted method to effect strength gains in it's clients.

Strength assessment

The traditional measure for strength in research is the 1 repetition maximum lift.[15] It has been applied most frequently to the bench press, but has also been used with other exercises.[8,16,17] The one repetition maximum test is used by the Acceleration Program to document changes in strength on the Eagle resistance equipment.

Literature Pertaining to Plyometrics

A plyometric training method involves, by definition, a quick, powerful movement involving a prestretching or countermovement that activates the stretch-shortening cycle.[18] The stretch-shortening cycle is a rapid stretch (lengthening) of a muscle prior to a quick shortening (contraction). This cycle produces greater force during the contraction than a contraction without a prestretch.[19,20] Theoretically, the force increase comes from two sources: the natural elastic energy stored in a muscle[21] and heightened excitability of the neuromuscular response.[22]

The primary training effect of plyometrics occurs through the neuromuscular adaptation as measured by EMG output. EMG has been shown to increase after plyometric training, indicating an increase in neural activity.[23] Plyometric trained subjects also display an EMG facilitation during the rapid stretch, whereas untrained subjects show neural inhibition.[24]

Plyometric adaptation is maximally applied in sports specific actions such as jumping while playing volleyball.[25] The effectiveness of plyometrics in improving power is debated in research. They have been shown to cause an increase in vertical leaping ability, but some studies show them to no more effective than any other techniques[26,27] while Duke[28] shows plyometrics to be superior. In any case, they are a training method with a physiological basis for their effectiveness.

Literature Pertaining to Treadmill Training

The skating treadmill used in the Acceleration Program is a recent invention patented to John Frappier and as such, does not appear in the literature at this time. The next section of review deals with issues pertinent to the skating treadmill: running treadmill studies, research done with overspeeding and a brief review of skating form. These areas provide the principles from which the skating treadmill was developed and the basis for its application in the Acceleration Program.

Treadmill running

One focus of research with treadmills examines how closely running on a treadmill mimics running overground. Areas of comparison include biomechanics and energy costs at comparable speeds. The energy requirements for the two types of running are virtually identical at speeds below 4.5 meters/second.[29] Above that speed the treadmill running required less energy, even with the air resistance encountered in actual running blocked with a special screen.[30,31]

The biomechanical parameters of running appear to differ most at speeds above 5 meters/ second. There is an increased stride frequency and a decreased non-support phase with the treadmill.[32]

Overall, it appears that treadmill running and overground running are not identical. The treadmill may reduce the energy requirements of the runner by bringing the support leg back under the body during support phase.[33] It is unknown if these same variations will occur with the skating treadmill.

Overspeed, or supramaximal, sprinting

A large portion of the perceived training benefit seen with a treadmill is its ability to "overspeed" sprinters to velocities they could not achieve on their own. The primary biomechanical difference between maximal and supramaximal sprinting is an increase in stride rate due to an increased neural activation.[34] This increase in stride rate increases sprinting velocity.

Neural activation as measured by absolute EMG activity in the lower extremities increases in amplitude with supramaximal speed when the muscles contract. The EMG activity during the time when the muscles aren't actively contracting remains constant at all speeds. This minimal muscular activity when the muscles aren't actively contracting is responsible for the stiffness in the muscle. This stiffness resists the impact forces during foot contact. Combined with the high impact forces noted in supramaximal sprinting this steady resistance accentuates both the neuromuscular and elastic portions of the stretch-shortening cycle causing an increase

in force production during the propulsive stage. An additional neural effect may be an increase in nerve conduction velocity with high speed training.[35] This allows the central nervous system to signal the muscles to fire more quickly. The above adaptations along with the muscle "learning" effect can increase the economy of running.[36]

The theoretical benefit of the skating treadmill is identical to that of the running treadmill. All of the above research suggests that supramaximal sprinting is a beneficial training stimulus and "may result in adaptation of the neuromuscular system to a higher performance level."[37] While it seems logical that the same adaptation would be seen in supramaximal skating, no research has been done in that area to this point.

Skating form

The type of skating seen in ice hockey is known as power skating, a form that allows for rapid acceleration.[38] To maximize acceleration a skater should have a forward trunk lean of approximately 42 degrees, the propulsive angle of the skate blade, toe pointed outwards, should be 30 to 40 degrees and the push-off angle, the angle above horizontal of a line between the hip joint and the toe of the push off leg, should be low, approximately 50 degrees. These enhance strong horizontal thrust.[39] Hockey coaches traditionally emphasize full extension of the hip, knee and ankle of the pushoff leg to accelerate quickly.[40] Significant correlations have been reported between maximum skating velocity and knee extension at toe off and knee flexion prior to propulsion.[41] Marino[42] indicates that forward lean, angle of push off and a stride rate are the most important elements of a skater's ability to accelerate.

Based on the preceding investigations, Acceleration Program training emphasizes a high stride rate with full hip and knee extension during propulsion and the proper forward trunk lean. These are the main items taught during training and are the criteria for skating form evaluation by video analysis.

Literature Pertaining to the B-200 Isostation Assessment

Trunk musculature performance is a vital aspect of athletic performance due to the trunk's role as the stable "base" from which the extremities operate. The B-200 Isostation is a triaxial dynamometer which measures the angular position, angular velocity and torque about three axes of trunk rotation.[43] Primarily intended for use with low back pain patients, this machine utilizes isoinertial exercise, a derivation of isotonic, to measure trunk motion and musculature performance.[44] In this form of exercise the resistance is held constant and the subject's ability to generate velocity is measured in degrees/second. The validity and reliability of this instrument in measuring trunk musculature performance has been established in previous studies.[45-49] Normative data has also been collected for the B-200 on normal subjects with no history of low back pain.[50-52] However, no published data is available concerning the performance of hockey players on the B-200 Isostation.

The B-200 Isostation has a strong background in literature and, although it has not been used to assess hockey players, is an appropriate measurement device for use with the current investigation.

Literature Pertaining to Lower Extremity Flexibility Assessment

Lower extremity flexibility is an important component of an athlete. Inadequate flexibility may be linked to an increase in injuries[53,54] and an injury could prevent a player from performing to his best potential.

The single most common test of flexibility in use today is the sit and reach test as described by Wells and Dillon[55,56] This test has been shown to be a reliable and valid measure of hamstring length.[57,58] Measurements of other lower extremity muscles and joints are usually done with standard goniometric techniques which have also been shown to be valid and reliable to within five degrees.[59]

The flexibility of hockey players specifically has little information in the literature. Agre[60] measured the trunk and hip flexibility of professional hockey players while Song[61] measured the flexibility of collegiate hockey players in both upper and lower extremity motions and compared them to other athletes. Hockey players were found to be more flexible in the lower extremities than the other athletes.

The current study uses the sit and reach test and goniometric measures to assess the effect of the Acceleration Program on lower extremity flexibility.

CHAPTER 3

METHODOLOGY

This study was originally designed in two parts. The first was a review of the charts of hockey players who had taken part in the Acceleration Program to gather the data detailing their performance before and after their participation. The second was an evaluation of a control group of ten hockey players participating only in pre-season on ice training. This evaluation was to be done using the same tests used by the Acceleration Program. The data was then analyzed for changes within each group as well as comparison of the Acceleration Program and control groups.

The study was approved by UND's Institutional Review Board prior to it's implementation. Athletes taking part in the Acceleration program sign a statement of informed consent allowing their data to be used for research purposes as a standard procedure. John Frappier gave his written consent for the use of the necessary data in this investigation. All control group members signed a statement of informed consent for data usage prior to their participation (See Appendix for copies of these consent forms).

Subjects were all college-age sub-Division I level hockey players. The charts of nine athletes were reviewed. Six underwent the full Hockey Acceleration Program and three trained only on the treadmill, forgoing resistance training and plyometrics. The control group was abandoned due to lack of athlete participation. The focus of the study was then altered to deal primarily with the changes seen in athletic performance secondary to participation in the Acceleration Program.

The chart review gathered data in the four areas of muscular strength, skating form, trunk musculature performance and lower extremity flexibility. The first area of information was the one repetition maximum strength testing on the following Eagle

resistance machines: multi-hip (hip flexion, extension, adduction, abduction); knee flexion; knee extension; abdominal flexion (two positions); trunk extension; pullover (narrow and wide grip) and shoulder abduction. These measurements were listed in pounds.

The second area reviewed was skating form. This was primarily a subjective evaluation, but included measurements in degrees of trunk forward lean, hip extension and knee extension taken from videotape analysis.

Third, trunk musculature performance data was gathered from the records of the B-200 Isostation evaluation for the Acceleration Program. The measurements included maximal isometric trunk rotation, lateral flexion, flexion and extension strength measured in foot pounds. Also measured was maximal trunk velocity in degrees for rotation, flexion/extension and lateral flexion against resistance equal to 25% and 50% of the maximum isometric output for that particular motion.

Finally, the measurement in degrees for right and left straight leg raise, hip extension and knee flexion along with maximal sit and reach test in inches were reviewed. All information was gathered form pre and post program measurements.

Statistical analysis was accomplished using the Statistical Package for the Social Sciences (SPSS-X) computer software. Descriptive statistical data was generated and all measures were tested for significant pre-post change with the Student's t-test at the .05 level of significance.

CHAPTER 4
RESULTS

The study could not be completed as designed. No control group data was processed due to lack of athlete participation. The data concerning strength evaluation and skating form was incomplete due to athletes not taking part in their post training evaluations for those areas.

The remaining data was useful for a pre to post Acceleration Program comparison of trunk musculature performance and lower extremity flexibility. The information gathered for trunk musculature performance and lower extremity flexibility for both the full Acceleration Program trained group and the treadmill only group (Tables 1-4.) proved mainly inconclusive, possibly due to the small number of subjects. The only incidences of significant change occurred in the full Acceleration Program trained group which showed a significant increase in the range of motion of left hip extension and the sit and reach test. That group also showed a significant decrease in the range of motion of left knee flexion.

Table 1. Trunk musculature performance pre and post training for the treadmill only group(n=3)

Test	Test Performance before	after	Percent Change	Significance
Isometric[a] rotation	78.7±7.3	85.2± 3.1	+8.3	.59
lat flexion	130.3±17.3	123.1±11.0	-5.7	.81
flexion	122.7±19.7	114.0±16.6	-7.6	.62
extension	148.5±18.4	156.9±12.1	+5.7	.80
25% Resistance[b] rotation	195.1± 20.3	195.1±24.6	+0.0	.99
flex/extension	225.6± 26.5	235.6± 21.6	+4.4	.48
lat flexion	214.5±16.9	244.7± 28.7	+14.0	.13
50% Resistance[b] rotation	168.0±14.9	195.5 ± 49.9	+16.4	.51
flex/extension	211.4±14.5	222.6± 23.0	+5.2	.33
lat flexion	188.4± 20.5	210.9±39.5	+11.9	.40

[a]Values for isometric strength test performance are in foot pounds.

[b]Values for resisted motion test performance are in degrees/second.

Table 2. Trunk musculature performance pre and post training for the full Acceleration group (n=6)

Test	Test Performance before	after	Percent Change	Significance
Isometric[a] rotation	76.1±5.3	86.1± 10.3	+13.0	.23
lat flexion	121.1±8.4	128.2±17.9	+5.9	.21
flexion	105.5±5.3	109.0±9.1	+3.4	.70
extension	143.4±11.8	147.6±7.4	+2.9	.53
25% Resistance[b] rotation	206.7± 11.1	211.2±11.3	+2.1	.30
flex/extension	250.6± 16.9	258.3± 16.4	+3.1	.60
lat flexion	230.3±21.5	234.5± 18.8	+1.8	.76
50% Resistance[b] rotation	144.4±16.1	156.2 ± 17.9	+8.2	.42
flex/extension	216.5±14.1	242.0± 20.2	+11.7	.08
lat flexion	192.0± 16.1	196.0±23.8	+2.0	.72

[a]Values for isometric strength test performance are in foot pounds.

[b]Values for resisted motion test performance are in degrees/second.

Table 3. Lower extremity flexibility pre and post training for the treadmill only group (n=3)

Test	Test Performance before	after	Percent Change	Significance
straight leg raise[a]				
right	66.7±13.2	81.7± 3.3	+22.5	.32
left	72.7±11.3	80.0± 2.9	+10.0	.49
hip extension[a]				
right	18.7±1.8	28.7±3.5	+53.5	.08
left	21.0± 2.6	23.3±1.7	+11.1	.49
knee flexion[a]				
right	123.3±1.7	126.0±3.8	+2.1	.42
left	120.0±5.0	128.3±5.7	+6.9	.20
sit and reach[b]	14.8± 2.8	17.0±3.0	+14.6	.21

[a]Values for the goniometry test performances are in degrees.

[b]Values for the sit and reach test performances are in inches. 15 inches represents touching the toes.

Table 4. Lower extremity flexibility pre and post training for the full Acceleration group (n=6)

Test	Test Performance before	after	Percent Change	Significance
straight leg raise[a]				
right	68.8±6.2	77.8± 5.5	+13.1	.25
left	70.5±3.9	76.2± 3.0	+8.1	.09
hip extension[a]				
right	18.7±1.8	24.0±1.9	+28.6	.08
left	17.0± 1.0	25.0±1.8	+47.0	.01*
knee flexion[a]				
right	131.7±3.1	130.0±2.8	-1.0	.75
left	136.6±1.0	130.8±1.5	-4.4	.01*
sit and reach[b]	17.0± 0.7	18.2±0.9	+7.3	.02*

[a]Values for the goniometry test performances are in degrees.

[b]Values for the sit and reach test performances are in inches. 15 inches represents touching the toes.

*Indicates significance at the .05 level.

CHAPTER 5
DISCUSSION

The original intent of this investigation was to act as a preliminary study for the evaluation of the effectiveness of the Acceleration Program. While significance was found in select subtests, the significance can not be explained. No conclusive results can be drawn from this work, but the groundwork has been laid for larger studies addressing this same topic.

In the future, more care will have to be taken to ensure that the subject athletes attend all of the necessary evaluation procedures. The Acceleration Program records must be complete. Some form of incentive may have to be developed to encourage the athletes in their attendance. Also the records of a greater number of athletes will have to be reviewed to establish statistically significant change, if any occurs.

Many future research topics are present within the Acceleration Program. There is need for a normative data base for athletic position and age for all evaluation procedures. A larger study, based on the design of this preliminary investigation, is necessary to establish the direct effects of the Acceleration Program. The training itself should be broken down to determine the efficacy of the resistance training versus the plyometrics versus the skating treadmill in causing changes in athletic performance. Finally and probably most importantly, research is needed to correlate any changes seen with the Acceleration Program and actual sports performance changes.

All of the training in the world is a wasted effort if it does not cause improvements in an athlete's on ice performance. The bottom line is, after all, how well a player plays.

APPENDIX

Statements of Informed Consent

Statement of Informed Consent

You are invite to participate in a study with the purpose of determining the effectiveness of Acceleration Products' hockey acceleration program. Your participation is desired because you are a hockey player of comparable caliber with a group of hockey players now going through the program.

This study will require approximately 2.5 hours of your time on two separate occasions, initially and then 4-6 weeks later. On each of those occasions you will be evaluated with the standard procedures of Acceleration Products, INC. uses to evaluate athletes participating in their programs. These procedures include one repetition testing on 10 different Eagle machines, a trunk strength evaluation on the B-200 Isostation, four flexibility tests and a videotaped skating evaluation on the skating treadmill. There exists a minimal risk of muscle strain during these testing procedures which will be guarded against with close supervision and proper warm up procedures. In the event that this research activity results in a physical injury medical treatment will be available to you as it is to a member of the general public in similar circumstances. Payment for any such treatment must be provided by you and your third party payor, if any.

The results of your evaluation will be released to you as well as a copy of the entire study, once it is completed. Any information that is obtained in connection wit this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Your decision whether or not to participate in this study will not prejudice your future relations with Acceleration Products, INC. If you decide to participate, you are free to discontinue participation at any time without prejudice. The investigators involved are available to answer any questions you have concerning this program. In addition, you are encouraged to ask any questions concerning this program that you may have in the future. Questions may be asked by calling Grey Rudolph at 775-8485 or 777-2831. You will be given a copy of this form for your personal records.

All of my questions have been answered and I am encouraged to ask any questions that I may have concerning this study in the future. I have read all of the above and willingly agree to participate in this study as it has been explained to me.

_____

signature date

I have explained this study and answered the questions of the subject to the best of my ability and will continue to do so as I am able.

_____

investigator date

IQ Response Technologies, Inc.)Hereafter referred
Red River Valley Sports Medicine Institute, Ltd.)to as the "Group."
John Frappier, Exercise Physiologist
488 First Avenue South
Fargo, ND 58103

Dated:_____

INFORMED CONSENT

PLEASE READ the accompanying information regarding the fitness evaluation protocols, equipment usage and equipment testing. If you have any questions, please ask them.

1. MY PARTICIPATION IS VOLUNTARY and I may withdraw from the evaluation or program at any time. The benefits associated with my participation include information regarding my personal state of fitness and the increase of my physiological knowledge.

2. The testing will be under the direction of John Frappier and/or his staff.

3. I HEREBY CONSENT TO and PERMIT THE "GROUP" and Frappier to use the data obtained in reports or publications, but my identity will not be associated with such reports unless I have given specific permission to do so.

4. I understand that this evaluation should not result in physical injury to me. However, I acknowledge the following:

> IN THE EVENT OF PHYSICAL INJURY RESULTING FROM THE EVALUATION PROCEDURES, EQUIPMENT USAGE OR EQUIPMENT TESTING, NO MEDICAL TREATMENT OR MONETARY COMPENSATION WILL BE PROVIDED BY THE "GROUP". I MUST LOOK TO MY OWN HEALTH INSURANCE POLICIES.

5. I acknowledge that the "Group" is relying on all information provided by me regarding my medical history and condition before allowing me to participate in any evaluation or program. I certify the information provided to be true and correct.

Sincerely,

_____
Signature of Participant

John Frappier
Clinic Director

_____
Address

_____
Phone

The participant is under the age of 18 years. I have reviewed the information provided and certify it to be true and correct. I represent that we currently have medical insurance, and I consent to _____ participating in the evaluation and program.

_____
Parent or Guardian's Signature

ACCELERATION PRODUCTS, INC.
100 South 4th Street
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Fargo, North Dakota 58103
(701) 241-9018
Fax (701) 237-0922

September 24, 1992

Human Subjects Review Board
University of North Dakota
Department of Physical Therapy
School of Medicine
501 N. Columbia Road
Grand Forks, North Dakota 58203

To Review Board Members:

I would like to address the fact that Acceleration Products, Inc. and I are fully aware of the scope of this study and are in full cooperation with both the chart review and control group portions of this study.

Sincerely,

John Frappier, M.S.
President

JF/nlf

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 1
To Grey Rudolph	From John Frappier
Co. UND	Co. A. P.I
Dept.	Phone # 701-241-9018
Fax # 777-3894	Fax # 237-0922

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